ERICSSON Review

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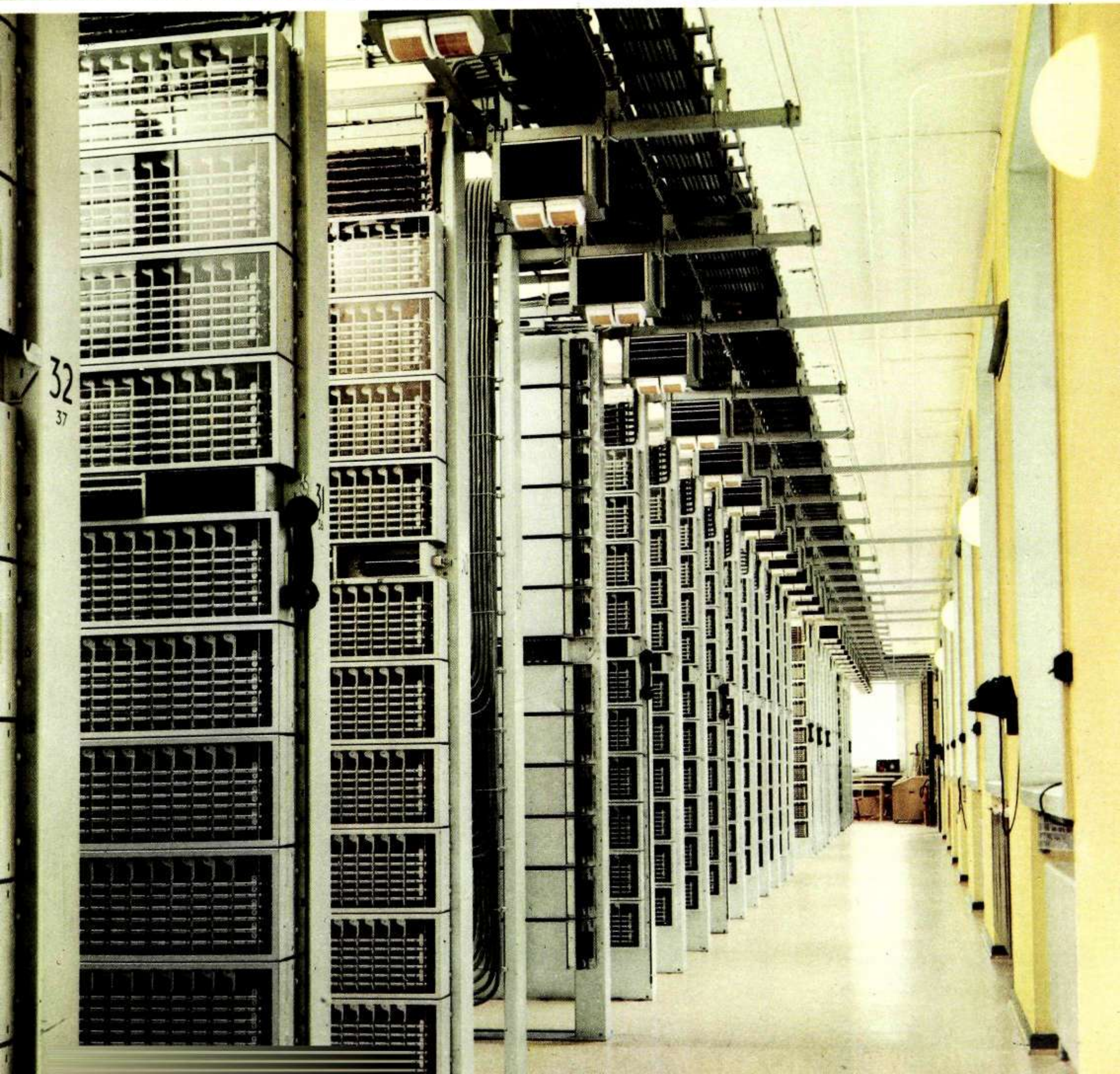
1957



ERICSSON REVIEW

Vol. XXXIV 1957

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On cover: The switchroom at Centrum local exchange, Aarhus: L M Ericsson crossbar system

Maintenance of Aarhus Area Exchanges

M AHM, CHIEF ENGINEER, JUTLAND TELEPHONE COMPANY (J.T.A.S.), AARHUS, DENMARK

U.D.C. 621.395.722.004.5

Six automatic local exchanges and a trunk exchange of L M Ericsson's crossbar system were opened in the Aarhus area on May 1, 1953. An article in Ericsson Review No. 3/1953 gave an account of the design of the system. The present article deals with the methods of maintenance and the results of operation for the first six months of 1956.

All six local exchanges use the ARF 10 system. The largest is the main exchange, Centrum, with 20,000 lines. The remaining five, with a total of 12,000 lines, are suburban exchanges. The trunk exchange uses the ARM 20 system with a capacity of 1,600 trunk and toll lines. It is operated jointly by the Danish P.T.T. and J.T.A.S.

The Centrum and trunk exchanges are installed in the same building. The equipment rooms are painted with turpentine-free paint, and the floors are covered with linoleum. The Centrum and trunk switchrooms have air conditioning systems with humidifiers, while the suburban exchanges have not. Where humidifiers are employed, the relative humidity remains steady at about 60 %; in the suburban exchanges it fluctuates between 30 % and 70 %.

During the run-in period, maintenance consisted mainly of periodic routine tests combined with trouble clearing. In course of time routine tests were made at less frequent intervals, and now, at Centrum, they are performed only as required. In the near future the same procedure will be adopted at the suburban exchanges. A system of qualitative service control, consisting of the compilation of statistics based on regular traffic tests, congestion metering, alarm panels, and the like, will be introduced. Only if the statistics reveal irreg-

Fig. 1 X 8013

The J.T.A.S. head office in Aarhus

The left-hand side of the building houses the Centrum and trunk exchanges.

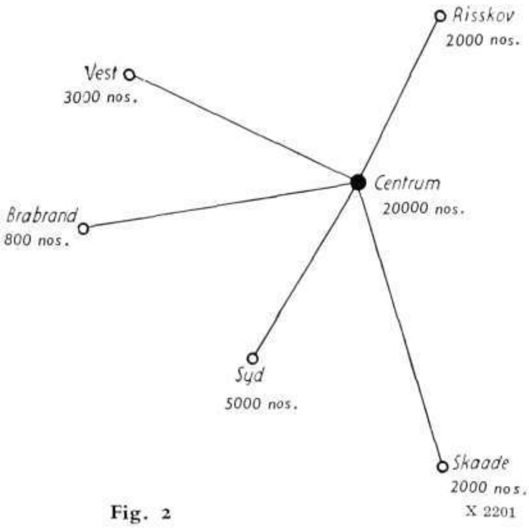


Fig. 2

Local exchanges in Aarhus area

ularities serious enough to affect service, will routine tests be instituted to trace the trouble. Faults observed by subscribers or operators will in most cases be reported to the wire chief's desk. Various forms of automatic routiners, such as traffic route testers, exchange testers, tariff testers, line testers, and register testers, are available.

The maintenance program can be classified as follows:

1. Localization of faults (traffic tester, centralograph, inspection, routine tests).
2. Clearing of faults.
3. Cleaning of exchange equipment.

The first two categories of maintenance work are performed by exchange maintenance men assisted by trainees. Cleaning of exchange equipment is done by women.

Maintenance of Local Exchanges

The quantity of maintenance work is dependent on the size of the exchange, the number of lines in service, traffic density, and the like. Some data of interest pertaining to the local exchanges in the Aarhus area are given in table 1.

Table 1

	No. subs. at 1/1/56	Busy hour traffic			Outg. calls per sub. and day
		SL (outg. + inc.) erlangs/100 subs.	I GV erlangs	II GV erlangs	
Centrum	14,802	7.0	495	518	9.0
Vest	2,393	4.9	101		6.5
Brabrand	560	4.6	20.7		6.0
Risskov	1,667	4.8	64.8		5.8
Skaade	1,074	5.1	43.2		6.2
Syd	3,586	4.9	143		5.9
	24,082	6.2	868	518	7.9

The number of calls per subscriber and day is calculated as the Monday—Friday average. On a day with heavy traffic the originated calls per subscriber on the Centrum exchange may number about 11, and incoming calls roughly the same.

The holding time on originating calls averages 105 sec.
» » » » incoming » » 115 »
Register holding time is .... 10 »

The busy hour calling rate is 11.5 for originating calls and 12.5 for incoming calls.

In accordance with the customer's specifications the equipment was designed for a congestion of 0.2 % in every switching stage, with total congestion not exceeding 1 %. At 10 % overload the congestion must not exceed 1 % per switching stage. The filling grade for the individual thousands groups, however, is not especially high, and only on rare occasions does the volume of traffic approach that for which the equipment was designed, so that congestion seldom arises.

As already stated, now that troubles associated with the installation and running-in period have largely disappeared, J.T.A.S. has confined routine testing to the Centrum exchange and only uses it there as required. The

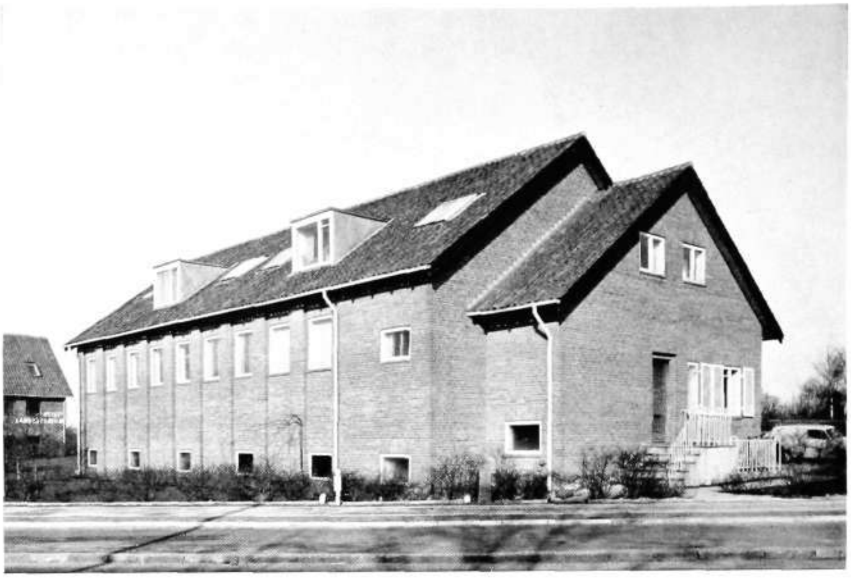


Fig. 3
The Aarhus Syd exchange

X 8014

method employed instead is test calls, which were formerly made by operators but are now performed by Ericsson's traffic route tester. Owing to the rotary occupation of the switching devices, an excellent survey of how the exchanges are working, and of their condition, is obtained by calling test numbers in the various thousands groups.

Table 2 shows the result of some 50,000 test calls made in the first six months of 1956 between 32 local numbers in the 32 thousands groups of the Aarhus local exchanges. The calls were distributed among the exchanges according to their size.

Table 2

Route	Number test calls	Faults and congestion (quant.)	Faults and congestion (in %)
Centrum, internal	20,030	19	0.09
Suburban, internal	5,850	4	0.07
Centrum—suburban	9,425	14	0.15
Suburban—Centrum	8,575	16	0.19
Suburban—suburban	6,000	9	0.15
	49,880	62	0.12

The percentage of faults, including congestion, averages about 0.1 %. The largest percentage of faults is on inter-suburban exchange traffic. The reasons for this are that congestion is calculated to be 0.5 % on junction circuits as against 0.2 % in the switching stages, and also that more equipment is called into use. However, the fault percentage is so low that, including congestion, it is below the congestion specified in the tender.

Faults found in automatic tests, as well as service complaints, are recorded on trouble cards and detailed trouble reports. As far as possible the faults are traced and cleared. The number of faults and their nature are set out in tables 3 and 4, covering the first six months of 1956. During that period a total of 421 cards were dealt with at Centrum, and 166 cards at the suburban exchanges. Of the faults reported at Centrum, 271 were cleared, while 150 remained untraced. The corresponding figures for the suburban exchanges were 127 and 39.

Faults at Centrum Jan.—June 1956.

Table 3

Out-of-adjustment faults	71
Dirty contacts	19
Burnt contacts	4
Sticking armatures	2
Opens	16
Shorts	39
Leakage	4
Soldering faults	13
Installation faults	4
Parts out of position	31
Burnt-out coils or resistors	18
Wear	1
Defective components	22
Other faults	22
Total	266

Faults at suburban exchanges Jan.—June 1956.

Table 4

Out-of-adjustment faults	39
Dirty contacts	3
Burnt contacts	0
Sticking armatures	4
Opens	10
Shorts	20
Leakage	1
Soldering faults	3
Installation faults	1
Parts out of position	23
Burnt-out coils or resistors	12
Wear	1
Defective components	5
Other faults	5
Total	127

The time spent on maintenance, including supervisor's time, at the Centrum and suburban exchanges during the first six months of 1956 was as follows:

Centrum	4,229 hours
Suburban exchanges	2,447 »

The numbers of lines at the Centrum and suburban exchanges are 20,000 and 12,000 respectively. On the assumption of similar conditions during the second six month period, the time spent on maintenance per subscriber's line and year would be

Centrum	0.43 hour
Suburban exchanges	0.41 »

Routine tests are still retained to a certain extent at the suburban exchanges. When this procedure is discarded, and tests are only made as required, the maintenance time at the suburban exchanges will undoubtedly be considerably reduced.

The working hours at Centrum are from 7 a.m. to 4.15 p.m. on weekdays, 7 a.m. to 1 p.m. on Saturdays. The suburban exchanges are unattended. Technicians are called in the event of serious trouble outside working hours.

Fig. 4 X 8011

Aarhus is a central point in the Danish trunk network with direct junctions to most main exchanges in the country

Maintenance of Aarhus Trunk Exchange

The Aarhus trunk exchange, as already mentioned, is run jointly by the Danish P.T.T. and J.T.A.S. Maintenance and fault clearing are the responsibility of J.T.A.S.

When the Aarhus trunk exchange opened, a large proportion of manual operation was considered necessary. Later, automatic operation was used more and more, the Aarhus subscribers and manual exchange operators themselves dialling the distant subscriber's number or manual exchange, as the case might be. This necessitated extensive changes in the trunk exchange, which have naturally affected the maintenance situation.

The trunk circuits to and from Aarhus consist of two-wire and four-wire lines. For the two-wire toll lines there are two switching stages with 400 outlets each and a load of roughly 100 erlangs per stage. The trunk circuits also have two switching stages with 400 outlets each, the load being about 240 erlangs per stage. The numbers of circuits terminating at the trunk exchange as at July 1, 1956, are tabulated below.

Table 5

Type of circuit	Inc.	Orig.	Bothway	Total
International circuits			9	9
P.T.T. circuits	83	89	28	200
J.T.A.S. trunk circuits	191	189	276	656
Toll circuits	88	5	292	385
	362	283	605	1,250

The holding time of connections on trunk circuits is about 250 seconds and on toll circuits about 205 seconds. The busy hour calling rate is 12.3 % for both types of circuit.

The same practice is adopted at the trunk exchange as at the local exchange, that traffic tests are performed in order to check the quality of service and for fault tracing purposes. But routine tests—of tariffs, registers, lines, and the like—are also retained to a much greater extent at the trunk exchange. The tests are at present done at fairly frequent intervals, but it has not yet been decided whether this will continue in future. The centralograph, which is connected into the circuit every time a fault condition arises, is a great help in tracing. The intention had been to record the faults indicated by the centralograph on punch cards, and so obtain an overall picture of the faults and their frequency in different parts of the equipment. However, the faults have proved too few to justify the use of this method.

In traffic tests during the first six months of 1956 there were 23,080 calls to trunk exchanges. The faults numbered 480 or 2.08 %. They are classified in table 6, from which it is seen that the fault percentage at the trunk exchange and local exchange is only 0.60 %.

Table 6

Total number of test calls			23,080
Number of faults on line, repeater station or distant exchange	342	1.48 %	
Number of faults at local or trunk exchange	138	0.60 %	
	480	2.08 %	

Altogether 279 fault cards were handled during the first six months of 1956, of which 263 were cleared and 16 remained untraced. The faults are specified in table 7.

Table 7

Out-of-adjustment faults	121
Dirty contacts	9
Burnt contacts	2
Sticking armatures	1
Opens	13
Shorts	34
Leakage	1
Soldering faults	36
Installation faults	5
Parts out of position	7
Burnt-out coils or resistors	12
Wear	9
Defective components	13
Other faults	0
Total	263

In addition, 147 faults occurred in the switchboard operators' equipment and a few out-of-adjustment faults on keys.

The time, including supervisor's time, spent on clearing faults at the trunk exchange during the period was 6,026 hours. Assuming the same conditions during the second six months, the time spent on maintenance per line and year would be 9.7 hours.

The number of connections established through the trunk exchange is about 24.6 millions a year. Thus the maintenance time per 10,000 connections is 4.9 hours.

Table 8 shows the lost calls due to busy route, conflicting call on bothway line, internal congestion and faults in the trunk exchange markers. The table is based on the average of the period 9.30—10.30 a.m. for the first six months of 1956.

Table 8

	Markers originating traffic		Markers incoming traffic	
	Number	%	Number	%
Occupations	4,785	100	5,873	100
Established connections	4,273	89.2	5,356	91.2
Busy routes	468	9.9	452	7.7
Other lost calls	44	0.9	65	1.1
Specification of other lost calls				
Conflicting calls	22	0.4	18	0.3
Internal congestion	4	0.1	27	0.5
Faults	18	0.4	20	0.3

As shown by the table, the number of non-established connections in the busy hour was roughly 10 %, the main cause being 8—10 % busy routes.

As already mentioned, the service data given in this article are average data only. But it can be said that at the present time the exchanges are working to the full satisfaction of subscribers, and there is no doubt that with careful maintenance the trouble rate should be low and the expenditure on maintenance comparatively slight. Maintenance time must of course not be cut below the point at which constant satisfactory service can be provided. On the other hand, entirely trouble-free service should not be considered necessary, since the last per mille of faults would be very expensive to eliminate.

Mechanization of the Åland Telephone Network

KNUT VON SCHANTZ, ÅLANDS TELEFONANDELSLAG, GODBY

U.D.C. 621.395.34(480.3)

In many countries where telephone networks have been converted to automatic operation the need for comparatively small rural exchanges soon became apparent. L M Ericsson's first rural exchange of crossbar type was delivered to the Swedish Telecommunications Administration in 1946. Since then 68,550 lines have been placed in service up to Jan. 1, 1957.

In the present article Mr. Knut von Schantz, head of the Ålands Telefonandelslag, gives an account of the results attained through the mechanization of the Åland network. The article was earlier published in the Finnish journal "Puhelin", but has been revised to include the latest available data.

There is a general belief on the mainland that Åland consists of countless islets and skerries, the inhabitants of which live on fishing and seafaring. Closer acquaintance with the islands, however, brings a different view. The main island is, in fact, 1,500 sq. kilometres in area with extensive forests, hills and fertile valleys and plains. Several hundred kilometres of roads wind through the countless villages of the nine parishes, and the thousand odd cars of the 20,000 inhabitants have all the space they need to move about in. — And nonetheless this natural beauty-spot possesses 6,654 rocky islets and skerries of every shape and size spread among a further six parishes.

This the most westerly of Finland's telephone zones counts some 4,200 subscribers on 50 or so exchanges. The main islands of Åland and Vårdö have about 3,500 subscribers. The remaining 700 are scattered throughout the surrounding archipelago. Among the former, 1,500 are served by Mariehamns Telefon AB, and the remaining 2,000 by Ålands Telefonandelslag. Among the archipelago subscribers 400 in the outer fringe come under the Finnish P.T.T., and 300 on Föglö are distributed among five small undertakings with as many exchanges.

Dial telephones are at present possessed by Mariehamn's 1,500 subscribers. The population of Mariehamn and environs is 6,000. A further 1,000, or one half, of the Ålands Telefonandelslag subscribers are connected to the automatic network. Of the entire number of subscribers 60 % have dial telephones.

Thus it will be seen that the telephone density of Åland is 21 subscribers per 100 inhabitants—in Mariehamn alone 25—compared with 11 per 100 for the whole of Finland.

Fig. 1 X 2204
Map of Åland

Opening Stages

In 1944 the cable plant of Ålands Telefonandelslag had deteriorated to such an extent that the transfer of the entire undertaking to the P.T.T. appeared the only possible course. At the last minute, however, it was decided to keep the company intact; and since the P.T.T. granted a respite of two years to put the network in order, an intense work of reconstruction was set in motion.

Mariehamn had gone over to automatic working in 1942 with the installation of L M Ericsson's AGF system based on 500-line selectors. But it was to take ten years before the example was followed in the rural areas. The

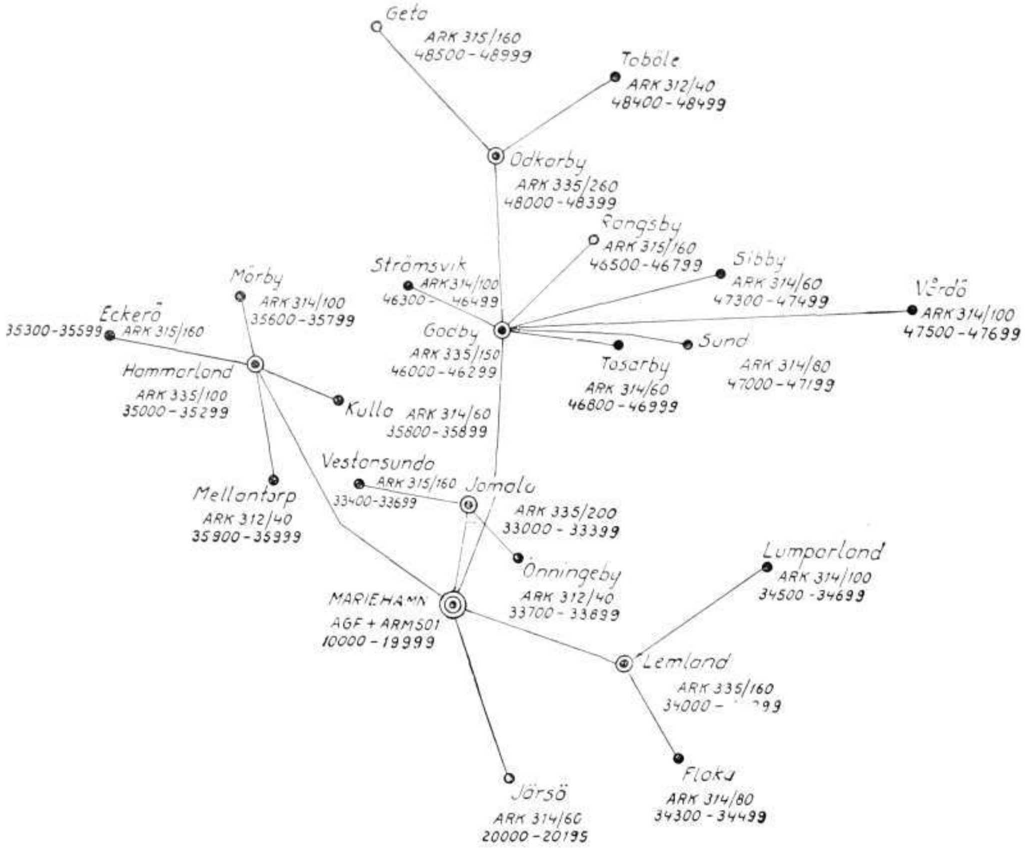


Fig. 2
Åland cable network

X 7711

decision to mechanize the Ålands Telefonandelslag area, comprising the greater part of the zone, was made in 1952. The calculations showed clearly that the step would pay provided that the capital was forthcoming. Tenders were requested from the leading firms, and L M Ericsson's offer of the ARK system proved the most favourable, having in mind the already existing system in the zone centre.

Maintenance of the System

All in all, the offer comprised 20 exchanges catering for 2,200 lines, of which half were to be handed over ready installed by 1956. As regards the other half, the agreement is for successive delivery up to 1960.

The choice of system was influenced partly by the special conditions under which the exchanges were to be looked after and maintained. The repair of a fault in a remote unattended exchange—and remote exchanges abound in the Åland area—costs many times as much as in a large staffed exchange.

Experience hitherto has shown that the system chosen has well fulfilled the expectations placed on it as regards quality of service and low maintenance expenditure. For the switching equipment alone at the terminal exchanges, excluding M.D.F. and power plant, the maintenance requirement has been 0.2 hr per subscriber and year. As an example, the Sibby 60-line exchange has had only 3 faults in 18 months, of which one was caused by lightning. To ensure efficient maintenance, complete remote measuring equipment is being installed in the zone area.

Outside Plant

It would hardly have been possible to carry through the conversion quicker than in nine years. The extensive cable network was mostly ruined, and financial considerations would not have permitted a quicker rate of work.

The quality of cable construction would have suffered, since satisfactory results depend largely on careful and accurate planning and efficient management. The network comprises some 14,000 poles and 100 kilometres of overhead cable. Part of the plant had admittedly been reconditioned by 1952, but the larger part of the work remained to be done.

The indispensable investment in the network for the years 1953—1960 was estimated at 117 million marks, covering the following average annual requirements of materials: 1,200 impregnated poles, 9,000 kg 2 mm steel wire, and 3.5 million marks worth of cable. Linesmen's wages amount to some 4 million marks per annum.

The trunk cables consist of old 3 mm steel wire, and, on grounds of attenuation, must in due course be replaced by 2.5 mm copper wire in many places. Between group centres and terminal exchanges 2 mm copper cadmium wire is already being used, as well as for very distant subscribers.

Mariehamn—Jomala is to be loaded in the near future, and Ödkarby—Mariehamn is to be provided with a carrier system, so attaining an attenuation gain of 0.2 nepers at the Ödkarby group centre. Vårdö is to be connected in due course to Jomala by radio link. Subsidiary automatic exchanges and party lines have been successfully employed where justified on economic grounds. Nevertheless the principle has been to employ these systems only when absolutely necessary for economic reasons. Such expedients always imply some kind of makeshift, with the restrictions attendant thereon.

The Zone Centre

The equipment needed at the zone centre at Mariehamn for mechanization of the rural area has been procured by Mariehamns Telefon AB. A written agreement has been drawn up in respect to its joint use. An automatic switching stage of L M Ericsson's type ARM 50 (GVN) for 24 volt operation was brought into use in September 1956. At the same time the dial lines

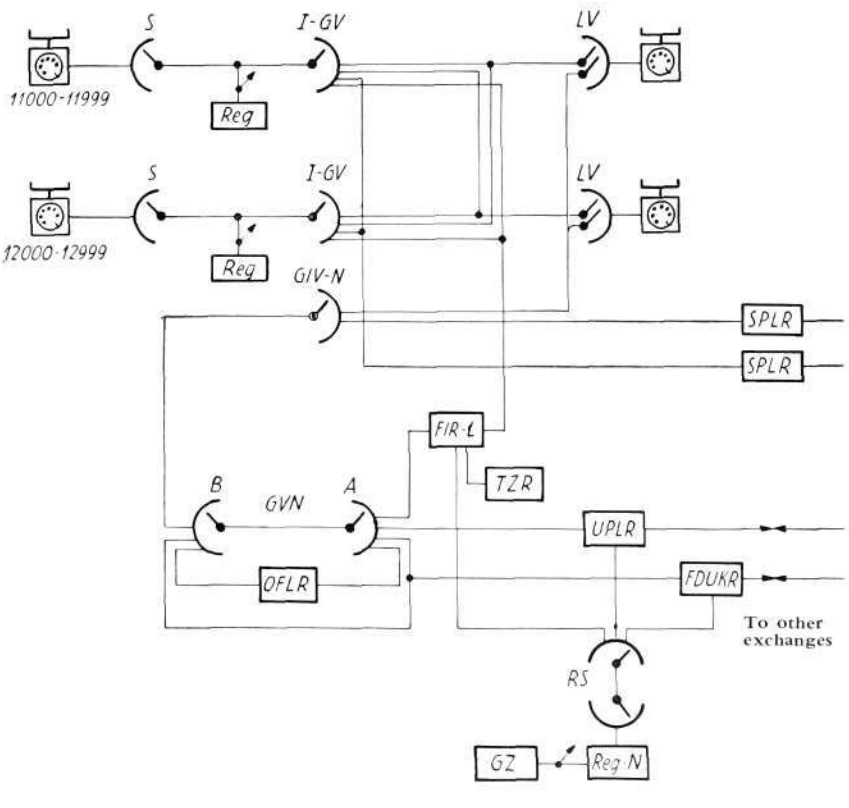


Fig. 3 X 8012

Mariehamn local exchange (linefinders S, 1st group selectors I-GV and final selectors LV) and the transit stage of type ARM 50 (GVN) with junctions FIR-L and FDUKR to Mariehamn and other exchanges

Fig. 4 X 2202
Auto exchange building

(UPLR) of the manual trunk exchange were transferred from the linefinder stage in the AGF exchange to the ARM 50 stage, and the registers were changed for 5-digit numbering. Simultaneously with the ARM 50 stage, the company had ordered the installation of a new power plant for 24 volts 50 amps. Thus when long distance subscriber dialling is extended to Åland, there will be equipment ready to receive the long distance circuits on a 4-wire basis. Mariehamn also administers Järsö exchange with its 30 subscribers, which is to be converted to the crossbar ARK system in 1957. The much discussed underwater mine at Nyhamn will be among the subscribers of the latter exchange.

Buildings

The rural automatic exchange buildings have been constructed of wood, the walls being made of old telephone poles that are still in reasonable condition, sawn down to 4″ × 4″ and bolted together. The walls were thereafter covered off with insulating material. The cost of such buildings ranged from 225,000—500,000 marks according to the size of the building. Owing to the key position of the Godby exchange, however, the latter building was constructed of Siporex blocks (30 cm, k = 0.5). It measures 4 × 8 metres and costs 750,000 marks. On the other hand there is an annual saving of about 7,000 marks on fire insurance premiums as compared with a similar wooden building. Power consumption up to now has amounted to about 70 kWh per cu.m. per annum, maintaining a minimum temperature in the automatic exchange buildings of 5—8° C. By pressing the minimum temperature to + 1° C, however, it should be possible to lower the power consumption.

The Mariehamn building has been extended on the north side by some 10 metres to accommodate the ARM 50 equipment, the M.D.F. being placed between the local exchange and the transit stage. The extension also provides space for the new power plant with its distribution board.

Finance

To finance the extensive project, the Ålands Telefonandelslag decided to raise the deposit from 10 to 30,000 marks per share, to be paid up over a number of years. The installation charge was fixed at 20,000 marks within a 3-kilometre area, and the annual subscription at 7,000 marks irrespective of distance.

In 1952 operators' salaries amounted to 8 million marks per annum. They have now fallen to half that amount, and the saving well covers the interest and amortization on the investment in automatic equipment and buildings.

The long term debt is at present 42 million marks and is calculated to rise to 70 million by 1960. By that time the outside plant will have been practically entirely renewed. Plant, property and equipment is expected to stand at about 150 million marks at the same date. The company's annual budget at present runs at about 55 million marks. After 1960, when all larger outlays have been completed, it should be possible to reduce outstanding debts fairly rapidly while at the same time lowering the tariffs.

System of Charges and Numbering Scheme

The company's previous charges, in manual and automatic areas alike, were 4 marks for local calls and 12 marks for a 3-minute zone call including the basic impulse in the automatic area. The automatic charges have now been unified to a single tariff of 10 marks per 2 minute period irrespective of the origin of the call. The reason for this step was the difficulty of arriving at fair rates for the different parishes since the group area boundaries and parish boundaries do not coincide. Moreover, one parish may have one exchange, while another has perhaps two or three. Thus the basic impulse fee has been deducted from the previous automatic charge, and local calls are charged on a time basis.

The local fee in Mariehamn is now 2 marks a minute, and for calls to rural districts 5 marks a minute—the same charge as within the rural network.

The tariffs of the manual group are 15 marks per 3 minute call to rural districts and 5 marks per local call.

When the ARM 50 stage was taken into use, 5-digit numbering was adopted throughout the entire automatic area including Mariehamn. By this means Mariehamn, which is growing steadily at a rate of nearly 100 subscribers a year, was assured of an adequate number reserve. At the same time the future connection of the outlying islands to the automatic area will be able to take place without friction.

Staff Policy

An important role in any reconstruction project of this magnitude, involving large investments and difficulty in obtaining capital, is played by the staff, whose competence and proficiency will have a decisive effect on the final success. Special attention must be paid to the powers of leadership, sense of responsibility and proficiency of foremen and others in key positions. If the care of pole lines, cables and exchange equipment—not to mention stores, office work and motor vehicles—can be entrusted to capable hands, the managing director and chief engineer will be freed from many unnecessary worries and the company will save substantial sums every year.

Thought must likewise be devoted to the training of craftsmen and to the question of how to get trained staff to remain in the company's service. It may be pointed out here that Ålands Telefonandelslag pays 50 % of the cost of correspondence courses taken by its employees whenever such studies are considered of benefit to the company. In addition, the company pays for the training of capable fitters at Helsinki and Stockholm.

With a view to binding the staff to the company, all salaried employees 24 years of age and with 3 years in the company's service are granted a pension insurance. The insurance includes full retiring age pension in addition to invalidity and family pension and funeral expenses. The company pays $^{2}/_{3}$, and the employee $^{1}/_{3}$, of the premium. The employee's share amounts on an average to 6 % of his salary. Other social benefits, such as staff housing etc., are provided as far as the company's finances permit.

Public Relations

An important factor—perhaps the most important for successful operation—is good relations with subscribers. A speedy trouble clearing service, politeness on the part of repairmen, the production of visible results, and an efficient information service in regard to all changes affecting subscribers, are examples of the means to strengthen these relations.—At a later stage a system of systematic observation of traffic conditions should be started, based on statistics, and the results should be used to maintain the quality of service above a minimum level of profitability and satisfaction to subscribers.

By the time Ålands Telefonandelslag has completed the mechanization of its area in 1960, it will have roughly 4,000 dial subscribers. Of the remaining magneto subscribers, it should be possible to link up the 300 Föglö lines with the rest of the network. Under present conditions, on the other hand, it is hardly conceivable that the 400 P.T.T. subscribers in the outer archipelago can be put on dial service without great financial sacrifice. But technical progress is rapid, and within a few years the conditions will be changed by the electrification of the archipelago—a fundamental condition for the fullscale conversion of this part of the area to automatic working.

Connecting and Protector Strips for Main Distribution Frames

E NYLUND, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.669

The connecting and protector strips made by L M Ericsson have undergone virtually no change for many years. They are rather bulky, however, and this may prove a serious inconvenience especially in rapidly growing telephone systems. A new connecting and protector strip with pairs on 10 mm centres was therefore designed, occupying only two-thirds of the vertical space required by the previous strip. The strip is composed of standard elements, so is simpler to manufacture, pack and install. New and more efficient excess current cut-outs and over-voltage arresters have been designed at the same time.

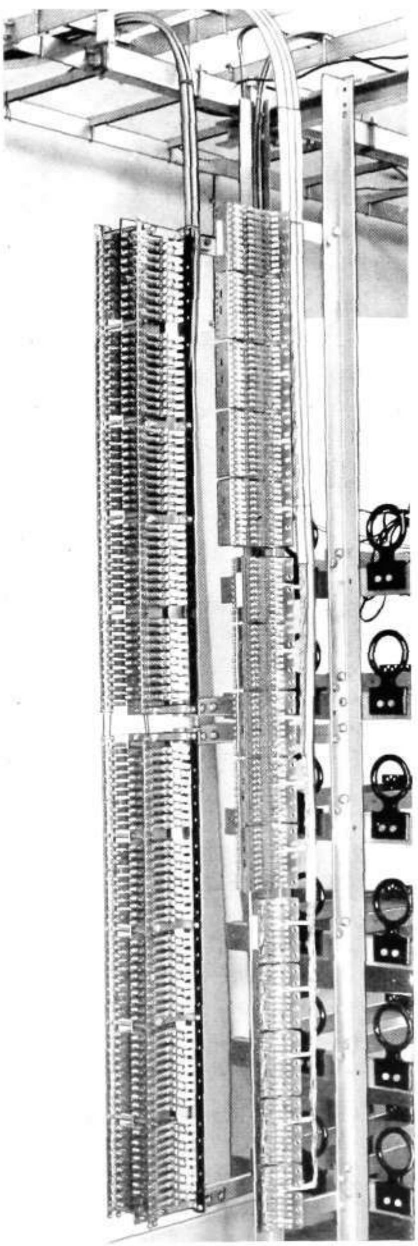


Fig. 1 X 2147

Main distribution frame type BAB 12

showing old connecting and protector strips (left) and the new designs (right)

Protector Unit Combinations

The most common method of protection used in telephone exchanges hitherto consisted of a combination of three protector elements placed in the following sequence: nearest the line a fuse which usually blows at 3 amps.; thereafter an over-voltage arrester, normally consisting of carbon blocks with mica separator, for protection against atmospheric discharges; and, on the exchange side, a heat coil which operates to long-duration "sneak" currents of min. 0.15 amp. This form of protection was originally designed since the external plant consisted largely of open wire lines.

Many areas are nowadays served entirely by metal sheathed cables and do not require so high a measure of protection; the over-voltage arrester at any rate must be considered unnecessary in such areas. If there is any risk of sneak currents or contact with power lines, however, excess current cut-outs should be installed. Sneak currents, if of sufficient duration, may unduly heat the coils of line relays. The current at which the heat coil operates must be above the transmitter current at the lowest line resistance, but below the sneak current that would cause overheating of the line relays.

L M Ericsson has designed a new fuse which is a combination of ordinary fuse and heat coil. In this combined fuse the current passes through a small heater element soldered to a straight fuse wire. At sneak currents exceeding 0.15 amp.—the minimum fusing current—the solder melts and disconnection takes place with roughly the same time lag as in the old heat coil. At currents above 2—3 amps. the straight wire fuses first, and very quickly, as shown in fig. 7. The combined fuse is described in greater detail below.

On the fringes of an exchange area long stretches of line may consist of bare wire or self-supporting insulated wire. Over-voltage protection will be required at the distribution points between bare wire and cable. Hazardous voltages caused by atmospheric discharges or by contact between the bare wire and a power line cannot enter the telephone cable or the exchange if the over-voltage protector operates in the required manner. It may happen, however, that part of the voltage wave from the overhead line continues to the exchange owing to high resistance to earth or to a fault in the protector elements. But this wave cannot attain higher amplitude than the breakdown voltage of the cable, which is usually limited to 2,000 volts. Under such

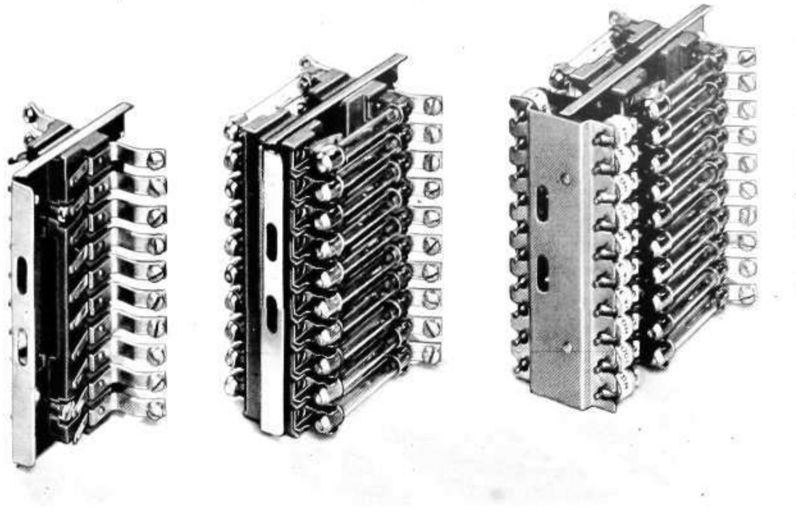


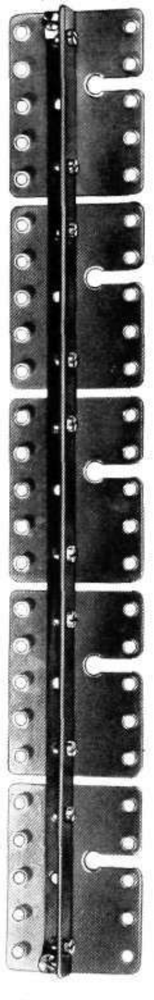
Fig. 2 X 6975

10-pair strips

(From left) connecting strip NEL 1100, protector strip NFL 3111, and protector strip NFL 3211

conditions it may be advisable to place over-voltage arresters in the protector strip at the exchange. A new over-voltage arrester has been designed. It consists of two metal electrodes pressed into a plastic tube to provide the proper spark gap. The 3-amp. fuses employed up to now, the main object of which was to prevent overheating of the over-voltage arrester, have been discarded. The new over-voltage arrester cannot be overheated since, when heated up, the plastic tube softens and the electrodes are forced together by the mounting springs, so providing a direct circuit to earth. The over-voltage arrester is described in greater detail below.

Opinions in regard to the proper protection for exchange equipment will, no doubt, always be divided. However, the present trend is towards a reduction in the number of protector elements at exchanges served by cables. There are already exchanges at which all protection has been discarded, or at which an ordinary 0.5 amp. fuse alone is retained. The new strip has therefore been designed for use either with or without different combinations of protectors.



Connecting and Protector Strips

The new connecting and protector strips are made up in 10-pair units. The 10-pair strips are assembled on a common mounting (fig. 3), which will carry 10, 20 or 50 pairs. Several 50-pair mountings can be placed one above the other in the M.D.F., as previously.

The 10-pair strips are made in various forms to cater for different combinations of protector elements. Consequently different categories of lines, even in one exchange, can be protected in different ways. These different types of 10-pair strips are interchangeable without reforming of the cables. Similarly, they are capable of replacement by other not yet existing types, as new ideas and designs of protector are produced. In the new strip the sections for alarm and interception circuits have been omitted. The alarm device was considered unnecessary since it functioned only on operation of the heat coil. Trouble of this kind represents only a very small fraction of the total interruptions to telephone service. The interception circuits are now terminated on the test jack strip. A main distribution frame is shown in fig. 1 with two 50-pair strips of the old type alongside three 50-pair strips of the new type.

Fig. 3 X 2148

50-pair protector mounting

At present five different 10-pair strips are being manufactured, as listed in table 1. They have soldering tags on the line side and screw terminals for the jumper wires.

Fig. 4 X 6976
Label holder NBM 1111

Table 1

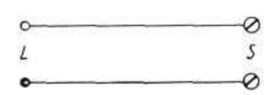
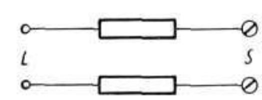
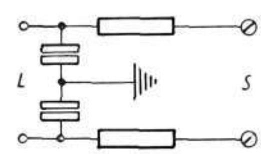
Strip	Protector elements	Connection
NEL 1100	—	
NFL 3101	Fuse *NGH 2201* (0.5 A)	
NFL 3111	Combined fuse *NGH 5001*	
NFL 3201	Fuse *NGH 2202* (1 A) and over-voltage arrester *NGA 3001*	
NFL 3211	Combined fuse *NGH 5001* and over-voltage arrester *NGA 3001*	

Fig. 2 shows three of the 10-pair strips tabulated above, viz. NEL 1100, NFL 3111 and NFL 3211. They are assembled on a frame of nickel-plated brass sheet, which at the same time constitutes the earth connection for the over-voltage arresters. The 10-pair fuse strips NFL 3101 and combined fuse strips NFL 3111 are of identical construction, differing only in the protector

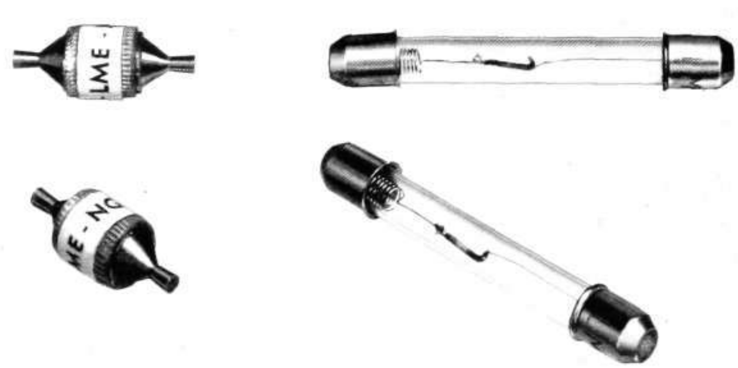


Fig. 5 X 6977
Over-voltage arrester NGA 3001 (left) and combined fuse NGH 5001

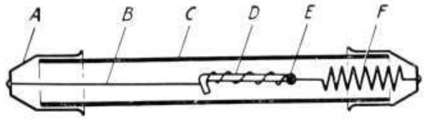


Fig. 6 X 2149

The combined fuse NGH 5001

A end cap
B fuse wire
C glass tube
D rod
E solder
F helical spring

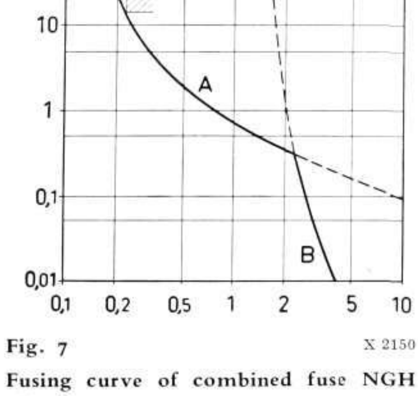


Fig. 7 X 2150 A

Fusing curve of combined fuse NGH 5001

elements. Similarly the 10-pair strips *NFL 3201* are of identical construction to strips *NFL 3211*. The pairs are on 10 mm centres. Every installed 10-pair strip occupies a vertical space of 105 mm.

The contact springs, of tinned german silver, are assembled on plastic blocks with high insulation resistance to breakdown and leakage currents. The leakage current paths are at least 4 mm long, which suffices for indoor installation. Under the connecting screw is a slot for the wire. This arrangement greatly simplifies the wireman's work, as the end of the wire need not be formed into a loop.

The Protector Mounting

Fig. 3 shows a protector mounting for five 10-pair strips. When carrying over-voltage arresters, the mounting at the same time serves as earth connection. As stated above, mountings are made for one, two and five 10-pair strips. No waste of space is involved in placing several mountings one above the other. For instance, one 10-pair and two 20-pair mountings occupy the same space as a 50-pair mounting. The mounting is made of nickel-plated brass and has earth terminals at each end. It also carries fanning strips for the jumper wires. The fanning strips are made of anodized aluminium. The anodization provides satisfactory protection against corrosion and is electrically insulating.

Label Holder *NBM 1111*

Every 10-pair strip can be fitted with a label holder as shown in fig. 4. Two spring catches permit the holder to be pushed into position without needing to be secured by screws. It is supplied with label and transparent protecting plate.

Over-voltage Arrester *NGA 3001*

This protector, illustrated in fig. 5, consists of two cylindrical metal electrodes of a patented alloy which are pressed into a plastic tube so as to produce the proper gap between them. The breakdown voltage is 700—1,000 volts d.c. As in all over-voltage arresters of this type, the striking potential increases by 10 to 20 per cent on steep wave front voltage surges. Its load capacity is greater than that of carbon arresters. Arrester *NGA 3001* withstands a large number of discharges of up to 0.2 coulombs, whereas carbon arresters are often short-circuited at 0.1 coulombs. In the event of a permanent arc being formed, the electrodes become heated. This causes the plastic tube to soften, whereupon the electrodes are forced together by the mounting springs so that the line becomes earthed. The protector must then be replaced.

Combined Fuse *NGH 5001*

This fuse, illustrated in fig. 6, is of a patented design. The end caps *A* and the glass tube *C* are the same as in fuse *NGH 22*. *F* is a helical spring which, at point *E*, is attached by a solder of low melting point to the metal rod *D*. Also soldered to point *E* is an insulated resistance wire, which is first wound a number of turns around the rod and then continues in the form of fuse wire *B*. At fairly low currents the rod heats up until the solder at point *E* melts. Owing to the relatively large mass of the rod, a certain period elapses before the break occurs. At high currents wire *B* melts very quickly, and before the solder. Fig. 7 shows the fusing curves of the solder (*A*) and the fuse wire (*B*). The curve of the combined fuse unit thus follows the fully drawn line. The resistance of this fuse is only about 4 ohms. The resistance of the old type of heat coil was 8 ohms.

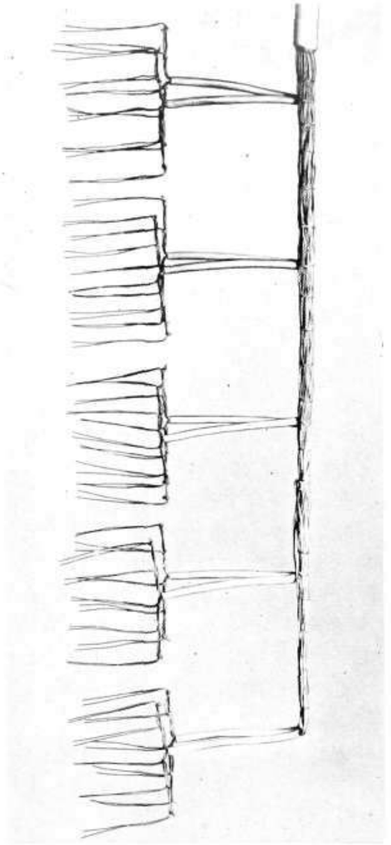


Fig. 8 X 6978

Cable, 50-pair, ready formed

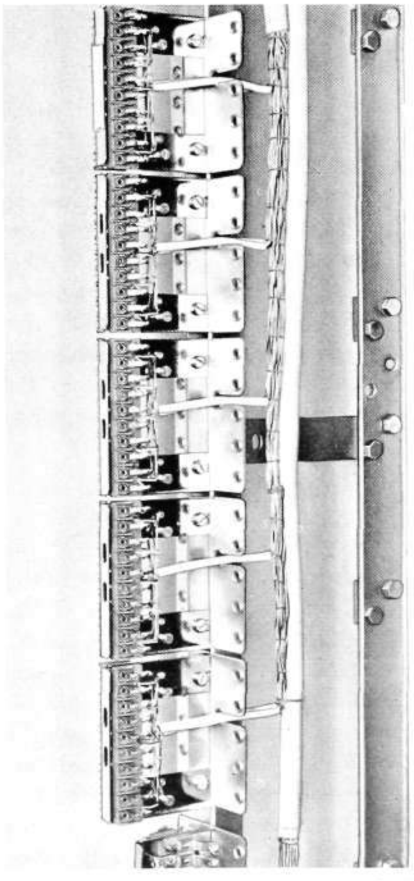


Fig. 9 X 2151

Protector strip with cable ready soldered

Fuse *NGH 22*

In conjunction with the redesign of the connecting and protector strips the fuses have also been modified to some extent, the end caps now being made of thin brass sheet instead of being turned out of bar stock as earlier. They have also been flanged to prevent the fuse from slipping in its holder. The new fuses are designated *NGH 22* and replace the former type *NGH 20*.

Installation

The new connecting and protector strips can be fitted to main frames *BAB 12—14* and other types. The frame need only be equipped with a simple fixing bar holed to take the new strips. Fitting of the fixing bar can be done without difficulty while the main frame is in service. If old type protector strips are replaced by new types, the cables must be reformed. If the strips are supplied complete with mounting they are numbered as in the table below.

Protector mountings, 10-pair strips and protector elements are packed separately for shipment. The mountings should be erected in the frame first. The switchboard cable should then be formed as shown in fig. 8. The 10-pair strips, from which the inside terminal blocks are removed, can thereafter be screwed into position and the cable connected as in fig. 9. As seen in the photograph, the fanning strips on the protector mounting are so constructed that the formed cable need not be threaded but can be laid directly into position.

Table 2

Code no.	Capacity pairs	Consisting of		
		10-pair strips		Protector mounting
		Number	Code no.	
NEL 1101	10	1	*NEL 1100*	479079
NEL 1102	20	2	» »	479080
NEL 1105	50	5	» »	475155
NFL 3131	10	1	*NFL 3101*	479079
NFL 3132	20	2	» »	479080
NFL 3135	50	5	» »	475155
NFL 3141	10	1	*NFL 3111*	479079
NFL 3142	20	2	» »	479080
NFL 3145	50	5	» »	475155
NFL 3231	10	1	*NFL 3201*	479079
NFL 3232	20	2	» »	479080
NFL 3235	50	5	» »	475155
NFL 3241	10	1	*NFL 3211*	479079
NFL 3242	20	2	» »	479080
NFL 3245	50	5	» »	475155

Visual Staff Locator System for Small and Medium-sized Offices

O IRGENS, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 654.938

L M Ericsson's keyset operated staff locator system with facilities for paging 100, or alternatively, 200 persons was described in Ericsson Review No. 1, 1954. So large a number of signals is seldom needed in small and medium-sized offices, and L M Ericsson has therefore introduced the similar, but smaller system presented in this article.

An important part of customer service is a well managed telephone switchboard. Customers tend to judge the whole efficiency of an organization by the speed and confidence inspired by the switchboard operator. What the customer notices is how long he has to wait for connection to the person he wants to speak to. To be kept waiting merely irritates him—and on long distance calls costs him money as well. Any firm that wants to show good customer service must make sure that telephone delay is cut to a minimum.

A common reason for telephone hold-ups is that some people, naturally, are kept on the move from one department to another. When the operator fails to get a person on his normal extension, she tries to trace him in other parts of the building and put the call through to him there. The quicker she is able to contact him, the less time will the caller have to wait. An invaluable aid in this respect is a staff locator system.

General Principles

A staff locator system should meet the following requirements:

The operator must be able to send signals from the switchboard to various points in the building.

Individual and easily recognizable signals must be allocatable to all persons whom the operator regularly needs to contact.

The signals must not be disturbing to persons at their normal place of work.

The manipulations required of the switchboard operator must be simple, and the signal must continue to be displayed until the sought party answers by telephone or by other means, or until the operator cancels it.

L M Ericsson's keyset operated, sequence paging system, described in Ericsson Review No. 1, 1954, meets these requirements to the full. Systems of this kind are mainly adapted to large organizations, and L M Ericsson has therefore introduced a similar smaller system comprising 31 signals with alternative steady or flashing light, so allowing in fact for 62 separate signals.

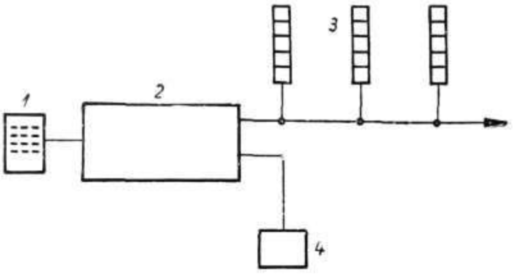


Fig. 1 X 2199

Block schematic of systems with keyset KEM 3294

1 keyset KEM 3294
2 lamp relay set KFB 15301
3 lamp indicators
4 transformer

Equipment and Operation

The new staff locator system is composed of lamp indicators, keyset, lamp relay set and mains transformer, as in the block schematic of fig. 1.

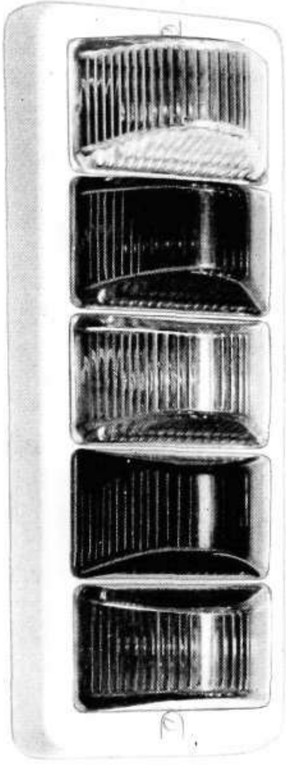


Fig. 2 X 4939

Lamp indicator KNH 8311

with differently coloured lamps in vertical array. Dimensions: width 90 mm, height 232 mm, depth 61 mm

Lamp indicators

The system is based on the principle of visual signalling on lamp indicators. Two kinds of indicator may be used (figs. 2 and 3), the vertical type having differently coloured lenses and the circular type red lenses. In the latter type the lamps are 1.2 W and are fully visible at distances of 30 feet and above; in the former type the lamps are 3 W, being visible at 100 ft. and within a sector of 180°. Both types of indicator are made for wall mounting and should be placed about 6 ft. from the floor. Thirty-one visual signals are obtainable: five by the lighting of the five lamps individually, twenty-five by different combinations of two, three or four lamps, and finally one signal consisting of all five lamps lighting at once. Since the two kinds of lamp indicator produce entirely different signal patterns, all indicators in one office should be of the same type. Both types can incorporate a built-in buzzer.

The usual arrangement is to have one lamp indicator in each room and others distributed as necessary in corridors, stock room, archives, mess rooms etc. The general rule should be that the signals should not disturb persons sitting at their desks. These persons can be reached by the operator on the phone, and the whole object of the staff locator system is to contact people who do *not* answer on their own extensions. The indicators should consequently be placed on the wall *behind* the occupant's desk so that they will cause him no disturbance but will be noticed by other people visiting him.

The addition of a buzzer in the indicator may be advisable in corridors and in localities where visual signals alone are insufficient. Irrespective of the

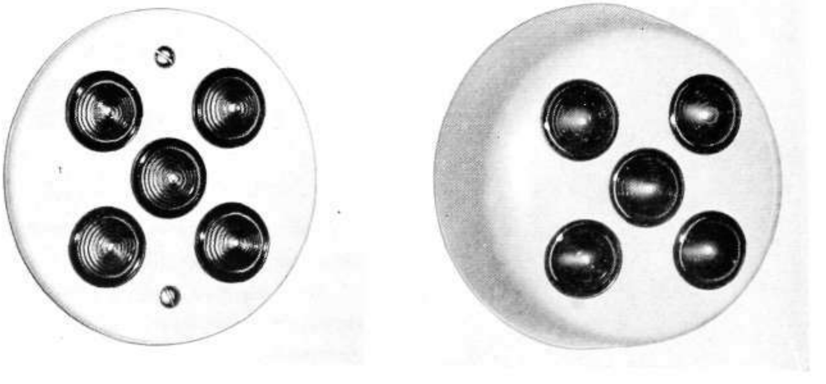


Fig. 3 X 4943 X 4949

Lamp indicators KNH 9501 for flush mounting (left) and KNH 9511 for surface mounting (right)

Dimensions:
KNH 9501: diameter 85 mm, depth 53 mm
KNH 9511: diameter 92 mm, depth 41 mm

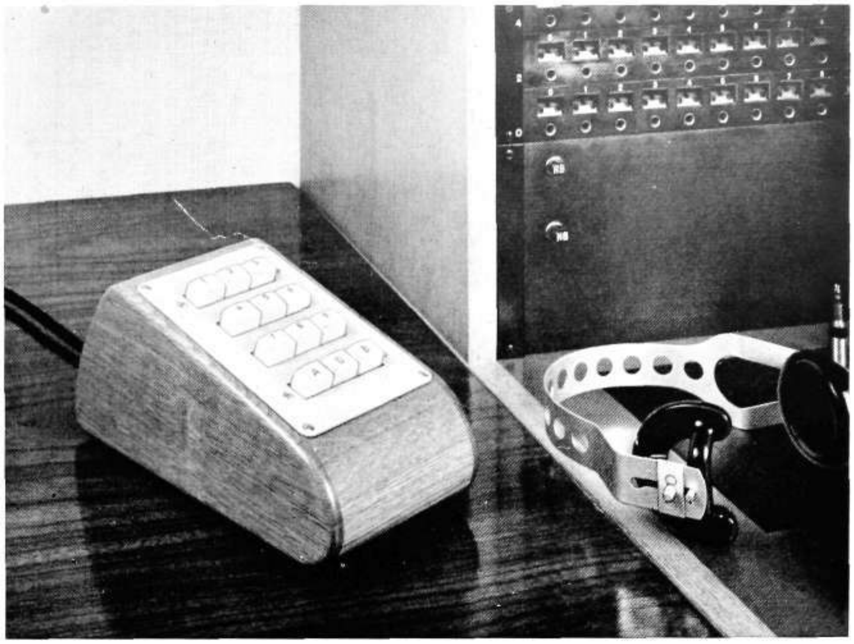


Fig. 4
Keyset KEM 3294
placed beside switchboard

X 8008

placing of indicators, it is a general fact that a steady light is far less apt to catch the attention than a flashing light, so that steady light signals should preferably be combined with acoustic signals. The buzzer should sound only when the lamp lights, and not continue while the light is on.

Keyset and lamp relay set

A keyset (fig. 4) for initiating the desired signal on the lamp indicators is placed at the switchboard. Every signal is represented by a 1, 2 or 3-digit number, the keyset having nine keys for this purpose. The keying of a number sets up the corresponding lamp combination in a separate lamp relay set (fig. 5), and when the operator thereupon presses key *A* or *B*, the signal is displayed on all lamp indicators. Key *A* produces a steady, and key *B* flashing, light. If buzzers are installed, both keys, by being pressed fully down, operate the buzzers as well. The signal is cancelled and the keys restored by pressing key *O* between keys *A* and *B*.

Power requirements

A mains transformer supplies 48 or 24 volts a.c. for operation of the lamp indicators and at the same time, via a rectifier in the lamp relay set, feeds the d.c. circuits in the keyset and lamp relay set. A 48 volt supply is normal in systems incorporating vertical type indicators, but the latter can be fitted with lamps for 24 volts if required. The circular indicator is intended solely for the lower voltage. So, too, are the buzzers, irrespective of the type of indicator in which they are mounted.

Cabling

Five separate conductors and a common return circuit are required between the lamp relay set and lamp indicators. If buzzers are desired, one additional conductor must be installed. A suitable cable is ordinary 12-wire P. V. C.

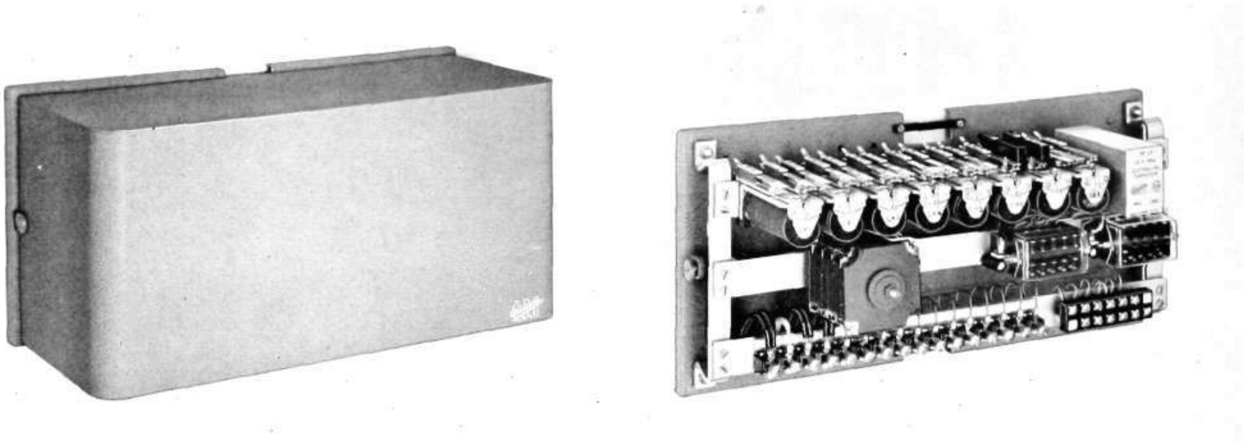


Fig. 5 X 7713

Lamp relay set KFB 15301

(right) with cover removed

insulated telephone cable (EKKX), in which 6 wires constitute the return circuit. All lamp indicators should be connected in parallel, and the cable can suitably be drawn from indicator to indicator without having to pass through terminal boxes. The voltage drop in the circuit should not exceed 10 % at maximum load. On long circuits it might therefore be necessary to combine the EKKX cable with a heavier feed cable (EKKP).

Absence Indicator

Paging signals will, of course, be of no use if the called party is away from the office. To avoid paging to no purpose, the system can be supplemented by absence indicator equipment. When the operator keys the number of a person who has marked himself absent, the signal is blocked by a special relay set (*KFB 15313*) in circuit with the keyset. A signal is at the same time returned to a time indicator panel, mounted at the switchboard, which informs the operator of the time at which the person is expected back or that he will be away all day. These indications are marked by the person himself on an absence indicator panel at the main office entrance. Every person to be accommodated on the system has his own knob on the absence indicator panel, which he turns to the required setting whenever he enters or leaves the office. The knobs are electrically connected to the relay set and to the time indicator panel at the switchboard. The absence indicator panel accommodates equipment for 31 persons.

The general layout of the system is shown schematically in fig. 6.

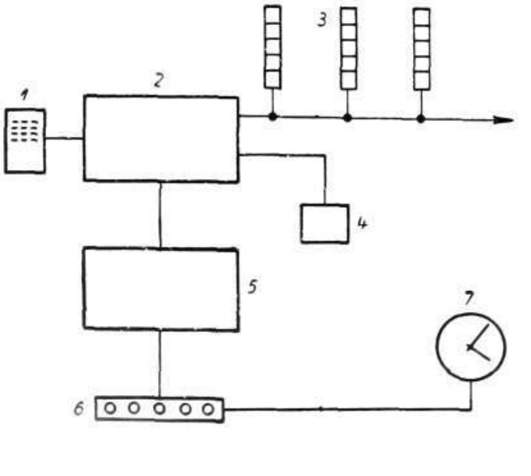


Fig. 6 X 2200

Block schematic of systems with keyset KEM 3294 and absence indicator

1 keyset KEM 3294
2 lamp relay set KFB 15301
3 lamp indicators
4 transformer
5 absence indicator relay set KFB 15313
6 absence indicator panel at main entrance
7 time indicator panel at switchboard

Traffic Signals at Västerbron, Stockholm

BENGT VON MATERN, THE STOCKHOLM TOWN BUILDING OFFICE

U.D.C. 656.056(487.1)

L M Ericsson's vehicle controlled traffic signals have been earlier described in Ericsson Review Nos. 3/1950, 1/1951 and 2/1955. The present article contains an account of the traffic control installation, with many interesting features, at the Långholmsplan intersection on the approach to Västerbron in Stockholm. In particular a new method of varying the maximum green periods, so providing several signal programmes, is described.

Traffic signals of L M Ericsson make were installed at Långholmsplan on the south side of the Västerbron Bridge in Stockholm in August 1956. Västerbron is the only north-south bridge west of the city and has to carry increasing quantities of traffic. At present some 45,000 motor vehicles and trams cross the bridge every day, and at rush hours it is used to maximum capacity. This heavy volume of traffic obliged the municipal authorities to widen the bridge to six lanes and to reconstruct Långholmsplan at its southern abutment.

Layout of Långholmsplan

Långholmsplan was earlier formed as a roundabout, which meant that right-turning traffic caused considerable stoppage. Since its reconstruction into a signal-controlled crossing with right-turn prohibition, and simultaneous widening of the bridge, the traffic flows more smoothly. The present layout is shown in fig. 1. It is seen that the tramway has a large stopping place in the centre of the intersection. Signals are located at three points: at the junction of Långholmsgatan—Högalidsgatan, and at two pedestrian crossings with push button operation on the east and west of the tram stop. An internally lit "No Right Turn" sign is presented to traffic coming from Västerbron. Vehicles intending to turn right from that direction are instead directed left immediately after the bridge abutment and take a newly built road under the bridge leading to the western part of Södermalm. Traffic from the opposite direction is likewise forbidden to swing direct right into Högalidsgatan. But such traffic is rare and is allowed to turn at point *a* (fig. 1).

Three Interconnected Installations

The three signal installations are interconnected, the larger constituting the master installation (*1*) with the two others (*2* and *3*) dependent on it.

If no demand has been registered from pedestrian push buttons at *2* and *3*, signals at *1* operate as a normal two-phase system whereas traffic passing signals at *2* and *3* has right-of-way. Two-way traffic movement takes place on Långholmsgatan during phase *A*, and on Högalidsgatan—which has two right-turn lanes leading onto the bridge—during phase *D*. The interplay between *1* and *2* is evinced if a pedestrian has required passage at *2*. Signals at *2* thereupon follow the changes at *1* in the sense that the red aspect is pre-

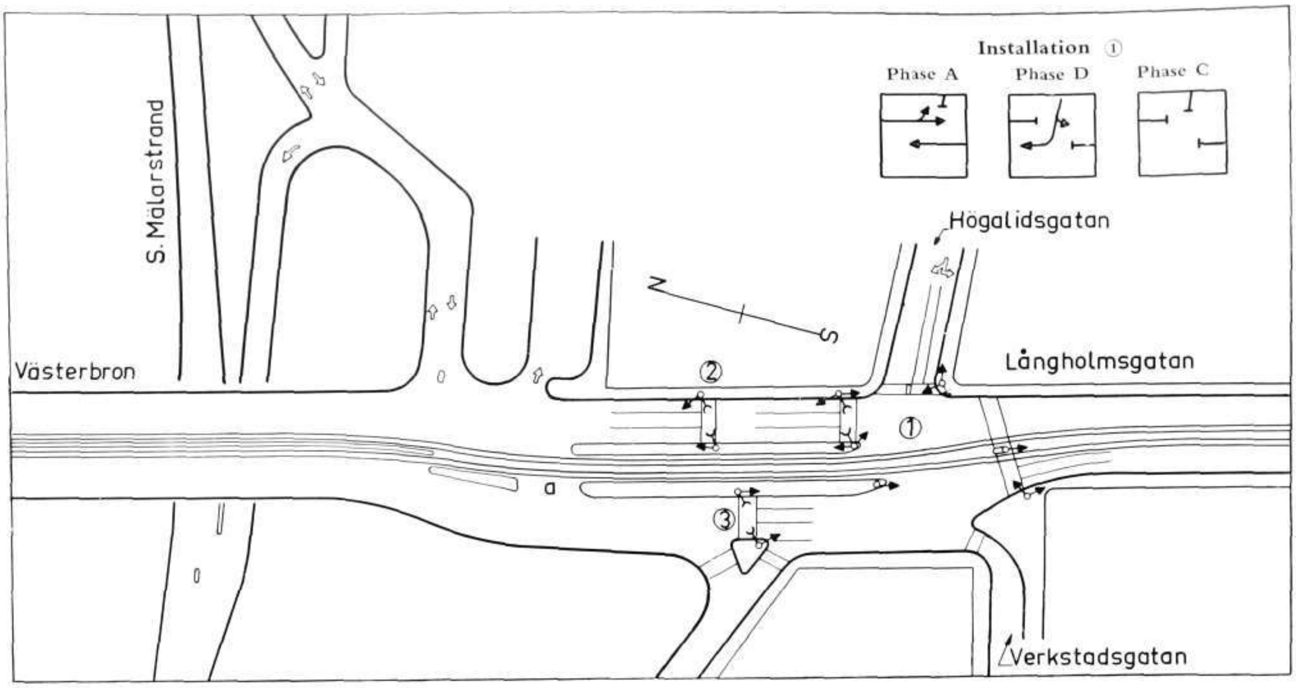


Fig. 1 X 7712

Sketch of site

A signal-controlled street crossing (1) and two signal-controlled pedestrian crossings with push buttons (2 and 3). The signals are interconnected.

sented to Långholmsgatan at *2* immediately before it is presented at *1*. After the pedestrian phase at *2* and *D* phase at *1*, the light for Långholmsgatan returns to green simultaneously at the two installations. The reason for the interconnection is primarily to avoid traffic from the bridge having to queue more than once per vehicle and to avoid vehicles queuing in the middle of the pedestrian crossing at *2*.

If there is no traffic on Högalidsgatan, and consequently no need of right-of-way for that street, *2* changes on operation of the button without waiting for any length of time for impulses from *1*.

Installation *2* may be said to be placed in front of the master installation in the direction of traffic movement. Thus the problem of warning *2* of the change in the master installation "that has not yet occurred, but which is to occur" has been solved without difficulty. Although the interconnection between *1* and *3*, the latter being placed behind *1*, should be simpler, another factor complicates the problem in this instance. This is that *3* is passed by traffic from two directions, by northward traffic on Långholmsgatan (phase *A*) and by traffic from Högalidsgatan (phase *D*). Since queuing in front of *3*, caused by one of these two streams of traffic, interferes with the other, it was considered advisable to preclude such queuing altogether. On the assumption that a pedestrian request has been made at *3*, the interconnection comes into effect in changing *1* from two-phase to three-phase. The third phase *C* (about 7 secs.) consists of "all red", that is to say the red aspect is presented to all directions of traffic. During this comparatively short phase there is time for a vacuum to form at *3*, i.e. the accumulation space *3* is empty of vehicles. The phase sequence in this instance is such that the last vehicle to pass northwards from Långholmsgatan immediately before the signals switch to the third phase—red in all directions—has just time to pass *3* before the pedestrian phase at *3* appears. After the all red phase at *1* has disappeared, the green aspect is given to Högalidsgatan, so that the first vehicle arrives in reasonable time to be met by green on signal *3*.

Three Programme Vehicle Control

The signals are vehicle controlled by means of magnetic detectors embedded under the asphalt. The detectors operate to all kinds of vehicles and are directional. The function of vehicle control—which must now be universally known—is that the lengths of the green periods automatically vary from one cycle to the next according to the *existing* volume of traffic passing the signal intersection, and that at maximum volume the green periods displayed to the different streets are limited to a predetermined maximum time. In normal vehicle controlled signal systems the maximum periods can be adjusted by means of knobs, each street and phase having a "maximum knob".

Experience abroad and in Sweden has shown that the maximum knob arrangement is usually adequate for the requirements both at peak hours and other times. But it has proved deficient at certain places where the morning traffic differs markedly in direction and volume from the afternoon traffic, or where other special conditions prevail. Many different procedures have been tried out to overcome this problem. Since the method of variable maximum green periods tried at Långholmsplan may be assumed to be entirely new, a brief description may be of interest.

Långholmsgatan has three maximum knobs, as also Högalidsgatan. Thus each phase has a "low maximum", a "normal maximum" and a "high maximum"—programmes I, II and III. The change from one programme to a higher or lower takes place automatically under certain given conditions, as follows:

An *increase* from programme I to programme II for phase *A* (Långholmsgatan phase) takes place on condition that the maximum period of programme I has been taken out fully by the traffic in street *A* n_1 times in succession. (n_1 can be set on a special n_1 knob from 1 to 10 units.)

An *increase* from programme II to III takes place under similar conditions. Here there is a n_2 knob which can be given values other than n_1.

A *decrease* from programme III to programme II takes place on condition that the maximum period on programme III has *not* been taken out n_3 times in succession.

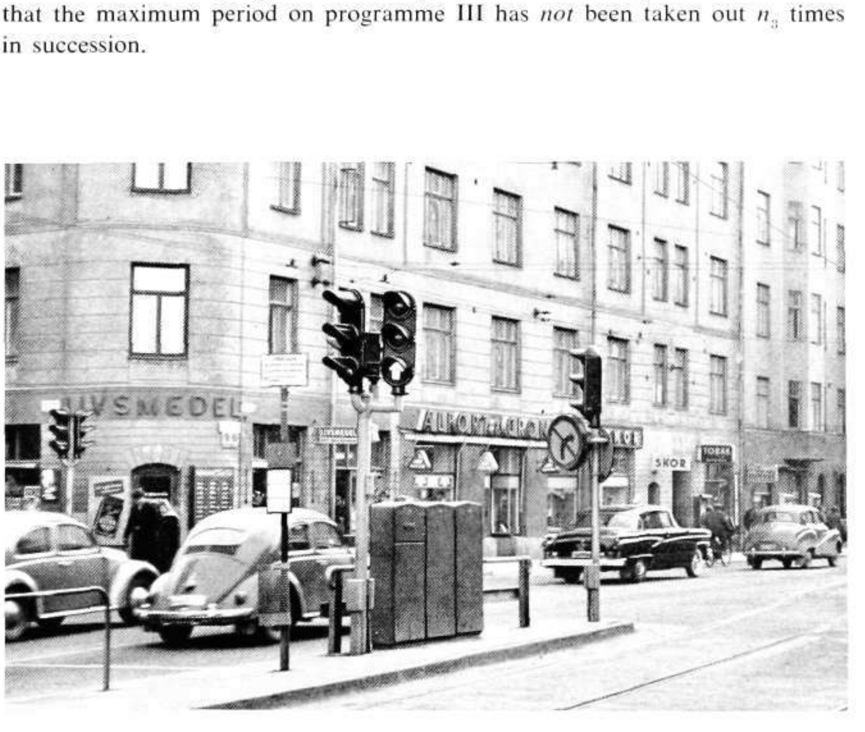


Fig. 2 X 8007

Control cabinet and signals at the street crossing

The signal head in the centre controls the tramway traffic and in the photograph shows a white arrow. The sign on the signal mast on the right indicates »No right turn».

A *decrease* from programme II to programme I takes place under similar conditions and with the associated n_4 knob.

Högalidsgatan is similarly equipped with three programmes. So far the following settings have been found suitable:

	Långholmsgatan (phase *A*)	Högalidsgatan (phase *D*)
Maximum times on		
programme I	20 secs.	12.5 secs.
programme II	30 secs.	17.5 secs.
programme III	50 secs.	25 secs.
Number of maximum times taken out by the traffic in sequence		
n_1 (I → II)	1	1
n_2 (II → III)	3	3
Number of maximum times *not* taken out by the traffic in sequence		
n_3 (III → II)	3	3
n_4 (II → I)	3	3

When the programme selectors are switched off, the installation functions as an ordinary vehicle-controlled system with maximum times that can be set separately and that are entirely distinct from the maximum times for programmes I, II and III.

To arrive at proper settings of the eight *n* knobs, as also of the maximum knobs, naturally requires a careful study of the traffic. The aim is to select values which cause the signals to follow programme I at nighttime, programme III during peak hours, and programme II at other times.

Experience gained hitherto has shown that the requirements have been satisfied. At midday, for example, it may be noticed that programme II alternates with programme I on Högalidsgatan, while at the same time programme III alternates with programme II on Långholmsgatan. At night programme I usually occurs on Högalidsgatan, and programme I or on some occasions programme II on Långholmsgatan.

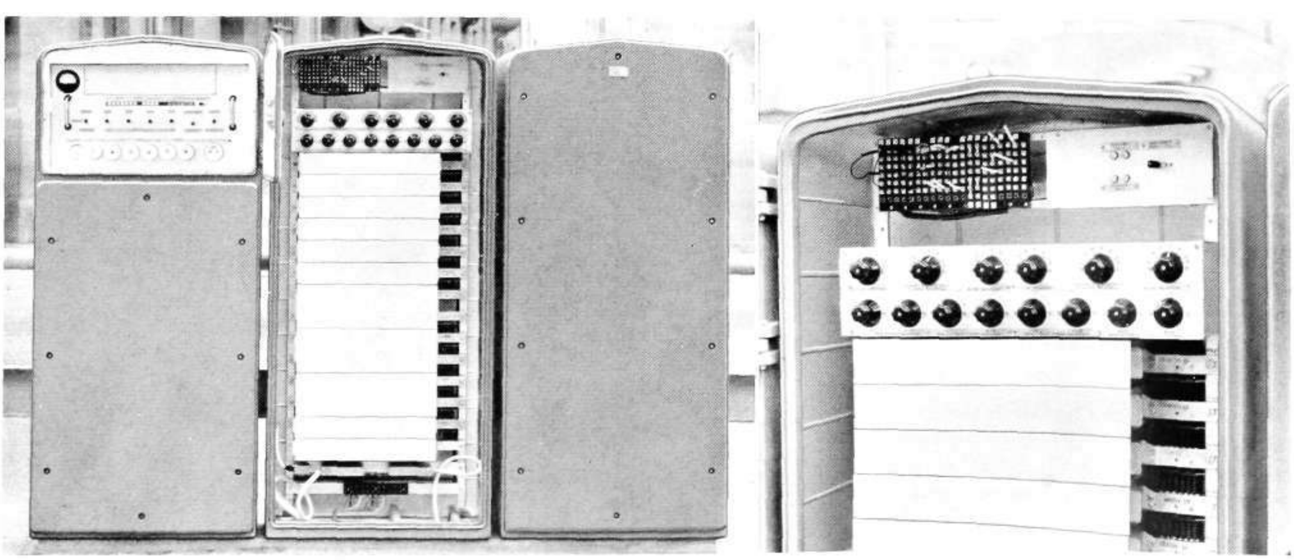


Fig. 3 X 7714

Control cabinet

On the left of the left-hand photograph is the control and indicating panel on which different forms of operation can be set and indications of vehicle impulses etc. can be read; *in the centre are the maximum time selectors.* The latter, shown in enlargement (right), are used for setting the different programmes between which the system automatically changes so as to adapt the signals as required by the current traffic situation.

Fig. 4 X 8009 X 8010

Two traffic situations

(Left) traffic in phase A and (right) in phase D

Ordinary vehicle control implies that the signals change before the termination of the maximum time if the traffic intensity diminishes to some extent during a phase. Programme control is a further step in the development of vehicle control, since the maximum green times as well can be adapted to the prevailing traffic load, i.e. the load during a certain number of successive cycles. The combination of ordinary vehicle control and programme control has very great advantages, therefore. The systems described have also proved their worth in bringing about a great increase in capacity and in more flexible handling of the traffic.

L M Ericsson Exchanges Cut into Service 1956

Exchanges with 500-line selectors

Town	Exchange		Number of lines
Argentine			
Mendoza	Mendoza II		3000
Paraná		(extension)	500
Australia			
Melbourne	PABX	(extension)	250
Bolivia			
Cochabamba		(extension)	1000
Brazil			
Belo Horizonte		(extension)	4000
Ribeirão Preto		(extension)	2000
Colombia			
Barranquilla	Principal		10000
Barranquilla	Estadio		3500
Barranquilla	Sur		1500
Bogotá DE	Centro	(extension)	1000
Bogotá DE	Chapinero	(extension)	3000
Bogotá DE	Las Cruces	(extension)	1000
Bogotá DE	Muzu		2000
Bogotá DE	Ricaurte	(extension)	2000
Medellín	Americal	(extension)	1500
Medellín	Bosque	(extension)	2000
Medellín	Centro	(extension)	3000
Ethiopia			
Addis Abeba	Centro	(extension)	1000
Addis Abeba	Filwoha	(extension)	600
Finland			
Karjasilta		(extension)	500
Kuopio		(extension)	1000
Pori/Björneborg		(extension)	500
Seinäjoki		(extension)	300
Turku/Åbo		(extension)	500

Town	Exchange		Number of lines
Italy			
North Italy			
Adria		(extension)	200
Chioggia		(extension)	200
Este		(extension)	100
Legnago		(extension)	900
Montagnana			700
Padova		(extension)	2400
Rovigo		(extension)	400
S. Bonifacio		(extension)	200
S. Donà di Piave		(extension)	200
Schio		(extension)	200
Thiene		(extension)	100
Treviso		(extension)	500
Valdagno		(extension)	200
Venezia	Centro	(extension)	1500
Venezia	Lido	(extension)	600
Venezia	Mestre	(extension)	1900
Venezia	Murano	(extension)	20
Verona		(extension)	2500
Vicenza		(extension)	1100
South Italy			
Alcamo		(extension)	200
Barletta		(extension)	200
Benevento		(extension)	500
Brindisi		(extension)	600
Caltagirone		(extension)	100
Capri		(extension)	110
Caserta		(extension)	500
Cassino			400
Catania		(extension)	2000
Catanzaro		(extension)	700
Cosenza		(extension)	700
Crotone			600
Enna		(extension)	100
Foggia		(extension)	800
Giarre Riposto		(extension)	40
Lecce		(extension)	700
Napoli	Centro	(extension)	2000
Napoli	Nolana	(extension)	2500
Napoli	Portici	(extension)	200
Napoli	Vomero	(extension)	1000
Nocera Inferiore		(extension)	300
Palermo	Libertà	(extension)	1500
Palermo	Polacchi	(extension)	4000

Town	Exchange		Number of lines
Palermo	S. Lorenzo		500
Ragusa		(extension)	500
Rossano			400
Siracusa		(extension)	1000
Vibo Valentia			400
Lebanon			
Beirut		(extension)	7500
Beirut	PABX	(extension)	720
Mexico			
México DF	Chapultepec	(extension)	1500
México DF	Madrid		10000
México DF	Piedad	(extension)	400
México DF	Roma	(extension)	3000
México DF	Sabino		3000
México DF	San Angel	(extension)	500
México DF	Zócalo	(extension)	1500
Netherlands			
Rotterdam	Centrum II	(extension)	7500
Rotterdam	1 PABX		200
Rotterdam	Schiedam	(extension)	500
Norway			
Narvik			2500
Porsgrunn		(extension)	500
Stavanger		(extension)	1000
Tromsö			3000
Panama			
Panama city	1 PABX		230
Union of South Africa			
Cape Town	PABX	(extension)	100
Sweden			
Arvika	1 PABX		160
Bollnäs		(extension)	1000
Borås	2 PABX		540
Eskilstuna		(extension)	3000
Fagersta	1 PABX		600
Falköping		(extension)	500
Filipstad	1 PABX		140
Finspång	1 PABX		400
Gävle	1 PABX		280
Gothenburg	1 PABX		140
Gothenburg	Hisingen	(extension)	3000
Gothenburg	Kålltorp	(extension)	3000
Gothenburg	Vasa	(extension)	500

Town	Exchange		Number of lines
Gothenburg	Örgryte		7000
Gothenburg	Kortedala	(extension)	2000
Hagfors		(extension)	500
Halmstad	1 PABX		100
Huskvarna		(extension)	1000
Hällabrottet	1 PABX		100
Härnösand	1 PABX		120
Jönköping		(extension)	2000
Karlstad		(extension)	1000
Kristianstad		(extension)	500
Kristinehamn		(extension)	1000
Köping	1 PABX		260
Landskrona	1 PABX		120
Lidköping		(extension)	1000
Linköping	1 PABX		140
Ludvika		(extension)	500
Lund	1 PABX		300
Mölndal	1 PABX		140
Norrköping		(extension)	1000
Nyköping	1 PABX		120
Oxelösund	1 PABX		120
Saltsjö-Järla	1 PABX		120
Smedjebacken	1 PABX		160
Solna	1 PABX		200
Stockholm	7 PABX		1360
Stockholm	Handen	(extension)	500
Stockholm	Hässelby	(extension)	4000
Stockholm	Mälarhöjden	(extension)	3000
Stockholm	Råsunda	(extension)	3000
Stockholm	Tullinge	(extension)	500
Stockholm	Ulriksdal		4000
Stockholm	Örby	(extension)	4500
Surahammar	1 PABX		300
Södertälje		(extension)	500
Sölvesborg		(extension)	500
Trollhättan		(extension)	1000
Uppsala	2 PABX		320
Västervik		(extension)	1000
Örebro		(extension)	6000
Östersund	2 PABX		240
Övriga Sverige	PABX	(extensions)	1480
Turkey			
Ankara	Bahçelievler	(extension)	1000
Ankara	Keçiören	(extension)	200
Ankara	Yenimahalle	(extension)	1000
Aydin			1000
Denizli			1000
Erzurum			2000
Iskenderun			1000
Izmir	Karsiyaka	(extension)	1000
Nazilli			1000
Tire			500
Venezuela			
Carúpano		(extension)	400
Mérida			1500
San Felipe			500
		Total	202830

Exchanges with crossbar switches

Town	Exchange	Number of lines
Denmark		
Horsens	(extension)	4000
Copenhagen	PAX	180
Copenhagen	PABX	120
Copenhagen	Bagsvaerd (extension)	1000
Copenhagen	Glostrup	5000
Copenhagen	Kastrup (extension)	2000
Copenhagen	Lyngby	10000
Copenhagen	Valby (extension)	2000
Copenhagen	Vestskel (extension)	1000
Copenhagen	Virum (extension)	1000
Copenhagen	Yrsa (extension)	1000
Odense		1000
Rudköbing		1000
Skagen		1600
Finland		
Helsinki/Helsingfors	Haaga/Haga	1000
Helsinki/Helsingfors	Herttoniemi/Hertonäs	3000
Helsinki/Helsingfors	Keskusta/Centrum (extension)	1400
Helsinki/Helsingfors	Käpylä/Kottby (extension)	5000
Helsinki/Helsingfors	Pakila/Baggböle	3000
Helsinki/Helsingfors	Sörnäinen/Sörnäs (extension)	2000
Netherlands		
Haag	1 PABX	120
Rotterdam	Centrum II (extension)	7500
Rotterdam	Noord II (extension)	5000
Rotterdam	West II (extension)	3000
Norway		
Oslo	1 PABX	70
Sweden		
Alingsås		4500
Finspång	1 PAX	300
Motala		6500
Stockholm	3 PABX	860
Stockholm	PABX (extension)	150
Sunne		1300
Västerås	PAX (extension)	100
Yugo-Slavia		
Bitolj		500
Nikšić		400
Pula		700
	Total	77300

Rural exchanges with crossbar switches, system ARK

Country	Number	Number of lines*
Finland	20	1970
Italy	18	2360
Sweden	3	2600
Total	41	6930

Rural exchanges with 100-line selectors, system XY

Country	Number	Number of lines*
Norway	12	4310
Total	12	4310

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

Exchanges with relay selectors, 100-, 30-, 25- and 12-line selectors (delivered from Stockholm)

	Number	Number of lines
Exchanges with relay selectors	173	1474
Exchanges with 100-line selectors, system AHD	106	9470
Exchanges with 30-, 25- and 12-line selectors, system OL	330	9700
Total	609	20644

Ericsson LM NEWS *from All Quarters of the World*

Mr. Göte Fernstedt signs the deed of transfer for the gift to the town of Cali. On his right is the Mayor of Cali. (Below) Mr. Olaf Gustafson presents the deed of gift to the President of Colombia.

L M Ericsson Presents Automatic Exchange to Cali, Colombia

In September last year a serious explosion occurred in the town of Cali, Colombia. Seven lorries loaded with dynamite exploded while parked on a barracks square. Eight blocks of buildings were levelled with the ground, windows were smashed within two miles radius, and the explosion left a crater 100 yards in diameter.

The death roll was very heavy, and large numbers of people were injured. The destruction in the town was appalling. All normal life stopped, military and civilian squads were sent in to assist the injured and clear up after the devastation.

L M Ericsson, represented in Colombia by their affiliates Cía Ericsson Ltda. contacted the Colombian relief organization Sendas and, by way of financial assistance, offered automatic telephone equipment for 5,800 lines of other make that happened to be available. The gift contributed to some extent to the relief campaign for Cali which was set in motion throughout the country.

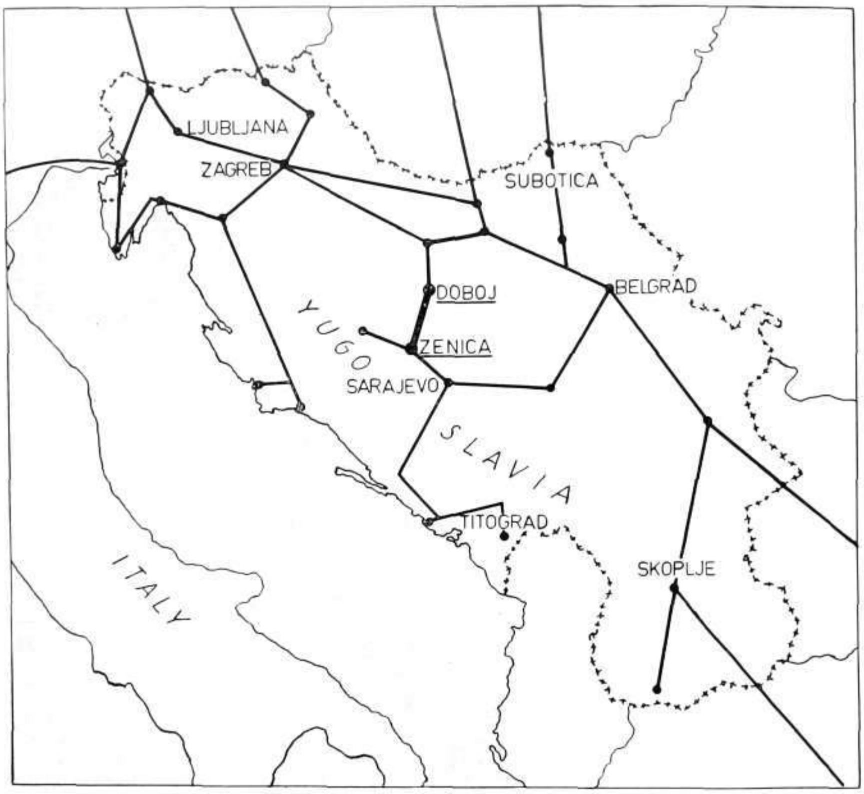
The head of Cía Ericsson Ltda, Mr. Olaf Gustafson, presented the deed of gift to the President of Colombia, General Gustavo Rojas Pinilla, at the end of last year. In February 1957 L M Ericsson was able to hand over the gift in concrete form to the Mayor of Cali, Col. Andres Muñoz, who officially accepted the equipment on Cali's behalf from Messrs. Göte Fernstedt and Olaf Gustafson.

The press devoted much space to this evidence of L M Ericsson's desire to help. The presentation ceremony was also televised.

The town of Cali has a telephone system which differs entirely from L M Ericsson's, so that the gift was in no way bound up with a business deal–a fact which aroused considerable respect and appreciation from the press and local population.

First Crossbar Switching Exchange in Africa

The first crossbar exchange in Africa was installed at Gatooma, Southern Rhodesia, in January to the orders of the Rhodesia Post Office. It is a 1,000-line city exchange of L M Ericsson's type ARF 50 with equipment for auto-manual trunk traffic. The equipment was installed by the Post Office staff with the assistance of an L M Ericsson engineer who remained for six weeks after the cut-over to give instruction to the Post Office maintenance staff. Before his departure 10,000 test connections had been made without a single fault occurring, and the exchange has since functioned satisfactorily.



C.T.C. for Jugoslavian Railways

The Jugoslavian Railways have decided to install modern interlocking systems and centralized traffic control (CTC) on the very heavily trafficked Doboj-Zenica section comprising some 100 kilometres of the single track line between Brod and Sarajevo. L M Ericssons Signalaktiebolag has received an order for the equipment and will also supervise the work of installation.

The Doboj-Zenica section has twelve stations, each with three or four tracks. The traffic is very heavy, and the present capacity of the line is inadequate. The capacity will be increased, however, by the introduction of signalling equipment and CTC, which will render the section capable of carrying the heavier traffic that is anticipated within the next few years.

All stations will have relay interlocking plants, but only the four largest exchanges will be equipped with local control panels that can be operated when the stations are disconnected from the CTC system. The CTC office will be located at Doboj, and all stations will normally be controlled from it.

Some ten road crossings will be protected by lifting gates and signals for automatic control by trains.

The CTC system will be of L M Ericsson's standard type with the illuminated track diagram separate from the keyset type control panel. The CTC office will also have a traingraph.

The Doboj-Zenica plant will be completed in three stages and be fully installed by 1960.

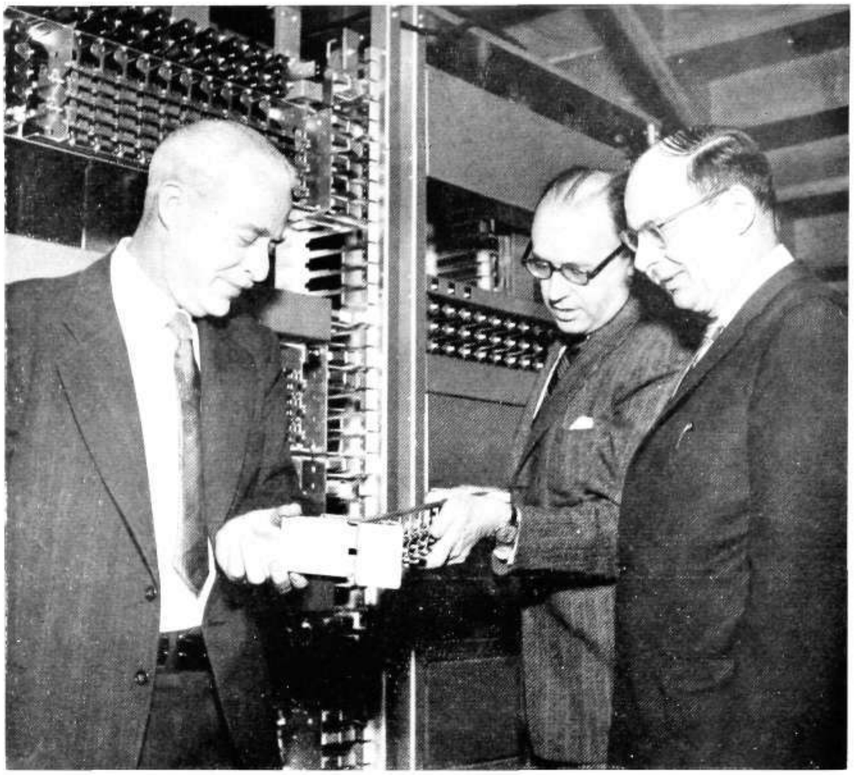
Ericsson Technics

Ericsson Technics No. 2, 1956, has recently appeared. An article by Professor C G Aurell of the Chalmers University of Technology, Gothenburg, entitled "The Equivalent Transmission Line of a Linear Four-Terminal Network. Calculations with Cascade-Connected Four-Terminal Networks", describes a systematic procedure for the calculation of impedances and powers in cascade-connected four-terminal networks. The concept "equivalent transmission line" is extended to apply also to non-symmetrical and non-reciprocal four-terminal networks. The article "New Types of Sections for Zig-Zag Filters" by Professor T Laurent, of the Stockholm Institute of Technology, presents new types of band-pass sections named "zig-zig" and "zag-zag" sections which can be introduced into a zig-zag filter ladder without producing reflection. This provides full freedom in the choice of attenuation peaks in a filter ladder of this kind.

Finally, an article by H Häggblom and S Tomner of AB Svenska Elektronrör, Stockholm, "Developments of the Strophotron", describes the theoretical and experimental work done on the development of strophotron oscillators within the frequency range 1,000–5,000 Mc/s.

On the 100th Anniversary of the Swedish State Railways on December 1, 1956, Messrs. H Thorelli, H Lindberg, H Insulander and A Westling presented a deed of gift for 25,000 kronor from the Ericsson group to Erik Upmark, head of S.S.R. It is proposed that this sum shall be used for scholarships to S.S.R. staff for travel within Europe.

L M Ericsson, Midsommarkransen, is admittedly a bit spoilt as regards celebrities. But it is no common occurrence to have two Nobel Prize Winners visiting the company at one time. This did happen recently, and the two gentlemen were Dr. Walter Brattain of Bell Laboratories and Professor John Barden of the University of Illinois. They are seen with Dr. Christian Jacobæus in the photograph (right). The two Americans were awarded the 1956 Physics Prize for their fundamental work in the field of transistors.



The Lapp, Anders Rikko, reindeer-owner from Gällivare, was in Stockholm at the end of January to have a look at the capital. He was particularly anxious to see LME. A friend arranged the introduction, and he was taken round the firm. He is seen (left) in his resplendent Lapp costume using an Ericofon in the Exhibition Room.

Loke Darshan, the Private Secretary of the King of Nepal, took the opportunity of visiting L M Ericsson when recently in Sweden. Here he is seen becoming acquainted with the Ericofon, L M Ericsson's new telephone.

The Head of the Peruvian Ministry of Telecommunications, Dr. Jorge Fernandez Stoll, recently visited LME's operating company, Sociedad Telefónica del Peru, at Arequipa. LME's Peru manager, Sr. Jaime Uminsky (right), demonstrated the Ericofon for the Minister.

New Automatic Exchange at Mendoza

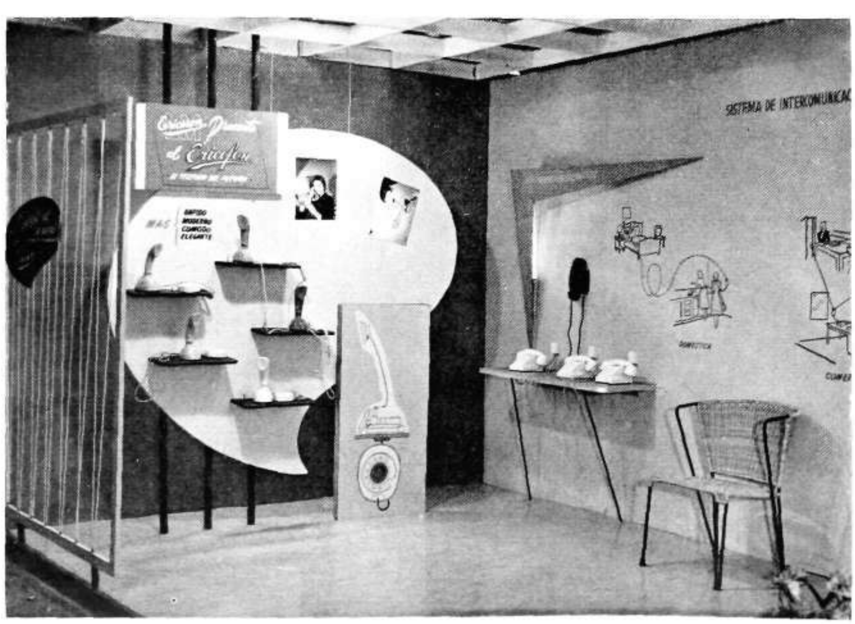
A main exchange with a capacity of 3,000 lines for the telephone operating company, Cía Argentina de Teléfonos, has been opened in Mendoza. The inaugural ceremony for the opening of the exchange–Mendoza II–which formed part of the official programme of the Province of Mendoza for the celebration of the Argentine Commemoration Day, was presided over by the Provincial Interim Governor, Dr. Isidoro Busquets, and the equipment was consecrated by the Bishop of Mendoza and Neuquen, Monseñor Dr. Alfonso Maria Buteler, seen in the photograph at the service observation desk. Among other persons at the opening of the exchange, the installation of which was carried out by Cía Sudamericana de Teléfonos L M Ericsson, were the entire provincial government and general staff.

New L M Ericsson Exchanges in Gothenburg, Landskrona and Leksand

The new automatic exchange at Örgryte, Gothenburg, was opened in December 1956. It is a central area exchange, having direct junctions with other exchanges in the inner area of Gothenburg. The Örgryte exchange is built on the 500-line selector system. It is of the same type as the previous L M Ericsson exchanges in Gothenburg and initially caters for 7,000 subscribers. When the new exchange was opened, some 4,700 subscribers from the Vasa exchange were transferred and renumbered. This transfer enabled the latter exchange to accept new subscribers.

The new automatic exchange at Landskrona, opened in February, offers the longest subscriber-dialled connections in Sweden. The exchange comprises 7,000 lines and has equipment for zone traffic and full-automatic trunk traffic. It employs crossbar switches of the Swedish Telecommunications Administration type manufactured by L M Ericsson. This exchange provided Landskrona with full-automatic trunking to Stockholm and Gothenburg, among other places, via the Malmö transit exchange. Since the opening of the Landskrona exchange Sweden's longest subscriber-dialled connection stretches from the island of Ven in the Sound to Singö in Roslagen, a distance of 818 kilometres.

A crossbar exchange of the Telecommunications Administration type, for 1,500 lines, has also been supplied recently by L M Ericsson to Leksand.



L M Ericsson partook in the first international exhibition for electronics, telecommunications and radio, held in Mexico in December 1956, through the agency of Compañia Comercial Ericsson S.A. L M Ericsson's stand presented a general survey of the company's production. (Right) The Ericofon corner.

U.D.C. 621.395.722.044.5

AHM, M: *Maintenance of Aarhus Area Exchanges.* Ericsson Rev. *34* (1957) No. 1, pp. 2–8.

Six automatic local exchanges and a trunk exchange of L M Ericsson's crossbar system were opened in the Aarhus area on May 1, 1953. The article deals with the methods of maintenance and the results of operation for the first six months of 1956.

U.D.C. 621.395.34(480.3)

VON SCHANTZ, K: *Mechanization of the Åland Telephone Network.* Ericsson Rev. *34* (1957) No. 1, pp. 9–13.

In this article an account is given of the results attained through the mechanization of the Åland network.

U.D.C. 621.395.669

NYLUND, E: *Connecting and Protector Strips for Main Distribution Frames.* Ericsson Rev. *34* (1957) No. 1, pp. 14–18.

Telefonaktiebolaget L M Ericsson has designed a new connecting and protector strip with pairs on 10 mm centres, occupying only two-thirds of the vertical space required by the previous strip. The strip is composed of standard elements, so is simpler to manufacture, pack and install.

U.D.C. 654.938

IRGENS, O: *Visual Staff Locator System for Small and Medium-sized Offices.* Ericsson Rev. *34* (1957) No. 1, pp. 19–22.

L M Ericsson's keyset operated staff locator system with facilities for paging 100, or alternatively, 200 persons was described in Ericsson Review No. 1, 1954. So large a number of signals is seldom needed in small and medium-sized offices, and L M Ericsson has therefore introduced the similar, but smaller system presented in this article.

U.D.C. 656.056.(487.1)

VON MATERN, B: *Traffic Signals at Västerbron, Stockholm.* Ericsson Rev. *34* (1957) No. 1, pp. 23–27.

An account of the installation of L M Ericsson's vehicle controlled traffic signals on the approach to Västerbron. In particular a new method of varying the maximum green periods, so providing several signal programmes, is described.

The Ericsson Group

Associated and co-operating enterprises

• EUROPE •

Danmark

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

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

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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

Société Cinéric *Paris 20e*, 111 Rue Villiers de l'Isle Adam, tel: Ménilmontant 87-51, tgm: cinericsson

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

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

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

A/S Norsk Kabelfabrik *Drammen*, P. B. 205, tel: 12 85, tgm: kabel

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

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Suom

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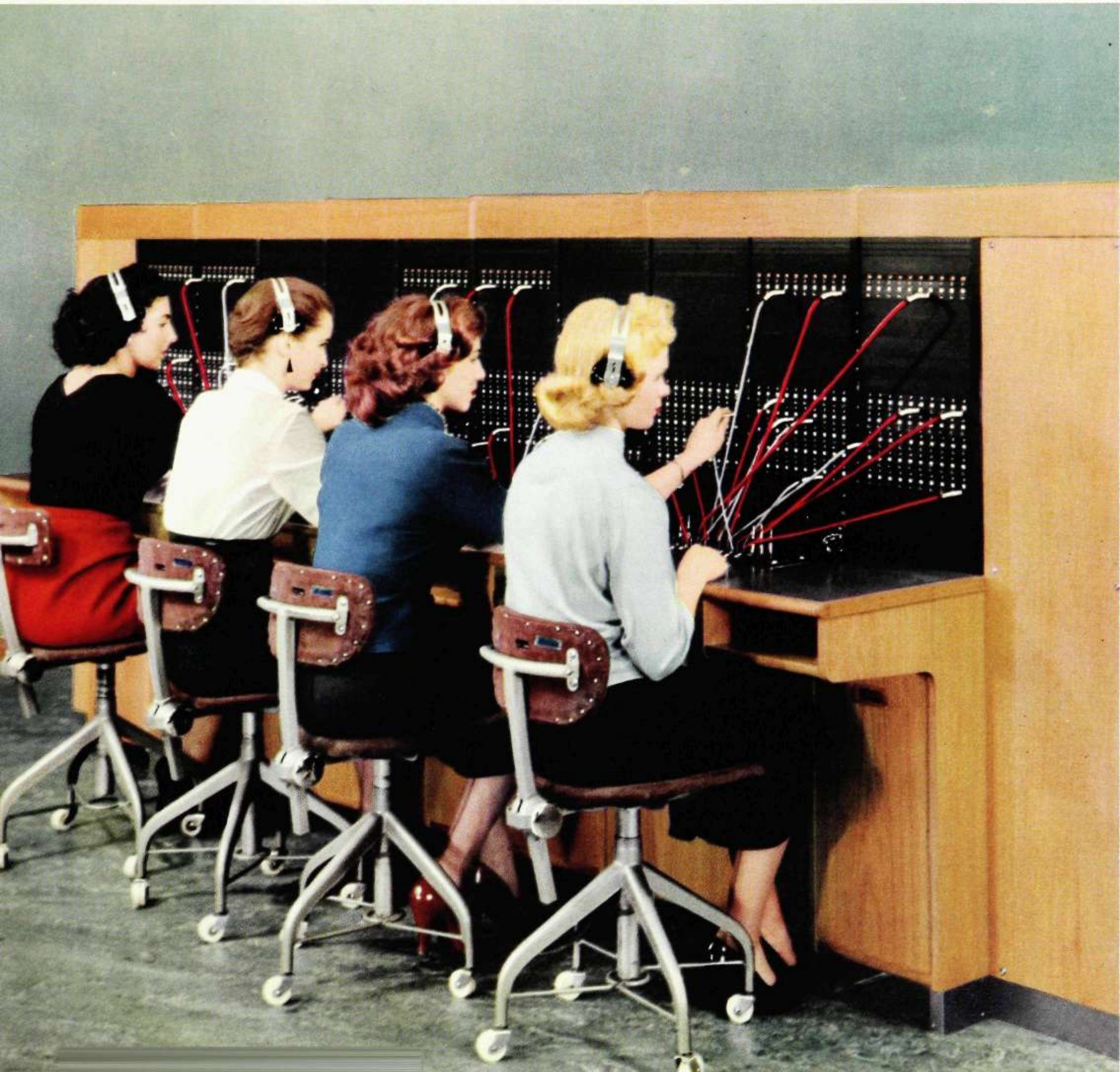
1957



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L M Ericsson's 960-Circuit System for Coaxial Cables

I. Introduction and Survey

B LUNDVALL, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.54

The present article and the two following describe L M Ericsson's 960-circuit system for coaxial cables. This introductory article gives a short review of the history of the development of the coaxial system and gives an account of the essential features of the 960-circuit system which have been determined by the recommendations of the CCITT and the requirements of the network. Having touched upon the technical requirements and the type of signalling, the article concludes with the prospect of future developments.

The intention of this article and the two forthcoming articles "II. System Line Equipment" and "III. Terminal Equipment" is to try to give a survey of the development and construction which has been carried out by L M Ericsson's Transmission Department during a period of years. In this introductory article, one is justified in touching on the short but intensive history of the development of the coaxial system, which forms the background to the decision to include this system in the manufacturing program of the Transmission Department.

History

It is rather natural that it was in the U.S.A. where the study was begun of the problem of being able to provide large groups of circuits between places separated by noticeably large distances from each other. As a start two methods of solution of the problem were pursued: by the so-called J-systems which constitute 12-circuit systems for open-wire lines and by the so-called K-systems which were designed as 12-circuit systems for symmetrical pair cables with separate cables for each direction of transmission. None of the solutions was ideal; open-wire systems gave large maintenance difficulties and even important technical difficulties with the variation of their transmission characteristics with weather conditions. Cable systems were on the other hand very expensive in laying out.

It was clear that the solution of the problem lay in the design of a new transmission medium which enabled transmission of a wide frequency band and had stable and reproducible transmission characteristics. So through development work at Bell laboratories, a new type of cable came into being, the so-called coaxial cable, intended for burying in the ground.

The original coaxial cable developed about 1933—35 does not differ appreciably from the modern coaxial cables manufactured today, with the exception that the earliest types had slightly smaller dimensions. The new cable showed itself capable of fulfilling the technical requirements of both

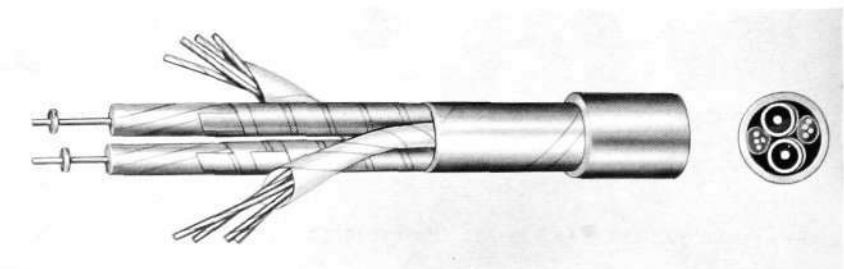


Fig. 1 X 8019

Coaxial cable of American type

Internal diameter of outer conducter 0.27". The figure shows the cable which was used in the experimental construction New York — Philadelphia, 1936 — 1937.

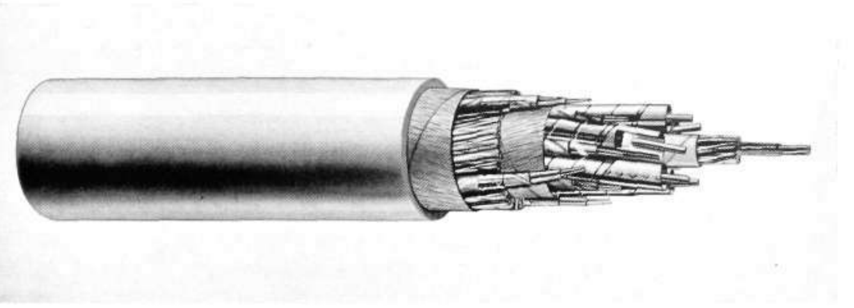


Fig. 2 X 8018

Modern 6-tube coaxial cable

with core and layer of quads and screened radio pairs

installation and transmission and very quickly formed the basis of the American long distance cable network which was built up during the years 1940—1950.

To be able to use what for that time was considered to be an enormous bandwidth, a carrier frequency equipment was developed by Bell Laboratories. This so-called L-1 system provided primarily the transmission of 480 circuits over the cable, the system capacity being later increased to 600 circuits. The first coaxial system was put into trial operation between New York and Philadelphia in the years 1936—1937.

It is clear that the American development affected the European telephone administrations, who were struggling with similar problems. Both the British Post Office in England and the then Reichspost in Germany commenced early investigation into the economic possibilities of the coaxial system in the telephone network of their respective countries. The first system was finished in England between London and Birmingham in the years 1937—38, and in Germany several main routes were built during the period 1936—42.

With regard to the Swedish network, the Royal Board of Telecommunications seriously studied the application of the coaxial system for the first time at the end of the 1930's for communication between Gothenburg, Hälsingborg and Malmö. As the actual number of circuits was then too small to enable the coaxial system to compete, an alternative was finally selected using 12-circuit systems for symmetrical pair cables.

The second world war caused development and system planning work on the telephone side to cease everywhere and this applied also to the coaxial system.

At the end of the war there was a very great demand for new long-distance communications, this applying also to Sweden. The studies which were carried out by the Royal Board of Telecommunications clearly demonstrated the economic advantages of the coaxial system. This led to the decision by L M Ericsson during the year 1946 to develop such a system.

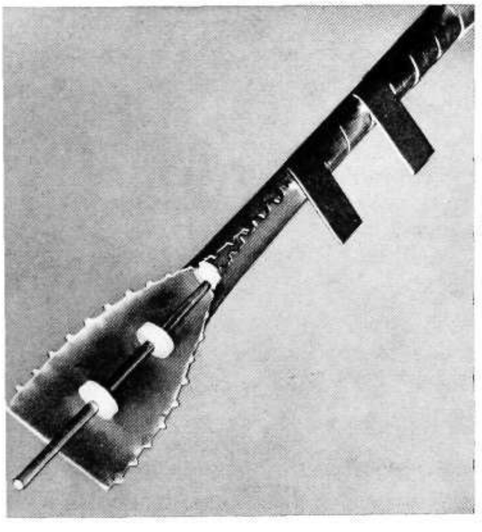


Fig. 3 X 2206

A coaxial tube of modern design

The internal diameter of the outer conductor is 0.375".

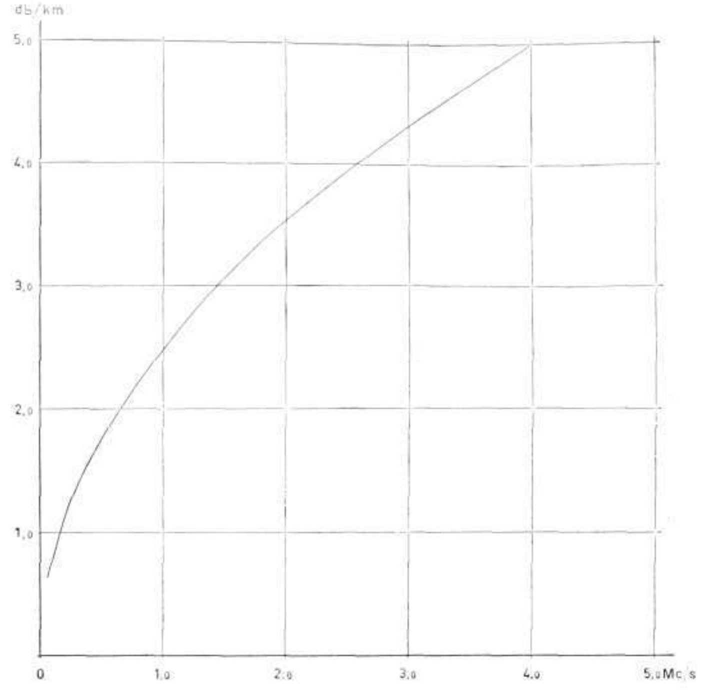
The Coaxial Cable

Even if the intention of this series of articles is to describe the characteristics of the carrier frequency equipment, a few words must be said about the coaxial cable so that the reasons for the design or "organization" of the system may be made clear. The vital transmission item in the coaxial cable is the coaxial tube, which in principle consists of a thin copper tube, in the centre of which is placed a solid copper wire supported by circular polythene washers spaced approximately 30 mm apart from each other. The copper wire (the inner conductor) carries the electric current in one direction and the copper tube (the outer conductor) acts as the return conductor. The attenuation of a coaxial tube having standardized dimensions varies with frequency in accordance with fig. 4. An important characteristic of the coaxial tube is that the crosstalk attenuation between two adjacent tubes increases with frequency. This characteristic together with that of the line attenuation, which at lower frequencies varies rapidly thereby making the equalization of attenuation at repeaters difficult, has determined that 60 kc/s has been chosen as the lower limit for the frequency band sent over the cable.

Fig. 4 X 8015

The frequency dependence of the attenuation in db/km at 20° C for a coaxial tube of normal type

6-tube cable manufactured by Sieverts Cable Works.



The upper frequency limit is, with the means which present techniques can offer, set at 10—20 Mc/s almost solely due to economic reasons.

In the system described here the upper frequency limit has been set at 4 Mc/s, or more accurately 4 092 kc/s, which gives an attenuation of 4.85 db/km at + 5° C. This in turn determines the separation between repeater stations at 9.5 to 10 km, as will be shown in more detail in a forthcoming article.

A distinguishing feature of coaxial cables is that, due to the high crosstalk attenuation between tubes, a tube for each direction of transmission can be contained inside the same lead sheath and a cable can contain several tube pairs. Cables containing configurations of 4, 6 and 8 tubes are the most common.

An advantage of the cable type is that the interstices which occur between the circular tubes can be filled with ordinary pairs or quads. Further, the core of the cable can be formed of layers of pairs or quads which with normal loading can be used for intermediate local communications along the long distance cable route. Hereby a significant economic advantage is of course obtained.

The voltage which the coaxial tube can withstand between inner conductor and outer conductor is so high that the requisite electrical power for operation of several repeater stations can be sent over the power line which can be formed from the inner conductors of two tubes.

Main Features of the System

It has already been mentioned that out of the potentially very wide frequency band, the range 60 kc/s to 4 092 kc/s has been chosen for the 960-circuit system.

This frequency band is employed in the system so that it is divided into 16 bands each of width 240 kc/s separated by spaces of 8 kc/s except between bands 1, 2, and 3 where the space is 12 kc/s (see fig. 5). Each of the 16 bands, a so-called supergroup, is composed of 60 telephone channels each of 4 kc/s nominal bandwidth. In the figure the frequency position of the so-called line pilots is indicated, i.e. signals which are continuously or occasionally sent out

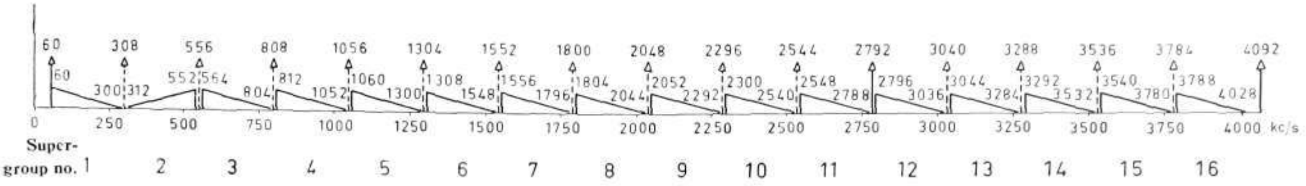


Fig. 5
X 7715
X 9149

Frequency spectrum for transmission on a h.f. line

Pilot frequency sent continuously

Measuring frequency sent occasionally

along the cable from a terminal. The characteristic of these pilots is that they are placed in the spaces between the supergroups or at the ends of the transmission band. Of the frequencies used continuously, 4 092 kc/s is used and sent out as the line regulating pilot which is used at each repeater station, 2792 kc/s is the line regulating pilot which is used at certain larger stations situated at a greater distance from each other, and 60 kc/s is the frequency comparison signal. The other so-called inter-supergroup pilots are only sent out occasionally and are used as measuring signals to check the levels along the cable.

As has been mentioned, the coaxial cable has rather a large attenuation which also varies with frequency. To compensate for this attenuation, repeaters are introduced at regular intervals along the cable. The maximum distance or rather the maximum amplification at a given upper limiting frequency for the transmitted band is solely decided by the output power available and the quality of electron tubes which are at one's disposal. The *choice of the upper frequency limit or of the transmitted bandwidth (which* in this case is the same) thereby becomes an economic question, dependent on the relationship between the price of coaxial tubes and repeater equipment.

The choice which was made already in 1947, of an upper frequency limit of approximately 4 Mc/s and a maximum amplification of 48 db (which permits a maximum repeater separation of about 10 km) has been a good compromise from the technical and economic point of view and is still valid today concerning new systems.

Due to the possibility of the feeding of power over the cable, a large number of repeater stations along the cable route can be made unattended. Normally about every 10th to 20th station is attended. At these stations, power feeding equipment is also located together with certain additional equipment for manual equalization of certain accumulating level variations. The sending amplifier equipment and the receiving amplifier equipment is placed at the terminal stations.

In this way a so-called h.f. line is built up, see fig. 6. As a rule the h.f. line is also a pilot section i.e. line pilots pass between both terminal stations without interruption.

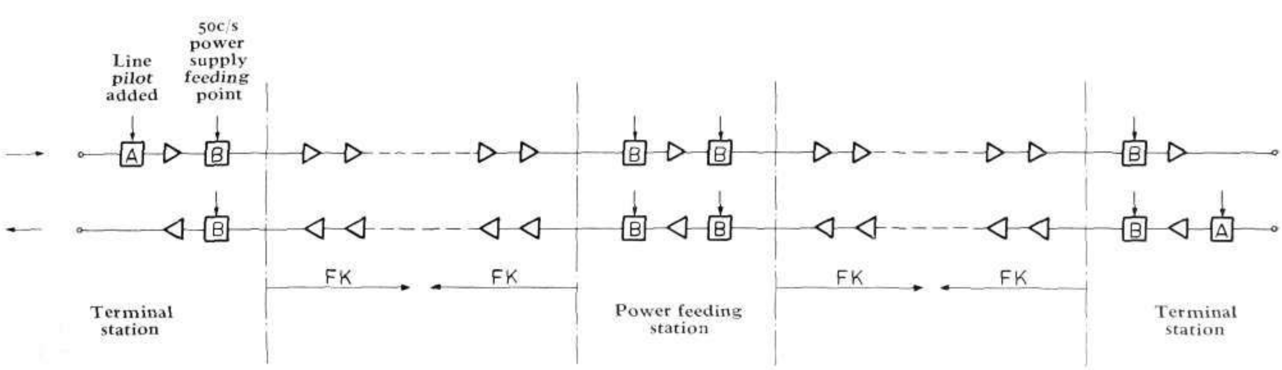
In the terminal stations the supergroups shown in fig. 5 are formed. This occurs, as in all Ericsson systems, by combining three channels to make a sub-group in the frequency range 6—18 kc/s at the first modulation stage. By repeated sub-group and group modulation, the following groups standardized by CCITT are formed, the basic group in the frequency range 60—108 kc/s containing 12 channels and the basic supergroup in the frequency range 312 to 552 kc/s containing 60 channels. The line frequency band of the coaxial system as shown in fig. 5 is obtained in the last group modulation in

Fig. 6
X 7716
X 9140

H.f. line. Very simplified block schematic diagram of a pilot section

FK Section for remote power feeding for up to 12 stations

Repeater equipment



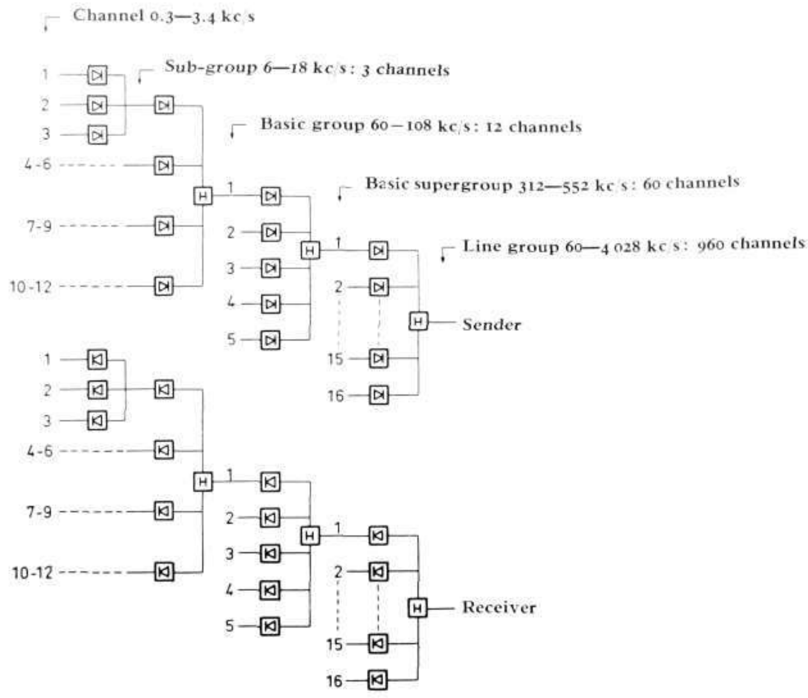


Fig. 7 X 8016

Very simplified block schematic diagram of the terminal equipment

accordance with the simplified block schematic diagram in fig. 7. A detailed survey of the lay-out of terminal equipment is given in a forthcoming article.

So far, the build-up of the coaxial system gives the impression of simplicity and straightforwardness. The picture is very much more complex when we proceed to the next chapter: Coaxial System Networks.

Coaxial System Networks

In leaving the simple case of pure terminal traffic on a coaxial cable between two stations and going on to consider the working on a coaxial cable system network which links the larger traffic centres, new requirements as regards system flexibility are necessary for economic reasons and also the transmission technical requirements must be improved for quality reasons.

The most important requirement as regards system flexibility is that it must be possible to through connect large blocks of circuits at a station where certain other blocks terminate without having to through connect on a voice frequency basis. This is an essential factor in the economics of the coaxial system, as a very large part of the cost of the terminal equipment is in the channel modulation equipment. For such through connexions, CCITT has recommended that groups of 12 circuits are through connected at 60—108 kc/s while groups of 60 circuits are through connected at 312—552 kc/s.

This latter factor is the indirect reason why the line frequency band for the 4 Mc/s system is divided up into 16 parts, each part consisting of a band of 240 kc/s or 60 circuits.

Both the through connexion facilities mentioned make it natural to introduce central "marshalling" or distribution points in the terminal equipments where through connexion and redirection of groups or supergroups can be carried out. These are the so-called group and supergroup distribution bays, see fig. 8.

To illustrate this, a typical station having four coaxial cables going out from it has been drawn in fig. 9. From the figure it is apparent that to each pair of tubes there is directly connected a so-called supergroup translating equipment. The duty of this equipment is to build up a line frequency band of 16 supergroups in the outgoing direction as shown in fig. 5, and to sepa-

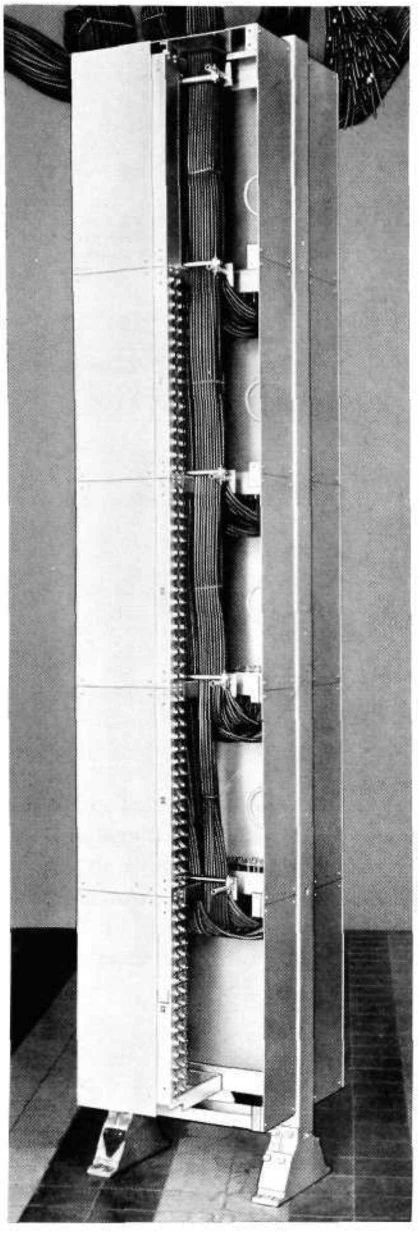


Fig. 8 X 2207

Supergroup Distribution Bay

The vertical jack field for the station side is nearest the viewer. In the rear is seen the horizontal jack field for the line side, each jack field catering for 16 supergroups.

rate and demodulate the line group frequency band into the component 16 supergroups in the incoming direction. These supergroups, now in the frequency band 312—552 kc/s, are sent to a distribution bay common to the station, where through connexion or termination can be carried out using cords. In the figure it is shown how supergroup 9 in the cable going to A via the distribution bay is connected to the group translating equipment in the station. Its function is to build up the basic supergroup from 60 channels in the outgoing direction and to break down the basic supergroup into 60 channels in the incoming direction by three stages of modulation and demodulation respectively. It is also shown how the incoming supergroup 15 in the cable coming from B via the distribution bay is sent to a through connexion filter and from there back again via the distribution bay to the outgoing side for supergroup 3 in the cable going to C. In the same way, the incoming supergroup 3 in the cable coming from C is connected to the outgoing supergroup 15 in the cable going to B. By this procedure, a block of 60 circuits has been transferred from the cable coming from B to the cable going to C without having been demodulated to the speech frequency band.

In characterizing a station in a coaxial network, the following concepts are employed.

HF Line Equipment, which comprises the outgoing and incoming amplifiers for each coaxial tube pair in the cable (terminal amplifier equipment).

Supergroup Translating Equipment, to which a certain cable, but not necessarily each tube pair is connected (it is possible to have stand-by tube pairs equipped).

Station Equipment for common functions, in which is included supergroup distribution frames, through connexion filters, group translating and channelling equipment, carrier frequency generators etc.

In addition to these characteristics it should be possible for a long-distance supergroup to be through connected at several stations. This leads to very high requirements concerning attenuation distortion and noise in the supergroup translating equipment and through connexion filters. It has also lead to a desire to be able to "mark" each supergroup so that it is possible to test each one. For this reason, each of the supergroups is provided, after it has been formed, with a pilot frequency of a precise value and level which then must follow the supergroup until it finally becomes broken down. Using special measuring instruments, the supergroup level can be tested during traffic at all through connexion stations.

In the supergroup translating equipment there exists also the possibility of introducing equipment for automatic level regulation of each incoming supergroup using supergroup pilots. In certain countries, through connexion of groups of 12 circuits also occurs. In principle it can be said that a new distribution frame is introduced between the second and third modulation stage in the group translating and channelling equipment shown in fig. 9. Even the 12 circuit groups are "marked" with a special group pilot frequency.

Technical Requirements for Transmission

When CCITT after the war took up its work again, it was clear that the coaxial system would be among the most important media for building up international communications. For this reason studies were immediately recommenced to decide on recommendations for the system. This work has now been carried on for ten years and has resulted in a large number of recommendations, which often go into very great detail.

One of the most important results has been the proposal of the so-called nominal maximum circuit for the 960-circuit system. This defines for calculation purposes a certain proposed usage and this is given in fig. 10.

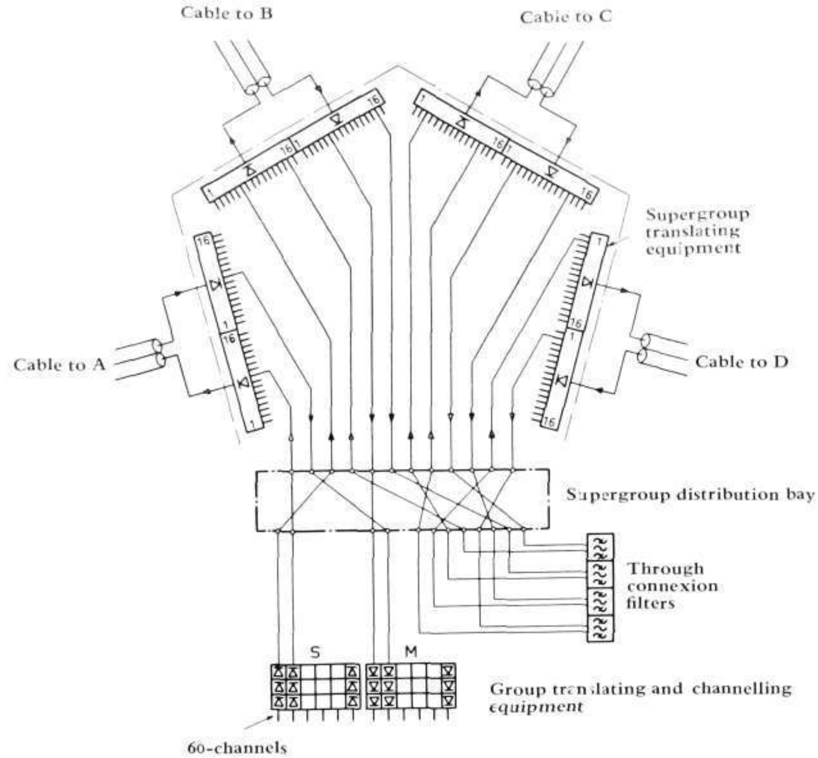


Fig. 9 X 8017

Station arrangement with through connexion and termination

The nominal maximum circuit is composed of 3 links connected in tandem with the links through connected at audio frequency. Each link contains one through connexion on a group basis and one on a supergroup basis and therefore consists of nine h.f. lines. The length of the nominal maximum circuit is 2 500 km. Each h.f. line is therefore assumed to have a length of 280 km. The system was originally defined so as to be able to fix the noise requirements. Today the average value of the noise in one channel over the whole length measured during the busy hour at a point of relative level 0 dbr should not exceed 10 000 pW. Of this value, 7 500 pW is allocated to the h.f. line and 2 500 pW to the terminal equipment.

Naturally, the nominal maximum circuit can also be used for other calculations or divisions of transmission requirements such as frequency stability, circuit level stability, intelligible crosstalk, circuit attenuation distortion etc. The creation of this nominal maximum circuit must be considered as one of CCITT's greatest contributions in the field of carrier frequency systems and it has been shown that it is very useful both to administrations and manufacturers to be able to have this circuit to fall back on when carrying out planning and design.

In the planning of the 960-circuit system, the following working targets were aimed at in the nominal maximum circuit.

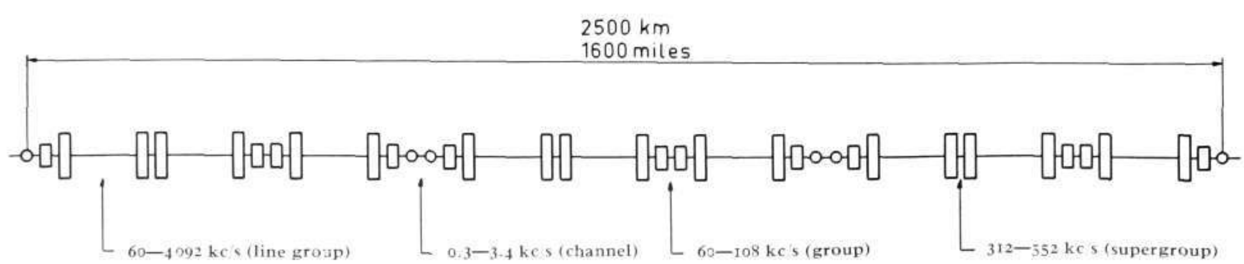
Noise including unintelligible crosstalk $< 10\,000$ pW
Average value measured during the busy hour at a point having a level of 0 dbr.

Intelligible crosstalk between circuits > 58 db
"écart diaphonique"

Fig. 10 X 7717 X 9141

CCITT nominal maximum circuit for 960-circuit system on a coaxial cable

- Channel Modulation Equipment
- Modulation and demodulation of groups to and from supergroups
- Modulation and demodulation of supergroups to and from the line group band



Circuit level stability	$< \pm 2$ db
Circuit attenuation distortion	Satisfying the requirement given in fig. 3, diagram 1 of Volume III of CCIF XVII Plenary Assembly
Frequency stability of the 800 c/s test tone	max $\pm$ 2 c/s

The sub-division of these basic requirements of the different parts of the system and how the problems are solved are given in the two articles to be published later.

The only serious criticism that can be directed against the nominal maximum circuit today is that it contains too few through connexions on a supergroup basis. The increasing use of coaxial systems in networks has meant that the number of through supergroup connexions can be from 8 to 10, even within one country. This in turn naturally means enhanced requirements for the supergroup translating equipment.

Signalling

Even on the subject of signalling, CCITT has in the past put in extensive work which has consisted of field trials over a long period using both 1-frequency and 2-frequency signalling within the speech band, to ascertain which of the two suggested systems was the most suitable for international semi-automatic or fully automatic use. The final result of this study was that both systems were recommended and freedom was left to the negotiating administrations to be able to choose the system which best suited the case in question.

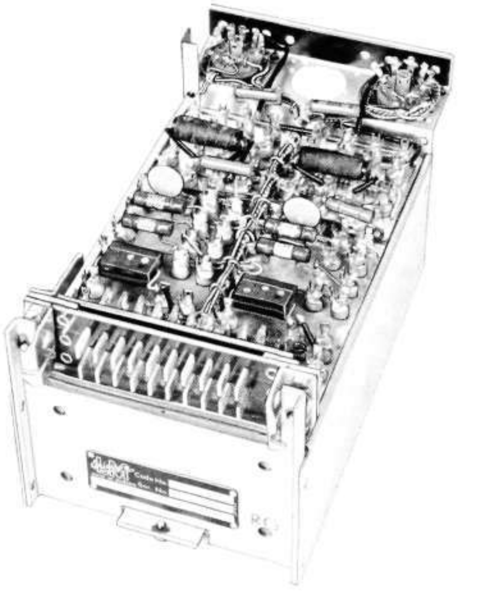
For the 1-frequency system, the frequency 2280 c/s was recommended, and for the 2-frequency system the frequencies of 2040 c/s and 2400 c/s were recommended. The frequencies chosen have been placed as high as possible within the speech band, taking account of what existing loaded cables could transmit without introducing too much attenuation. By selecting high frequencies the risk of signal imitation by speech currents in the channel is reduced.

In the planning of the construction of the voice frequency parts of the coaxial system, a very strong requirement was proved to be that of making the part consisting of four-wire termination, v.f. signalling receiver, channel amplifier and the pads for level adjustment as flexible as possible so as to be able to meet different customers' requirements. This question was solved by mechanically separating the channel filter equipment and those parts just referred to and putting them on different bays, and also as a consequence by introducing plug-in functional units to a very great extent.

Another requirement in the construction was that both 1-frequency and 2-frequency signalling equipment should be integral parts built into the carrier system whereby a saving of cost could be obtained. As the equipment was realized in practice, it is possible to take care of practically every occurring requirement regarding signalling systems and signalling frequencies of the 1-frequency and 2-frequency system type, using two variants of the voice frequency bay and variants of the signalling receiver units and relay equipment. Examples of 1-frequency and 2-frequency receivers are shown in fig. 11.

In latter years, interest has arisen in a new method of signalling on carrier systems where the signal is sent by means of a frequency placed outside the speech band. Using suitably designed filter protection, a signalling channel which is protected and independent of the speech channel can be formed. The frequency of 3825 c/s has been chosen as the signalling frequency. This

a



b

Fig. 11 X 2208 X 2209

1-, 2-frequency signalling receivers for in-band signalling

a) Two 1-frequency signalling receivers in a plug-in unit.

b) One 2-frequency signalling receiver in a plug-in unit.

makes a compromise between the desire of having the largest possible distance from the signalling frequency to its own speech band and to the neighbouring channel, and to carrier leaks and group pilots. The characteristics of this method of signalling are that signals may be sent while speech is present and that greater possibilities exist for sending continuous signals such as those that are present in pure d.c. systems than exist with the in-band systems. With certain special signalling or tariff metering methods, or with certain methods of building up intermediate relay sets, out-band signalling, particularly the continuous type, can be attractive.

This system has also been able to be included in the existing design of the 960-circuit system due to the flexibility of the voice frequency parts, as mentioned earlier.

Development Tendencies

The cable plant which comes into existence in the laying down of a coaxial cable represents a considerable investment. Partly from this factor and partly from "competition" with centimetre wavelength radio links with their lower plant cost, a desire has arisen that more intensive use could be made of the available frequency band of the coaxial tubes. To this must also be added that the existing 4 Mc/s band does not make possible the complete transmission of a 625-line television signal, which requires an effectively transmitted bandwidth of 5 Mc/s. As the special character of the television signal—the band between 25 c/s and 5 Mc/s must be transmitted—makes the transmission using single sideband with a suppressed carrier practically impossible, the transmission must take place on a vestigial sideband basis with a partly suppressed carrier, whereby a bandwidth of about 5.5 Mc/s is required of the transmission medium.

As a result of this struggle to obtain better use of the coaxial tube, the so-called L-3 system was developed at the end of the 1940's at the Bell Laboratories in U.S.A. This system had a transmitted frequency band of from about 300 kc/s to 8.5 Mc/s, whereby the repeater spacing was reduced to 4 miles.

Somewhat later in Europe, repeater equipment was developed for transmission of television signals having an upper frequency limit of about 6 Mc/s, and having practically the same repeater spacing as for the 960-circuit system. The repeater equipment however is rather complex and a great disadvantage is that when operating with telephone circuits, no more than 900 of these can be permitted.

For the present, development in Europe follows two lines, one towards the design of repeater equipment capable of operating satisfactorily over a frequency band of 300 to 12 000 kc/s, and the other towards an improved 6 Mc/s system. The final frequency plan for the first system, the so-called 12 Mc/s system, has not yet been decided by CCITT. However it is being planned to be similar to the L-3 system either for pure telephony operation when 2 700 circuits may be transmitted, or for combined operation when 1 200 telephone circuits and a 625-line television circuit can be transmitted simultaneously over a tube pair.

The increase in transmitted bandwidth is carried out in a similar manner to the L-3 system by halving the 4 Mc/s system repeater spacing, which means that the sections become 5 km max. The situation has not yet become clear concerning the economics of the system, except that it may be economically motivated to put the system in on existing cables when the 4 Mc/s system capacity is no longer adequate.

Improvements of the characteristics of electron tubes during recent years have meant that it may be possible to develop simple three stage repeaters for the 6 Mc/s systems while retaining the 4 Mc/s system repeater spacing

(10 km maximum) and in principle having the same design. Simultaneously the frequency band used for telephony can be increased to about 5.5 Mc/s thus taking care of 1 200 telephone circuits. No final frequency plan has yet been decided by CCITT. It is rather clear that this system is economical primarily for new installations of cable and equipment, and that its occurrence will provide very great competition with the 4 Mc/s system, particularly in the cases where television will also be transmitted on some of the tube pairs in the coaxial cable.

The terminal equipment characteristics are now, at least for systems with 4 kc/s carrier spacing, so bounded by CCITT recommendations that no further developments are likely at least as regards the frequency plan, except for the complementary group modulation stages that 12 Mc/s and 6 Mc/s systems require. Other characteristics such as frequency stability, noise, intelligible crosstalk, attenuation distortion etc., have in the main been fixed. These requirements have now been driven so far on many points that they are on the limit of what can be obtained in fairly rational production. There are many signs that future improvements will be concentrated on developing designs which are suitable for smoother production in order to obtain a reduction in costs.

The introduction of new components will naturally affect the construction and price, without however bringing with them radical alterations in performance. The introduction of transistors, primarily in the channelling equipment, will in this way facilitate a continued reduction of the equipment volume and result in an appreciable reduction in power consumption. Several of the factors named operate so that the coaxial system slowly but surely will reduce the distance below which the loaded cable is the more economic transmission medium.

Multi-Position C.B. Type Private Manual Branch Exchanges

W ADENSTEDT, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.26

Telefonaktiebolaget L M Ericsson has introduced a new type of switchboard for large P.M.B.X.s requiring more than one operator's position. In the design of these switchboards particular attention has been paid to low running costs and good telephone service, as well as to reliability and simplicity in handling. To facilitate installation, maintenance and future extensions, the switchboards are made up as building blocks complete with switchboard units, switching sets and relay sets. These switchboards, designated ADF 301 and ADF 302, will operate in conjunction with all automatic and manual public telephone systems.

The new C.B. type P.M.B.X.s possess all the normal facilities for calls between extensions and between extensions and public exchange subscribers, with dialling either by the extension or by the operator, and in addition many new features and finesses.

The first feature that strikes the eye is the introduction of the so-called multiple lamp system. This is most efficient for multi-position switchboards, and not especially costly since the usual form of separate answering fields with their intermediate distribution frame can be eliminated. The multiple lamp system enables all operators to answer any call that comes in. This evens out the work of operators, makes for better utilization of operators' time, reduces waiting time, eliminates concentration problems, and makes more efficient use of the switching units. The curves in fig. 1 show roughly the difference in traffic handling capacity between a system with separate answering fields and a multiple lamp system. The switchboards have also been equipped with automatic repeated ringing, which starts when the operator plugs up the ringing cord, while at the same time ringing tone is sent to the calling party. If required, switching over to manual ringing—to provide a less disturbing signal, which may be important at nighttime in hotels, hospitals, etc.—can be simply arranged.

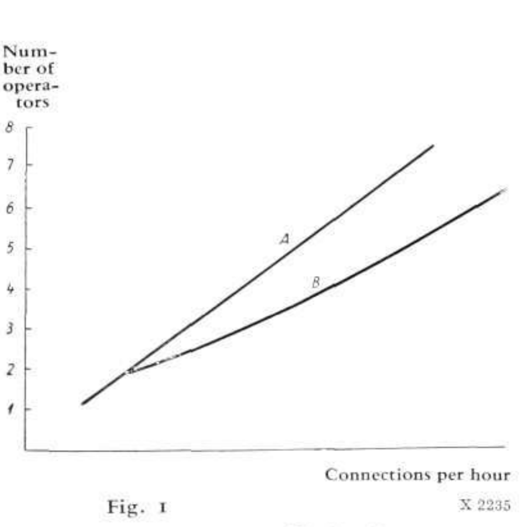


Fig. 1 X 2235

Difference in traffic handling capacity between a system with separate answering fields (A) and a system with multipled calling lamps (B)

If a requested number is engaged, the operator can plug the calling party to a waiting jack. A slowly flashing lamp reminds the operator that a call is waiting to be put through, while at the same time the waiting party hears an intermittent tone indicating that he is still connected to the switchboard. It is likewise possible for an operator to connect the line to a supervisory jack while waiting for a trunk call. This connection permits audible supervision of the expected trunk connection while the operator is answering other calls.

An operator can never listen to a conversation connected through any of the cord pairs without the conversing parties' knowledge. An intermittent tone is automatically extended to warn them that a third party is listening.

Transfer and enquiry facilities are provided on incoming exchange line calls and on outgoing calls established by the operator.

The exchange lines have been equipped with busy lamps so that the operators can easily and quickly find free lines in the group, and the busy test to extension lines is done with the tip of the ringing cord plug.

Fig. 2 X 8022
P.M.B.X. type ADF 301

During periods when the switchboard is unattended, all exchange lines can be placed on night service and the current to the switchboard can be cut off. The battery supply for night service extensions comes from the public exchange. The extension instruments should therefore be matched to the supply system of the public exchange. Every cord pair can be connected through individually, which enables an executive to have a direct line to the public exchange.

Fig. 3 X 7719
ADF 301, rear view with rear covers removed

Both switching sets and relay sets are made in the form of plug and jack units. If any unit in the switchboard is suspected of being faulty, it is a simple matter to remove it for inspection and adjustment, or replace it by another, without the operator's work being hindered.

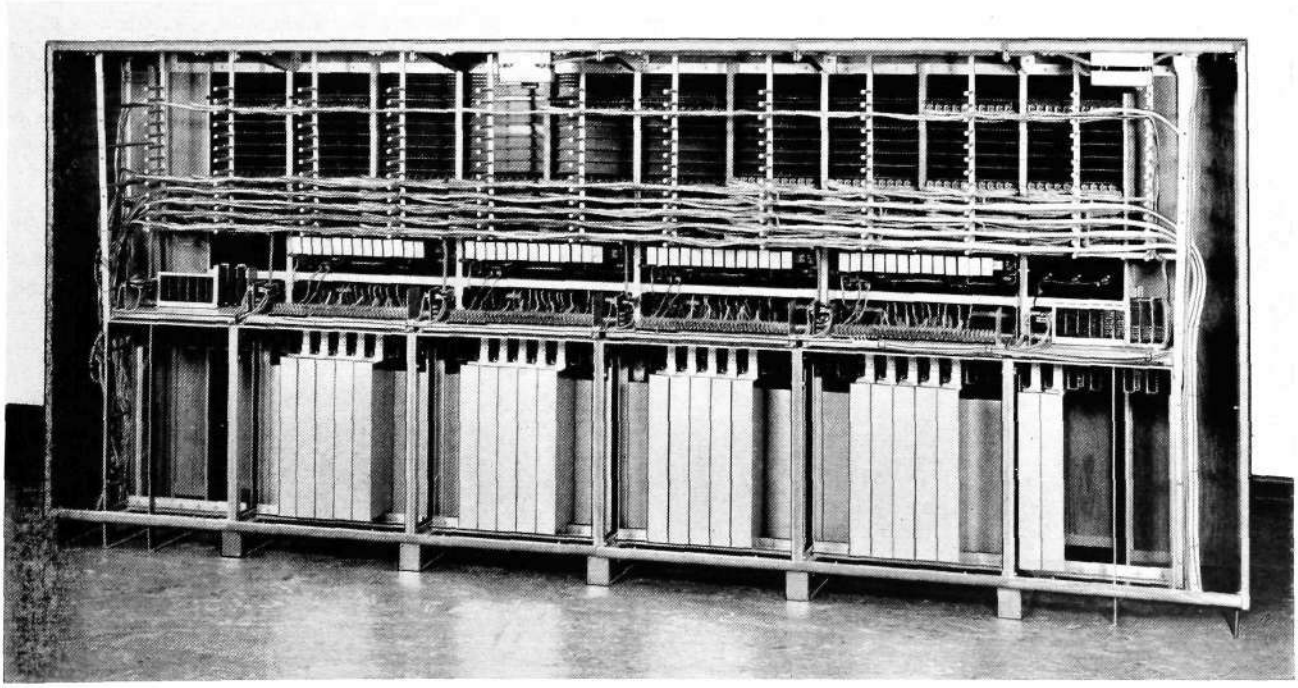


Fig. 4 X 2212
Relay jack

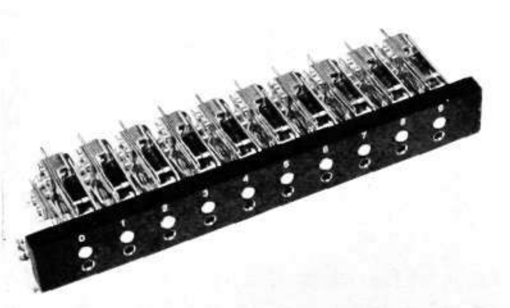


Fig. 5 X 2217
Line unit for extensions to ADF 301

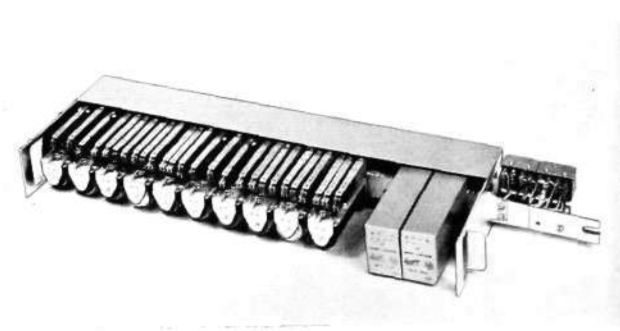


Fig. 6 X 7719
Relay set with front cover removed

The switchboards are designed for an operating voltage of 24 ± 4 V. The system works with a line resistance of 500 ohms and leakage resistance of 15,000 ohms.

The current consumption during the busy hour is about 2 amps per position.

Construction

The suite is composed of single position sections with two-panel jack fields. Every section is made up of a steel frame and all woodwork consists of oak veneered laminated boards.

The keyshelf accommodates 18 switching sets and 1 position set. The keyshelf is lined with green linoleum and forms an admirable writing surface. Under the keyshelf is a compartment for the operator's personal belongings. A metal kicking shield is provided along the bottom of the board. The rear cover consists of a light wood fibre board with deal frame.

The cable turning units that are always placed at each end of a suite resemble the normal operators' positions but have a single-panel jack field, so that the first and last operators in the row have the same access to a complete multiple as the intermediate operators. The cable turning units are spaceous and incorporate all incoming cables as well as certain equipment common to the suite. Figs. 2 and 3 show a P.M.B.X. consisting of four operators' positions and two cable turning positions.

The frames of the line units are made of nylon-filled thermoplastic. The equipment for every line consists, in the first multiple appearance, of a relay, jack and lamp combined into a single unit, the relay jack (fig. 4). Fig. 5 shows a line unit consisting of ten such relay jacks. Despite its compact construction, all springs are readily accessible for inspection and adjustment. The first multiple appearance has complete relay jacks, whereas the remainder of the multiple has no relays and thus comprises units consisting of jack and lamp only, made up in sets of ten.

The vital element of the switchboard, the cord pair equipment, consists of two units—the switching set, used by the operator and therefore placed on the keyshelf, and the relay set located at the back of the position. Both units are connected by multi-pole plugs and jacks. The relay set comprises equipment for two cord pairs, so that it is advisable to always equip every position with an even number of cord pairs. The switching sets (fig. 7) have frames of nylon-filled thermoplastic, which has a high mechanical strength and good tropicproof properties. The cord circuit keys are equipped with frames of die cast zinc, which ensures a high standard of precision in key operation. The springs have twin contacts to ensure reliable contact performance. Fig. 6 shows the cord relay set with the protecting cover removed. All relay springs naturally have twin contacts.

The exchange line call relays have also been assembled into relay sets located at the rear of the left-hand cable turning position. Each of these relay sets serves 10 exchange lines. At the right of fig. 3 are seen two such exchange line relay sets.

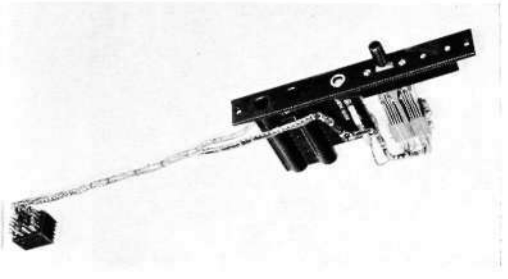


Fig. 7 X 2211
Switching set

The position equipment, i.e. the common equipment for one operator's position, is divided into two units. The larger unit (fig. 8), comprising the position set proper, is placed on a cross-glued oak board covered on both sides with paper laminate. This unit is located in the vertical field below the jack panel. The position relays, keys, jacks and lamps are mounted on this unit, being connected by multi-pole plugs. On the front of the position set are seen the jacks for the waiting and supervisory circuits, the keys for audible calling and clearing signals and for switching from automatic to manual ringing, as well as a pilot lamp with white lens and a fuse lamp with red lens. The splitting key and manual ringing key, as well as an observation lamp, have been mounted on a smaller unit (fig. 9) and are wired to a multi-pole plug. The smaller unit is placed on the keyshelf beside the cord pairs.

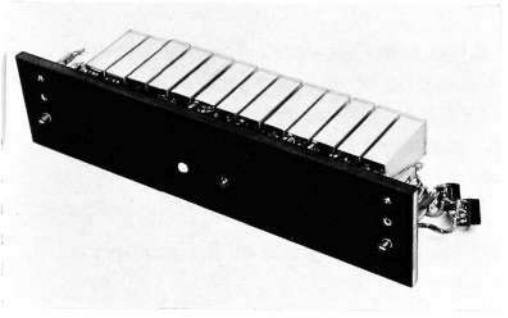


Fig. 8 X 2215
Position set

For the interconnection of relay sets, switching sets and position sets, some form of wiring unit is required. This unit, known as the switchboard unit, has been designed as shown in fig. 10. The switchboard unit also accommodates fuses for the cord pair relay sets and for pole changers. In addition, there are cord terminal blocks, cord fasteners and screw terminal blocks for the ringing source, manager's telephone instrument, hand generator and dial.

All components have been designed to withstand tropical climates. Plastic insulated wire is used throughout. All vital components are protected against dust to the greatest possible extent.

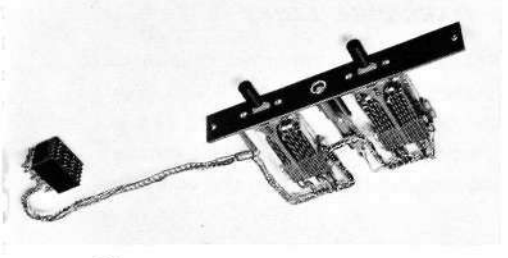


Fig. 9 X 2216
Splitting and ringing key unit

ADF 301

ADF 301 has a maximum capacity of 40 exchange lines and 480 extensions. The number of exchange lines can be increased at the expense of the extension lines. The space for multiple wiring is so ample that the wiring can be formed as a circular cable as shown in fig. 11, which can be easily made up by the installation personnel. All relay equipment is mounted inside the switchboard, which makes installation work easier and cheaper and reduces the space required for the plant.

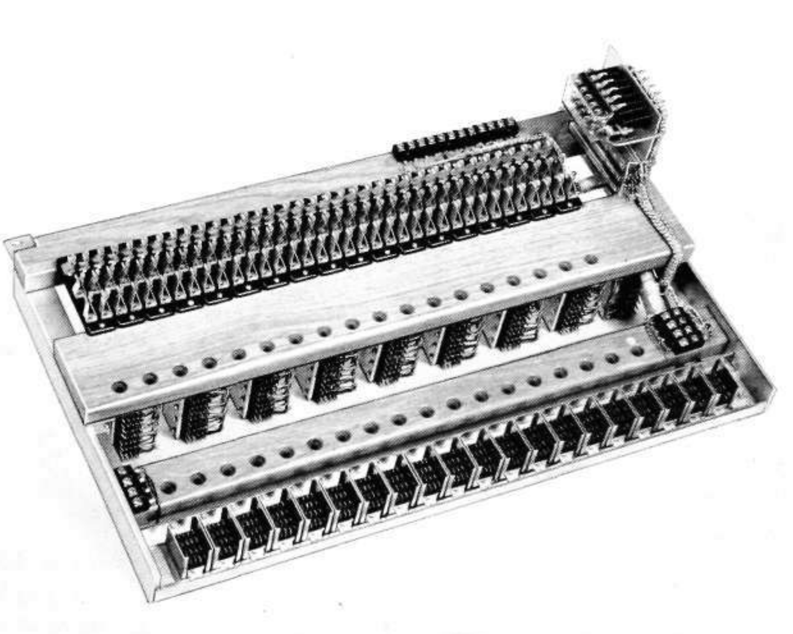


Fig. 10 X 8021
Switchboard unit

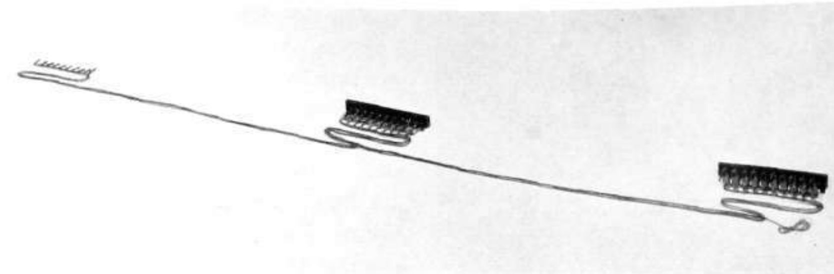


Fig. 11 X 8023
Multiple cable for ADF 301

ADF 302

In this switchboard the line and cut-off relays have been placed in a separate rack so that the extension multiple can be made up of ordinary jack and lamp strips, each strip accommodating 20 jacks or lamps. By this means a maximum capacity of 40 exchange lines and 1,400 extensions has been attained. The number of exchange lines can be increased at the expense of extension lines.

In this type of switchboard the multipling must be composed of flat multiple mats as shown in fig. 12.

Accessories

Equipment for Magneto Public Exchange Lines

Exchange lines to a magneto public exchange must be equipped with special relay equipment. On plugging up to a magneto exchange line, a call signal is automatically sent to the magneto exchange. When the extension handset is replaced at the end of conversation, a clearing signal is sent to the exchange. Under night switching conditions the calling and clearing signals are controlled from the extension's C.B. instrument.

Main Distribution Frame

The M.D.F. constitutes a link between the switchboard and lines. It enables the lines to be easily moved to any desired position in the switchboard multiple, which is a valuable feature when a person transfers to a new office but wishes to retain his old telephone number.

A suitable M.D.F. is BAB 25 with connecting strips NEL 1105 and test jack strips RNR 1001. This M.D.F. can also accommodate protector strips NFL 3245 with fuses and overvoltage arresters.

Extension lines, being normally located indoors, need not generally be protected against overvoltages. If there are lines subject to the risk of overvoltages, they should be equipped with overvoltage arresters and fuses.

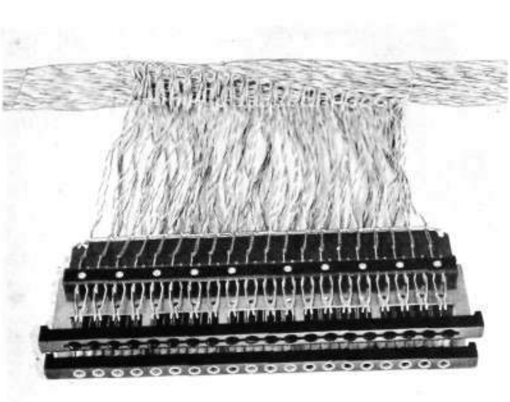


Fig. 12 X 2218
Jack and lamp strip for ADF 302 wired to the multiple mat

Ringing Equipment

A ringing machine is required to generate the ringing current. In small and medium-sized plants the ringing machine may consist of a pole changer of type RGN 6012, made up of a relay, a transformer and a capacitor accommodated in a metal box. RGN 6012, which is operated by a primary voltage between 20 and 28 V, supplies a 25-cycle ringing current with a power sufficient for simultaneous ringing on ten bells.

If A.C. supply is available, a frequency transformer of type RES 250 can be used. These transformers are made up in different designs according to whether they are to operate on 50-cycle or 60-cycle systems. The frequency transformers have no moving parts subject to wear and are, therefore, a more reliable source of ringing current.

If mains failure is of common occurrence, it is advisable to combine the frequency transformer with the pole changer RGN 6012. By being connected to a switching relay of type RGN 6030, it is automatically switched into circuit in the event of current failure.

Power Plant

The most reliable and uniform current supply is undoubtedly obtained from storage batteries with automatic charging unit. For the switchboards under consideration it is advisable to use a storage battery with a capacity of about 15 Ah per position. In considering the design of the power plant, attention should be paid to the anticipated ultimate capacity.

The battery charging unit should recharge a run-down battery after about ten hours. The following types of charging units, designed for connection to an A.C. system, are recommended.

Code	Current rating	Frequency	Suitable final capacity
	A	c/s	
BMM 1832	4	40—60	2—3 positions
BMM 1923	8	40—60	4—5 »
BMM 1924	12	40—60	6—8 »

If there is very little risk of failure on the A.C. supply system, the battery can be eliminated and a mains-connected power unit can be used instead. The following types of unit are recommended:

Code	Current rating	Frequency	Suitable final capacity
	A	c/s	
BMN 3202	6	50	2—3 positions
BMN 3301	12	50	4—6 »

These units will operate on mains voltages of 110, 127 or 220 V.

The L M Ericsson Attendance Time Recorders

E LUNDQVIST, TELEFONAKTIEBOLAGET L M ERICSSON, DIVISION ERGA, STOCKHOLM

U.D.C. 681.174

When L M Ericsson some thirty years ago started to make time recorders this was on a rather modest scale. The production rate has since then gradually increased and by now there are about 20,000 L M Ericsson machines in operation. In addition L M Ericsson attendance time recorders are produced on license in England where over 12,000 recorders have been manufactured.

The requirements on a time recorder for attendance control with regard to reliability and mechanical strength are very exacting indeed and in addition a comparatively long operational life is generally expected, about 15 or 20 years. The development of new designs in this field is, therefore, rather a slow process as each mechanism and piece part must be subjected to penetrating and above all time-consuming laboratory tests and field trials. A series of engineering developments and revisions have recently been concluded based on many years of experience with regard to installation, operation, maintenance and production in different countries and in a wide variation of conditions. This work has resulted in a range of improvements on already existing card operated time recorder models and also in a number of new types of machines. At the same time all production of handle operated time recorders has been terminated. A presentation of the L M Ericsson new card operated fully automatic attendance time recorders should, therefore, be of general interest.

In the past a time recorder was generally looked upon as something necessary evil, a watchdog keeping a severe eye on anybody being late for work in the morning. The disciplinary aspect of the time recorder still remains but nowadays other tasks are considered more important particularly the collecting of the basic data which is required by the accountancy and personnel departments in an organization. Added to this public authorities and other institutions must in these days be provided with an ever growing amount of statements regarding illness, holidays, overtime &c. At the same time the time card is more and more being regarded as a contract between the employee and the employer. Whereas time recorders earlier were used almost exclusively for labour paid by the hour in factories and works, they are now just as common in offices, banks and warehouses with salaried staff. The reason for this is obviously not the need for more rigid discipline but the fact that a check system with time recorders has proved to be not only the most reliable but also the cheapest method of obtaining the data required for wages and personnel accounting.

It is, therefore, evident that the requirements on a modern time recorder differ considerably from those prevailing, say, 25 years ago. Instead of the ancient time clock, severe in lines and action, and with a slight touch of Gestapo in it, people now want a machine of the same nature as an office machine, a typewriter or a calculator. Apart from an attractive appearance, which in itself is of no small importance, this means that the machine always, also out of normal clocking hours, should be immediately ready for use and easy in operation with a minimum of manual controls. It also means that the registrations without exceptions should be clear, certain and easy to read.

The degree of fast and automatic action depends on the one hand on the printing process as such and on the other on the method of separating successive registrations. From the first of these requirements follows that the printing action should take place on the insertion of the card in the receiver without

Fig. 1 X 2220
Time recorder KCA 310—KCA 339 for attendance registration

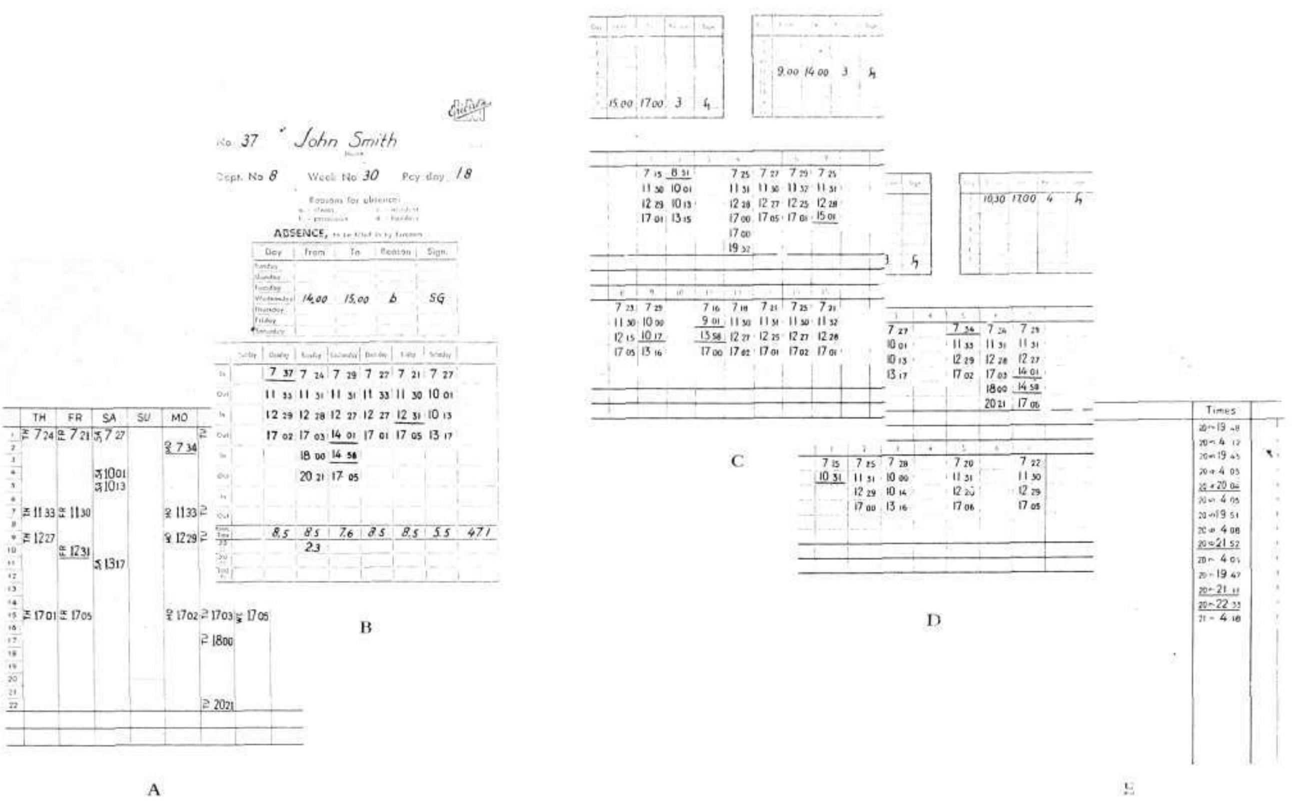


Fig. 2 X 7722

Different methods of registration on the time cards

A Time controlled printing location
B LME registration with consecutive spacing, weekly cards
C Semi monthly card
D Fortnightly card
E Single column card

(Underlined recordings are actually printed in red.)

the agency of handles or keys; from the second that the location of the registrations on the card must be fully automatic and that the layout of the registrations is easy to read.

Location of Registration

If the more or less manual methods of card setting are disregarded, as being definitely obsolete, there are at present two methods in use for the location of each particular registration to a particular place. In one of these systems the clocking position is controlled by time, the printing spaces being moved vertically at intervals according to a predetermined time program. According to the other the registrations are placed one under the other irrespective of time i.e. two consecutive recordings on the same card will always appear adjacent to each other.

With the first mentioned system the registrations will be scattered down the card (A in fig. 2). There are usually about twenty printing positions in a column and the registartions will appear in each of these during a certain time period. This means that, if two recordings are made during the same period, they will be printed in the same space. The time program for the space shifting must, therefore, be arranged not only with reference to arrival and departure times but also to the probability of irregular recordings at different times of the day. Overtime before and after normal working hours must also be considered.

The L M Ericsson time recorders are designed according to the second alternative, which we may term consecutive spacing (B in fig. 2). With this method overprinting, i.e. two different recordings in the same space, is principally impossible. No time program is required and the registrations always appear in the correct positions one immediately under the other irrespective of their referring to overtime, short absences or normal clocking time. This

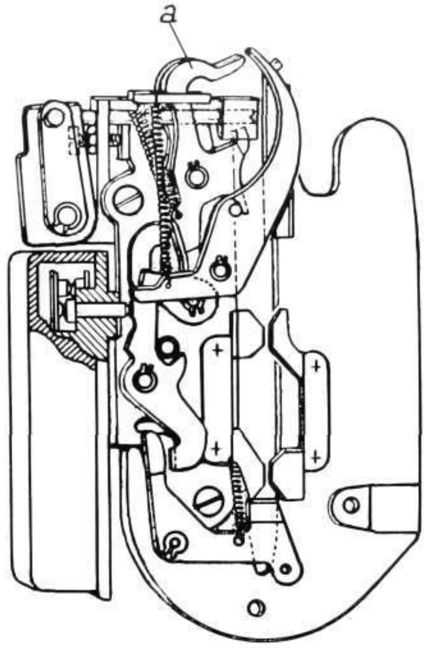


Fig. 3 X 2223

Card locating mechanism

a locating levers

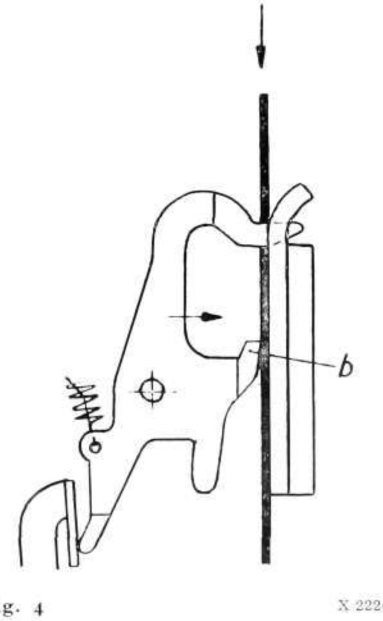


Fig. 4 X 2224

Locating lever arresting the card

b stopping edge

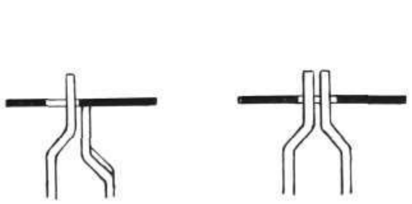


Fig. 5 X 2225

Locating action

left, one locating lever entering hole, right, both levers entering

is particularly valuable in offices and warehouses where arrivals and departures necessarily vary more than elsewhere. Personnel with irregular working hours such as cleaners, van drivers and night watchmen can use the same machine as the rest of the employees without any special arrangements having to be made.

With the consecutive spacing the registrations are printed in an office-like manner with one entry under the other. The compact form of the recordings makes the card clear and easy to read; the eye does not have travel up and down the card to find the different registrations.

The cards for the L M Ericsson time recorders have vertical day columns. If the pay-period or check-period is one week, the card has seven day columns with space for eight clockings per column (B in fig. 2). This machine agrees as regards function with the standard type which has been marketed by L M Ericsson for many years.

A new development is a machine producing 16 record spaces per column (D in fig. 2). The card is divided in two sections each intended for one week. The first week is printed in the upper section and the second week in the lower section of the card. Another new type is intended for cards with eight slightly narrower columns also divided in two sections (C in fig. 2). This machine may be used when the pay-period is half a month or a full month. Each end of the card can be used for clocking during 16 days. On each of types C and D the card layout normally allows six registrations per day.

Finally in another new model the recordings are arranged in one single column with space for 22 clockings (E in fig. 2). This type of recording is particularly useful for shift-work in three shifts, where registration in separate day columns as a rule is not quite satisfactory. This machine is also excellent as job coster and as dual purpose machine for both attendance recording and job costing in small factories, garages and jobbing workshops.

Mechanical Design of the Card Locating Mechanism

On the L M Ericsson time recorders the consecutive spacing is achieved by means of hole-punching. On each clocking a hole is punched at the side of the registration. When the card is printed the first time in a column and is pushed down the card slot, it is halted by a fixed stop. For subsequent registrations in the same column the card is arrested by a locating mechanism which catches in the hole previously punched. This mechanism (fig. 3) consists of two locating levers which are pressed against the inserted card by a system of levers and spiral springs. When a hole arrives in front of the locating levers, these will be rotated forward causing a sharp edge on each lever to jam the card against the frame just below the hole (fig. 4). It should be noted that the locating pointers which enter the hole in the card, do not themselves halt the downward movement, as was the case on previous models. The halting action is wholly due to the stopping edge on the levers jamming the card and this explains why closer spacing now can be produced without any danger of the card being torn or ripped.

The double locating lever arrangement allows wider variations on the card width. In previous designs, where one locating lever was used, excessive side play of the card could result in a hole passing at the side of the locating pointer, which then would fail to enter. The two locating levers in the present design can enter a hole independently and one or the other or both will always be in the path of the hole (fig. 5).

Time recorders with consecutive spacing require accurate sideway location of the card. In the L M Ericsson recorders the sideway movement of the card receiver is obtained by means of a worm spindle allowing a minimum of lateral play. An improvement has been made on the new models by the introduction of a six-start worm spindle in place of the earlier two-start spindle. The operation of this new spindle has proved very satisfactory in the most adverse conditions.

Fig. 6 X 2221

Reserve handle

fitted on time recorder

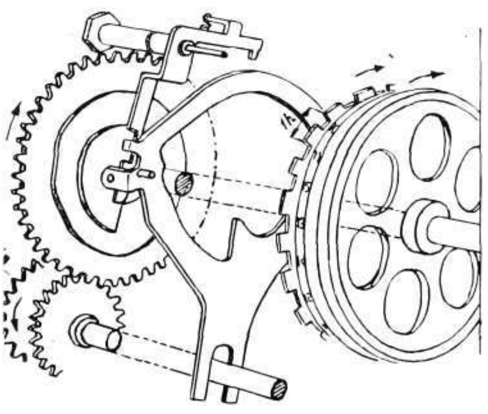


Fig. 7 X 2226

Stepping movement for hour printing wheel

Automatic Printing

The L M Ericsson new time recorders have been designed with special attention to easiest possible clocking procedure, high clocking speed, one-hand operation and lowest possible noise level. The operating time is less than 1/10 sec. and the machine is after an operation immediately ready to make a new impression. The clocking speed is, therefore, not dependent on the machine as such but is limited by other factors such as the finding and reinsertion of the time cards in the card rack pockets, the nimbleness or slowness of different individuals and local layout. Thirty recordings per minute has proved to be a fair maximum although the interval between two successive clockings sometimes may be one second or less.

The printing mechanism in the L M Ericsson time recorders is operated by two powerful electromagnets. The power supply consists of a rectifier fitted inside the machine which can be connected direct to the electric mains of 220 V or 110 V A.C. or D.C. The magnets are controlled by a contact spring set which is closed when the two locating levers enter a hole or when the bottom edge of a card not previously punched hits a platform. The contact is opened as soon as the printing action is completed and cannot be closed again until the card has been pulled out of the recorder. It is, therefore, impossible to make several recordings in the same position. If the card is lifted before the printing action is completed the contact will break and the action is discontinued and it is, therefore, equally impossible to produce a recording if the card is not in the correct position. The operating time varies between 50 and 100 msecs depending on variations in the mains voltage.

Reserve Handle

In certain districts mains failures occur frequently. The L M Ericsson time recorders can, therefore, be fitted with a reserve handle when necessary (fig. 6). The reserve handle mechanism is a selfcontained unit which can be fitted on all present types of machines. It is mounted on the inside of the cover on the right hand side of the machine and has been given a shape and position not inviting to use unless required. The printing mechanism is operated when the handle is pulled forward.

Printing Wheels

Time recorders for cards covering a week, a fortnight, half a month or a full month, i.e. 7-column or 8-column machines, print the time in hours and minutes. Single column machines print in addition week number and week day.

The hours are registered in accordance with the 24-hour system but machines can be supplied for 12-hour system with P.M. figures underlined. The minute registration may be printed either as ordinary minutes or in 1/10 hour or to nearest 1/100 hour.

The step by step movement of the hour wheel is controlled by a cam disk on the minute wheel spindle in cooperation with a stepping plate (fig. 7). The mechanism is designed in such a way that the hour wheel is locked in all positions of the minute spindle and it cannot, therefore, be brought out of phase accidently when the cover is removed for ribbon replacement, setting operations &c. Day wheels and week number wheels on single column machines are operated by a tripping mechanism of the disk and pinion type.

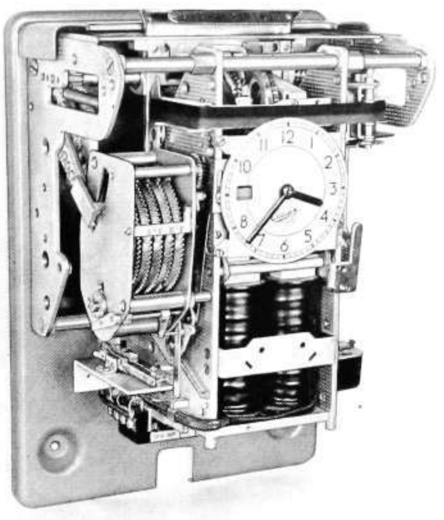


Fig. 8 X 2222

Sound signalling device

mounted in the bottom left hand corner of the machine

Driving Mechanism

The L M Ericsson time recorders are operated by 1/1-minute master clock impulses. The impulses operate an electromagnetic stepping mechanism driving the printing wheels, the dial on the front of the machine, program unit and card receiver day change mechanism. The current consumption is 60 mA per impulse for the standard voltage 24 V.

In districts with reliable frequency controlled A.C. mains it is, particularly for small installations, possible to connect the machines to the electric supply voltage in order to cut out the cost for master clock and power supply.

In such cases the time recorder is provided with a synchronous motor attachment which is mounted as a selfcontained unit inside the machine. This attachment can be supplied for 220 V or 110 V, 50 c/s or 60 c/s.

Program Unit

The L M Ericsson time recorders are provided with two-coloured ink ribbon and clock regular time in blue and the late arrivals, early departures, breaks and other irregularities in red.

The colour changes take place automatically and are controlled by a program unit inside the machine which also controls the card receiver day change movement. The setting of a required colour change program takes place by means of small flat program pins being inserted in narrow slots arranged round the periphery of the four program wheels in the unit. Colour changes can be arranged on even 5-minute intervals but other times can be set by the use of specially bent pins. The four program wheels are in action one at the time and in a sequence which allows a deviating program on one day in the week, usually the Saturday.

A sound signal device can when required be fitted in conjunction with the program unit. This device will operate bells or buzzers at the colour change times to indicate starting and stopping of work. The signals can be automatically cut out on Sundays or any other day if required. The duration of the signals is adjustable between 5 and 15 secs. The operating voltage for the signal device and the bells may be obtained from existing 24 V battery or from a separate 24 V bell transformer.

General Mechanical Construction

In the design and engineering of the L M Ericsson new time recorders a considerable amount of work has been spent on the selection of raw material, tolerances and manufacturing methods. Accelerated laboratory tests have been made on separate units as well as complete machines with considerable margins outside normal life. As an example may be mentioned a test on a complete machine closely assimilating actual working conditions. At the end of 1 1/2 million registrations the wear was found to be so insignificant that the operating margins before and after the test were practically indentical. Apart from laboratory test field trials have also been carried out.

All spindles and pivots are made of stainless steel and other steel parts are zinc plated ensuring a minimum of corrosion. Heavily loaded cam disks, pawls and ratchets are made of steel alloys and hardened. The program wheels are turned from brass hot stamping to ensure highest possible strength of the segments between the program slots. The printing wheels are zinc alloy die-castings of the same quality as in the past has proved to stand up to the hammer action very adequately.

As shown in figs 1 and 6 the new L M Ericsson time recorders are enclosed in a moderately streamlined cover finished in grey-green hammer-tone stove enamel. This finish produces a smooth and durable surface which is easy to keep clean.

The cover contains a compartment for the collection of the punch bits from the cards. It is also provided with a lock to prevent unauthorized access to the interior. The removal of the cover is very easy, the only operation necessary being the turning of the key in the lock. When the cover has been removed all parts for the setting of the machine and replacement of ribbon is readily accessible from the front.

The design of a good time recorder must in mechanical respects combine fine tolerances with robustness. The close tolerances are necessitated by the watch and program character of the machine with requirements of correct identification of each of the 10,080 minutes in a week, to mention one example only, and on the other side by requirements related to the printing process to produce clear, uniform and correctly positioned registrations. At the same time the recorders must stand up to very rough treatment and operate satisfactorily in unfavourable conditions. Added to this the fault rate must be low, for one thing due to the fact that the machines themselves record their fault in no uncertain manner.

From the above it should be clear that these fundamental requirements have been well satisfied in the development of the L M Ericsson new time recorders particularly in view of the technical and scientific resources and the long tradition of quality engineering which are behind its production.

Mechanization of Duct Manufacture

N SIDENMARK, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.315.233

The majority of cables in a modern urban network are placed in conduits. The ducts may be made of different materials such as concrete, tile, fibre etc. L M Ericsson's ducts consisting of precast concrete blocks 1 metre in length, with one or more ducts in each, have been used for more than 50 years and still stand up to the high requirements that must be placed on an underground cable installation.

Until a few years ago ducts were hand-tamped (see Ericsson Review no. 1, 1938, and instruction N 1531—001). In view of the universal rise in wages and the greater demands for rapid, uniform production with unskilled labour, a mechanical form of production became an urgent requirement. In collaboration with Ottoverken of Borrby, therefore, Telefonaktiebolaget L M Ericsson has designed a compressor-vibrator machine for 4-way ducts, with which conduit construction can be carried out much more rapidly. The machine also produces ducts of higher quality despite the lower quantity of cement employed.

1. Importance of Underground Conduits in a Telephone Network

When planning a telephone network, attention must be paid not only to keeping down first costs and reducing service interruptions as far as possible, but also to the possibility of rapid and inexpensive extensions of the network to keep pace with the rise in subscriber density. Underground conduits have long been found to be the generally best solution. This method of construction employs a piping system laid at a depth of 0.8—1 metre, into which the telephone cables can be pulled. To facilitate the pulling-in of the cables, manholes are placed at intervals of 80—100 metres along the system.

The laying of conduit to cater for the requirements during a period of 15—20 years is admittedly quite costly, but involves the following important advantages:

1. Rapid and inexpensive installation of cables.
2. The cables are well protected against mechanical damage, and a minimum of interruptions in the service may be anticipated.
3. When an extension is to be made, the work is limited to pulling-in a cable containing the desired number of pairs into an empty line of ducts without the need of excavating the roadway. With armoured cables buried directly in the earth, on the other hand, every extension will involve the digging and filling in of a cable trench, with the consequent expense of breaking up and relaying the roadway.

2. Different Types of Conduit

Conduit systems may be divided into two main types, one employing precast units, the other using ducts cast on site.

L M Ericsson's conduit system belongs to the first type, the units consisting of concrete ducts one metre in length, generally 1—4-way (earlier up to

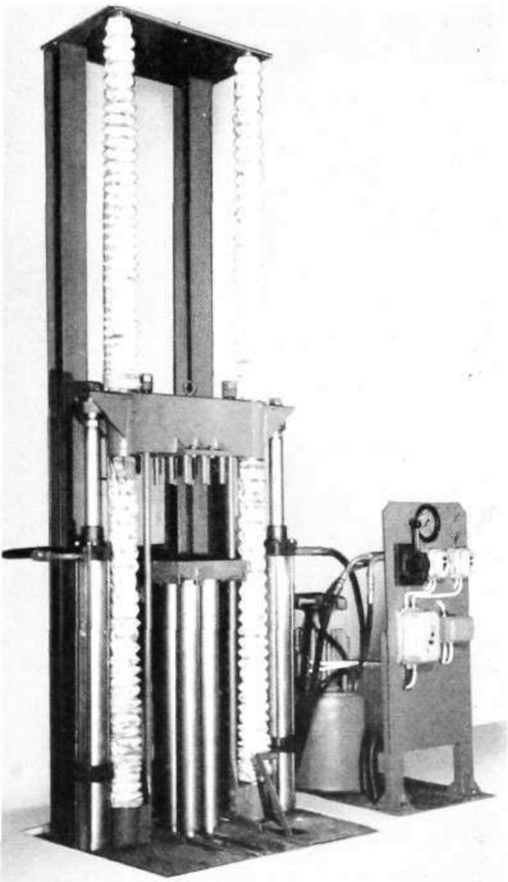


Fig. 1 X 2228
Compressor-vibrator LVA 3015

37-way ducts were used). The inside diameter of the ducts is 90 mm, permitting the pulling-in of cables of up to 75 mm diameter. Tile ducts with up to 8 ducts, used especially in U.S.A., also belong to this type. For ducts cast on site, use is made either of fibre tubes, Eternit tubes, or the like, which are cast in a concrete bed, or of inflated rubber tubes which, when the concrete has solified after a couple of days, can be deflated and withdrawn.

3. Mechanization of Duct Manufacture

In our mechanical age the old method of hand-tamping must be considered outmoded. It may still be warranted in small telephone networks, since the transport and installation of a large machine for only some tens of thousands of duct metres would not pay. But for systems comprising 5,000 lines and upwards, requiring 50,000 duct metres or above, a mechanical form of duct making must be profitable.

At the same time a hand tamped duct can never be watertight; to become watertight, the concrete must be vibrated. The need of watertight ducts arises now and again, as in low-lying city areas, and the possibility of manufacturing watertight ducts may mean the avoidance of expensive armoured cables which always cause trouble in any extension of networks.

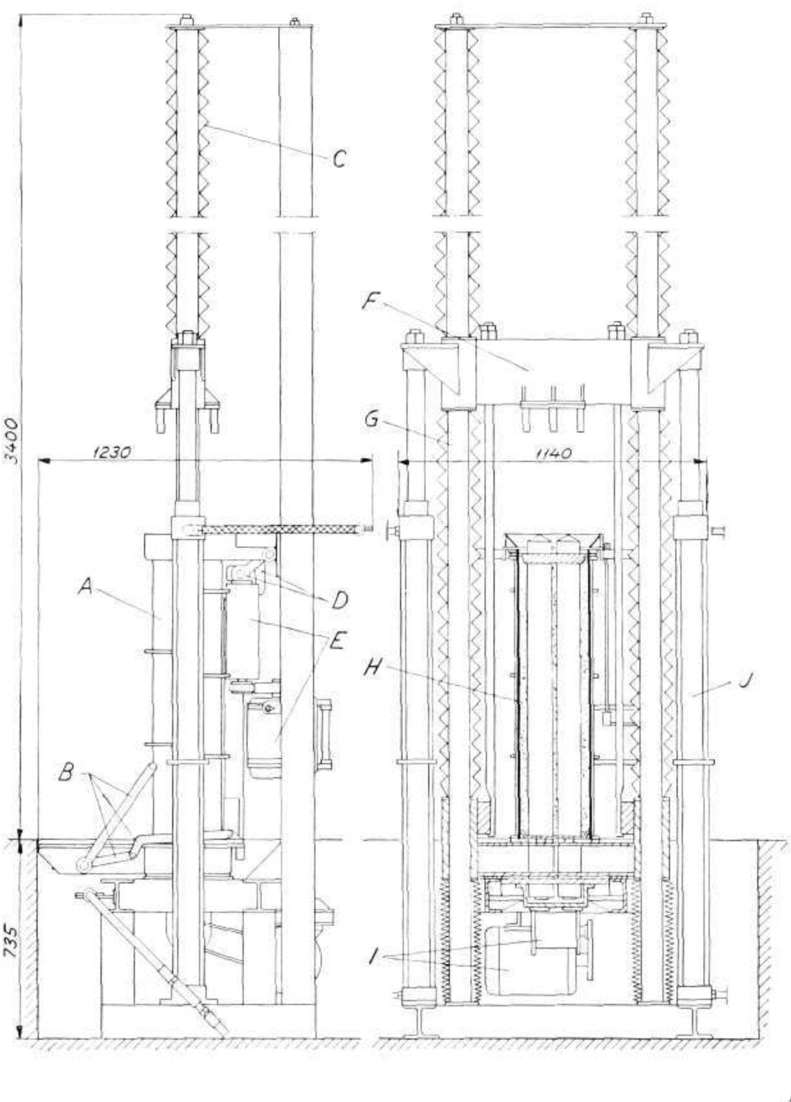


Fig. 2 X 8025

General assembly of compressor-vibrator LVA 3015

A Mould
B Mould traverser
C Canvas sleeve
D Automatic table raising device
E Mould vibrator with motor
F Upper press
G Guides
H 4-way duct
I Core vibrator with motor
J Hydraulic cylinder

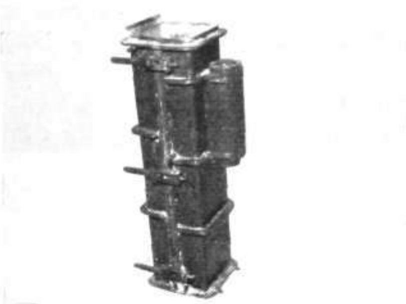


Fig. 3

Fig. 4

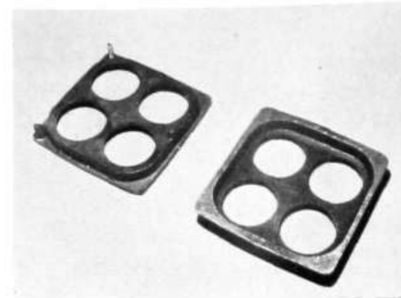


Fig. 5

Fig. 3 X 7720

Mould LVA 2024

Fig. 4

Upper flange plate LVY 1114

Fig. 5

Bottom flange plate LVY 1104

Another disadvantage of manual production is the lack of uniformity in quality of the ducts, which leads to a fairly high rate of rejections. The rejection rate can be considerably reduced by mechanical production.

For these reasons, in L M Ericsson installations ducts are being mechanically produced to an increasing extent, using a specially constructed compressor-vibrator. This machine has also been delivered to a number of telephone administrations.

Compressor-Vibrator LVA 3015

The appearance and dimensions of the compressor-vibrator will be seen from figs. 1 and 2. The following equipment is required for the manufacture of ducts:

3 moulds LVA 2024 (fig. 3)
3 upper flange plates LVY 1114 (fig. 4)
400 bottom flange plates LVY 1104 (fig. 5)
2 mould removing forks LVY 1121 (fig. 6)
2 mould assembly frames LVY 1131 (fig. 7)
2 mould carriages LVY 1012 (fig. 8)
1 grinding machine LFA 1001 (fig. 9)

The machine is also supplied with a set of tools and of spare parts.

As the name of the machine indicates, it works on the principle of compression and vibration. The vibration takes place partly in the cores and partly in the mould, resulting in a very powerful and uniform vibration of the concrete. The pressure is applied to an upper flange plate which is forced down into the concrete-filled mould.

The body of the machine consists of a rectangular stand of welded I beams. At the rear of the stand are welded two vertical I beams, and at the front are bolted two vertical shafts. The vertical beams and shafts are held together at the top by a steel plate. Two cross beams, one upper and one lower, slide vertically on the shafts.

Fig. 6 X 7721

Mould removing fork LVY 1121

Fig. 7

Frame for assembly of mould LVY 1131

Fig. 8

Mould carriage LVV 1012

Fig. 6

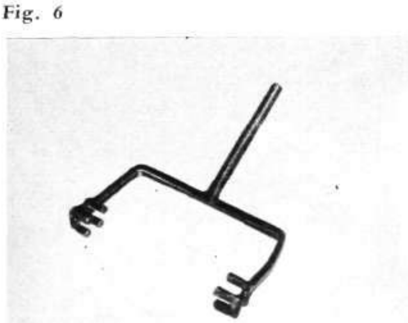


Fig. 7

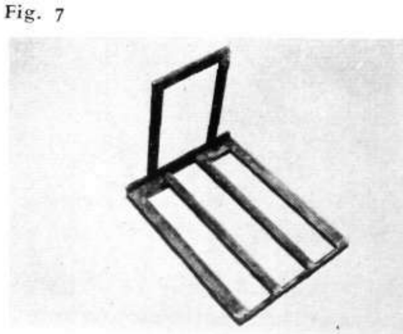
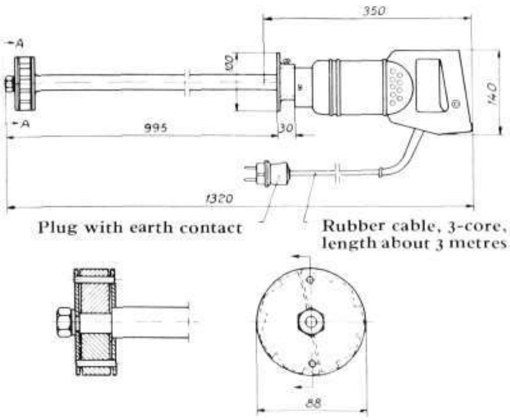


Fig. 8



g. 9 X 2227
rinding machine 1001

In the lower cross beam, on which the mould stands, are holes for the four cores which form the four channels (ways) through the concrete duct. The cores are bolted to a vibrator box in the stand. The box is separated from the stand by vibration insulators, so that the vibrations from the bottom vibrator are transmitted only to the cores and not to the stand. The core vibrator is operated by an electric motor with belt drive. In the lower cross beam is a traversing device which, when the cross beam with mould has been hoisted above the tops of the cores, swings the mould horizontally above or away from the cores. In the upper cross beam is a plate fitted with tappets which force the upper flange plate down into the mould after the mould has been filled with concrete.

The upper and lower cross beams are connected by two tie rods. The shafts on which the cross beams are mounted are protected against dust and concrete waste by canvas sleeves. The movements of the cross beams are governed by two hydraulic cylinders driven by an I.M.O. type pump. The pump is driven by an electric motor. The working pressure of the pump can be adjusted by means of an overflow valve built into the hydraulic system. The direction of movement of the cylinders is determined by a 4-way valve.

A mould vibrator, likewise driven by an electric motor, is attached to each mould. The motion is transmitted through a friction disc on the driving wheel of the vibrator. The mould vibrator motor, mounted on a hinged bracket on one of the rear beams, can be swung out from the vibrator and, in the operating position, is held pressed against the vibrator by a spring. This movement is synchronized with the movement of the feed table for filling the mould with concrete, the feed table being likewise mounted on two bearings on the two rear beams. Both these movements are geared to the movement of the lower cross beam and thus take place automatically in conjunction with the lifting and lowering of the mould.

After the mould has been placed in position on the lower cross beam, all operations (with the exception of the two stated below) are mechanical, being controlled from an instrument panel on the right of the machine. This panel carries the following apparatus:

motor fuse and pump motor switch
4-way valve for cylinders
core vibrator switch
mould vibrator switch
pressure gauge

Immediately behind the panel is the overflow valve for regulation of pressure, mounted in one of the branches of the hydraulic system.

The only manual operations are the movement of the mould over or away from the cores, which is done with the handle of the abovementioned traversing device, and the placing of the upper flange plate into the mould. Filling of concrete is usually done from a concrete mixer with chute, but can of course be done by hand. The construction of the machine is described in greater detail in instruction N 1551—002 "Compressor-Vibrator LVA 3015".

Orders for the machine must specify the supply system at the site of installation of the machine. The machine is normally supplied for 3-phase, 220/380 V, 50 c/s. For other systems the motors will naturally be adapted to the requirements.

Compression-Vibration Procedure

Preparation of Concrete Mixture

Precise instructions regarding the quality of the raw materials for the concrete mixture—cement, sand (or shingle) and water—are available. The same applies to the grading of the sand (cf. instruction N 1531—003).

The concrete mixture should contain about 325—400 kg cement per cu.m. concrete.

The amount of water required in the mixture will depend on local conditions and is difficult to state in advance. With too much water the duct sticks to the walls of the mould, and longitudinal cracks may arise in its surface when removed from the mould. With too little water the duct, when removed from the mould, does not hold together but will collapse on the slightest touch. A brief trial run at the start of fabrication, however, should soon show the correct quantity of water to be added.

The compression-vibration method of duct making is always employed for the production of fairly large quantities. Both on economic grounds, therefore, and to ensure a uniform quality of mixture, the preparation of the concrete should be done mechanically in a special concrete mixer. The latter should be erected in the immediate vicinity of the compressor-vibrator. The ready mixed concrete is tapped into a hopper with chute located above the feed table of the compressor-vibrator. The hopper must be built on site.

Assembly of the Mould

The mould LVA 2024 should be assembled in a special frame LVY 1131 on the storage site for newly moulded ducts.

The mould is brought up to the machine in a mould carriage LVV 1012, close enough to be tipped directly into its position in the machine.

Fig. 10 X 8027
Placing the mould in the machine

Fig. 11 X 8028
Hoisting the mould above the cores

Fig. 10

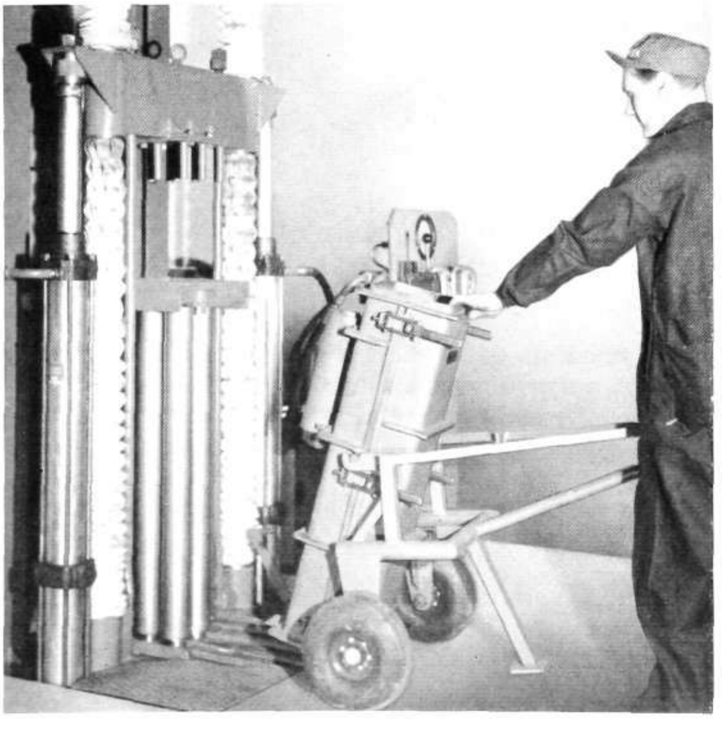
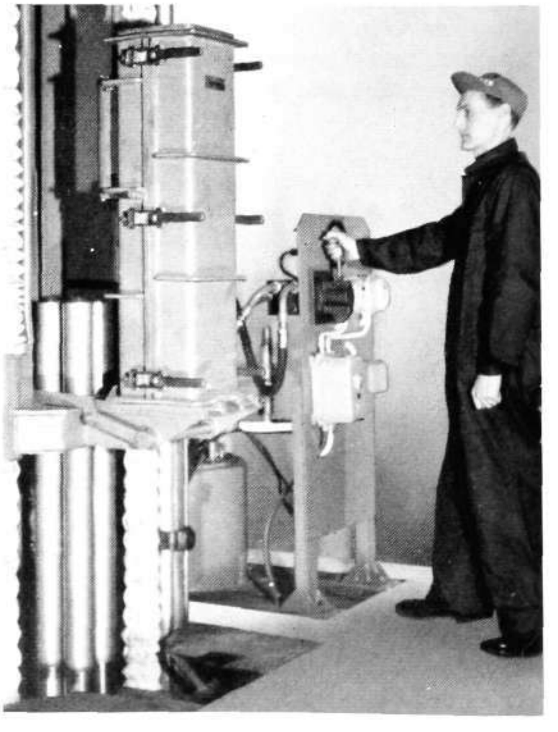


Fig. 11



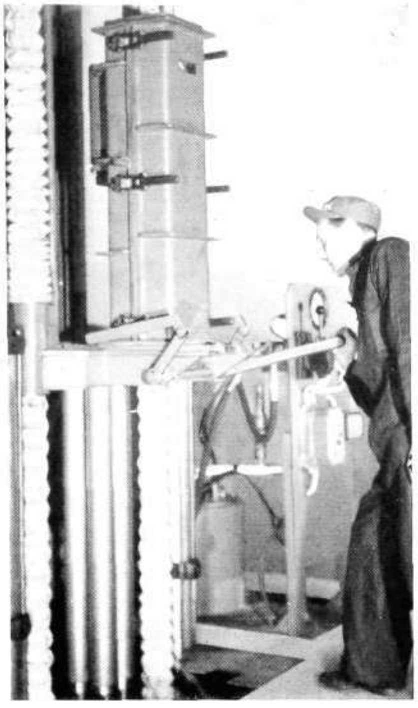


Fig. 12 X 2231

Moving the mould above the cores by hand

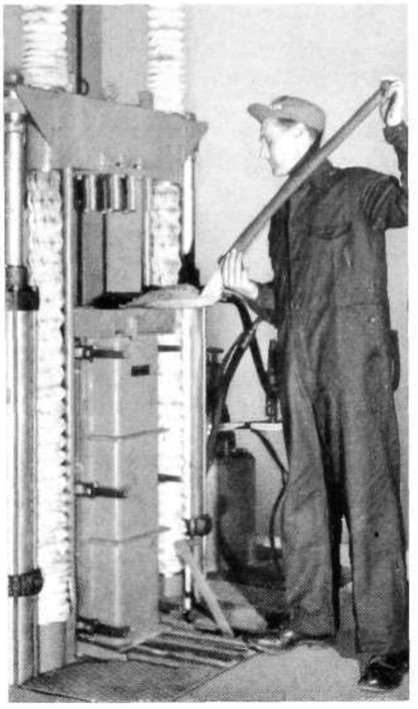


Fig. 13 X 2232

Filling the mould with concrete (here done by hand, in practice from a concrete mixer)

Fig. 14 X 2233

Placing the upper flange plate in the mould

Operating Process

The assembled mould is placed on the lower cross beam (fig. 10), and the pump motor for the hydraulic system is started.

The 4-way valve is set to negative pressure and the mould is hoisted up above the cores (fig. 11). When the mould has reached the desired level, the 4-way valve is restored to zero, which stops the movement.

By means of a lever, fitting into two hooks in the bottom of the mould, the mould is swung over the cores by a simple manual operation (fig. 12). The 4-way valve is set to positive pressure, which lowers the mould over the cores. When the lower cross beam has reassumed its bottom position, the valve is restored to zero.

Simultaneously with the lowering of the moulds the feed table automatically drops, grips the mould and locks it. When the table is lowered, the mould vibrator motor is likewise automatically swung forward and connected to the mould vibrator through the friction coupling.

The core vibrator is started, and filling of the mould with concrete starts (fig. 13). When the mould is roughly one third full, the mould vibrator is also started, after which the mould is filled completely. Both vibrators are then stopped and the upper flange plate is placed in the mould (fig. 14).

The 4-way valve is set to positive pressure, whereupon the upper cross beam descends. At the same time both vibrators are started once again. The switching of the 4-way valve from positive to negative pressure produces repeated brief pressures by the upper press, which forces the upper flange plate down into the mould and compresses the concrete in the top of the mould (fig. 15). After attaining sufficient compression, the vibrators are stopped. Care should be taken that the upper press bears on the upper flange plate until both vibrators have stopped.

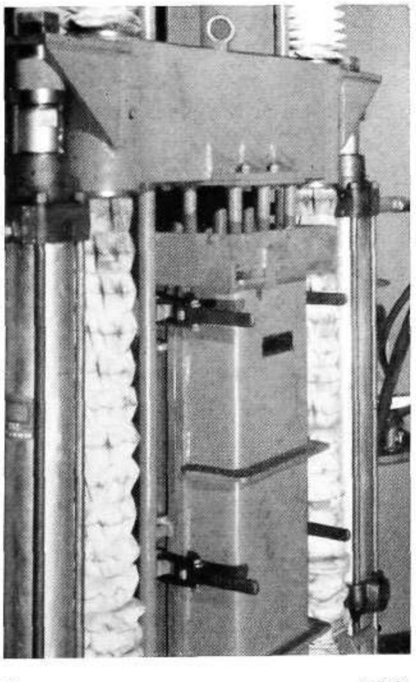


Fig. 15 X 2234

The upper press forces down the upper flange plate

Fig. 16 X 2229
Removing the mould from the duct

The 4-way valve is set to negative pressure, whereby the mould with the ready cast duct is hoisted up above the cores. The movement is stopped by restoring the 4-way valve to zero.

By means of the lever the mould is brought forward so as to clear the cores. The 4-way valve is set to positive pressure, the mould is lowered in front of the cores and the cross beams reassume their bottom positions. The 4-way valve is then restored to zero.

The mould with the ready cast duct is then removed from the machine and transported to the removal site.

Removal of Mould

The mould is now carried off with the duct inside it to the storage site for newly cast ducts.

The mould is then removed (fig. 16). The floor surface at the removal site must be completely plane so that the new ducts stand exactly vertically. The floor should be solid, preferably of concrete, but requires no special preparation as in hand tamping when the ducts must be left standing each on its own bottom plate during the 24 hours following removal of the mould. A special mould removing fork is supplied for separation of the two halves of the mould.

Final Treatment

After casting, the ducts must go through a careful final treatment.

Watering

The ducts should remain on the removal site for up to 24 hours (fig. 17). After this period to allow for preliminary setting of the cement, the ducts are carried out to the stock pile in the open air. Here they are stacked horizontally in 7 to 8 layers one above the other.

The curing of the ducts now starts, and for at least 3 weeks they must be constantly watered.

During the curing period in the open air the ducts should not be exposed to direct sunlight. It will therefore be necessary either to build up a simple form of shelter or to cover the ducts with fibre mats or similar material.

Polishing the Duct Ways

To obtain a perfectly smooth surface in the ducts, they should be polished with a grinding machine LFA 1001 (fig. 9) driven by a built-in electric motor.

Storage

The ducts should be stored for at least 4—5 weeks. The longer they are kept in the open air before being laid underground, the greater will be their durability and strength.

Assembly, Starting and Maintenance of Machine

The machine should be erected on a concrete foundation which brings the upper edge of the lower cross beam (and thus the bottom of the mould) level with the floor.

The electrical connections should be made in accordance with the connecting diagram supplied with the machine. A separate instruction is supplied for starting and maintenance of the machine (N 1551—002).

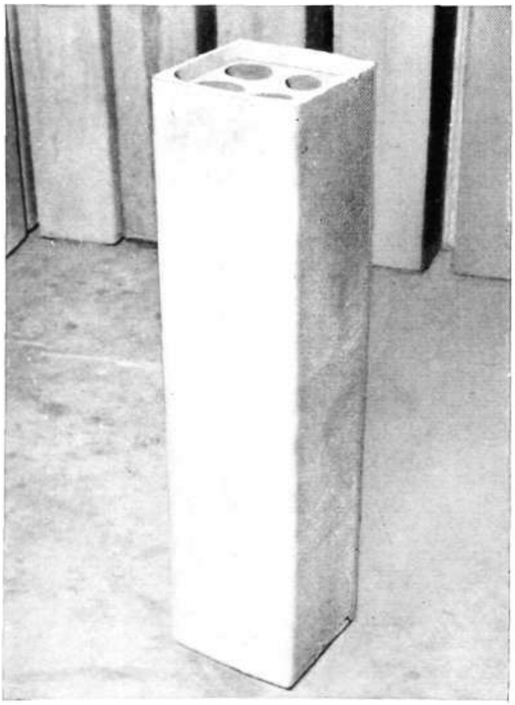


Fig. 17 X 2230
The finished duct

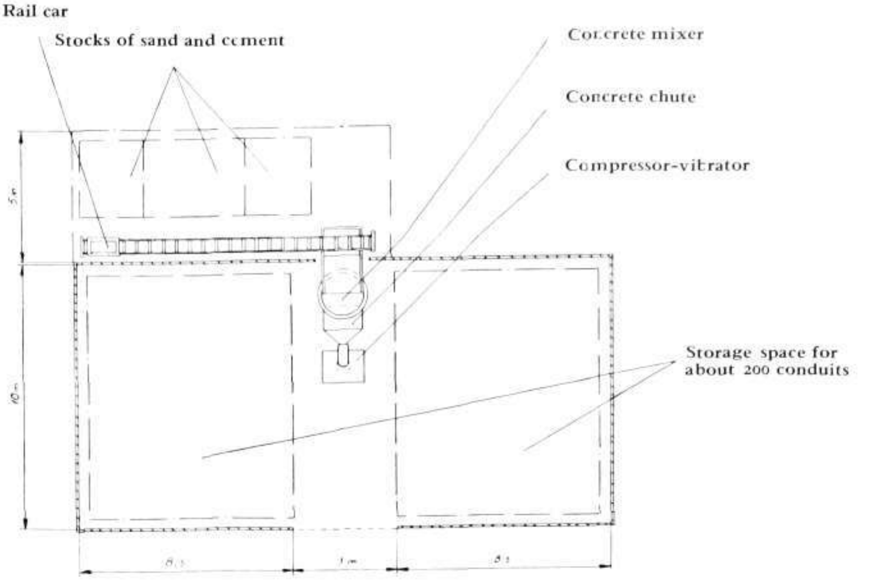


Fig. 18 X 8026

Layout of plant for manufacture of ducts

Space and Staff Requirements

Fig. 18 shows a suitable floor plan for the manufacture of ducts by this method. The floor space required per duct during the first period of curing, which should not be less than 24 hours, is 0.375 sq.m. For a daily production of 150 units per 8-hour shift, about 250 sq.m. should suffice. About 90 sq.m. will be required for machinery, stores etc.

The plan takes into consideration the entire process through the plant from raw material up to the finished product. The raw materials (cement, sand and shingle), are loaded into a car equipped with a scale which enables the correct proportions of materials to be directly weighed. The car runs on rails and is emptied through a bottom trap into the ladle of the mixer. The transport of the raw materials can, of course, be arranged with ordinary wheelbarrows. From the mixer the ready mixed concrete passes via a chute direct into the compressor-vibrator. This machine has been centrally located in order to reduce as far as possible the distance to the removal site.

The following hands are required:

1—2 men for weighing of sand, transport of sand and cement to the concrete mixer, and handling of the mixer;
1 man to operate the compressor-vibrator;
2 men to remove moulds (depending on distance from machine to removal site);
2 men to transport the ducts to the place of storage, damp them and, when necessary polish the ducts and perform other minor tasks.

With a team of this size the capacity of the machine will be a good 150 ducts per 8-hour shift. The output will of course vary according to local conditions. Considerably better results have been obtained in certain cases. This compares with about 25 ducts per mould and 8-hour shift produced by hand-tamping.

Comparison between Compression-Vibrated and Hand-Tamped Ducts

Mechanically vibrated ducts have a number of advantages over hand-tamped, both as regards water tightness and mechanical strength.

Despite the superior quality of the vibrated duct, the cement content has been reduced. With hand-tamping 500 kg cement per cu.m. concrete is required, whereas the vibrated product only requires 325—400 kg cement per cu.m.

The quality of ducts produced by hand-tamping, moreover, must of necessity vary very considerably. Such factors must be taken into account as the individual skill of the workman and that, if he is tired, he cannot work the concrete as efficiently as when he is rested. With the compressor-vibrator the quality will be uniform, since the concrete is always worked to the same extent.

Finally as regards the production costs, the mechanical method is very much cheaper than the manual. For a production of 150 × 4-way ducts per day the following comparison may be made between the labour required in the two cases.

	Hand-tamping	Mechanical production
Concrete mixer	1 man	1 man
Tamper	6 men	—
Machine operator	—	1 man
Mould remover	—	2 men
Finishers	2 men	2 men
	9 men	6 men

These figures show that mechanical production can reduce the working time by about 33 %. In conclusion, therefore, it may be said that the mechanical method offers the possibility of quicker production and higher quality at lower production costs.

It may be added that the compressor-vibrator LVA 3015 is designed solely for 4-way ducts. In the extension of networks it has proved most economical to base conduit construction on this type of unit. On heavy cable routes the 4-way unit can be combined to form capacities of 8, 12, 16 ducts etc. On smaller routes, such as branches from the main route to risers to poles or a wall, it may be advisable to employ single-way or 2-way ducts, which should then be hand-tamped.

There is no essential difficulty, however, in manufacturing compression-vibration machines for ducts of other capacities, or of different shape or size, such as for 100 mm inside diameter.

Electromagnetic Underpillow Loudspeaker

H EKSTRÖM, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.623.7

L M Ericsson has started to manufacture an underpillow loudspeaker type RLE 901—902. It is intended for central radio installations in hospitals and as extra loudspeaker for connection to home radio sets and similar equipment. A description of the underpillow loudspeaker is given in this article.

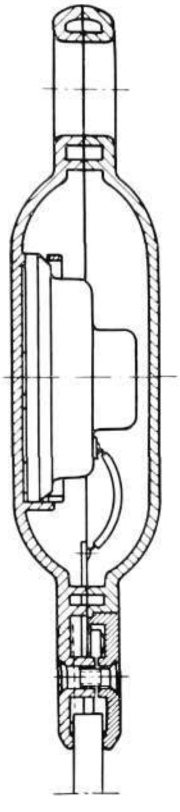


Fig. 1 X 2205
Cross-section of underpillow loudspeaker RLE 901

The possibility of listening to radio and gramophone or tape recorded programmes is of enormous value to the well-being of hospital patients. Such arrangements have been provided for a long time past in hospital common rooms and private wards where it has been possible to use an ordinary loudspeaker. In general wards, however, the usual practice has been to provide earphones for individual use. Earphones are very uncomfortable, on the other hand, and tiring for patients to have on. A modern and robust pillowspeaker has therefore been a long-felt need. The introduction of L M Ericsson's underpillow loudspeaker presents general ward patients with high-class individual loudspeakers which cause no disturbance to other patients.

The underpillow loudspeaker RLE 901 is intended for use in conjunction with central radio installations at hospitals and has been specially designed in consultation with hospital experts. It has soft lines and causes the patient no inconvenience when placed under the pillow. The loudspeaker has an electromagnetic system with very good sound quality. It has a compensated frequency response curve, which ensures perfect reproduction: the damping effect of the pillow, moreover, contributes to correct reproduction of the bass register. Adjustment of volume is most simply done by changing the position of the speaker under the pillow.

The polystyrene case which encloses the magnetic system is easy to keep clean and is insensitive to impact. The loudspeaker is entirely enclosed, so that the case can be safely washed and disinfected. The pillowspeaker can be hung up by means of a hole through the frame.

Fig. 2 X 8020
The handy size of the underpillow loudspeaker is seen from this photo. When in use it is pushed in under the pillow.

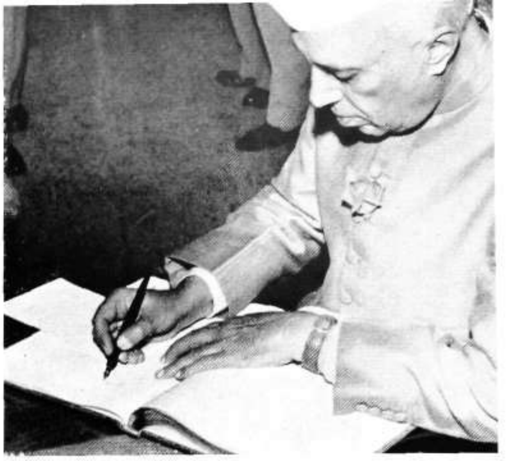
The underpillow loudspeaker is made in two models: type RLE 901 for hospitals, and type RLE 902 for home use as extra loudspeaker with radio sets and similar equipment.

The hospital type pillowspeaker is ivory-white and has a plastic cord with plug for connection to a central radio terminal by the bedside. Thanks to its high efficiency and high impedance (7,500 ohms) the loudspeaker can be connected direct to existing earphone circuits. This model requires a signal voltage of about 14 volts. The power consumption is 1/10 watt.

The model for home use is made in a light-green shade, likewise with plastic cord. It has low impedance (15 ohms), so can be connected direct to an extra loudspeaker terminal on a radio set.

In addition to filling a great need at hospitals, the new underpillow loudspeaker has manifest advantages for private use as well. One or more pillowspeakers can be connected to any modern radio set and so enable each member of the family to hear radio programmes without disturbing others.

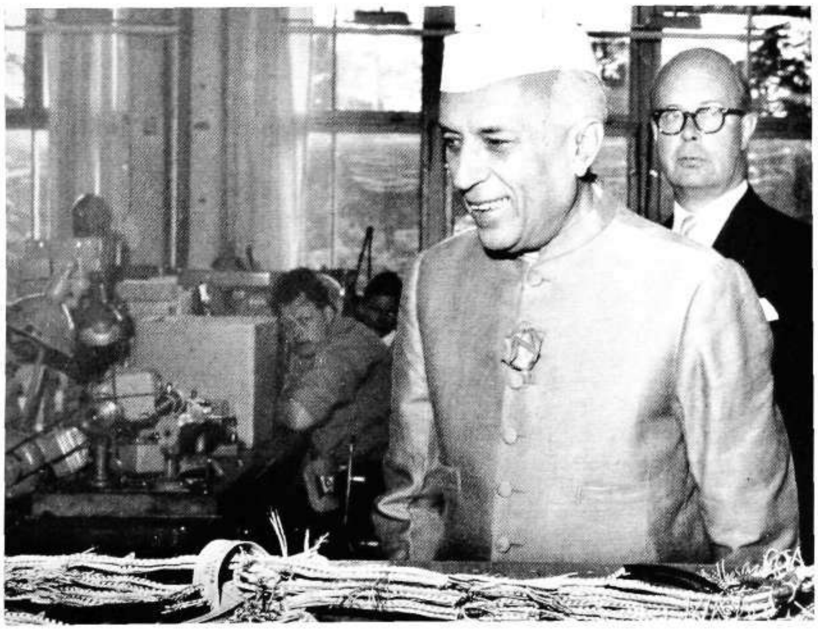
Ericsson LM NEWS *from* *All Quarters of the World*



Prime Minister Nehru Visits L M Ericsson

During his official visit to Sweden in June, India's Prime Minister Jawaharlal Nehru, made a call at L M Ericsson's plant at Midsommarkransen, Stockholm. Ciceroned by the president of the company, and accompanied by the Swedish Ambassador to India, Mrs Alva Myrdal, and various representatives of the company's management, Mr Nehru made an hour's tour of the plant, where he took an eager interest in the various products and manufacturing processes.

(Top right) Mr Nehru signing the visitors' book. The visit commenced with a brief address on the company's activities by the president, Mr Sven T. Åberg. (Left) Mr Nehru seated between (from right) Mrs Alva Myrdal, Swedish Ambassador to India, Mr Ernfrid Browaldh, vice chairman of the board of L M Ericsson, and (on left) Messrs Hans Thorelli, vice-president of L M Ericsson, and Gustav Cederwall of the Ministry of Commerce. During his tour of the plant Mr Nehru met two Indian engineers working at L M Ericsson (above). Before his departure, the Prime Minister was presented with a photograph album containing snapshots taken during the visit (below).



New Ship — New Telephones

Capt. Gunnar Nordenson, of the Swedish America Line's new flagship "Gripsholm", using one of L M Ericsson's streamlined Ericofons, which are installed in all luxury cabins on the ship. With Capt. Nordenson is Mr Nils A. Sterner, L M Ericsson's vice-president in New York, who visited the 23,000-tonner on the completion of her maiden voyage. "Gripsholm" is Scandinavia's largest luxury liner and the first vessel to be equipped with this "telephone of tomorrow".

Dial Telephones in Aalborg

Aalborg, Denmark's third largest city, has been equipped with dial telephones. The exchange is accommodated in a magnificent new administrative building at Nytorv, and is the largest exchange so far to be equipped with L M Ericsson's crossbar system ARF *101*.

On Sunday morning, April 28, Aalborg subscribers tried out their dial telephones with good results. Calls can now be dialled not only to the neighbouring exchanges, but also to Copenhagen and Aarhus, among other localities.

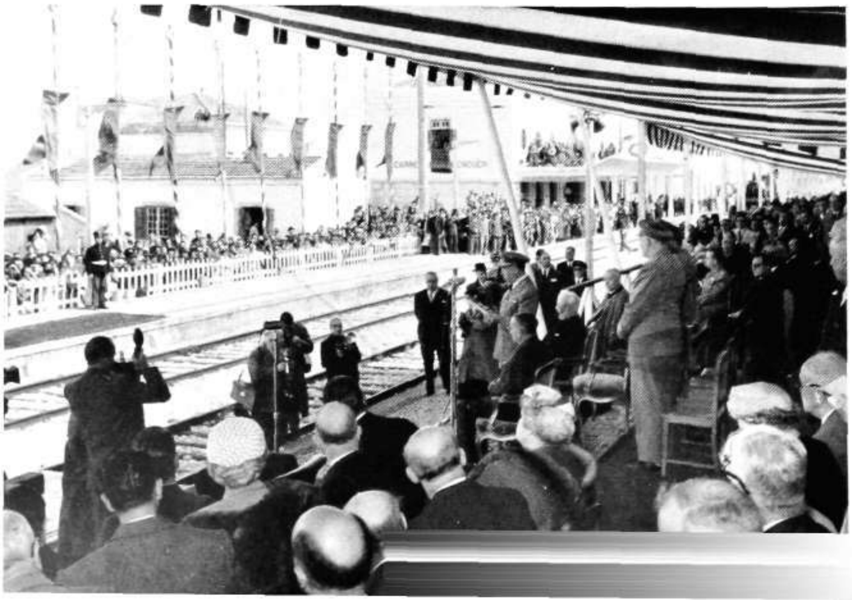
The equipment was jointly delivered by L M Ericsson, Midsommarkransen, Telefon Fabrik Automatic of Copenhagen, and L M Ericsson's Danish affiliates, L M Ericsson A/S.

(Above) The first dialled call through Aalborg's new exchange was between Mr P. Schack Eyber, chairman of Jydsk Telefon A/S, Aarhus, and Mr Sven T. Åberg, president of L M Ericsson. Interested onlooker is Mr Paul Draminsky, president of J.T.A.S.

The Portuguese State Railways, Companhia dos Caminhos de Ferro Portuguese (CP), opened the first electrified section of the Portuguese railway network on April 28. The installation covers the Lisbon-Sintra and Lisbon-Entroncamento lines, 37 and 107 kilometres in length respectively. L M Ericsson's deliveries comprised complete telephone equipment including cable, line material, automatic exchanges and selective calling system.

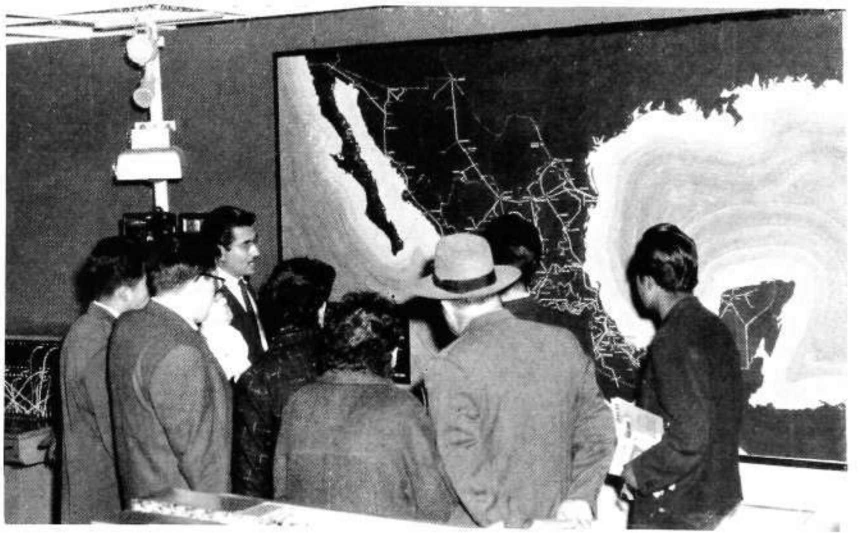
Among the guests of honour at the inauguration ceremony were the President of Portugal, General Francisco Craveiro Lopes, the Minister of Communications, General Manuel Gomes de Aranjo, and the Cardinal of Lisbon, don Manuel Goncales Cereira, who pronounced his blessing on the enterprise in accordance with Catholic custom.

(Left) In the foreground are seen (from left) the President of Portugal, the Minister of Communications, and Mr R. Espregueira Mendes, Director General of CP. Starting from Santa Apolónia Station in Lisbon, they accompanied the première train over the entire electrified section.



Unofficial visitors to Stockholm in the middle of June were Prince Rainier of Monaco and his wife, Princess Grace. During their stay here, the celebrated visitors were presented by L M Ericsson with an Ericofon. Here they are, becoming acquainted with their new telephone.

L M Ericsson was recently visited by fifteen French sales directors. Mr Otto Siewert acted as their guide on a tour of the Midsommarkransen plant. Here the guests are inspecting a central equipment for sound distribution system.



Mexico City recently held an exhibition in conjunction with the first International Congress of Electronics. The L M Ericsson company, Teléfonos de México, S.A., was represented in no less than five sections of the exhibition. An interested group of visitors is here studying a map of the TDM telephone network in Mexico.

75th Anniversary Exhibition of Elektrisk Bureau, Oslo

On May 2 this year L M Ericsson's Norwegian associates, A/S Elektrisk Bureau of Oslo, celebrated their 75th anniversary. This company, the oldest electrotechnical enterprise in Norway, was for many years the only manufacturer of telecommunications equipment in the country and, since its start in 1882, its main activities have been in the field of telephony. In recent years Elektrisk Bureau has started to manufacture other telecommunications equipment as well. The firm has large installation departments and conducts comprehensive business activities.

On the morning of May 2, at a celebration attended by the assembled management of the company and by members of the board, gifts were presented from the staff of Elektrisk Bureau and from Norwegian and foreign business connections. The gift of the parent company was presented by the president, Mr Sven T. Åberg, in person.

Later on the same day the anniversary exhibition was opened under the title of "Contact over land and sea" in the exhibition rooms of the Oslo Handicrafts and Industry Association. The welcoming address was delivered by the president of Elektrisk Bureau, Mr V. Harboe Lund, and the commemoration speech by the chairman of the board, Mr G. Ring Amundsen. The Norwegian Minister of Commerce, Mr Jens Haugland, extended the good wishes of the government. During the days on which the exhibition was open it was visited by over 25,000 persons, a remarkably high figure in view of the various competing attractions in Oslo at the time.

Conference on Maintenance of Telephone Exchanges

During the period June 3—7 a conference attended by 27 delegates representing the telephone administrations of a number of countries, and called at the initiative of L M Ericsson, was held at Midsommargården, Stockholm, for the discussion of exchange maintenance problems.

In consideration of the fact that a large proportion of the budget of a telephone administration is allocated to maintenance, the discussion revolved especially around the means of reducing maintenance costs without thereby neglecting the justified demands of the public for efficient service. Particular attention was paid to servicing methods for automatic exchanges and long distance equipment. One day was spent in visiting some of the Swedish Telecommunications Administration automatic exchanges in the Stockholm area and in Uppsala.

It was the general opinion that the mutual exchange of experience during the conference would prove of great value to the administrations in the handling of their maintenance problems.

Full Automatization of Lysekil Area

On Sunday, May 12, dial telephone traffic was opened for the 5,500 subscribers in the Lysekil area. In addition to the automatization of the entire area, dial trunk facilities were opened to a number of localities including Gothenburg, Kungsbacka, Trollhättan, Vänersborg, Uddevalla, Färgelanda, Munkedal, Grästorp and Lerum.

Of the 21 exchanges in the Lysekil area, all of which operate on the Swedish Telecommunications crossbar system, the five largest were manufactured and installed by L M Ericsson.

The Lysekil exchanges comprise 1,900 lines and equipment for toll and full-automatic trunk traffic. The Gravarne and Hunnebostrand junction centres and the Bovallstrand and Brastad terminal exchanges have a total of 2,700 lines and interworking equipment.

L M Ericsson Scholarship Grants for 50000 kronor

Telefonaktiebolaget L M Ericsson's Foundation for the Promotion of Electrotechnical Research has granted seven scholarships this year amounting to 16,000 kronor.

The company's Foundation for Travel and Study Scholarships has at the same time made grants amounting to 33,225 kronor to 24 employees of the Ericsson group and to 6 employees of the Swedish Telecommunications Administration.

(Below) Some of the maintenance conference delegates — from left, Messrs T. Kaczynski, Poland, F. Arig, Turkey, and D.A. Alberts, Holland, with, in the centre, Mr M. Patricks of L M Ericsson.

U.D.C. 621.395.44

LUNDVALL, B: *L M Ericsson's 960-Circuit System for Coaxial Cables. I. Introduction and Survey.* Ericsson Rev. *34* (1957) No. 2, pp. 36—45.

The article gives a short review of the history of the development of the coaxial system and gives an account of the essential features of the 960-circuit system. Having touched upon the requirements for transmission technique and the type of signalling, the article concludes with the prospect of future developments.

U.D.C. 621.395.26

ADENSTEDT, W: *Multi-Position C.B. Type Private Manual Branch Exchanges.* Ericsson Rev. *34* (1957) No. 2, pp. 46—51.

A new type of multiposition P.M.B.X. has been introduced by L M Ericsson. The main emphasis is on low operating cost, reliability and ease of management. The boards are made up in units to facilitate installation, maintenance and future extensions.

U.D.C. 681.174

LUNDQVIST, E: *The L M Ericsson Attendance Time Recorders.* Ericsson Rev. *34* (1957) No. 2, pp. 52—57.

A presentation of the L M Ericsson new card operated fully automatic attendance time recorders.

U.D.C. 621.395.623.7

EKSTRÖM, H: *Electromagnetic Underpillow Loudspeaker.* Ericsson Rev. *34* (1957) No. 2, pp. 67—68.

An underpillow loudspeaker for use with central radio installations in hospitals, and as extra loudspeaker for home radio sets, is being made by L M Ericsson.

U.D.C. 621.315.233

SIDENMARK, N: *Mechanization of Duct Manufacture.* Ericsson Rev. *34* (1957) No. 2, pp. 58—66.

The article describes a recently constructed compressor-vibrator machine for manufacture of 4-way ducts, which offers considerable advantages over previous methods of duct manufacture.

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

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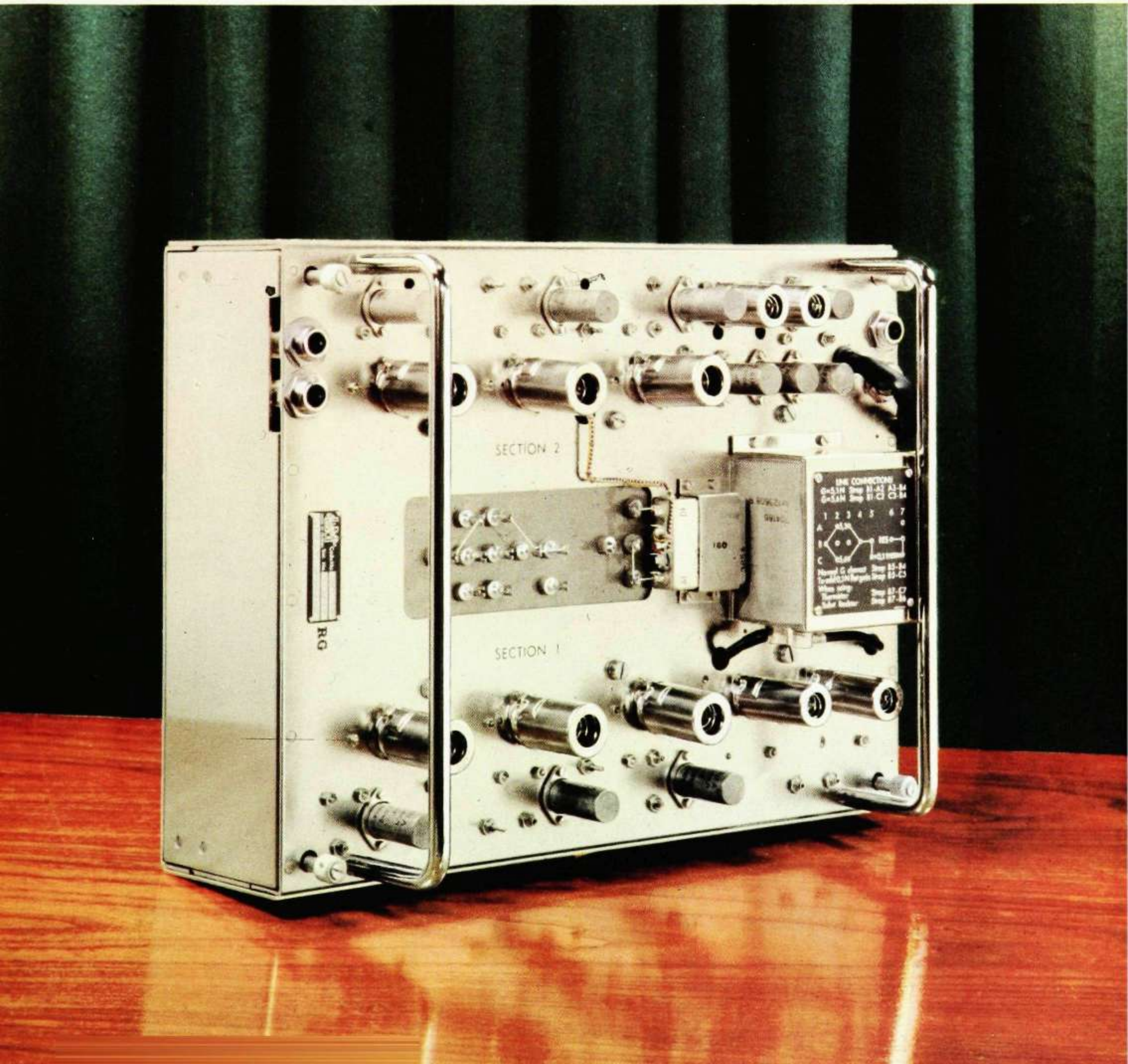

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On cover: Line Amplifier for L M Ericsson's 960-Circuit System for Coaxial Cables.

L M Ericsson's 960-Circuit System for Coaxial Cables

II. HF Line Equipment

O EKHOLM, E ERIKSEN & T KJELLERYD, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.44

L M Ericsson's new h.f. line equipment for the 960-circuit system ZAX 960/2 is described in this and the following two numbers of Ericsson Review. The present article deals with those parts of the equipment which are directly connected with the transmitted signal band, the h.f. signal path.

A brief explanation of the different types of repeater stations is given by way of introduction. The h.f. characteristics of the transmission medium—the coaxial cable—and the nature of the transmitted signal are then dealt with. A special section is devoted to the problem of maintaining the level of the wide signal band at a constant value, and finally in a section on the line amplifier, details are given of how the requirements which must be placed on an h.f. line equipment as regards high frequencies have been satisfied.

In forthcoming numbers of Ericsson Review, equipment for power supply and supervision and the mechanical construction and maintenance problems will be treated.

As the term "h.f. line" cannot yet be considered as belonging to every-day tele-technical language, it is appropriate that this term be defined. By the term h.f. line is to be understood an equipment which transmits a given frequency band from one terminal station to another with a certain stated loss or gain, which is normally constant over the frequency band, and whose distortion lies within fixed limits. In principle an h.f. line can consist of any type of equipment satisfying the loss and distortion requirements. Most common now are cable or radio link h.f. lines, at any rate when the transmission of large blocks of telephone channels is concerned. To have really quite clear for oneself where the h.f. line begins and ends is of great importance both for the design e.g. of power supply and supervision equipment, and for routine maintenance. On important traffic routes it may be justifiable to have an h.f. line as stand-by for one or more h.f. lines in traffic. The input and output of an h.f. line are therefore often characterized by having manual or automatic arrangements at these points for switch-over without interruption to a stand-by line.

In the following, an h.f. line is described where the transmitted band is from 60 to 4092 kc/s and the transmitting medium is made up of coaxial lines. As mentioned in a previous article, this h.f. line equipment consists of, as well as the cable:

a) *Terminal Repeater Stations*

The sending equipment in this type of station contains a pre-emphasis network and an amplifier for changing the "flat" signal level* received from the terminal equipment to a signal level curve which increases with frequency and thus is more suitable for sending out to the coaxial line. In addition, equipment for stabilization and continuous transmission of two

* By the term "flat" signal level is meant here and subsequently that the level per channel for all channels at this point is the same irrespective of the position of the channel in the frequency band.

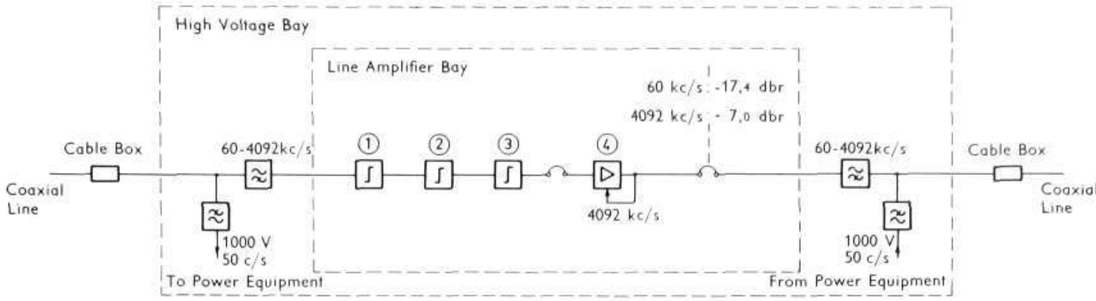


Fig. 1 X 7730

Block Schematic of an unattended repeater station

Only one direction of transmission is drawn.

1. Line Building-out Network
2. Equalizer Network
3. Gain Equalizer
4. Line Amplifier

line pilots 4092 and 2792 kc/s which are used for automatic supervision and gain regulation in subsequent stations is included.

The receiving equipment amplifies the signals coming in from the cable and sends them out with a flat level characteristic to the terminal equipment. In addition to the automatic pilot regulation, a manually regulated equalizer may be required for compensation of level errors which have accumulated over a number of repeater sections.

The terminal repeater stations also contain plant for the feeding of power to the nearest unattended repeaters and equipment for remote supervision of a number of dependent repeater stations.

b) *Attended Repeater Stations*

These contain plant for feeding power in two directions, and if so desired can be provided with equipment for manual and automatic equalization. In general they are comparable with the following:

c) *Unattended Repeater Stations*

These compensate for the loss and its principal variations in the previous cable section in each of the two directions of transmission. Fig. 1 shows how the signal path is formed in an unattended repeater station.

The HF Signal Path

The Coaxial Cable

The cable constitutes an appreciable part of the h.f. line equipment, and as the electrical characteristics of the coaxial tube determine the design of the amplifier equipment, the most important line characteristics will be mentioned.

Loss

The line constant which is of most interest is the attenuation coefficient α. It can be shown that to a close approximation, α is proportional to the expression

$$\frac{1}{D} \cdot \frac{1 + \frac{D}{d}}{\ln\left(\frac{D}{d}\right)}$$

where D is the internal diameter of the outer conductor and d is the external diameter of the inner conductor. It is seen that the attenuation coefficient is inversely proportional to the diameter of the outer conductor. Differentiation of the expression shows that a minimum is obtained for a diameter ratio $D/d = 3.6$. All coaxial tubes are therefore constructed with a diameter ratio which lies near this value.

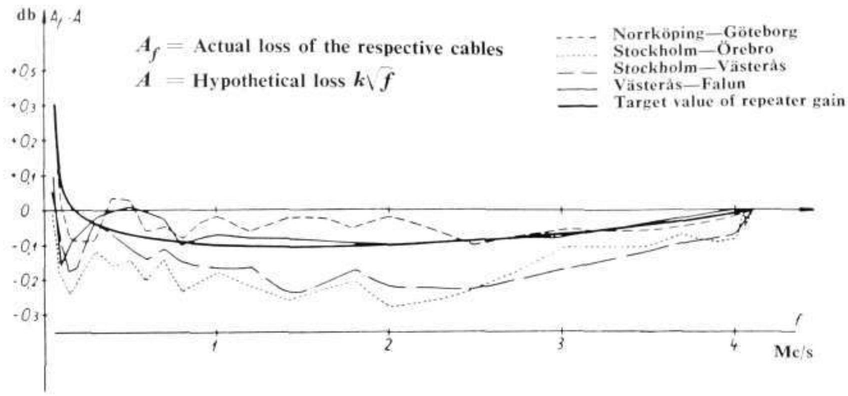


Fig. 2

Relative losses for coaxial cables

X 8033

Now if a coaxial tube having a large outer diameter is chosen, an expensive cable will certainly be obtained though with few coaxial repeater stations. If a small outer diameter is chosen, the cable will be cheaper, but on the other hand many repeater stations are required. It is clear that with fixed prices for cable and repeater equipment, it is possible to determine a cable diameter which is the most economical for the whole system.

On the basis of calculations of this nature, the CCITT (previously CCIF) have recommended a coaxial line having the following dimensions:

$$D = 9.5 \text{ mm} \quad \frac{D}{d} = 3.6$$
$$d = 2.6 \text{ mm}$$

The optimum dimensions stated however show very flat maxima and therefore not all manufacturers follow exactly the values given above. The coaxial cables used in the USA and likewise several coaxial cables in Sweden therefore have the following dimensions:

$$D = 9.47 \text{ mm} \quad \frac{D}{d} = 3.72$$
$$d = 2.55 \text{ mm}$$

The frequency dependence of the attenuation can for example for the latter cable type be given as

$$\alpha = 0.016 + 2.428\sqrt{f} + 0.009\, f \text{ db/km at } + 15^\circ \text{ C}$$

where f is the frequency in Mc/s.

It is seen that the attenuation is mainly dependent on the square root of f. This frequency dependence arises due to the apparent increase of resistance with frequency due to the skin effect in the inner and outer conductors.

To obtain a practical idea of the difference in attenuation between coaxial lines of different manufacture and different manufacturing batches, the attenuation for a series of actual cable routes has been measured. The measured values have then been adjusted for the length of cable so that the attenuation at 4.1 Mc/s corresponds to 48.6 db (5.6 N). Then the differences in the attenuations thus obtained and the attenuation of an idealized cable with the coefficient

$$\alpha' = 24.1\sqrt{f} \text{ db}$$

have been calculated. The result is shown in fig. 2. It is seen that the greatest differences occur at frequencies 60 kc/s and 2.0 Mc/s where the difference between the cables goes up to about 0.3 db. On the same diagram, the amplification design target for a complete repeater station has been drawn in. It is seen that the differences between this target curve and the actual cable attenuations are not large, so that the same repeater equipment can be used without re-trimming for all these types of coaxial cable.

As the cable attenuation is mainly determined by the a.c. resistance of the copper conductors, the attenuation is dependent on the temperature of the cable. The dependence is about 0.21 % per degree Centigrade, this coefficient being the same for all frequencies within the actual frequency band.

A change of temperature is thus electrically equivalent to a change of length of the cable. For cables buried at a normal depth of 80 cm (32″), the annual variations of the cable temperature in the Scandinavian countries is about ± 10° C maximum. The diurnal temperature variations, of the order of ± 0.1° C, produce hardly any effect on the cable attenuation.

Impedance

It is possible to give a mathematical expression for the cable impedance and its dependence on frequency in a similar way as for the attenuation. For coaxial conductors with $D/d = 9.47/2.55$ mm,

$$Z = 74.3 + \frac{0.92}{\sqrt{f}}(1 - j) \text{ ohms}$$

where f is the frequency in Mc/s ($f > 0.1$ Mc/s)

The impedance actually measured, however, never shows such a smooth relationship, but sudden deviations of up to ± 0.3 ohm from a mean curve can occur. These are caused by the different joint lengths not being alike in impedance, and also by small variations in impedance which can arise in the joint itself. Irregularities of impedance are most quickly measured with the assistance of a pulse echo meter. With this instrument the position of the impedance irregularities which may have arisen during the laying of the cables can also be localized. It may be assumed that a repeater section of the jointed cable is free from echoes worse than 60 db down. For telephone transmission it is possible to tolerate a higher echo, but coaxial cables are often installed with the idea of future use for television transmission. It is therefore usually ensured that the cable system satisfies the requirements for an echo-free transmission of the latter type of signal, even if such a signal is not planned at the time.

Crosstalk

The electromagnetic field is totally enclosed by the outer conductor. No inductive type coupling with other coaxial tubes can therefore occur even if these are contained in the same lead sheath. At high frequencies, galvanic couplings are also excluded as no current flows on the outside of the coaxial line due to the skin effect. The skin effect becomes less at lower frequencies and the possibility of galvanic couplings begins to arise. This in general is the reason why a coaxial cable is not used for frequencies lower than 60 kc/s.

Technical Transmission Requirements

So as to be able to design the h.f. line amplifier, one must have a thorough knowledge of the signal to be transmitted and of what distortion it may undergo.

Character of the Signal

Since the h.f. line interconnects the multiplex equipment for a large number of channels, the transmitted signal will consist of the frequency-translated

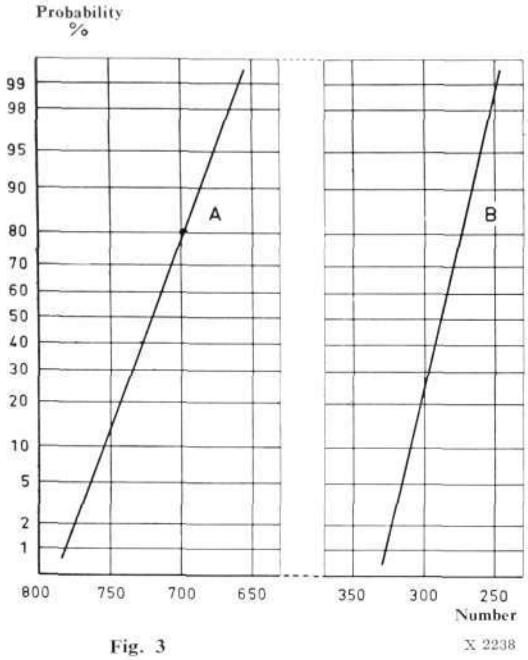


Fig. 3

Probability curves for the number of seized (A) and active (B) channels respectively in a traffic group of 960 telephone channels

speech voltages from a continually varying number of telephone subscribers. The properties of the transmitted signal can therefore best be described on a statistical basis.

It can be assumed that the traffic on the h.f. line is composed of groups of junction circuits linking various automatic or manual exchanges. Some of these are first-choice groups carrying relatively heavy traffic. The amount of traffic carried by such a group during the busy hour can amount to as much as 0.9 erlang/junction. The majority are however later-choice groups which reject only a small proportion of the traffic offered. The maximum traffic carried for, say, a 1 % overflow depends on the number of junctions in that group. Thus a group of 12 circuits carries 0.5 erlang/circuit, whereas a group of 60 circuits with the same grade of service carries 0.8 erlang/circuit.

An investigation of a considerable number of such groups, in a network with automatic exploitation of a large proportion of the groups, gave an average value of 0.72 erlang/circuit. However it may be expected that the future will see an increase in the size of groups of high traffic density. In what follows the values for loading have therefore been calculated on the basis of an average traffic of 0.75 erlang/circuit.

If it is assumed that traffic in both early-choice and later-choice junctions is Erlang-distributed, then it can be shown on the basis of the above traffic figures that the deviation is approximately equal to the square root of the average traffic for late choice junctions and about half this value for early choice junctions. The traffic on the h.f. line as a whole can also be assumed to be Erlang-distributed. This implies that the distribution for the total traffic lies somewhere between a Poisson and a binomial distribution. By calculating on the basis of a Poisson distribution, an absolute upper limit of possible traffic distributions has been chosen, independently of how the circuits are later allocated between early and late choice junctions. Fig. 3 gives graphically (distribution curve A) the probability with which at least as many channels as shown in the abscissa are seized for traffic, for an h.f. line having a bandwidth permitting a maximum of 960 channels.

On a circuit carrying traffic the conversation proceeds alternately between the *A*- and *B*-subscriber. To calculate the loading of the line amplifiers by speech, one is interested in the time during which a circuit transmits continuous speech in one direction. The channel in question is then said to be active. Since it can be assumed that there is as much talking from *A* to *B* as from *B* to *A*, a seized channel is active at most 50 % of the time, as a long-term average. Some time besides is accounted for by pauses in conversation, or time during which the circuit is seized but the called subscriber has not yet answered etc. Consequently a reasonable assumption is that a seized channel is active 40 % of the time. On this basis a distribution curve for the number of active channels has been calculated. This is curve B of fig. 3.

It now remains to asses the magnitude of the speech power for continuous speech in, say, a point of zero relative level. This power must also be dealt with statistically, since it is affected by a number of factors such as the reference equivalent of the microphone, the loss in the subscriber's line, and the sound volume of the subscriber's speech. Besides all this, the speech voltage in itself is of a very complex nature. It has therefore been a much discussed question for many years as to what average power per active channel one should allow for in designing the h.f. line. In recent years a number of measurements have been published touching this subject[1, 2], from which it appears that speech power can be taken as having a log-normal distribution with an average value of –10 to –15 dbm0 and a deviation $\sigma = 5$ db. The CCITT (formerly CCIF) have recently recommended that the following average values should be used

speech	16 μW
signalling	10 μW
carrier leak, etc.	6 μW

In the value of 16 μW the CCITT have allowed for a channel activity of 25 %, so that the average power for continuous speech is 64 μW or −12 dbm0.

The values in Table 1 (below) for a 960-channel h.f. line have been calculated on the following assumptions

1) Speech power distribution, log-normal

$m = -12$ dbm0
$\sigma =$ 5 db

2) Constant loading in all channels due to signalling, carrier leaks, etc., 16 μW, corresponding to − 18 dbm0.

3) Curve B, fig. 3.

Table 1

Power of the composite signal referred to channel test level		
% of time during busy hour	Average power	Peak power
50	+ 15.3 dbm0	+ 28.3 dbm0
1	+ 15.8 dbm0	+ 28.8 dbm0

For systems in which the signal voltage is composed of a large number of speech voltages, the composite signal has the same character as white noise. Table 1 thus points the way, not only as regards the work of design, but also in that the values given in the column "Average power" can directly be used for test measurements on actual h.f. lines, where the signal voltages are simulated by means of a noise generator.

Noise Requirements

As already mentioned in the previous article (Ericsson Review No. 1, 1957) the CCITT have standardized a nominal maximum circuit of length 2500 km as an aid to design calculations. According to this, the h.f. line may contribute an average noise power of 7500 pW during the busy hour, referred to a point of zero relative level. This value refers to channels with 4 kc/s spacing and is weighted in accordance with the CCITT psophometer curve as recommended in 1951. Since the nominal maximum circuit passes over 9 distinct line sections, each of which can transmit different signal voltages, the total noise power can be sub-divided between them on a power basis. An h.f. line section 280 km long may thus contribute a total noise of 830 pW.

However, line sections of considerably greater length than 280 km can occur in practice. Consideration must then be given to the fact that within a single line section distortion products can add on a voltage basis. This can lead to difficulties if the equipment is not designed from the start so as to maintain very low values for non-linear distortion, even if the basic thermal noise thereby necessarily becomes somewhat higher. Our design targets for the contribution of each repeater station, at a distance of 9.5 km from the next, were therefore made

for basic noise	$<$ 15 pW
for intermodulation noise	$<$ 1 pW

Intermodulation noise is here supposed measured with a loading on the h.f. line of + 15.3 dbm0 in accordance with Table 1.

Equalization

For an h.f. line of as little as 1/9 of the length of the nominal maximum circuit, the loss for the signal voltages at the highest frequencies is 1350 db. This large loss has to be compensated for so that the residual error is of the order of 1 db. It can thus be understood that the accuracy with which the gain at each station corrects for the cable loss and the stability of this gain are each subject to exacting requirements. Here one must distinguish between on the one hand errors in the desired compensation of the cable losses which do not vary with time ("fixed errors"), and on the other hand those which vary with time ("variable errors").

Fixed Errors

It was clear from the outset in planning the system that there would be a great simplification of maintenance for telephone administration if *a single type* of line amplifier were used, without regard to the length or type of cable.

The following causes of fixed errors could be noted

a) Coaxial line sections are of different lengths.
b) The target value of gain will not correspond exactly with the cable loss, since there are minor differences in loss between different types of coaxial cable.
c) The actual gain does not exactly correspond with the frequency response design target.

To equalize those level errors which arise due to the varying lengths of the line sections, the latter may be built out with passive networks to the same electrical length. This naturally gives rise to the same basic noise as if all the sections were of maximum length. However it not infrequently happens in laying out a cable network that a large proportion of the cable sections are shorter than the design maximum. By providing the amplifier with alternative strapped connexions, it has been made to correspond to either of two different cable lengths, viz. 9.5 and 10.0 km (46.0 and 48.6 db gain at the highest frequency transmitted). It is thereby possible to reduce the basic noise by some 3 db for every cable section which does not exceed 9.5 km, compared with that which would have resulted if the 10.0 km amplifier had been used throughout. This change in gain does not involve any additional adjustment, and the basic idea of a uniform amplifier has thus been retained. Building-out networks are provided in a variety of types so that building-out can be made in steps of about 250 m (1.13 db at the highest frequency). The residual loss error due to varying lengths of cable need thus not exceed about 0.6 db, and this error can without difficulty be taken up by the automatic regulation for cable temperature.

The errors arising under points a) and b) are small, but they occur at every repeater station, often in such a way that the errors add directly. Our experience with actual installations is that it usually suffices to equalize these errors at every sixth repeater. To permit equalization even in cases where the gain is insufficient, provision has been made for raising the gain of the line amplifier by 3 db over the entire frequency band.

It should be noted that a line amplifier can be changed without any need for altering the equalizing network. The line amplifiers are in fact manufactured to so close tolerances that the deviation in gain from one to another does not exceed 0.05 db.

Variable Errors

The most important causes of variable errors are

a) change in cable loss due to temperature variations.
b) change in repeater gain due to tube aging.
c) change in repeater gain due to temperature variations.

Of the causes mentioned, that of change in cable loss due to temperature variations is the most significant in magnitude. As will appear from earlier remarks under the heading "Coaxial cable", the annual variation in loss in Scandinavia amounts to at most ± 2 %. For a loss at the highest transmitted frequency of 48.6 db per repeater section, the corresponding change in loss is thus about ± 1 db. This change is already so large as to need correction at every repeater, in order that the balance between basic noise and intermodulation noise shall not be upset, with a resulting increase in total noise. Since the frequency dependence of changes in loss is proportional to the cable loss and thus practically the same for all types of coaxial cable, automatic correction of this error can relatively easily be arranged. This is done with the aid of an auxiliary signal or "pilot" which is transmitted over the h.f. line. The frequency chosen for this pilot is 4092 kc/s, near the upper edge of the band, which is a natural choice as it is there the variations are greatest.

The pilot level is measured at each repeater, and deviations from nominal are arranged to control the repeater gain. This control is in the proper sense for a correction of the level error, in accordance with the usual principles of servo regulation. The range of regulation of the amplifier needs to be greater than the ± 1 db required by the cable temperature error for two reasons. The first is that, as mentioned earlier, this regulation also takes care of the deviations due to the building-out network being available only in steps of 250 m. The second is that it is not always possible during installation to determine exactly the cable temperature and hence the proper working point for the temperature-compensating regulator. The regulation (servo) loop has therefore been designed for a *normal* working range of ± 2 db.

Changes in repeater gain due to changes in ambient temperature, humidity, etc., can become difficult to handle. As a rule they occur very rapidly and therefore need an automatic form of correction. Considerable effort has however been expended in the choice of components and mechanical design, in order to prevent these particular effects from becoming noticeable at all. The stability thereby achieved is so high that as a rule no automatic regulation will be required for coaxial line sections of up to 500 km in length.

Nevertheless, regulation equipment controlled by a 2792 kc/s pilot is available for h.f. lines working under extreme conditions. If this equipment is found to be necessary, an extra amplifier needs to be included in the signal path to compensate for the basic loss in the control network. This does not cause any problem, as the bays for attended intermediate and terminal repeaters are wired so that this regulation equipment can always be inserted.

The dependence of the amplifier equipment on tube aging is a source of error of a rather different kind from the other two mentioned. Thus the average mutual conductance for a whole coaxial line link only alters very gradually. It has furthermore a tendency to become stabilized at a particular value, provided there are no changes in maintenance procedure. This implies that the effect of tube aging can be corrected by a manual adjustment. Experience shows that besides those changes taking place due to the causes mentioned, there are others for which it is difficult to attribute any particular cause. These changes usually occur slowly, and although they may individually be small, the result is that the error curve requiring manual equalization is of a variable nature. To enable these error curves to be equalized in a simple manner a so-called "cosine equalizer" has been introduced. If a Fourier analysis of the given error curve is made, it can be resolved into a series of cosine terms, which can then be corrected one at a time by means of the cosine equalizer. This cosine equalizer will be described in more detail in an article in the next issue of Ericsson Review. However, a summary of the procedure can be given here.

1) Additional measuring pilots, with frequencies situated between the supergroups in the line group, are transmitted over the line. These pilots, also called inter-supergroup pilots, can be transmitted without interfering with traffic.

2) The levels of these pilots are selectively measured, and discrepancies from the nominal levels noted.

3) By means of a computer developed for the purpose, the necessary adjustments to the cosine equalizer are calculated.

4) The cosine equalizer is adjusted accordingly; this concludes the equalization operation.

All equipment is so designed that station maintenance personnel can carry out the entire operation by following the procedure given above.

The cosine equalizer has a large inherent loss, so that it cannot be introduced without at the same time providing additional amplification. As with the 2792 kc/s regulation, the bays for terminal and attended intermediate repeaters have been so wired that they can at any time be equipped with cosine equalizers. For h.f. lines generally speaking, only about every fifteenth repeater needs to be provided with such manual equalizer equipment.

The Line Amplifier

In this section the new line amplifier for 4 Mc/s coaxial systems is described, with emphasis on its use in unattended repeater stations.

Characteristics Required

Some of the necessary requirements concerning amplifier equipment for a coaxial system have already been treated in the previous section, and these will be briefly recapitulated together with further requirements which make their appearance in the design of the system.

a) The target value of gain is decided by the average loss of a number of known cables. Manufacturing and maintenance requirements point to *one* type of amplifier. However, noise calculations for systems already designed or projected show the desirability of having a 9.5 km and also a 10 km amplifier variant. The object has therefore been to combine these opposing aims by making one amplifier with provision for strapping, giving either 46.0 db or 48.6 db gain respectively. These values of gain are by definition the gain between the input and output cable boxes of the station. The amplifier itself must be designed to produce a somewhat higher gain to allow for loss in certain unavoidable networks in the whole station.

b) Strict requirements must be fulfilled as regards noise and intermodulation.

c) Each amplifier equipment must be able to compensate automatically for the variation of attenuation with temperature in the preceding cable section.

d) High stability against the effect of changes in ambient temperature and humidity, and also against supply voltage variations and tube aging must be aimed at.

e) The requirement of freedom from self-oscillation is self-evident.

f) A fault in a single tube or at component in the power supply equipment must not result in an interruption in traffic.

g) Input and output impedances must fulfil certain requirements.

If the input impedance of the amplifier equipment is exactly equal to the cable impedance, all the energy which is transmitted by the cable will be accepted by the amplifier, and therefore no part of the energy will be reflected back to the cable. This is in itself of no great importance. The problem first arises if the attenuation back to the previous station is low, and further that the output impedance of that station does not exactly correspond with the cable impedance. A part of the energy is then reflected again, but this time in the same direction as the transmitted signals. This appears as a voltage whose phase, due to phase shift in the cable or in the input and output circuits of the amplifier equipment, can assume any angle relative to that of the transmitted signal voltage. Both voltages add vectorially, which in practice manifests itself as if the cable attenuation varied irregularly with frequency. The CCITT have recommended that for telephone transmission the attenuation distortion due to mismatches between amplifier equipment and the cable shall not exceed 1 % per repeater section i.e. the over-all echo attenuation shall be at least 40 db. According to this

$$A_{r\,tot} = A_{r\,in} + A_{r\,out} + 2A_k$$

where $A_{r\,in}$ and $A_{r\,out}$ are the values of return loss at the input and output respectively of a repeater station, and A_k is the cable loss per repeater section.

The CCITT recommendations mean, as will be seen, requirements on amplifier equipment only at low frequencies where there is low cable loss. In addition to the CCITT recommendations, a design target has been set up for the new h.f. line equipment of a value of return loss for the line amplifier of at least 16 db over the whole frequency band. This helps to make the amplification obtained in practice more reproducible in different applications. If the amplifier impedances were not controlled, small variations in the adjacent impedances could produce disturbing variations in the operating gain. This is especially important when operating with line building-out networks and equalizer networks.

The Electron Tube

The electron tube is the basic element which determines the targets which can be obtained in the line amplifier and thereby in the whole h.f. line. The figure of merit, noise resistance and distortion determine the maximum repeater spacing. The power consumption decides the number of unattended stations that can be supplied with power via the cable using a given feeding voltage. The tube life will have a deciding importance in the routine maintenance carried out by administrations. Good characteristics in this respect must be weighed against the cost of the tubes, which however can be allowed to be rather high, especially if one can thereby reduce maintenance. The choice has fallen on the long-life tube type *404 A* which was originally standardized by Western Electric for use in their *TD 2* radio link system. This tube is now manufactured in Sweden by AB Svenska Elektronrör. With the idea of their use in unattended repeater stations specially in mind, the Swedish tubes have been made with gold-plated pins.

The most important data for the tube type 404 A are the following:

Mutual Conductance	$S = 12.5$ mA/V
Figure of Merit $\frac{S}{2\pi (C_{in} + C_{out})}$	$= 210$ Mc/s
Noise Resistance	$= 550$ ohms
Distortion factors	$A_{k2} = 39$ db
	$A_{k3} = 72$ db
Tube Life	> 10000 hours

The distortion factors are given for an output power $P_o = 1$mW in an anode resistance $R = 1.4$ kilohm. A_{k2} is the ratio between the fundamental and the second harmonic and A_{k3} is the corresponding ratio for the third harmonic. The tube life is defined as the guaranteed average life for a large batch of tubes whose end-of-life point is set at 65 % of the nominal value of the mutual conductance. Long life tests already completed and in progress show that the true value of the tube life under operating conditions considerably exceeds the guaranteed 10000 hours.

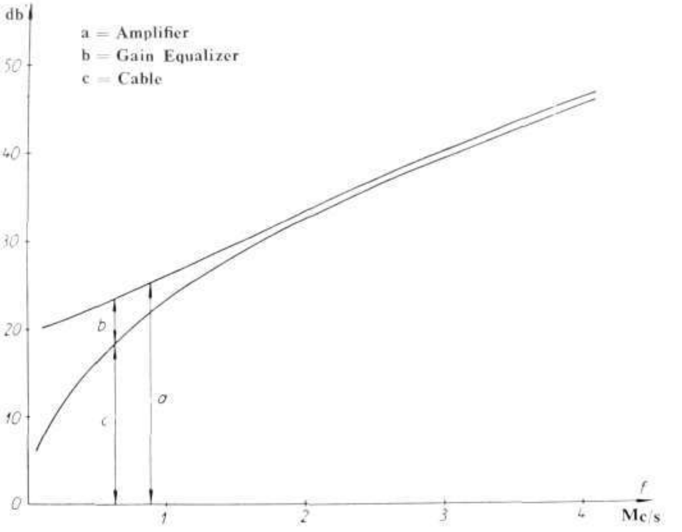


Fig. 4 X 8034

The subdivision of the amplifier response curve between amplifier and gain equalizer

Electrical Construction

Networks determining amplification

The target gain curve according to the preceding section applies to the complete repeater station. The internal subdivision of the curve between the amplifier and the different types of networks can naturally be varied. At one extreme one can consider the use of a flat response amplifier in tandem with an attenuation building-out network, in modified form wholly or partly combined with the input and output transformers of the amplifier. At the other extreme, the whole frequency dependence could be thought of as being determined by a feedback network in the amplifier itself. In L M Ericsson's new repeater equipment, it has been decided that the curve in the upper part of the frequency band be fixed with the help of a feedback network, while for the lower part, a completely separate "gain equalizer" be used. It is outside the scope of this article to give the reasons for this division. It may be stated here however that with a given total gain, a network connected in tandem will mean either an increase in the basic noise or the intermodulation noise. On the other hand, as regards a feedback network in the amplifier, its mechanical dimensions must be kept small so as to be able to obtain a high feedback at high frequencies. The method of connexion of the networks for compensation of the fixed attenuation of the cable, and the subdivision of the amplification curve are shown in fig. 1 and fig. 4. The loss of the power separation filter is negligible within the signal band 60 to 4092 kc/s.

Two variants of gain equalizer exist, one being used in stations where the amplifier is strapped to give a gain of 46.0 db and the other where it is strapped to give a gain of 48.6 db.

Connexion of the network for automatic regulation can be made in several different ways. Placing this before or after the amplifier gives a reduced effective repeater gain for a given signal-to-noise ratio, due to the additional attenuation which the network itself introduces. Placing the network between two separate amplifiers would mean a total of at least four tube stages and thereby an increased number of tubes. In addition, the stability requirement of the single amplifier would be doubled.

An investigation has shown that for a 4 Mc/s amplifier the most suitable position for the network is in the feedback path. The stability requirement for self-oscillation when the amplifier has been regulated down to give minimum gain certainly means that the effective repeater gain cannot be set as high as would be possible with amplifiers having fixed negative feedback. This reduction of gain however need not be so great as in the first alternative with the same signal-to-noise ratio. In addition, for a network in the negative

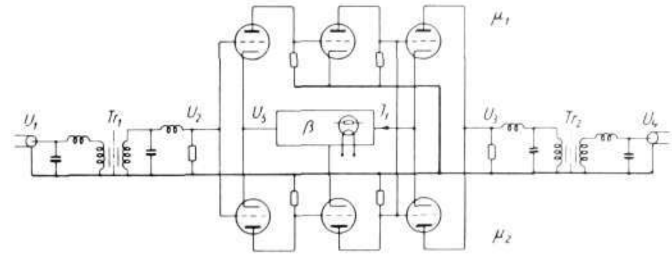


Fig. 5 X 8035

Circuit diagram for the Line Amplifier

Tr_1 Input transformer
Tr_2 Output transformer
β Feedback network
μ_1, μ_2 Amplifying sections

feedback line, no real impedance requirements need be made. It can therefore be designed using fewer components than a network in the signal path itself. The network has been designed so that a variation in level of ± 2 db at 4 092 kc/s can be corrected with a nearly constant control ratio.

Amplifier Circuit Diagram

The basic principle is a three-stage feedback amplifier with the feedback network β between the cathodes of the first and last stages, see fig. 5. The amplifying part, the so-called μ-part has been constructed as two parallel μ sections, μ_1 and μ_2, which in principle are independent of each other, and each of which receives its power supplies from its own power supply unit. To reduce distortion the grids of the final tube stages are connected together as far as h.f. is concerned. The transformers and feedback networks are common. By using this method of construction, a fault in one of the μ sections, e.g. a tube fault or a fault in any of the power supply units, has negligible effect on the characteristics of the repeater. The tube currents as well as the separate feeding voltages are individually supervised. A fault at an unattended station produces an alarm at the supervising station and can therefore quickly be cleared so that operational security is restored. In cables where all tube pairs carry traffic or with new installations where a complete stand-by h.f. line is considered to be too expensive, this duplication of the μ sections is of great importance in operational security.

With a large amount of feedback ($U_5 \simeq U_2$), the following gain formula applies (see fig. 5)

$$A = A_1 + A_2 + 20 \log \frac{Z_k Y_{15}}{2} = 20 \log \frac{U_4}{U_1} \text{ where}$$

$$A_1 = 20 \log \frac{U_2}{U_1} = \text{Input transformer } (Tr_1) \text{ turns ratio}$$

$$A_2 = 20 \log \frac{U_3}{U_4} = \text{Output transformer } (Tr_2) \text{ turns ratio}$$

$$Z_k = \text{Impedance of cable, 75 ohms}$$

$$Y_{15} = \frac{I_1}{U_5} = \text{Transfer admittance of the } \beta \text{ network}$$

The Transformers

As is seen from the amplification formula, the turns ratio of the input and output networks should be as large as possible. The limit is set by the capacitances which are a part of the terminations on the high impedance side of the transformers. These capacitances consist mainly of tube capacitances, but stray capacitances of components and wiring are also included. In the design of the input and output networks, one can consider firstly a characteristic which increases at higher frequencies and secondly a flat frequency characteristic. The latter alternative naturally gives somewhat less gain with a given signal-to-noise ratio, but on the other hand is less sensitive to variations in component values, e.g. with temperature, and needs only a little more than half the number of components for the same impedance requirements. The flat type has therefore been chosen, with both transformers resistively terminated on the high impedance side. The large band width of 60—4092 kc/s puts stringent requirements on the design of the transformers (see fig. 6), especially as regards a small and stable leakage coefficient. The solution of this problem has been possible by using a special technique of grinding ceramic coil bobbins with small dimensions and close tolerances and also by

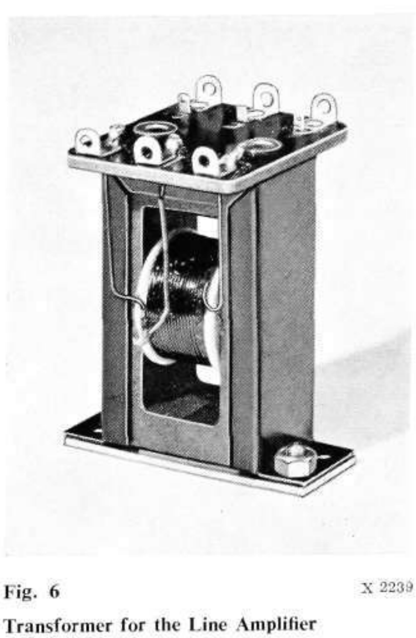


Fig. 6 X 2239

Transformer for the Line Amplifier

using ferrite cores. The leakage inductance and capacitance of the transformer are made so as to constitute a low-pass filter at high frequencies. In this way the design impedance requirements for a value of at least 16 db return loss have been achieved.

The feedback network

The feedback network consists of a common regulation network and two supplementary networks which can be strapped for 46.0 or 48.6 db gain at 4092 kc/s.

Regulation is obtained by using an indirectly heated thermistor. The regulation range is limited to 4.7 db irrespective of the thermistor current. Alternatively for convenience during installation measurements etc., the thermistor can be replaced by a fixed resistor (265 ohms), whereby the nominal value of amplifier gain (46.0 or 48.6 db) is obtained. The two supplementary networks provide the possibility of making a flat gain correction of about 0.2 db and a slope gain correction from about 3500 to 4092 kc/s with an amplitude of about 0.4 db. This is the only adjustment needed on final testing of the amplifier in the factory.

Feedback

The object of feedback is both to reduce distortion and to increase the stability against variations in the μ sections. The design chosen implies that the feedback is a maximum at low frequencies. In this way a simple form of gain variation with tube aging is also obtained. The limit for the feedback obtainable is set in principle by the figure of merit for the tube and the stray circuit capacitances. Freedom from self-oscillation is determined by the phase and amplitude margins in the feedback. These margins are so chosen that self-oscillation cannot occur for tube mutual conductances up to 35 % above nominal. The tubes operate with d.c. feedback, so that the influence of the supply voltages on the mutual conductance of the tubes is appreciably reduced.

Components

By maintaining close tolerances on the components in the networks determining the gain, the scatter in production is kept low. As regards capacitors and coils, this result is achieved by measurement with a bridge and by using resonance adjustment respectively. Such measuring methods need precision equipment, but on the other hand result in simpler final testing.

Measurement of non-linearity in components is used to a large extent in order to detect incipient bad contacts.

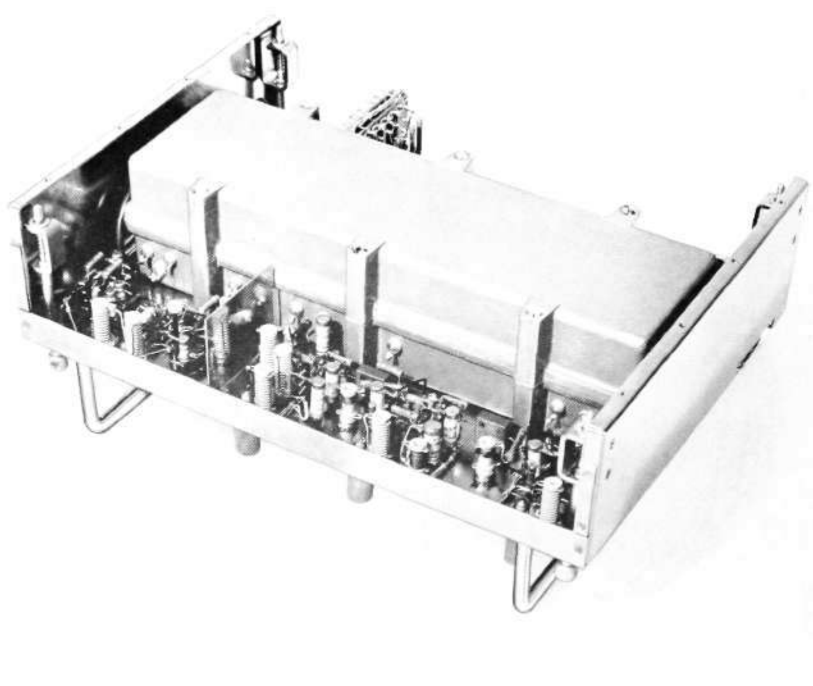


Fig. 7 X 8042

The Line Amplifier

Reer view with cover removed

The Mechanical Construction of the Amplifier

The general principle for the equipment is that it should withstand a tropical climate. This has been obtained by putting all networks which determine gain into hermetically sealed containers. In the line amplifier the transformers and the feedback network are mounted in a die-cast box, the lid of which has rubber seals. The μ sections have not been mounted in hermetically sealed containers, as their effect on amplification is appreciably less, see fig. 7. By the use of tropicalized components, reliability of operation has been further increased.

By having great mechanical stability and precise location of the components, good reproducibility has been obtained, even at the highest frequencies where the amplifier characteristics must be tested for stability against self-oscillation i.e. up to some 100 Mc/s.

The mechanical and electrical construction also permit the amplifier to be changed without affecting operation or necessitating trimming.

Performance

Methods of Measurement

The requirement of having small deviations from the target value of gain curve places very high demands on the accuracy of measurements. Special measuring equipment has therefore been developed by means of which a measurement accuracy of 0.01 db is obtained. For trimming of return loss, the use of a specially developed sweep meter results in an appreciable simplification. This trimming results in very little scatter in the insertion loss of the transformers. The following data are all obtained from manufacturing results and are given for the connexion of the repeater corresponding to 46.0 db nominal gain.

Gain

Fig. 8 shows the departure of the actual gain curve from the target value and applies for tubes with nominal mutual conductance. The standard deviation σ is also shown.

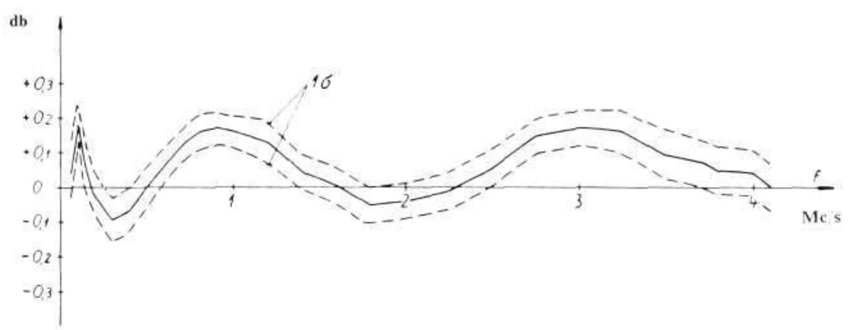


Fig. 8 X 8036

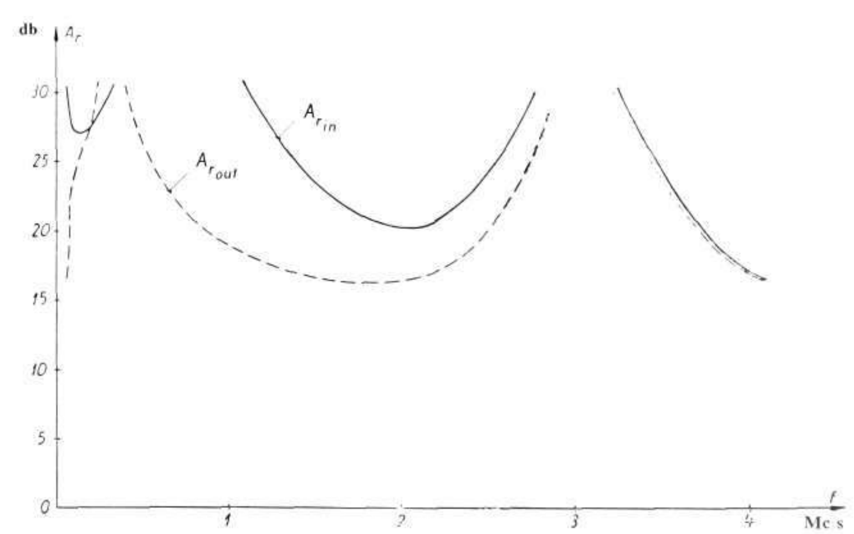
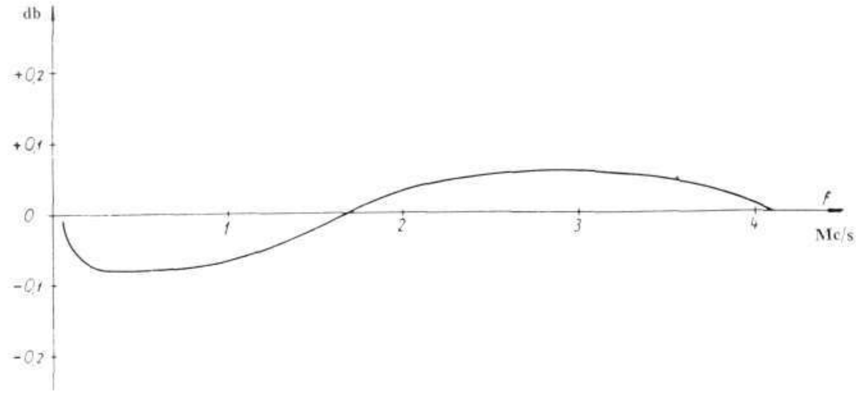


Fig. 9 X 8037

Fig. 10 X 8038



Impedance

Fig. 9 shows the return loss relative to the cable for the input and output impedances.

Regulation

Fig. 10 shows the regulation error for a regulation of 2 db.

Distortion

With a signal level of 0 dbm at the output side of the amplifier and a frequency of 1 Mc/s, the second harmonic (2 Mc/s) has a level of –78 dbm and the third harmonic (3 Mc/s) has a level of –103 dbm. Overloading occurs at an output level of +23 dbm.

Stability

Fig. 11 shows the change in gain due to a reduction in mutual conductance of all tubes by 1 db.

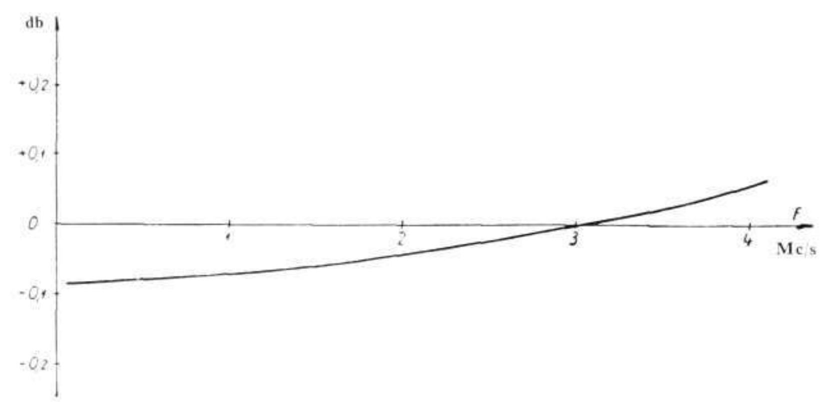
The change in gain after 10 repeater stations with a 2 % reduction of the feeding voltage can also be seen from fig. 11. The feeding voltage is normally maintained within this tolerance by stabilizers in the power feeds to the cable.

Fig. 12 shows the change in gain for an ambient temperature of 20 ± 30°C.

As will be seen, the temperature coefficient has the same form as the regulation graph, and so the temperature error is almost regulated out.

Tropical tests have been carried out in accordance with IEC 68 D IV, which comprises temperature cycling between 20° C and 54° C at 100 % relative humidity for 6 days. The change in gain after completion of these tests was negligible.

Fig. 11 X 8039



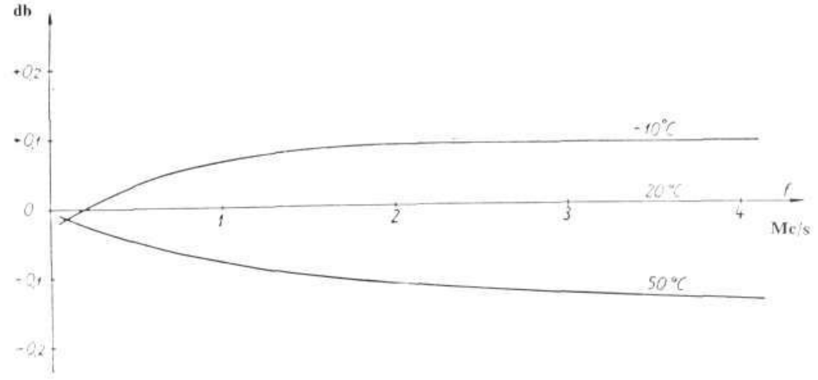


Fig. 12

X 8040

The Pilot Receiver

The pilot receiver consists of a crystal filter for separating the pilot frequency and a two-stage negative feedback selective amplifier.

In this amplifier the long-life tube 403 B is used. The pilot receiver is mounted in the same mechanical unit as the line amplifier and constructed according to the same general principles.

A normal pilot level of −17.4 dbm produces a regulating current of 2.5 mA.

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The Multirecorder — An Instrument for Recording Switching Time Functions

ERIK NYLUND, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 681.178:621.395.65

A portable multirecorder, ZTT 10001, designed for the recording of switching time functions, has been introduced by Telefonaktiebolaget L M Ericsson. The instrument, its method of operation and performance data are presented in this article.

L M Ericsson's circuit laboratories have long felt the need of an apparatus for the recording of relay switching time functions. Since the commercially available recorders are either too slow or contain too few styli, a recorder specially adapted for the purpose was designed. It is primarily intended for the checking of circuit diagrams in the laboratory.

The switching processes of operating telephone exchanges should preferably be recorded in conjunction with fault tracing and regular routine testing. A comparison with earlier recorded charts will show what changes have occurred in the switching time functions.

The multirecorder can, of course, be used for other kinds of apparatus as well, provided that the recording speed and number of styli are suited to the purpose.

General Description

The multirecorder, designated *ZTT 10001*, is made in portable form (fig. 1). It is contained in an oak case with rubber feet and fitted with a handle. The schematic arrangement of the recorder is shown in fig. 2. It has 29 styli for

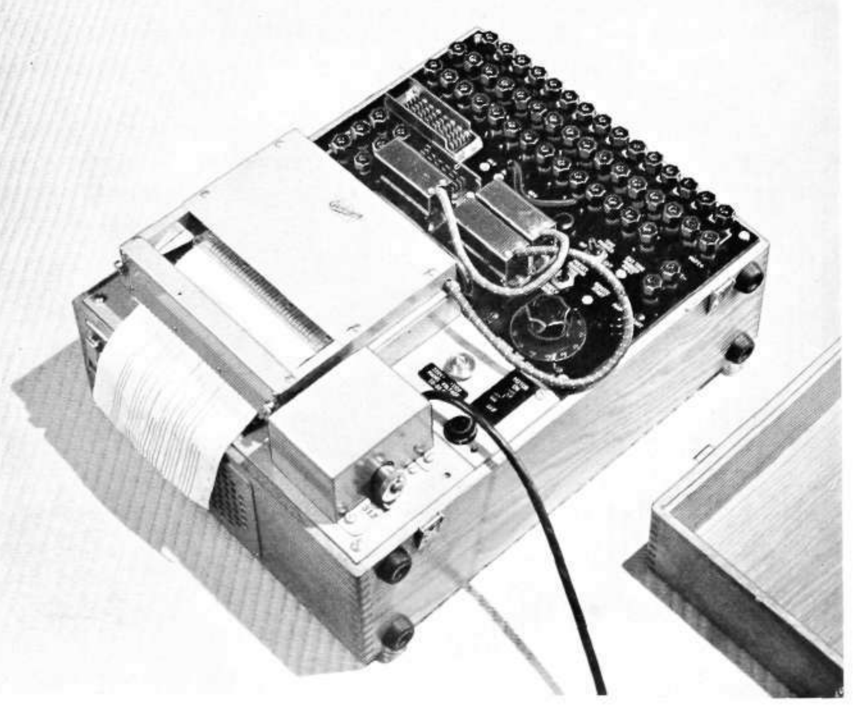


Fig. 1 X 8032
Multirecorder ZTT 10001

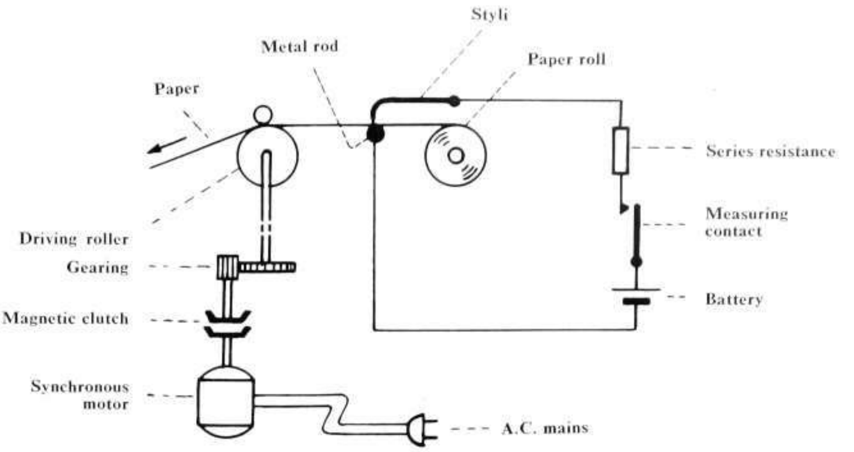


Fig. 2 X 8029
Main components of multirecorder

recording and 3 for time marking. The chart is produced on electrolytic paper of the same type as used in telefacsimile equipment for video transmission.

Recording on this paper takes place very simply and smoothly without need of optical equipment, magnets, amplifiers or other complicated apparatus. The text is immediately visible. The paper runs over a metal rod under stainless steel styli. A 20—30 mA current through the paper from the stylus to the rod produces a black line on the paper.

The recording pulses are usually obtained from a special measuring contact temporarily screwed to the relay. On operation of the relay armature the contact closes the circuit to the styli. The use of suitable series resistances enables recording to be done at the normal battery potentials employed in telephone exchanges.

The chart is fed forward by a rubber roller driven by a synchronous motor. The recorder must be connected to A.C. mains, and the paper feed rate and the distance between the time markings are determined by the mains frequency.

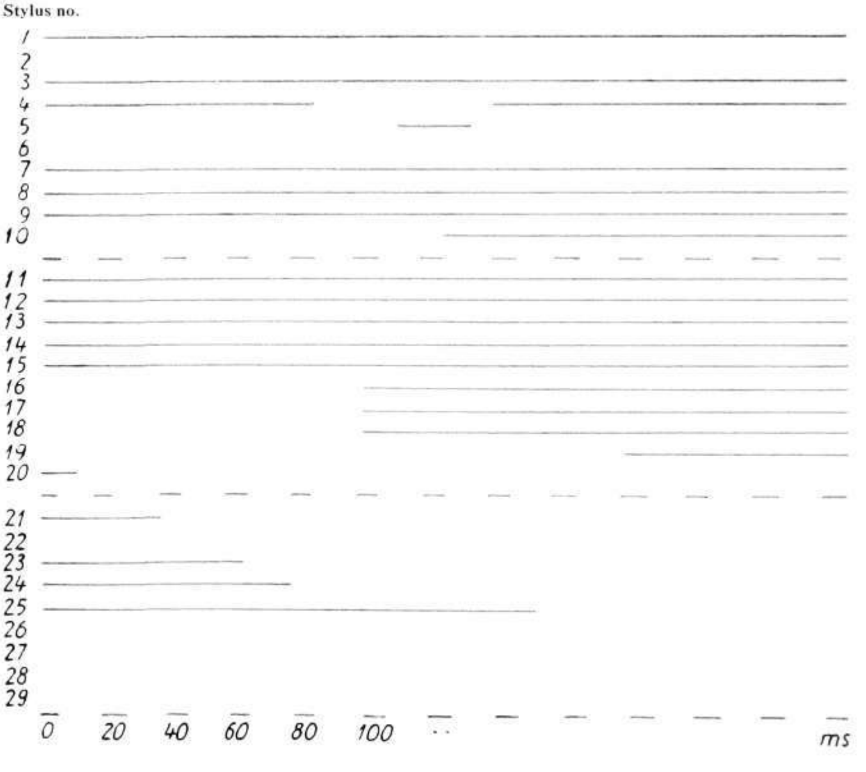


Fig. 3 X 8030
Part of chart
Approx. full size. Max. speed

In addition to actual recording equipment the recorder contains devices which reduce paper wastage at the start and end of recording.

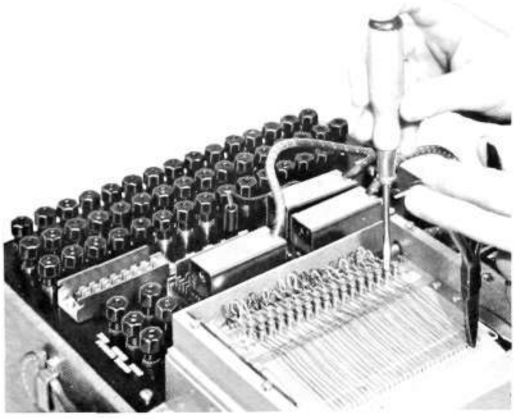


Fig. 4 X 2236

Change of styli

Recording Paper

The electrolytic paper must be moist when used. It is delivered with correct moisture content in plastic bags or sealed containers. When the paper dries, it shrinks by 2 to 3 per cent. The feed rate is so calculated as to produce the correct length of paper in dry state. The paper is not lined, but the time elapsing between two events must be determined by measuring the length on the chart or by counting the time markings. A specimen chart is shown in fig. 3.

Styli

The styli are made of stainless steel, but are nevertheless liable to wear as a result of abrasion and electrolytic corrosion. The styli have therefore been made easily interchangeable (fig. 4).

Paper Speed and Accuracy of Measurement

The chart is fed forward by a rubber roller driven by a synchronous motor operating on 110 or 220 volts at 50 or 60 c/s. The motor runs continuously. When recording is to take place, the feed roller is connected to the motor through a magnetic clutch. By this means the paper quickly attains full speed without the considerable wastage which would otherwise arise during the starting of the motor. An adjustable gear permits three different feed rates. The accuracy of reading is about 1 mm. The accuracy in terms of time, for the three feed rates, is tabulated below.

Table 1

Gear	Paper speed, mm/s		Time for 1 mm paper feed, ms	
	50 c/s	60 c/s	50 c/s	60 c/s
3	500	600	2	1 2/3
2	166 2/3	200	6	5
1	50	60	20	16 2/3

Time Marking

The three time marking styli are connected in parallel, being placed as shown in fig. 3. When the *"Time marker"* key is switched to *"Int."*, the time marking pulses are received from a transformer connected to the mains. The current passes through a rectifier, so that the time between the pulses will be 20 ms at a mains frequency of 50 c/s. When the key is switched to *"Ext."*, the transformer is disconnected, and any other pulse generator may be connected between the negative terminal and the *"Ext. time marker input"* socket.

Power Supply

The exchange battery must be connected to the recorder's battery terminals. The magnetic clutch and the four auxiliary relays are designed for 24 V operation. For higher voltage a series resistance must be placed in the circuit by setting a battery voltage selector in one of four positions marked 24, 36, 48 and 60 V.

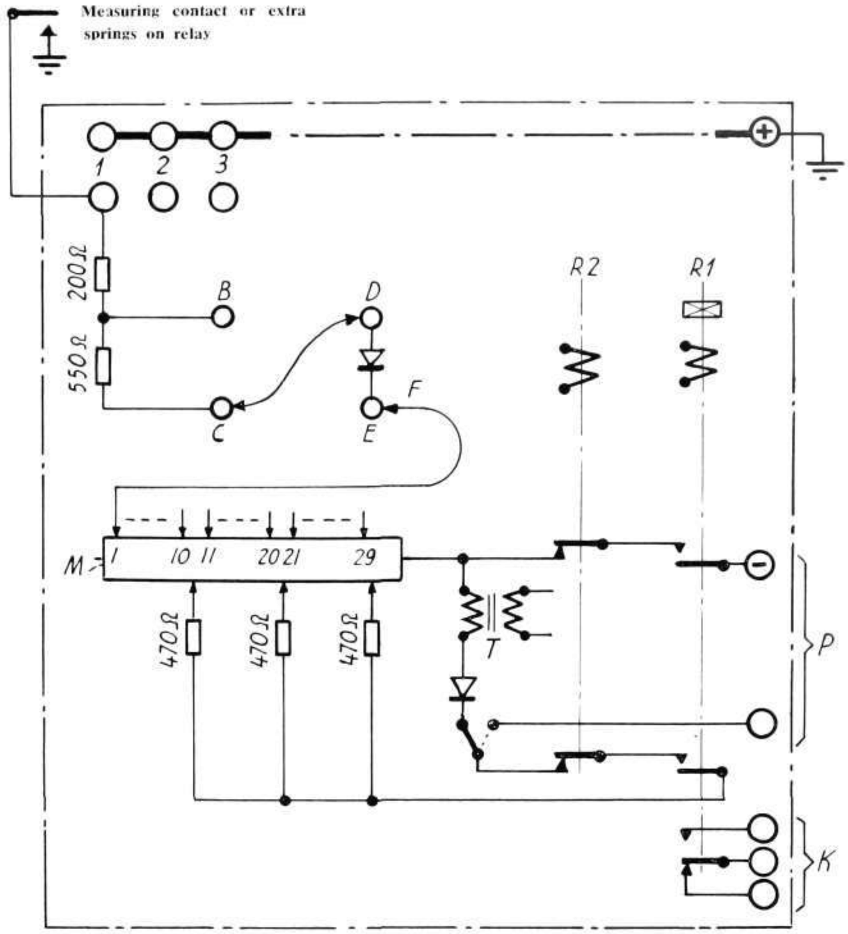


Fig. 5 X 8031

Main circuits of multirecorder

R1 start relay
R2 stop relay
B–E jacks
F plug
M metal rod
T time pulse transformer
P terminals for external time pulse generator
K control terminals

The recorder must also be connected to an A.C. supply of 50 or 60 c/s. A mains voltage selector is provided with positions for 220 and 110—127 V.

The styli are connected to the control board by a 30-point plug *F* (fig. 5). By inserting the plug into one of jacks *B*—*E* and using an interconnecting cord, several alternative connections can be obtained. If the plug is placed in jack *B* the series resistance will be 200 ohms, and in jack *C* 750 ohms. The higher resistance should preferably be used. The lower resistance should only be used if the lines are too faint, which may happen at high speed and low battery voltage. Insertion of the plug in jack *D* or *E*, and using an interconnecting cord, places a rectifier in addition to the series resistance in series with the styli. The function of the rectifier will be described below.

The indicated polarity of the battery and rectifier is suitable for a system with earthed positive. If the negative happens to be earthed, the battery and rectifier connections may be reversed. In the latter case, however, the lines will be clearest on the underside of the paper.

Connection of Equipment to be Tested

The main circuits of the recorder are shown in fig. 5. The contacts which provide the recording pulses are connected between any one of terminals *1*—*29* on the control board and the positive terminal.

The pulses can be obtained in any of the following ways:

1. The relay to be tested is provided with a special measuring contact *LMY 1501* (fig. 6), which is temporarily screwed to the front of the relay. The spring assembly of the measuring contact is actuated by the movement of the armature and closes when the armature operates. One spring is connected to a single-wire cord with banana plug. The other spring is connected to the frame, so that it is normally in circuit with the positive terminal of the battery through the rack. On the frame of the measuring contact there is also a screw terminal for direct connection of the battery positive in the event that the relay frames or the rack are not earthed.

The measuring contact also carries a set screw with which to adjust the make to coincide with a given contact function of the relay.

2. If there is an extra make contact on the relay, it can be used for recording.

3. In certain cases the stylus can be connected to one of the ordinary make contacts of the relay. In such case the aforementioned rectifiers should be connected in series with the styli, so that the circuit through the moist paper does not prolong the release lag of the relay that is controlled by the particular contact.

Fig. 6 X 2237

Measuring contact LMY 1501

Recording

Recording is started by pressing the *"Manual start"* button. Remote starting can be effected by applying positive potential to the *"Remote start"* socket.

There are two methods of running the recorder, the desired method being selected by means of a switch.

1) When the switch is set to *"Direct control"*, the paper runs as long as the button is held depressed or positive is applied to the *"Remote start"* socket.

2) When the switch is set to *"Preset running time"*, the paper runs for the preset time and then stops automatically. The desired running time is set on the *"Running time, sec"* scale, which is graduated from 0.2 to 1.2 seconds. The time is determined by an electronic timer containing a thyratron tube.

When the recorder is started, a relay with holding contact operates. The preset running time of the recorder is independent of the length of the start pulse. The relay energizes the magnetic clutch and start relay *R1*, which is slow to operate (fig. 5). The magnetic clutch couples together the feed roller and motor, so that the paper starts to move forward. After about 50 ms, when the paper has attained full speed, relay *R1* closes a circuit to the metal rod and recording can start. Relay *R1* also starts the electronic timer which, after the preset time, actuates stop relay *R2*. The chart thereupon stops and the relays return to normal.

Owing to the high speed of the paper, it is difficult to avoid considerable waste of paper if the chart has to be started first, followed by the relay set to be tested. To eliminate this wastage, start relay *R1* is equipped with a spring assembly with two change-over functions, so enabling the relay set to be started at the same moment as the recorder is ready for recording. These are marked *"Control terminals"*.

All styli, control terminals, positive and negative terminals terminate in a 40-point jack. If the relay sets to be tested are from the outset equipped with a suitable test jack, the entire relay set can be connected to the recorder at one time by means of an interconnecting cord. This also enables battery voltage to be applied to the recorder from the test jack.

A New Tape Recorder — Ericorder KTB 212

Å ELMQUIST AND P NORMARK, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 681.84.083.8

The magnetic method of tape recording has within a few years won a popularity throughout the world that would appear to be permanent. This is best illustrated by the fact that the manufacture of recording tape during the last three years has increased more than five times. New applications and fields of use have revealed the need of different designs of tape recorder.

L M Ericsson have therefore added to their previous range a smaller and lighter model of Ericorder which is even easier to handle than its predecessors. The new instrument is coded KTB 212 and is a general purpose recorder, both for speech and music.

Ericorder *KTB 212* is based on the same principles as models *KTB 201* and *202* described in Ericsson Review No. 4, 1954, but differs from them in some respects. The new Ericorder is operated by a combination of keys and knobs. The tape speeds are the internationally accepted 3 3/4″ and 1 7/8″ per second. The higher speed, which among other things gives a greater frequency range, is mainly intended for high quality requirements, whereas the lower speed, which allows twice as long an uninterrupted playing time and therefore better tape economy, is mainly intended for recording speech.

The design of the apparatus is based on the standardization work hitherto performed by the international committee (IEC). This applies particularly to track position and recording characteristics.

The choice of frequency range provides for a fidelity at the higher speed of 3 3/4″ per sec. that well complies with the requirements the apparatus is intended to meet. This was achieved particularly by a reduction of the gap in the recording head (fig. 2), the width of which determines the upper limit of the frequency range. On the other hand, the gap cannot be reduced indefinitely in view of the high sensitivity to wear and, in particular, because the signal

Fig. 1 X 8045

L M Ericsson's Ericorder KTB 212

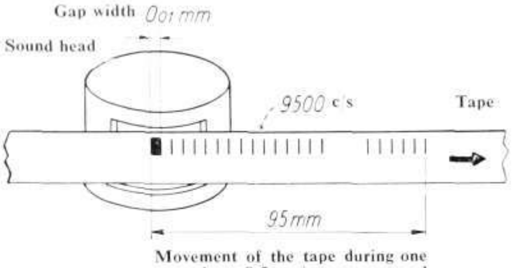


Fig. 2 X 2243

Sound head gap

The theoretical upper frequency limit of a tape recorder is dependent on the number of impulses which can be transmitted, without overlapping, from the sound head gap to the tape during one second. In the present fictitious example the resulting value is $\frac{95}{0.01} = 9\,500$ c/s.

Fig. 3 X 2240

Ericorder KTB 212

in portable case with microphone, leads and four spare reels of tape

to noise ratio deteriorates with diminishing gap width. The compromise that has been made between gap width and signal to noise ratio is based on the tape material available today. The sound heads are, as earlier, designed for dual track recording, which ensures good tape economy.

Main Design Features

Ericorder KTB 212 is in its exterior design roughly similar to the previous model with full loudspeaker front and functionally placed controls, which has won such high appreciation. However, the new model features compression formed wooden cabinet, with smoother lines and rounded edges. This has reduced the weight and increased the resistance of the set to careless handling. No deck cover plate is required. The combination of tropical wood and plastic materials presents an impression of elegance and lightness.

All controls lie conveniently to hand on the top of the set, with the speed change knob at the rear between the tape reels. Other controls are assembled on a plastic panel which also covers the erase and sound heads.

All inputs and outputs are on the rear of the set. Recessed handles are provided in the sides for facility of handling.

KTB 212 is available either in mahogany or teak cabinet. The mahogany cabinet has blue control panel and loudspeaker front. The teak cabinet has these parts green. The loudspeaker front is bordered with gilt ornamentation. Similar ornamentation exists around the control keys, counter and knobs.

The recorder is thus designed to harmonize with even the most pretentious surroundings. An extra accessory is the elegant case, which entirely protects the apparatus since it has no openings for loudspeaker and terminals, which would be necessary if the actual cabinet were used as case. The case accommodates the microphone, leads, and four spare reels of tape in original cartons. Owing to its comparatively light weight (only 8 kilos) and small dimensions the recorder is very portable.

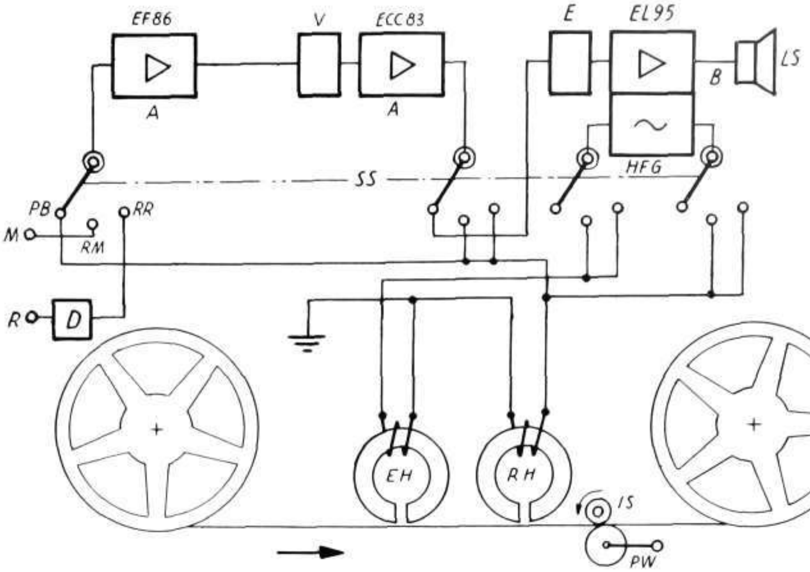
Operating Equipment

KTB 212 i designed for operation on A.C. mains and can be adapted to normally occurring voltages by means of the externally actuated selector on the bottom of the set. For optimum stability and precision the chassis is built up in an aluminium cast frame in which the amplifier is mounted as a separate unit. The tape is fed by an induction motor with capacitively coupled auxiliary phase. The reel adaptors are friction coupled to the motor for winding and rewinding. This coupling is mechanically controlled by means of the control knob. Stretching of the tape and braking is achieved by means of self-wrapping brakes which ensure exact and rapid manipulation and eliminate the risk of damaged tapes. In the movement of the tape past the magnetic heads during recording and reproduction the power transmission from the motor is via a driving belt to a capstan which pulls the tape at a constant speed. To compensate for eventual speed variations the capstan is provided with a balanced flywheel. Shifting of speed is arranged by mechanical devices in the transmission system and can be done while the tape is running. The reel adaptors have centres for the usual cine type spools employed for this category of recorder. Tape spools of up to 6″ diameter and 350-metre lengths of tape (LP tape) can be used. The total playing time of these tapes is 2×128 mins. at the lower speed. At the higher speed the playing time is

Fig. 4 X 8058

Simplified block schematic of Ericorder KTB 212

A amplifier
B power stage
D pad
E equalizer
EH erase head
HFG H. F. generator for biasing and erasing
IS driving shaft
LS loudspeaker
M microphone
PB playback
PW rubber clutch
R radio
RH record and playback head
RM record, microphone
RR record, radio
SS record-playback switch
V volume control



halved, i.e. 2 × 64 mins. These times are based on the tape thicknesses available today. The tape transport mechanism is so designed that the apparatus can without difficulty be used with the synchronizing devices that are now supplied for many types of sub-standard film projectors.

Any desired recording on the tape can be easily selected by means of the three-digit counter with rotating drums and zeroing device. The device is very exact and even enables a particular recorded word to be found very quickly. The counter is driven by the left-hand spindle. By this means it is prevented from in any way affecting the passage of the tape past the sound heads, where there is highest sensitivity to speed variations. The positions of recordings on the tape can be noted on the space provided for this purpose on the tape cartons.

The amplifier has three tubes. An additional tube of "magic eye" type is used as recording level indicator. To ensure maximum reliability in operation the rectifier in the mains unit is of selenium type. Combined with the volume control are a mains switch and a switch for tone equalization during playback. Lifting of the volume control knob suppresses the lower frequencies, which improves the intelligibility of speech recorded under poor acoustical conditions, such as at conferences. The depressed position of the volume control gives full frequency range and should preferably be used for music reproduction. The loudspeaker is of elliptical type and is specially adapted to the recorder cabinet and the amplifier.

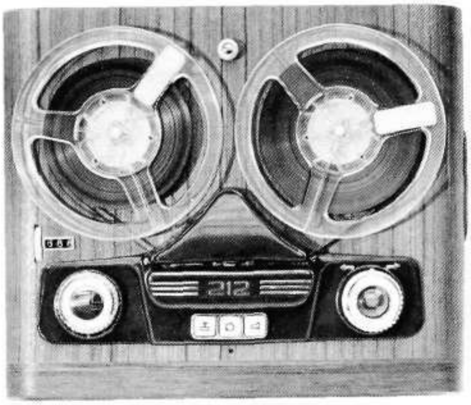


Fig. 5 X 2244

Ericorder KTB 212, viewed from above

The knob on the left is a combined mains switch, volume control and equalizer; that on the right is for tape transport, with recording level indicator in the centre. In the middle are the keys for (from left) radio recording, microphone recording and playback. At the rear between the tape spools is seen the speed switch, and on the opposite side of the left-hand spool is the counter.

The biasing oscillator is of feed-back type and supplies a frequency of 45 kc/s. This frequency was chosen out of consideration for the maximum reproduced frequency, so as to avoid interference between the signal and biasing frequencies. Both the erasing head and the combined recording and reproducing head have the design typical of the Ericorder, with the possibility of changing track position by reversing the head. The apparatus is normally supplied for the now internationally accepted CCIR standard, with recording and reproduction on the upper half of the tape when the tape runs from left to right.

A keyboard is used for switching the set for reproducing, recording from radio (gramophone, telephone etc.) or from microphone. Before starting recording, the optimum volume can be set with the volume control without registration on the tape. The latter is not started until the right-hand knob is turned clockwise. The recording level indicator is situated in the centre of the latter knob. Since the functions of this knob and of the keyboard are mechanically interconnected, no special "stop" device is required. A direct change-over can be made from recording or reproducing to fast winding or

Fig. 6 X 2242
Microphone for KTB 212

rewinding. Turning of the knob then releases any key that is depressed. This makes the recorder easy and quick to manipulate, which is a valuable feature since, like the camera, the tape recorder must often register instantaneous events. The high speed of winding and rewinding—350 metres of tape in less than one minute—is another valuable asset in Ericorder KTB 212. It should be noted that winding and rewinding always take place at this high speed, irrespective of the position of the speed switch.

The recorder's microphone (fig. 6) is of new design with crystal system. For tropical countries the microphone is supplied with ceramic cartridge which withstands extremes of moisture and temperature. The microphone casing is of ivory-white plastic.

The sensitivity of the microphone is –50 db which, in conjunction with the high degree of amplification of the tape recorder, enables recordings to be made at great distances between sound source and microphone.

Combined on a panel on the rear of the set are jacks for connection of microphone, radio or gramophone for recording, extra loudspeaker and amplifier or radio for reproducing (fig. 7). The extra loudspeaker terminal is so designed that if the loudspeaker plug is pushed fully home the tape recorder loudspeaker is automatically disconnected. If the plug is only pushed in half-way, both loudspeakers are in circuit.

The terminal for reproduction through, for example, a radiogram or amplifier system functions in such manner that, when the corresponding plug is inserted, the power stage and loudspeaker of the tape recorder are disconnected. With an amplifier of high quality and power output, good reproduction can be counted on even at high volume and with several loudspeakers. This terminal can also be used for interconnecting two tape recorders for tape copying, the feed from the reproducing set being connected to the radio jack on the recording instrument.

The total power consumption of the recorder is only 45 watts. It can therefore be run off a 6, 12 or 24-volt car battery with the aid of the now readily available vibrator-converters.

Accessories

Supplied with the recorder are a microphone, one tape (normal tape) of 260 metres and two leads for connecting to, for example, a radiogram.

Special orders may be placed for the portable case, *ÖR 41270*, as described above, and mixer *KTY 1051* (fig. 8) with which up to four microphones can be simultaneously connected to the Ericorder. The set is equipped with input jacks and volume controls for individual regulation of microphone volume. The mixer is, moreover, equipped with a channel selector with an "all" position.

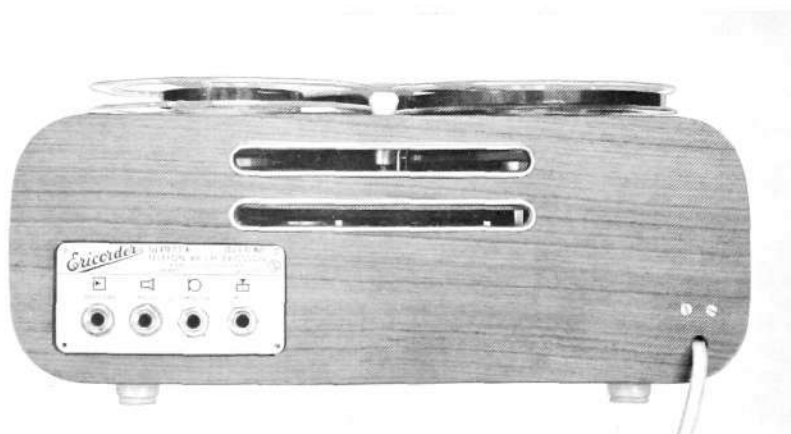


Fig. 7 X 8044
Ericorder KTB 212, rear view
(Left) jacks for connection of microphone, radio or gramophone for recording, extra loudspeaker and amplifier or radio for reproducing.

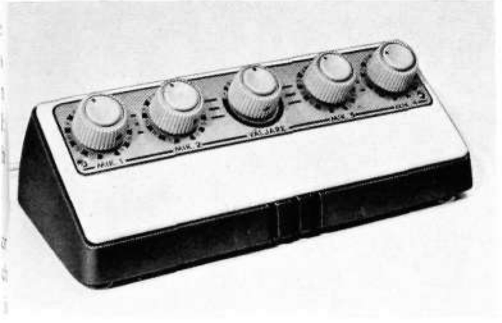


Fig. 8 X 2241

Mixer KTY 1051

For simultaneous connection of four microphones to Ericorder.

Special Facilities

For recording of telephone calls the Ericorder KTB 212 can be connected to a telephone wall terminal via an adaptor. This unit is equipped with cords and plugs for connection to the tape recorder's radio input and telephone wall terminal.

Technical Data

Mains voltage	110, 130, 140, 150, 220, 240 V A.C.
Mains frequency	50 c/s
Power consumption	45 W
Frequency response at 9.5 cm/s (3 3/4"/s) over feeder output	55—9,500 c/s ± 3 db
Playing time (6" reel, dual track)	
4.75 cm/s 350 m tape	2 × 128 mins.
4.75 cm/s 260 m »	2 × 90 »
9.5 cm/s 350 m »	2 × 64 »
9.5 cm/s 260 m »	2 × 45 »
Fast wind and rewind	1 min.
Erasing and biasing frequency	45 kc/s
Tubes	EF 86, ECC 83, EL 95, EM 34
Recording level indicator	Magic eye
Feeder output for separate radio or amplifier	0.8 V across 56 kohms (disconnects the power stage)
Signal to noise ratio	Better than 44 db
Sensitivity of microphone input	5 mV across 10 Mohms
Output power	3 W
Output impedance	4 ohms
Loudspeaker	9 × 155 mm 10,500 gauss
Equalizer	For playback
Inputs	Microphone, radio (gramophone, telephone)
Outputs	For driving power stage or radio and for extra loudspeaker
Cabinet	Mahogany or teak
Dimensions	Height 160 mm Width 345 mm Depth 295 mm
Weight	8 kilos
Normal accessories (supplied with set)	Microphone *ÖR 41250* Recording tape 6" *ÖR 75237* 260 m Empty reel 6" *ÖR 75101* Interconnecting cables (2) *ÖR 40805* with connectors to radio or amplifier
Extra accessories	Portable case *ÖR 41270* Mixer *KTY 1051* Stethoset *ÖR 75086* Telephone adaptor *KTY 1001* Extension cable to microphone *ÖR 75098*

Ericsson's TV Range 1957

U. ENFORS, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.397.62

Svenska Radioaktiebolaget's programme for 1957—1958 includes six TV models which are described in this article. All models are built up on the same chassis, the production of which started last year.

Technical Data

The Ericsson TV chassis is a so-called vertical chassis mounted behind the picture tube. This enables the controls to be placed on the side, instead of in front under the viewing screen, so saving valuable cabinet space. Another important feature of the vertical mounting is that the whole of the underside of the chassis becomes accessible for service simply by removing the rear panel. If a tube or other part has to be changed, the chassis can be folded out of the cabinet by releasing two screws.

The use of the same chassis for all TV models is a great factor in reducing production costs, and the assembly line can quickly change over to another model without loss of time and money.

The chassis, which is of A.C./D.C. design, is wired in the conventional manner with the exception of the IF amplifier which has printed wiring in order to obtain as high electrical stability as possible. Uniform quality of production is necessary for rational and inexpensive testing and alignment, in addition to which the electrical stability is of decisive importance to the reliability and picture fidelity of a TV receiver.

The input stage uses the low noise tube PCC 88 in cascode connection. The IF amplifier has four stages (EF 80) with 33.4 Mc/s audio signal and 38.9 Mc/s video signal. It is phase-linear, i.e. the group delay is constant across the band, so avoiding delay distortion of the video signal.

The video amplifier consists of two stages. The automatic gain control operates so quickly that even signal fluctuations due to passing aircraft are

Fig. 1 X 8046

Ericsson Tjugoett

Table model with 21" screen. Similar design to Vinjett, which has 17" screen.

effectively compensated. The line oscillator is a Hartley oscillator controlled by a voltage derived from a comparison between synchronizing pulses and pulses generated by the oscillator itself. This gives rise to a "flywheel effect" which considerably diminishes the sensitivity to noise. The picture tubes are of type AW 43—80 (17″) and AW 53—80 (21″) with 90° deflection and electrostatic low voltage focusing.

All Ericsson models have two sets of controls. On the rear of the cabinet are controls for frame and line hold, height, vertical linearity, focus, tone and aerial matching. These controls are adjusted in the factory and need not normally be touched.

On the right-hand side of the cabinet are five conveniently accessible controls: channel selector, fine tuning, light, contrast and mains switch/sound. Only the latter three are required in daily use.

The audio amplifier consists of IF stage, detector and low frequency amplifier, and has a frequency range of 40—15000 c/s.

The loudspeakers are all of Ericsson manufacture and equipped with diaphragms of which the cross-section follows an exponential curve. This ensures that the high tones are in correct proportion throughout the treble register. Two loudspeaker sizes are employed—18 and 20 cm—with ranges 60—15000 c/s and 40—15000 c/s. In the combined TV/radiogram Alltett there are, in addition, 10 cm dynamic tweeter loudspeakers.

Vinjett

During the past year Ericsson brought out a new 17″ table model named *Vinjett*. It won an outstanding popularity and has been retained without modification in the present year's programme. Thanks to the vertical chassis the dimensions of the cabinet front are determined entirely by the screen, being only: height 39, width 52, depth 45 cm. The cabinet has simple, clean lines and a dignified appearance. On one side is a sound opening behind which a 16 cm wide range loudspeaker has been mounted.

Vinjett is made both in teak and mahogany and can be fitted with screw-on legs.

Tjugoett

Following on the generous reception given to Vinjett a larger model with 21″ screen, *Tjugoett* (fig. 1), was added to the programme. In design and construction it is entirely similar to Vinjett, but the larger size has permitted the addition of a second loudspeaker. Thus Tjugoett has two 18 cm broad band loudspeakers mounted behind sound openings in the sides of the cabinet. Owing to the use of the short picture tube with 90° deflection the depth of Tjugoett permits the set to be placed on a normal-sized table.

Like Vinjett, Tjugoett can also be fitted with screw-on legs. The cabinet is in teak or mahogany, its dimensions being only: height 49, width 63, depth 54 cm.

Vidett

The Ericsson 21″ console receiver *Vidett* was introduced last season and became one of the most demanded console sets (fig. 2, left). Vidett was not only a technical innovation, but also represented a new and subtle solution of the complicated design problem attaching to television sets. The front is entirely taken up by the screen and the loudspeaker baffle, behind which

Fig. 2 X 8047

Ericsson Vidett with 21″ screen (left) and Konsolett with 17″ screen

The two models are of similar exterior design.

two 18 cm wide range loudspeakers are mounted. The controls are placed in a recess in the right-hand panel.

Vidett is fitted with tropical wood sliding panels which can be drawn across the screen when no viewing is in progress, and the dignified furniture style harmonizes with the most differing environments.

The cabinet is in teak or mahogany, its dimensions being: height 85, width 65, depth 51 cm.

Ericsson Konsolett

Fig. 3 X 8048

Ericsson Dubblett

(left) with viewing screen covered by tropical wood sliding panels and the radio unit lowered.

Konsolett is a 17″ console set in teak or mahogany (fig. 2, right) of similar exterior design to Vidett. The cabinet dimensions are: height 76, width 54 and depth 42 cm. It has tropical wood sliding panels which can be drawn across the screen when the set is not in use. The loudspeaker equipment

consists of two 18 cm wide range loudspeakers, and the controls are placed in a recess in the right-hand panel. The small dimensions of Konsolett make it the ideal console model for families with limited accommodation.

Ericsson Dubblett

Last season's experience revealed a great interest for combined radio and television sets. The Ericsson autumn series comprises two combination sets, of which the smaller type, *Dubblett* (fig. 3), contains a radio receiver and a 17″ TV receiver. The cabinet dimensions are: height 83, width 54 and depth 42 cm, which makes it no larger than many of the existing 17″ console television sets. The small size was achieved by placing the radio in a fold-out unit, the front of which is taken up by the loudspeaker baffle. The unit is well balanced and equipped with an air brake which gives it soft and silent movement. Like Konsolett, the screen can be covered with tropical wood sliding panels when the set is out of use. Thus, despite its ample technical equipment, Dubblett has a sober and dignified exterior which makes it a handsome piece of furniture. The cabinet is in teak or mahogany.

The radio unit consists of a 7-tube receiver of high sensitivity and good selectivity. It has long, medium and short wave bands and FM, all bands being covered by built-in aerials. The selection of the desired wave band, gramophone and switching-off of the set is done with five keys. The scale carries two station indicators, one for FM and one for other bands, the selection depending on which key is depressed. This so-called auto-duplex coupling permits independent selection of the two programmes with the same knob, the change from one to the other being effected simply by depressing a key.

The TV unit is entirely similar to Konsolett, having a 17″ screen and controls placed in a recess in the right-hand panel.

The audio equipment consists of two forward-directed 18 cm wide range loudspeakers. On both radio and television units there are tone controls for adjustment of bass and treble.

Dubblett is designed for A.C. only.

Ericsson Alltett

With the appearance of *Alltett* (fig. 4) last season Ericsson had already introduced a complete radiogram with remarkable performance data, combined with a 17″ TV receiver. Alltett was a great sales hit, largely owing to its fine exterior and remarkably neat dimensions—height 75, width 98 and

Fig. 4 X 8049

Ericsson Alltett

(right) with flap lowered and door open, showing the radio receiver and viewing screen.

Fig. 5 X 2245

Part of Ericsson Alltett

The flap has been lowered both steps, giving access to the record changer

depth 42 cm—which are no greater than those of the existing larger types of radiogram.

The front of Alltett consists, on the right-hand side, of a folding door which covers the viewing screen and, on the left, of a flap which can be lowered in two steps; the first step gives access to the radio receiver. This unit has 10 tubes and 6 wave bands, medium, long, 3 short and FM, all covered by built-in aerials. The selection of the desired wave band, gramophone or separate tape recorder, and switching off, is done with seven keys. The magic eye and the wide and easily visible scale ensure accurate tuning. Separate bass and treble controls with visual indication are provided. The low frequency amplifier has a push-pull output stage and supplies about 8 watts to the five loudspeakers. Three of the latter are 18 cm wide range loudspeakers, and two are 10 cm dynamic loudspeakers.

Under the radio unit is the record changer, a Garrard RC 120 (fig. 5). Access to it is obtained by lowering the flap a further step. The record changer can be used for all existing record speeds—16 2/3, 33 1/3, 45 and 78 r.p.m. By a simple manipulation it can be changed over to function as record player. The pick-up is replaceable and has double, reversible sapphire needles with a needle pressure of less than 9 g.

The TV unit has a 17″ screen and is entirely similar to Konsolett.

Alltett is designed purely for A.C. and has a mahogany or teak cabinet.

Ericsson LM NEWS *from All Quarters of the World*

Crossbar Exchange opened at Mansfield, Ohio

The crossbar exchange delivered by L M Ericsson's associates, North Electric, to Mansfield, Ohio, was cut over on June 1. The exchange comprises 8000 lines with some 25000 subscribers and comprehensive short-haul toll equipment. The Ericsson system was modified by North Electric to suit conditions in the United States.

The crossbar equipment in Mansfield is the second of this type to be installed by North Electric within a span of six months. The cut-over was performed in the presence of representatives of the Mansfield Telephone Company, North Electric Company and Telefonaktiebolaget L M Ericsson. The photograph above shows Hans Kraepelien, President of North Electric Company, Gustav Hirsch, Vice-President of Mansfield Telephone Company, Hans Thorelli of Telefonaktiebolaget L M Ericsson, Russell Bucek and R E Johnson of the Gustav Hirsch Organization and R B Wiseman, North Electric Company.

Swedish State Railways install C.T.C. over 300 miles of Single Track

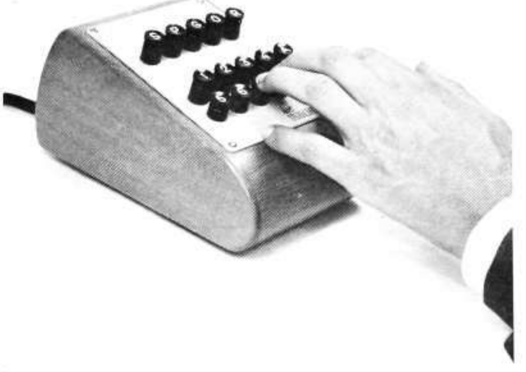
The Swedish State Railways brought their first Centralized Traffic Control installation into service in the summer of 1955 on the single-track line between Ånge and Bräcke (Sweden), where the headway is between 60 and 70 trains a day. As a result the capacity of the line was sufficiently increased to avoid the necessity of installing double tracks, which had previously been under serious consideration.

The equipment for the Ånge—Bräcke installation, as also for the double-track line Alingsås—Herrljunga, was supplied by L M Ericsson. The latter installation will be brought into operation in the near future.

At the end of 1956 the Swedish Railways placed a new order with L M Ericsson for C.T.C. equipment on the single-track iron ore railroad north of the Arctic Circle. This installation, which is expected to be completed by the New Year 1958, will be over 80 miles long and, to start with, will have 13 stations between Kiruna and Riksgränsen. A further recent order is for the Ljusdal—Mellansel section, 225 miles in length, with 39 stations. The latter section is chiefly single-track. The C.T.C. equipment is to be delivered within two years.

This rapid extension of C.T.C. equipment on over 300 miles of railroad brings the Swedish State Railways into the foremost rank among European railway organizations as regards the use of C.T.C. equipment. And the Ljusdal—Mellansel line will be the longest single section of C.T.C. track in Europe.

The C.T.C. office serving the Ånge–Bräcke line, and located at Ånge, employs keyset operation. This means that the train dispatcher–the C.T.C. operator–can control the entire signalling system throughout the supervised section with the aid of a small keyset (right). He can sit in comfort at his desk with an excellent view of the entire track diagram in front of him. The Ånge installation is the first in the world to operate under keyset control.



Karlskrona Converts to Dial Operation

On June 30 this year the major part of the Karlskrona area went over to dial operation. Apart from the Karlskrona town exchanges, the area comprises two group centres and 40 terminal exchanges. Of the two town exchanges Trossö is to serve the "town between the bridges" and Gullberna the northern part of the town with certain suburbs. This was the largest system ART 204 installation yet supplied by L M Ericsson to the Swedish Telecommunications Administration.

Trossö has 9,500 installed lines, of which 600 for P.A.B.X. subscribers. The exchange is chiefly intended to serve local traffic, but also contains automatic trunk switching equipment and junctions to Gullberna. Gullberna consists partly of a 2500-line local section, including 200 P.A.B.X. lines, and a toll exchange with 420 outgoing and 440 incoming junctions.

(From left) Rear Admiral Erik Samuelson, Director General Håkan Sterky, Provincial Governor Erik von Heland, and Messrs. Malte Patricks (partly hidden) and Hans Thorelli of L M Ericsson, at the Karlskrona cut-over.

Luxury Hotel at Curaçao orders LM Ericsson Telephones

To the ultramodern Hotel Curaçao Intercontinental, opened in September at Willemstad on Curaçao Island in the Dutch West Indies, L M Ericsson has supplied a P.M.B.X. switchboard type ADF 301 for 160 extensions and 20 exchange lines, and a P.A.B.X. ALD 23 for 25 extensions and 5 exchange lines. The delivery comprises 160 telephone instruments.

The hotel is built on the historical site of the old Waterfort. From the massive fortifications, which now serve as promenade, the hotel guests enjoy the view over the Caribbean Sea which surrounds the hotel on three sides.

LM Ericsson's Malmö Branch enters New, Modern Premises

L M Ericsson's Malmö branch has recently moved into a new building with modern office and warehouse accommodation.

The Malmö branch is represented by AB Alpha, AB Ermi, L M Ericsson's Sales, Sieverts Cables, Svenska Radio and L M Ericssons Driftkontroll AB. The new premises occupy some 8,000 sq. ft. of floor space, including a show room and servicing shops for L M Ericsson Sales and Svenska Radio.

The warehousing accommodation, in particular, brings much relief, as materials previously had to be stored at various points of the town. The new warehouse contains 24,000 sq. ft. of floor space.

New Chairman of Swedish Chamber of Commerce, New York

Nils A Sterner, vice-president of L M Ericsson, was recently appointed chairman of the Swedish Chamber of Commerce in New York.

From the Visitors' Book

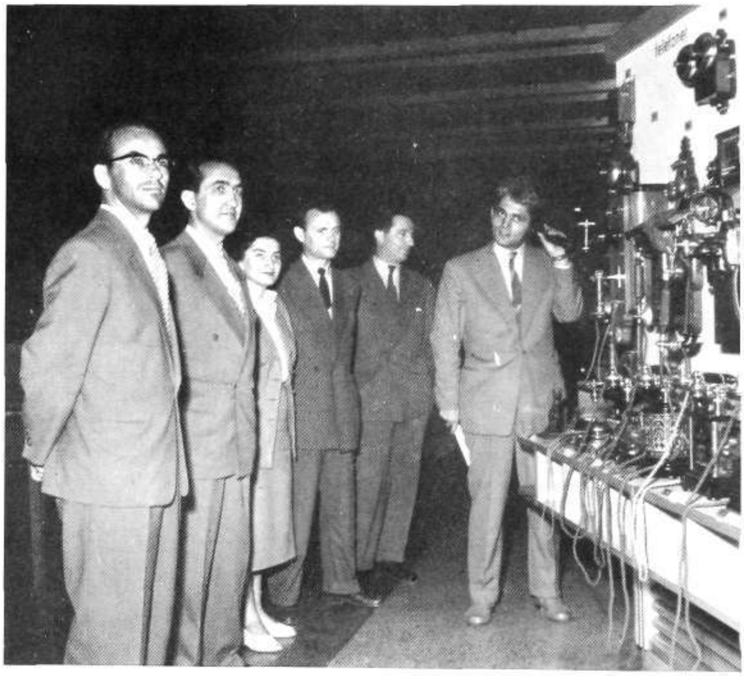
The Turkish Ambassador in Stockholm, M Orhan Eralp, visited L M Ericsson in June, accompanied by Commercial Attaché Hikmet Princcioglu. The Ericofon was the object of interested study.

A number of units from the British Home Fleet under the command of Admiral Sir John Eccles made an official visit to Sweden this summer. The Admiral was presented by L M Ericsson with an Ericofon which was installed in the after-saloon on HMS "Maidstone". The Admiral expressed his great appreciation of the efficient and elegant design.

During the visit of the U.S. cruiser "Northampton" in the spring, L M Ericsson likewise presented an Ericofon which won high praise from the visitors.

During the official visit to Sweden of Queen Juliana of Holland, L M Ericsson welcomed a group of officers from the Dutch cruiser "de Zey

The U.S. Minister of Commerce, Mr Sinclair Weeks, after opening the American Pavilion at the St. Eriks Fair in Stockholm at the beginning of September, paid a call at L M Ericsson in the company of Mr Charles Squibb, Boston (left). Mr Sven T Åberg here demonstrates the Ericofon.



A Jugoslav trade delegation was in Stockholm at the end of June. Their programme included a visit to L M Ericsson. Second from the left is the Secretary of the Jugoslav Chamber of Commerce, Milorad Konjovic, head of the delegation.

New Icelandic Dial Exchanges

Two new exchanges of type AGF 24 at Reykjavik, Iceland, were ready for service at the beginning of July. One, Reykjavik Centrum, was a 3,000-line extension; the other was a new 3,000-line exchange at Grensås in the suburb of that name. Both exchanges employ 500-line selectors with crossbar registers.

The photograph shows the exchange building at Reykjavik.

Doctorate for L M Technician

Anders Elldin of L M Ericsson presented in June his doctor's thesis "Applications of Equations of State in the Theory of Telephone Traffic". The thesis was presented at the Royal Institute of Technology, Stockholm.

Dr. Elldin has been with L M Ericsson since 1944. Since 1950 he has been engaged on traffic research at the Ericsson Research Department.

The thesis presents a study of the possibilities of applying the method of equations of state, introduced by Erlang, to the theory of telephone traffic. It opens with a discussion of the possibilities of adapting the assumptions to the physical conditions, and of the future uses of the method. Thereafter follow two applications—one to gradings with random occupation, the other to a two-stage link system. An approximate solution is presented to the congestion in a grading consisting of three selector groups, the accuracy of which is evaluated with the aid of "transition coefficients". The significance of asymmetrical loading and the number of selector groups in a grading can be explicitly assessed in a formula. Finally, the paper contains approximate solutions to the distribution of the number of busy pairs in a link system. An iterative method adapted to computer operation is also presented.

The opponents of the thesis were Christian Jacobæus, L M Ericsson, Arne Jensen, Copenhagen Telephone Co., and Gösta Neovius, L M Ericsson.

New number of "Ericsson Technics"

Ericsson Technics No. 1, 1957, opens with a paper by Bertil Agdur of The Royal Institute of Technology, Stockholm, "On the Interaction between Microwave Fields and Electrons, with Special Reference to the Strophotron". This paper reports on a theoretical and experimental study of the interaction between a microwave field and electrons in a system in which the electrons oscillate in a non-linear electric field consisting of a static and a dynamic component.

Robert Magnusson of the Chalmers University of Technology, Gothenburg, in an article on "Sensitive Group Delay Meters", describes methods of measuring the group-delay of wide band IF amplifiers.

In the following article, "A Survey of the Applicability of Equations of State in the Theory of Telephone Traffic", Dr. Anders Elldin, of Telefonaktiebolaget L M Ericsson, discusses the applicability of the method of equations of state, introduced by Erlang in 1917, in relation to the mathematical aids of today and to the possibilities of adapting the assumptions to the existing physical conditions.

Veteran Awards

Since the institution at the beginning of last year of the L M Ericsson Silver Plaque with award of shares to employees on completion of 50 years' service, this mark of distinction has fallen solely to male workers. It is therefore a pleasure to be able to present the first woman silver medallist, Miss Lisa Carlsson, employed at the head factory at Midsommarkransen. Miss Carlsson started with L M Ericsson at the age of 14, when the factory was situated at Tulegatan in Stockholm. In due course she moved over to the winding department, where she worked for 20 years before becoming master controller. She is now on the measurement and inspection of transformers at the head factory.

The plaque and share certificates were presented by Mr Hans Thorelli at a simple ceremony in the directors' dining room.

At the end of June another veteran of the Ericsson group—Erik Lundström, Engineer-in-charge, Control Section, AB Alpha—received the same distinction. The plaque was presented at a dinner at Ulriksdals Värdshus by the head of Alpha, Mr N Kallerman.

The growing importance of polystyrenes in the telephone industry—used, among other things, in the manufacture of the Ericofon—necessitated studies of the impact strength of these plastics. In the last article of this number Hilding Högberg, of Telefonaktiebolaget L M Ericsson, gives an account of such studies and finds, among other things, that the strength is greatest in the surface layer of the moulding. He concludes by discussing the dependence of strength properties on moulding conditions.

U.D.C. 621.397.62

ENFORS, U: *Ericsson's TV Range 1957.* Ericsson Rev. *34* (1957) No. 3, pp. 100—104.

The Ericsson TV range for the 1957—58 season is presented. All models are built on the same chassis, the production of which started last year.

U.D.C. 621.395.44

EKHOLM, O, ERIKSEN, E & KJELLERYD, T: *L M Ericsson's 960-Circuit System for Coaxial Cables. II. HF Line Equipment.* Ericsson Rev. *34* (1957) No. 3, pp. 74—89.

The article deals with the parts of L M Ericsson's new h.f. line equipment for the 960-circuit system ZAX 960/2 which are directly connected with the transmitted signal band, the h.f. signal path. A brief explanation is given of the different types of repeater stations. The h.f. characteristics of the transmission medium—the coaxial cable—and the nature of the transmitted signal are then dealt with. The problem of maintaining the level of the wide signal band at a constant value is illustrated, and in a section on the line amplifier, details are given of how the requirements which must be placed on an h.f. line equipment as regards high frequencies have been satisfied.

U.D.C. 681.178:621.395.65

NYLUND, E: *The Multirecorder—An Instrument for Recording Switching Time Functions.* Ericsson Rev. *34* (1957) No. 3, pp. 90—94.

Telefonaktiebolaget L M Ericsson has introduced a portable multirecorder, ZTT 10001, designed for recording switching processes in relay sets. The article describes the meter, its operation and performance data.

U.D.C. 681.84.083.8

ELMQUIST, Å, & NORMARK, P: *A New Tape Recorder—Ericorder KTB 212.* Ericsson Rev. *34* (1957) No. 3, pp. 95—99.

To the present range of Ericorders, L M Ericsson has added a new model, that is smaller, lighter and easier to handle. The new Ericorder is coded KTB 212 and is a general purpose recorder both of speech and music.

The Ericsson Group

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ERICSSON Review

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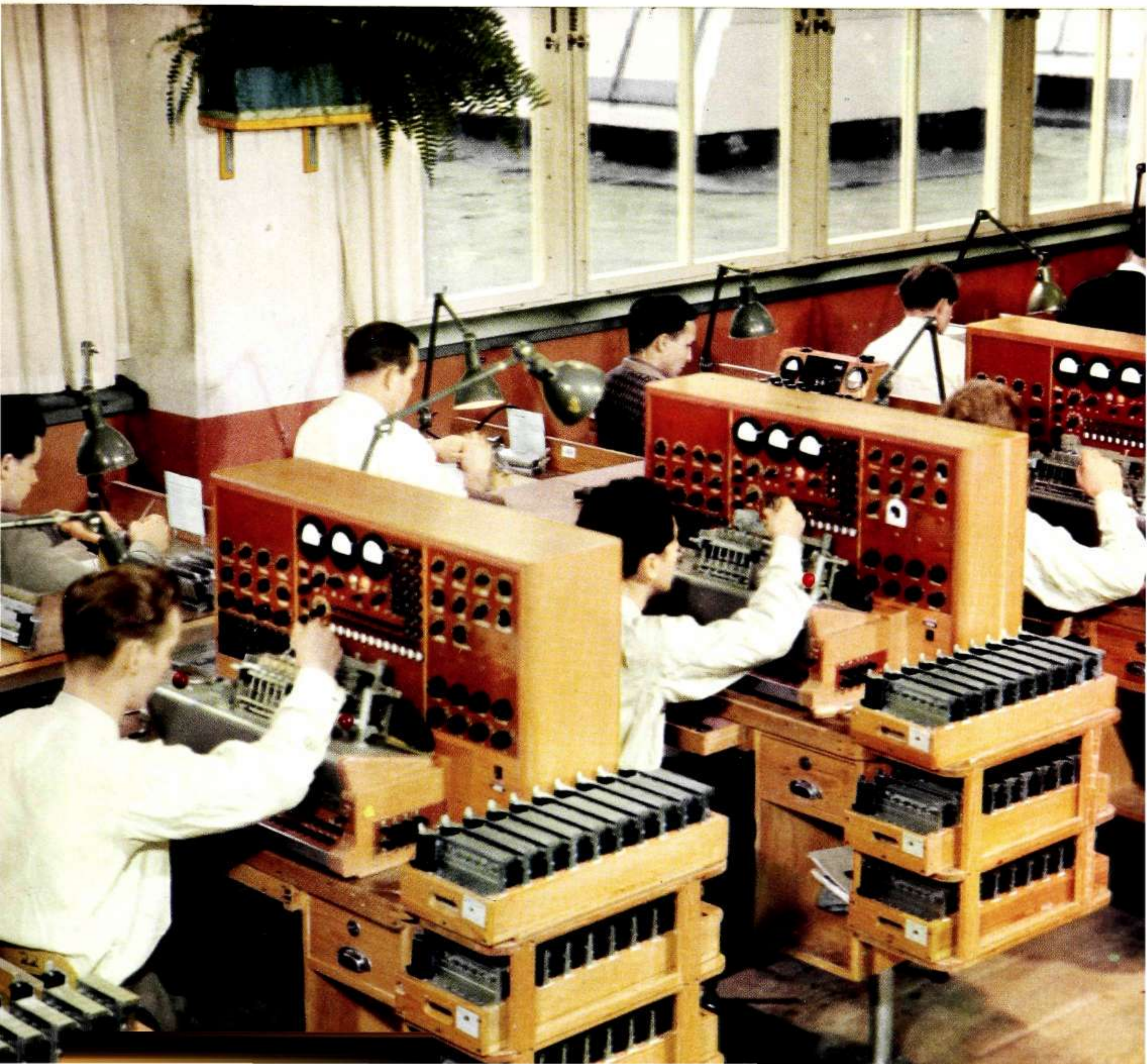
1957



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L M Ericsson's 960-Circuit System for Coaxial Cables

II. HF Line Equipment

The HF Signal Path: The Cosine Equalizer

N O JOHANNESSON, E OLOFSSON, N O TANGEN, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.44
621.395.521

Continuing the description of the h.f. line equipment for the coaxial system ZAX 960/2 which commenced in the previous number of Ericsson Review, this article deals with a newly designed equipment for manual equalization of the variations in loss on the h.f. line. The design is based on an all-purpose equalizer, a so-called cosine equalizer, together with a computer with the help of which the correct setting of the equalizer can be calculated from measurements of pilot levels. A special advantage of this equipment is that equalization can be made while the line is in traffic. In connexion with this a brief description is given of an inter-supergroup pilot sending equipment, for sending out measuring pilots in the frequency spaces between supergroups, and a portable inter-supergroup pilot measuring set, which is used for measuring pilot levels. Finally, several different examples of equalization of different loss curves are given for a ZAX 960/2 coaxial system h.f. line.

General

Carrier telephony on coaxial cable is largely a question of compensation of loss with great precision. As already mentioned in the previous article in this series, the main compensation is carried out by the line amplifier itself in conjunction with line building-out and equalizer networks, and by the automatic regulation of gain with the variations in attenuation of the coaxial cable due to temperature changes. Due to the high accuracy and stability in these circuit elements, the total compensation of loss on a percentage basis is certainly very good. As regards long h.f. lines, where the loss at the upper part of the frequency band can be of the order of 1500—2000 db, the absolute compensation of loss would, however, be insufficient if reliance was placed on these elements alone. A large number of uncontrollable secondary losses or gains changing with time also occur, caused by, among other things, aging of tubes and components in amplifiers and correction networks, mechanical changes in the coaxial cable itself, gradual changes in temperature and humidity in the repeater huts etc. In the h.f. line equipment developed by L M Ericsson, the changes are so small for each separate repeater station that they could only be detected by extremely sensitive measuring equipment. A realistic view of the equalization problem requires, however, that account is taken of these secondary effects already from the beginning and assumes an adequate equalization equipment for them. The following demands should be placed on such an equipment.

1. *Flexibility.* It schould be possible to equalize fairly arbitrary residual error curves with this equipment, which is installed when the line is put into service. It is impractical to make special variable correction networks for "typical residual error variations", as the frequency trends of

these show peculiarities individual to each h.f. line, and it would be necessary to wait at least a year in order to obtain reliable statistical data.

2. *No extra systematic errors shall be introduced.* On a long h.f. line the variable additional loss must be divided up at several points, and it must not then introduce its own systematic errors. It has been shown for example that it is easy to obtain an unfavourable rippled character for the equalized loss curve, if variable networks are used which consist of a number of small attenuation peaks which are variable in amplitude and which lie close to each other in frequency.
3. *Traffic shall suffer as little interference as possible.* The need for periodic extra equalization should take up as little as possible of the active traffic time. Equalization should preferably be possible during traffic.
4. *Clear procedure and rapid setting of the equalizer.* The network for the supplementary equalization should be adjustable by control knobs rather than soldered connexions and strappings. It should be possible to determine the correct setting of each control independently so that time-wasting successive approximations are avoided. The method should be simple and clear so that correct adjustment can be achieved without cut-and-try procedure. This has been a difficulty in the case of the networks previously mentioned, where the variable loss is produced by a number of differently shaped "equalization humps" situated more or less arbitrarily at different frequencies.

The equalization equipment chosen by L M Ericsson satisfies all the above requirements. It is based on the following three main principles:

1) The variable loss network selected, a so-called *cosine network*, provides several setting possibilities, thus allowing a generalized approximation to a loss curve.
2) The necessary information on the requisite loss compensation is obtained by measuring the levels of the line regulating and measuring pilots recommended by CCITT for the h.f. line*.
3) Use is made of a special analogue computer, a so-called *cosine equalizer* adjustment computer, for deriving the correct setting of the cosine network from the measured level discrepancies.

Equalization is carried out in accordance with the following straightforward procedure.

1. Firstly, measuring pilots, situated in the space between the supergroups are applied. These inter-supergroup pilots can be transmitted without interfering with the traffic.
2. The level of the inter-supergroup pilots is measured selectively and the deviations from the nominal levels are noted.
3. The deviations noted are set up on the cosine equalizer adjustment computer, which by electrical analogy evaluates the correct setting of each control in the cosine network.
4. The cosine equalizer is set to the calculated values and the work of equalization is thereby completed. Setting up of the network can be carried out when traffic is in progress without any risk of interference.

All equipment is so simple to manage that maintenance personnel can quickly carry out the work of equalization. This contrasts with older methods which required both time, patience and experienced personnel.

In the following section the equipment will be described. The cosine network itself is treated in some detail as this is the foundation of the idea of the method of equalization.

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* As mentioned in the introductory article in Ericsson Review, No. 2, 1957, a number of measuring pilots, so-called inter-supergroup pilots, are sent intermittently for routine checking of the variations of loss along the h.f. line. In addition, the 4092 kc/s and 2792 kc/s pilots for automatic line regulation and the 60 kc/s pilot for frequency comparison are sent continuously. In the section on "The Cosine Equalizer Adjustment Computer", fig. 9 shows the frequencies of these pilots.

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Cosine Networks

The Problem of Approximation

The problem is as follows:

Within a certain frequency band a given loss curve is to be approximated by a finite number of variable component terms. Conditions outside this frequency band have no significance.

This can be compared with a well-known approximation problem in mathematics. Within a given interval, it is possible, according to Fourier, to approximate any finite and continuous function in a very satisfactory manner by using a series of harmonically related sine and cosine terms. (Outside this interval the Fourier series repeats itself periodically, but this is of lesser importance in this connexion). If one could produce an electrical network giving variable loss curves with frequency characteristics of this form, the problem of approximation could be solved in a very elegant manner.

From a purely practical point of view, it has been shown that a variation curve having a sinusoidal frequency characteristic is much more difficult to obtain than one of cosine shape. Fortunately it is mathematically possible to approximate a function within a given limited interval using only cosine terms. The only difference is in the performance of the approximating series outside the interval, but this is of course hardly of any interest. The way in which such so-called cosine networks are assembled will now be treated, while the approximation will be examined further in the section on the cosine equalizer adjustment computer and the equalization result.

Electrical Construction

The name "cosine network" is actually an abbreviation for "correction network having a variable cosine-shaped loss curve". For variable correction networks, it is preferable to choose circuits with only passive elements, as active elements, such as tubes, always introduce aging, risk of intermodulation etc. Further, the networks should be of the constant image impedance type so that they can easily be connected in cascade. The bridged-T network is a simple and well-known network which satisfies the above conditions, and it has therefore been chosen.

Theory of the bridged-T network

Fig. 1 shows the circuit diagram. The resistor elements within the dotted rectangle form a pad having real image impedance R_0 and image attenuation $2A_0$ Neper. The variable impedances Z_1 and Z_2 are ganged so as to be the inverse of each other, that is

$$Z_1 \cdot Z_2 = R_0^2 \tag{1}$$

Due to this ganging the image impedance for the bridged-T network is always real and equal to R_0.

The image transfer constant Γ for the bridged-T network is naturally dependent on the values given to Z_1 and Z_2. It will be seen directly that the image attenuation varies from 0 to $2A_0$, if Z_1 is varied from 0 to ∞. (Due to the ganging Z_2 then varies from ∞ to 0.) The exact expression for the image attenuation as a function if Z_1 and Z_2 can be written in different ways. A specially suitable result is obtained if one proceeds from the resistive values of Z_1 and Z_2, R_{01} and R_{02} respectively, for which the image attenuation is equal to A_0, i.e. half the basic loss $2A_0$. We now introduce the concept of *reflexion factor* ϱ, defined by

$$\varrho = \frac{Z_1 - R_{01}}{Z_1 + R_{01}} = -\frac{Z_2 - R_{02}}{Z_2 + R_{02}} \tag{2}$$

(It will be seen that $|\varrho| \leq 1$.)

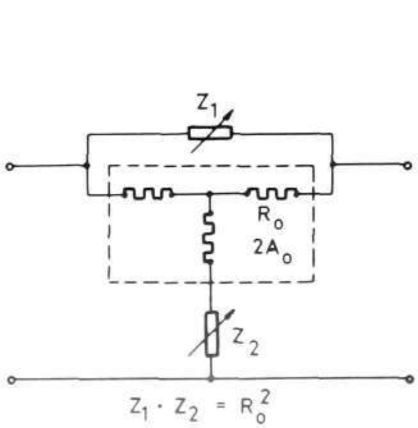


Fig. 1 X 2264

Constant impedance bridged-T network

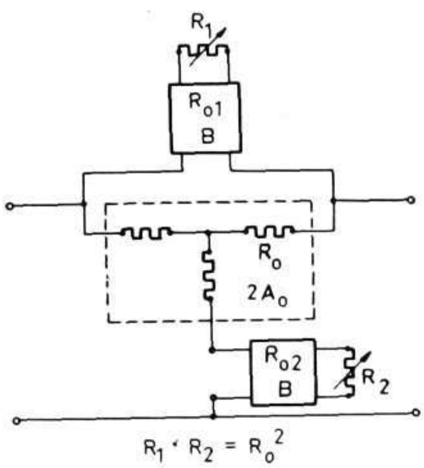


Fig. 2 X 2265

Bridged-T network with auxiliary quadripoles

The image attenuation for the bridged-T network can then be approximated with considerable accuracy by the following simple expression.

$$\Gamma = \alpha + j\beta = A_0 + \varrho \cdot A_0 \tag{3}$$

If Z_1 and Z_2 are variable resistors then the reflexion factor ϱ is real, and a variable pad having a loss curve which is independent of frequency is then obtained. The basic loss is A_0 and the maximum variation becomes $\pm A_0$.

Due to practical reasons, only resistors can be considered as variable impedance elements. When, therefore, a variable loss curve is required, which is not independent of frequency, the reflexion factor in equation (3) must be changed by auxiliary quadripoles, connected as shown in fig. 2.

Let us assume that both auxiliary quadripoles are composed of phase shifting networks having the same phase shift B but having image impedances R_{01} and R_{02} respectively (R_{01} and R_{02} are defined as previously). The quadripoles are terminated with the variable resistors R_1 and R_2, which are ganged in opposite directions so that $R_1 \cdot R_2 = R_0^2$.

The reflexion factors for the terminating resistors alone are

$$r = \frac{R_1 - R_{01}}{R_1 + R_{01}} \text{ and } r = -\frac{R_2 - R_{02}}{R_2 + R_{02}} \text{ respectively} \tag{4}$$

$$-1 \leqslant r \leqslant +1$$

When seen through the auxiliary quadripoles, the reflexion factor becomes

$$\varrho = \exp(-j2B) \cdot r = (\cos 2B - j \sin 2B)\, r \tag{5}$$

which on introduction into equation 3 gives the complex image transfer constant. Now we are only interested in loss, which gives

$$\alpha = A_0 + A_0 \cdot \cos 2B \cdot r \tag{6}$$

As the phase angle B must always change with frequency, we have therefore obtained a loss variation which is frequency dependent and which can be arbitrarily set between the maximum limits $\pm A_0 \cos 2B(f)$ by varying the factor r. The factor r is varied in its turn by variation of the resistors R_1 and R_2.

* This can be explained in the following manner. The incoming current-voltage wave is first shifted in phase by angle B radians in the quadripole. The part which is reflected toward the terminating impedance is then shifted in phase also by angle B on return through the quadripole. In this way the factor 2 is obtained.

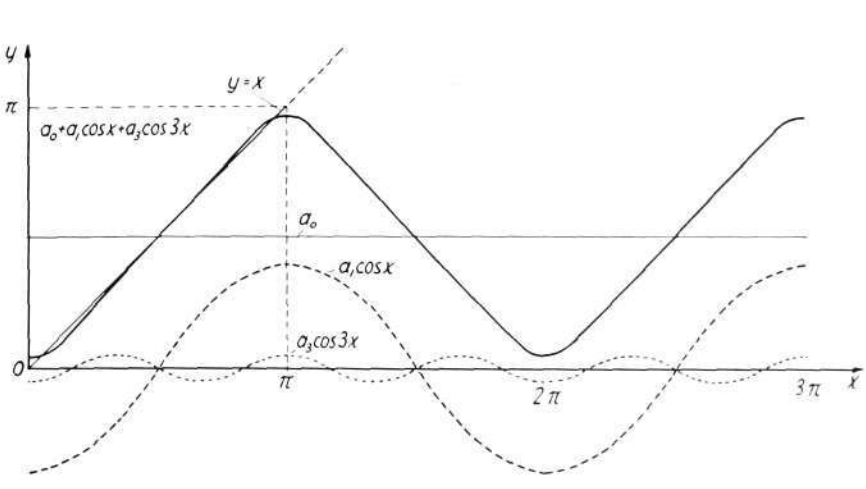


Fig. 3 X 8066

Approximation of y = x with cosine terms for $0 \leqslant x \leqslant \pi$

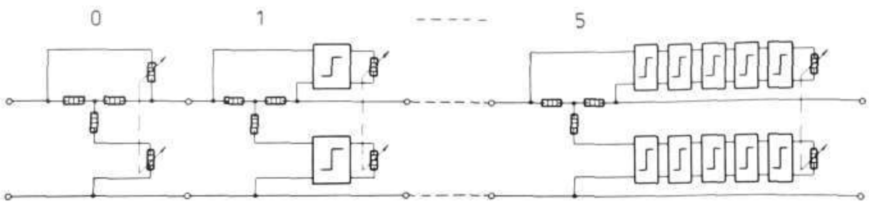


Fig. 4 X 8067

Circuit diagram for cosine networks

Summation of several cosine curves

It can be shown that a Fourier approximation of a certain function within an interval $0 \leqslant x \leqslant \pi$ can be expressed as a series of cosine terms having the general formula

$$A_0 + A_1 \cos x + A_2 \cos 2x + A_3 \cos 3x + A_4 \cos 4x + \ldots \tag{7}$$

It is seen that the cosine terms are in harmonic relationship with each other, i.e. the coefficients 1, 2, 3, 4, etc. before the x are integers.

Fig. 3 as an example illustrates how the function $y = x$ within the interval $0 \leqslant x \leqslant \pi$ with good accuracy can be made up of the series

$$y_1 = 1.57 - 1.27 \cos x - 0.14 \cos 3x \tag{8}$$

Outside the stated approximation interval, y_1 repeats itself in a period of 2π, while the function $y = x$ continues to increase.

In equation (6) for the loss of the bridged-T network there is also a cosine term, although instead of x there is the angle $2B$. This indicates how an expression can be obtained which as far as loss is concerned is similar to the sum in equation (7). A number of bridged-T networks, with phase shifting auxiliary networks as mentioned previously, are quite simply cascade connected, each phase shifting network being made up of a different number of simple basic networks. All T networks are assumed to have the same average loss A_0.

The first network has an auxiliary quadripole with one basic network and a phase shift of $B_0(f)$.

The second network has an auxiliary quadripole with two basic networks and a phase shift of $2B_0(f)$.

The Nth network has an auxiliary quadripole with N basic networks and a phase shift of $NB_0(f)$.

Moreover there is a network without any phase shifting network at all, "the zero term".

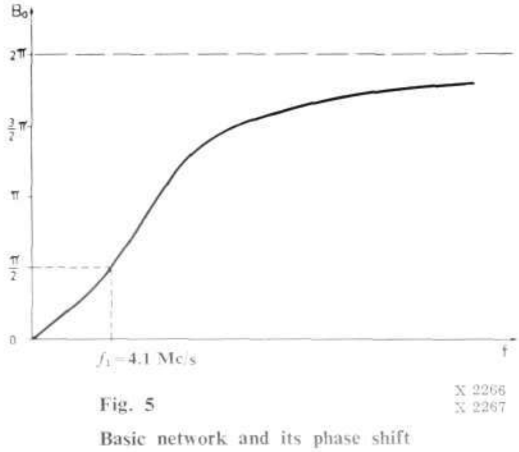
Fig. 4 shows the circuit schematic.

The total loss for such a network now becomes:

$$\alpha = (N+1)A_0 + A_0 r_0 + A_1 r_1 \cos 2B_0(f) + A_2 r_2 \cos 4B_0(f) + \ldots$$
$$\ldots + A_N r_N \cos 2NB_0(f). \tag{9}$$

It is seen that the variable x in equation (7) directly corresponds with the factor $2B_0(f)$ in equation (9). The term $(N+1)A_0$ is the total average loss. If the loss curve which must be imitated by the correction network is drawn as a function of angle $2B_0$, the losses of the networks are to this scale pure cosine curves of 0, 1, 2, 3, etc., i.e. they are in harmonic relationship with each other. In this new scale it is also possible to make a Fourier analysis in the normal way of the residual error curve, whereby the coefficients for each cosine term are obtained. If then these corresponding values are set on the respective correction network a good approximation to the residual error curve is obtained.—See the later section on the cosine equalizer adjustment computer and examples of the results of equalization.

The basic network which gives $2B_0(f)$ should be as simple as possible, and fig. 5 shows the design used by L M Ericsson together with its phase shift curve. (As is seen, it is only necessary to use a part of the available phase shift in the basic network, as $x = 2B_0 = \pi$ at the upper cut-off frequency $f_1 = 4.1$ Mc/s.)



X 2266
X 2267

Fig. 5

Basic network and its phase shift

Choice of the Number of Cosine Terms and Variation Range

Theoretically, one can make a cosine network with an arbitrary large number of cosine terms each one having a large variation range, but this naturally results in excessive basic loss. It has been shown for L M Ericsson's h.f. line equipment that five cosine terms and a zero term go far enough, and for each term a basic loss of 4.8 db and a variation range of ± 2.8 db have been chosen.

Fig. 6 shows the frequency characteristics of the different loss curves.

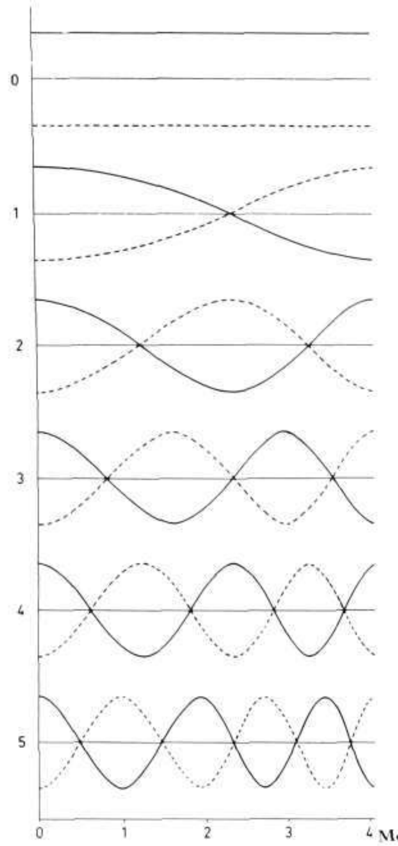


Fig. 6 X 2268

Loss curves of cosine networks

Mechanical Construction of the Cosine Networks

The electrical components of each cosine term are contained in a hermetically sealed container, with the exception of the variable resistors. These are two special deposited carbon layer potentiometers with logarithmic resistance-angle of rotation characteristic which are connected together on the same spindle so that the resistance values vary in opposite directions. The spindle has a large clear drum-type scale, directly calibrated in db or N. The setting is carried out using a worm gear. All networks and their setting mechanism are mounted behind a front plate on a standard panel of five height modules. As protection against accidental resetting of loss, the setting knobs are provided with a cover. Further details of the mechanical construction are shown in fig. 7.

Cosine Analysis

Theory for Cosine Analysis

Fourier analysis in mathematics is based on integration. In numerical analysis a somewhat different procedure is used which could better be called *trigonometric interpolation*. Here the function which is to be simulated is sampled in such a way that its value is given at certain points. A trigonometrical series having a number of terms equal to the number of given points is assumed, and a system of equations is formed from which the unknown coefficients for the sine and cosine terms can be calculated. In most text-books on numerical analysis such systems are worked out for 8, 12, 16 and 24 equidistant points. In our actual case only cosine terms are used and we will here go through the special method of calculation procedure.

Assume that we have an overall loss curve y drawn as a function of x, where $x = 2B_0$ (B_0 is the phase shift of the basic network as a function of

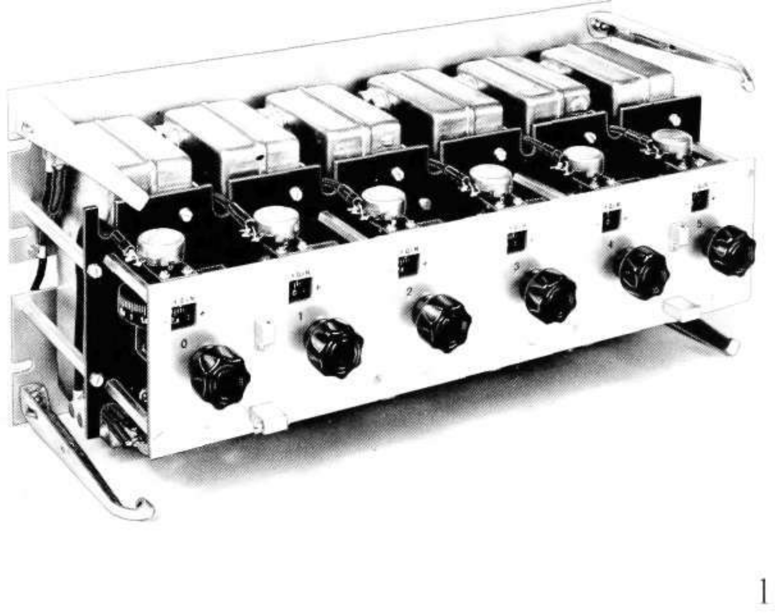


Fig. 7 X 8062

Cosine equalizer, consisting of a zero term and five harmonic terms

with dust cover and protective cover removed

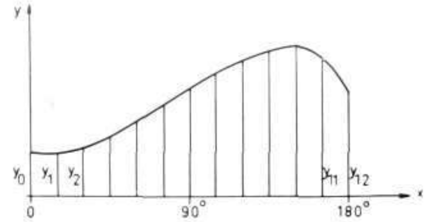


Fig. 8 X 2269

Sub-division points for analysis

the frequency). This means that all the loss curves of the correction networks are of cosine shape and the upper cut-off frequency $f_1 = 4.1$ Mc/s corresponds to $x = \pi$, or expressed in degrees, $x = 180°$. (Numerical calculations are clearer if one works in degrees instead of radians.)

This interval is sub-divided into twelve equal parts and the values of the loss at points 0, 1, 2 . . . 12 are called y_0, y_1, y_2, . . . y_{12}, see fig. 8. Each interval is therefore 15 degrees wide.

We now form the following cosine series where the coefficients r are for the moment undefined.

$$y = r_0 + r_1 \cos x + r_2 \cos 2x + \cdots + r_{12} \cos 12x \tag{10}$$

This series is to agree at each of the points 0, 1, 2 . . . 12 with the given values y_0, y_1, y_2 . . . y_{12}. The following family of equations is obtained

$$\left.\begin{aligned}
y_0 &= r_0 + r_1 \qquad\quad + r_2 \cdots\cdots\cdots + r_{12} \\
y_1 &= r_0 + r_1 \cos 15° + r_2 \cos 2 \cdot 15° + \cdots + r_{12} \cos 12 \cdot 15° \\
y_2 &= r_0 + r_1 \cos 30° + r_2 \cos 2 \cdot 30° + \cdots + r_{12} \cos 12 \cdot 30° \\
&- - - - - - - - - - - - - \\
y_{12} &= r_0 + r_1 \cos 180° + r_2 \cos 2 \cdot 180° + \cdots + r_{12} \cos 12 \cdot 180°
\end{aligned}\right\} \tag{11}$$

This family of equations is not so difficult to solve, despite its many terms, mainly due to the fact that the distance between points has been chosen constant. The following general solution for the required coefficients r is obtained

$$r_n = \frac{1}{6}\{y_0 \cdot k_0 + y_1 \cdot k_1 + y_2 \cdot k_2 + \cdots + y_{12} \cdot k_{12}\} \tag{12}$$

In this equation the stated values y are therefore multiplied by coefficients k which are worked out and given in the table below. It is seen that for the coefficients k there are only nine different values occurring with positive or negative signs.

r_n \ k_n	k_0	k_1	k_2	k_3	k_4	k_5	k_6	k_7	k_8	k_9	k_{10}	k_{11}	k_{12}
r_0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$
r_1	$\frac{1}{2}$	$\cos 15°$	$\cos 30°$	$\cos 45°$	$\cos 60°$	$\cos 75°$	0	$-\cos 75°$	$-\cos 60°$	$-\cos 45°$	$-\cos 30°$	$-\cos 15°$	$-\frac{1}{2}$
r_2	$\frac{1}{2}$	$\cos 30°$	$\cos 60°$	0	$-\cos 60°$	$-\cos 30°$	-1	$-\cos 30°$	$-\cos 60°$	0	$\cos 60°$	$\cos 30°$	$\frac{1}{2}$
r_3	$\frac{1}{2}$	$\cos 45°$	0	$-\cos 45°$	-1	$-\cos 45°$	0	$\cos 45°$	1	$\cos 45°$	0	$-\cos 45°$	$-\frac{1}{2}$
r_4	$\frac{1}{2}$	$\cos 60°$	$-\cos 60°$	-1	$-\cos 60°$	$\cos 60°$	1	$\cos 60°$	$-\cos 60°$	-1	$-\cos 60°$	$\cos 60°$	$\frac{1}{2}$
r_5	$\frac{1}{2}$	$\cos 75°$	$-\cos 30°$	$-\cos 45°$	$\cos 60°$	$\cos 15°$	0	$-\cos 15°$	$-\cos 60°$	$\cos 45°$	$\cos 30°$	$-\cos 75°$	$-\frac{1}{2}$
r_6	$\frac{1}{2}$	0	-1	0	1	0	-1	0	1	0	-1	0	$\frac{1}{2}$
r_7	$\frac{1}{2}$	$-\cos 75°$	$-\cos 30°$	$\cos 45°$	$\cos 60°$	$-\cos 15°$	0	$\cos 15°$	$-\cos 60°$	$-\cos 45°$	$\cos 30°$	$\cos 75°$	$-\frac{1}{2}$
r_8	$\frac{1}{2}$	$-\cos 60°$	$-\cos 60°$	1	$-\cos 60°$	$-\cos 60°$	1	$-\cos 60$	$-\cos 60°$	1	$-\cos 60°$	$-\cos 60°$	$\frac{1}{2}$
r_9	$\frac{1}{2}$	$-\cos 45°$	0	$\cos 45°$	-1	$\cos 45°$	0	$-\cos 45°$	1	$-\cos 45°$	0	$\cos 45°$	$-\frac{1}{2}$
r_{10}	$\frac{1}{2}$	$-\cos 30°$	$\cos 60°$	0	$-\cos 60°$	$\cos 30°$	-1	$\cos 30°$	$-\cos 60°$	0	$\cos 60°$	$-\cos 30°$	$\frac{1}{2}$
r_{11}	$\frac{1}{2}$	$-\cos 15°$	$\cos 30°$	$-\cos 45°$	$\cos 60°$	$-\cos 75°$	0	$\cos 75°$	$-\cos 60°$	$\cos 45°$	$-\cos 30°$	$\cos 15°$	$-\frac{1}{2}$
r_{12}	$\frac{1}{4}$	$-\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{1}{4}$

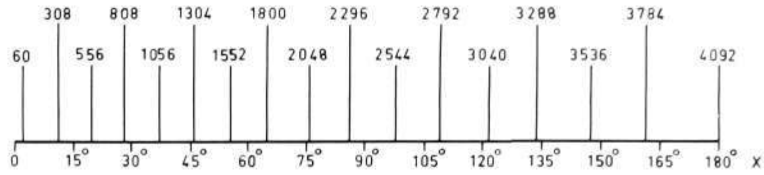


Fig. 9 X 8068

Positions of the inter-supergroup pilots compared with the sub-division points

Matching to the Position of the Inter-Supergroup Pilots

The residual loss curve which is to be analysed is given by the values of levels measured at the pilot frequencies recommended by CCITT. The positions of these pilots unfortunately do not agree with an equal 15 degree sub-division in the angle scale x, see fig. 9. This difficulty can, however, be overcome by making a linear interpolation of the measured values of the two pilots lying on either side of the sub-division point in question. The frequency 60 kc/s must correspond with the sub-division point 0 and frequency 1056 kc/s is not used at all. It is true this means a small approximation, but it is of little consequence for the practical result in our case.

Electrical Construction of the Computer

In order that maintenance personnel need not carry out a manual analysis of the residual loss curves, a special analogue computer, the cosine equalizer adjustment computer has been developed. Its method of operation is as follows:

The errors in level of each of the inter-supergroup pilots have been measured and noted in a table. For each inter-supergroup pilot, the computer has a potentiometer on which the respective level error is set. The potentiometer also has a polarity switch for positive or negative sign. Each potentiometer is fed with 1000 c/s alternating current from a resistive voltage divider with an output which can be selected by a selector switch. The output voltages from the potentiometers are connected in series via isolating transformers, and the resultant voltage is measured by a vacuum-tube voltmeter. Each component voltage is therefore the product of the respective potentiometer control setting and the output condition selected by the selector switch from the voltage divider. This has just those tappings which correspond to the numerical values of the coefficients k in the table. Each one of the cosine terms corresponds to a certain position of the selector switch, so that the correct multiplication in accordance with the table is obtained. It is easily seen that the vacuum-tube voltmeter measures a voltage which is proportional to the amplitude of the respective cosine term. The polarity is determined by adding a small auxiliary voltage to the vacuum-tube voltmeter and seeing whether the deflexion increases or decreases. Fig. 10 shows a simplified block schematic of the computer. Certain of the potentiometers have been connected together electrically in order to give linear interpolation between the values of the settings for two adjacent measuring points as mentioned previously. This however, has not been shown in the diagram.

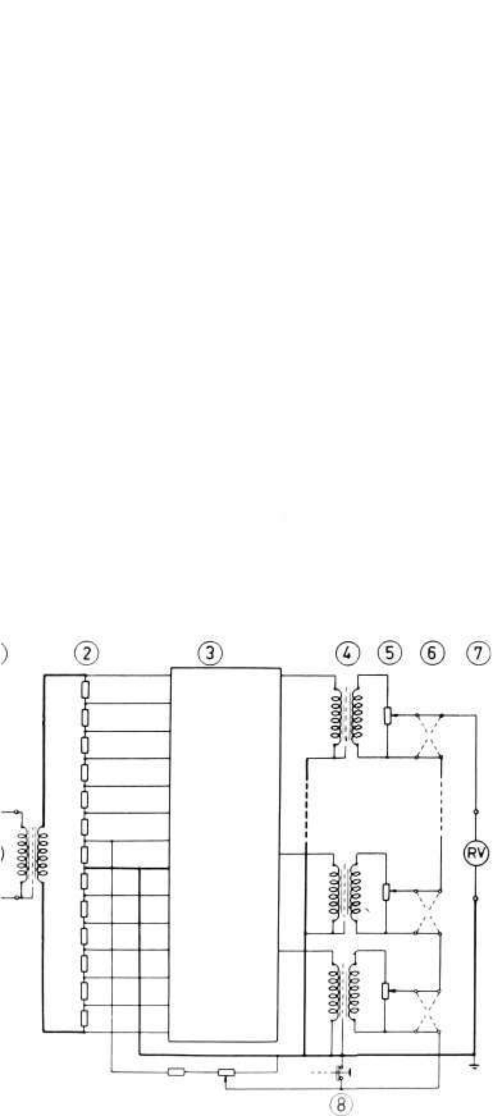


Fig. 10 X 2274

Block schematic of the cosine equalizer adjustment computer

- ① 1 000 c/s oscillator
- ② Voltage divider
- ③ Selector switch
- ④ Isolating transformers
- ⑤ Potentiometer
- ⑥ Polarity switch
- ⑦ Vacuum tube voltmeter
- ⑧ Push button for polarity
- RV Vacuum-tube voltmeter

The computer also contains a mains supply unit which supplies anode and heater voltages to the vacuum-tube voltmeter and the 1000 c/s oscillator as well as the operating voltage for a stepping coil which drives the selector switch. The mains supply unit is fed from the normal a.c. mains supply, and therefore no voltages from the carrier equipment are needed.

The computer can give the values of a total of 12 cosine terms. It can therefore also be used, even if more terms are added to the present five cosine networks.

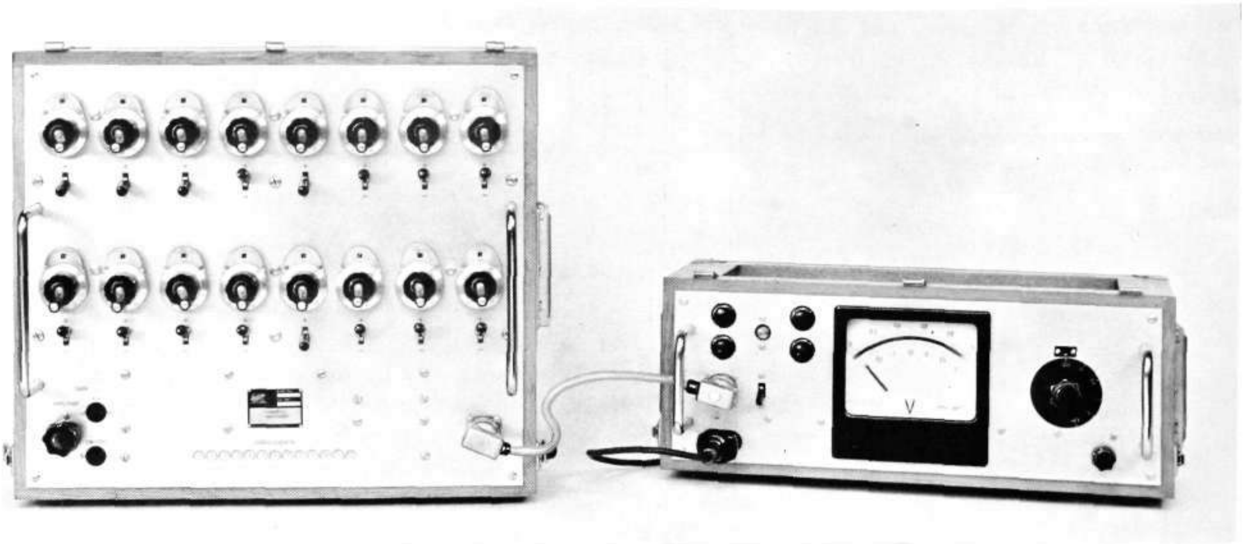


Fig. 11 X 7729
Cosine equalizer adjustment computer

Mechanical Construction of the Computer

The computer is mechanically divided into two separate and easily portable units, see fig. 11.

The larger unit contains potentiometers, the selector switch and the isolating transformers. The potentiometers are of the precision helical type with a range of ten revolutions giving a total scale length of 3600 degrees. The control knobs are provided with a handle for quick setting. Each potentiometer is marked with the frequency of the inter-supergroup pilot to which it belongs, in order to avoid confusion. The selector switch, which has hard gold-plated contacts, is driven round by a push-button operated rotary switch so as to obtain a quick and easy setting. Indication of the position of the selector switch is obtained with the aid of a number plate with signal lamps. On the front plate there is also a push-button for connecting the auxiliary voltage which is used to determine if the cosine term corresponding to the selector switch position has positive or negative polarity.

The smaller unit contains the vacuum-tube voltmeter with its range switch, the oscillator for 1000 c/s and the mains supply unit. The requisite leads for connecting both units together and for connexion to the a.c. mains supply are stored in the lid of the smaller unit.

Test Equipment

Inter-Supergroup Pilot Generating Equipment

Generation and distribution of the inter-supergroup pilots may be carried out in two different ways, namely:

a) Injecting the frequency 308 kc/s together with each basic supergroup band 312—552 kc/s. In this case the inter-supergroup pilots are formed by the modulations in the supergroup translating equipment.

b) Generating the inter-supergroup pilots in a separate equipment and injecting these direct into the respective h.f. lines.

The first alternative is naturally the simplest but, on the other hand, is so limited in its use that it is suitable for only a few operational cases.

As pilot generation is then bound up with the terminal equipment, pilots are only obtained on the h.f. lines in traffic, and not on any stand-by lines. This limitation is often of deciding importance. Furthermore the method of modulation means a certain unstability as the modulator and filter losses can vary somewhat outside the edges of the respective supergroup band.

The simple method is therefore useful only for short h.f. lines which are all in traffic and where a cheap equipment needing a small amount of space is required.

In order to be independent of the terminal side, the second alternative therefore must be chosen. This means a larger and more expensive equipment compared with the simple 308 kc/s feeding equipment, but on the other hand it is possible to supply a larger number of h.f. lines.

In this section, L M Ericssons inter-supergroup pilot generation equipment operating on the last named principle will be briefly described.

Electrical Design

The electrical design of L M Ericsson's inter-supergroup pilot equipment is seen from the block schematic, fig. 12.

The equipment normally generates 14 inter-supergroup pilots, as the space between the eleventh and twelfth supergroups is already used by the line pilot 2792 kc/s. To obtain the best equalization, we are also interested in the end frequencies 60 kc/s and 4092 kc/s. With L M Ericsson's terminal equipment, both these frequencies are available on the h.f. line, the former as the frequency comparison pilot and the latter as the line pilot. When terminal equipment of other than L M Ericsson's manufacture is operating over the h.f. line, the 60 kc/s pilot may not be present. To take care of these cases also, the equipment can, where necessary, be supplemented with a 60 kc/s oscillator, which is shown dotted in the lower part of the block schematic.

All the pilots are generated by separate crystal-controlled oscillators with individually adjustable output levels. The pilots are injected via U-links to frequency combining equipment, consisting of filters, pads and a hybrid. The inter-supergroup pilot spectrum obtained in this way can be injected into each of six different feeding cables.

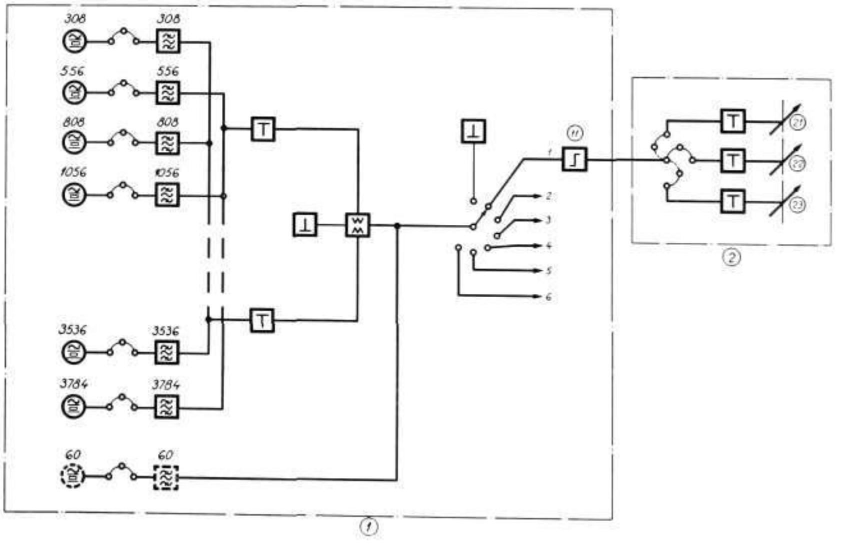


Fig. 12 X 2270

Block schematic of inter-supergroup pilot generating equipment

- 1 Inter-supergroup pilot generating bay
- 2 Injection panel on the supervisory bay
- 11 Correction network
- 21–23 HF lines

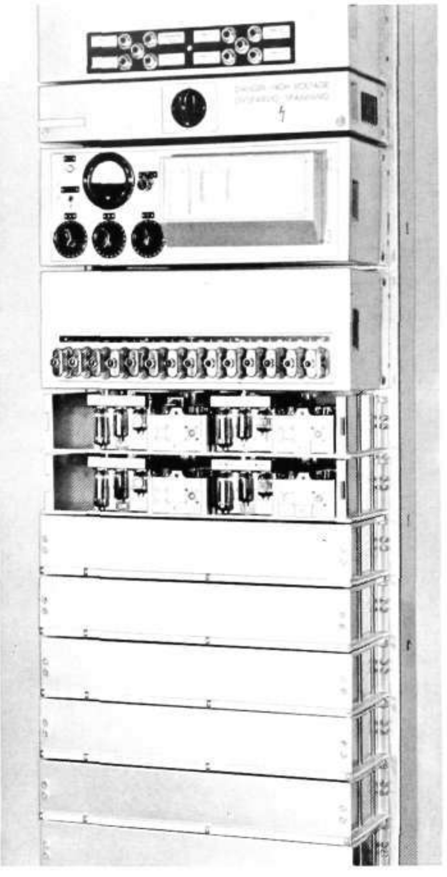


Fig. 13 X 2279

Inter-supergroup pilot generating bay type ZDT 220001

The oscillators, frequency combining equipment and distribution are all combined on one bay, the inter-supergroup pilot generating bay, which is shown within the dotted frame 1.

Injection into the respective h.f. lines is carried out in a special U-link panel on one of the supervisory bays of the coaxial routes. This is shown schematically in the right-hand rectangle 2 in the diagram. The figure shows injection into three h.f. lines, one of which is intended as a stand-by.

To compensate for different lengths of cable between the inter-supergroup pilot bay and the pilot injection bay, correction networks which are adjustable by strapping can be connected into the distribution cables.

With the possibilities of distribution shown, a single inter-supergroup pilot generating bay can supply up to six different coaxial routes or 18 h.f. lines.

Electrical Data for L M Ericsson's Inter-Supergroup Pilot Generating Bay Type ZDT 220001

Pilot frequencies	308, 556, 808, 1056, 1304, 1552, 1800, 2048, 2296, 2544, 3040, 3288, 3536 and 3784 kc/s, also where necessary 60 kc/s.
Output impedance	75 ohms unbalanced
Level per pilot on the h.f. line	— 10 dbm0

Mechanical Construction

The mechanical construction of the inter-supergroup pilot generating bay is shown in fig. 13.

The oscillators 308 kc/s to 3784 kc/s are situated in the seven lower panels. Each oscillator is built into a plug-in unit and two such units can be accommodated in the same panel. The additional oscillator for 60 kc/s is also of plug-in construction, and is placed when necessary in its own panel directly below the other oscillators.

Above the oscillators are the U-links for individual testing and interruption, also the frequency combining equipment with filters, pads and hybrid. The U-links and frequency combining equipment have been placed together in their own panel.

Then follows a current distribution panel with fuses and facilities for measuring supply voltages, direct currents in the tubes and a main switch panel. The latter is provided due to the special nature of the inter-supergroup pilot generating bay as an intermittently operated test equipment.

The uppermost panel is the pilot distribution panel, which is provided with a jack-field and correction networks. The jacks are so placed that wrong connexions causing interference cannot be made.

If an inter-supergroup pilot generating bay is to be installed in a terminal station which is already fully built out, the question of space can often be a problem. In such cases the whole inter-supergroup generating equipment complete with cabling, but excluding terminal strips can be removed from its own frame and mounted on a supervisory bay for one of the h.f. line routes. The inter-supergroup pilot panels are here installed directly below the pilot-injection panel on the supervisory bay and have the same position as they would have on their own bay.

Fig. 14 X 2289

Inter-supergroup pilot measuring set

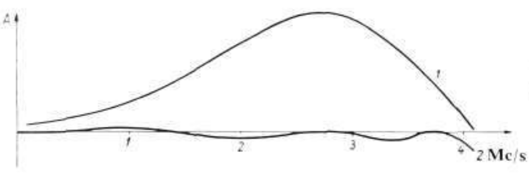


Fig. 15 X 2271

Typical curve for residual loss

1 Before equalization
2 After equalization

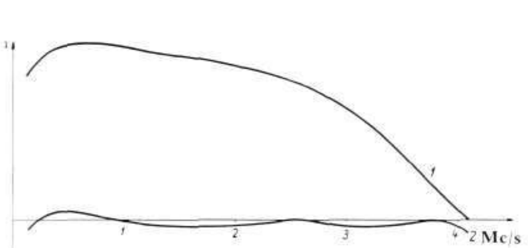


Fig. 16 X 2272

Typical curve for residual loss

1 Before equalization
2 After equalization

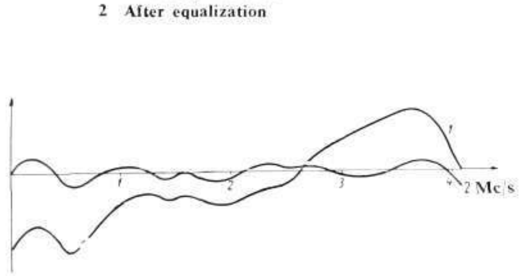


Fig. 17 X 2273

Typical curve for residual loss

1 Before equalization
2 After equalization

Inter-Supergroup Pilot Measuring Set

For maintenance measurements on a coaxial h.f. line equipment, a selective level measuring set is required, intended especially for testing the above-mentioned recommended pilots. The general requirements which must be placed on such a set are as follows:

a) It must be easily transportable so that it can be carried to the unattended repeater stations.

b) It must have such a high selectivity that measurements may be carried out while traffic is in progress.

c) The input impedance must be so high that the instrument itself does not load the h.f. line and thus distort the measurement results.

Such an instrument is manufactured by the Danish firm, Radiometer, to specifications drawn up by L M Ericsson.

Electrical Design

The measuring set manufactured by Radiometer works on the principle of a heterodyne receiver. The difficult problem of image frequencies commonly encountered with such receivers has been avoided by pre-selection, and by choosing such an intermediate frequency that the image frequencies for all the pilot frequencies fall in a frequency band where neither telephone channels nor pilot frequencies occur. The requisite frequency stability of the local oscillator has been obtained by using crystal control, a separate crystal being selected for each pilot frequency. So as to be able to check the performance of the set in service, a special calibration oscillator is included. To obtain the requisite high input impedance, a transformer contained in a special measuring probe is used. This is connected to the set by a normal 75 ohm coaxial lead.

Mechanical Construction

The mechanical construction is seen from fig. 14. The measuring set is divided into two units, the upper one in the figure being the measuring set itself, and the lower a stabilized power supply unit. The power supply unit can be operated from either a 6 volt accumulator or from 220 volt a.c. mains. (In all the repeater equipment for ZAX 960/2, a special a.c. mains outlet has been provided for operation of this set. The power consumption of the set has been reduced to such a low value that the power required can be drawn directly from the coaxial cable power supply.)

Typical Examples of Equalization of Loss Curves

The curves of changes in loss error against frequency for an h.f. line due to aging turn out to be rather smooth, although they naturally may occur in many forms.

Figs. 15 and 16 show certain possible but essentially rather different typical curves, together with the residual error obtained on equalization with cosine networks. As will be seen the errors have been appreciably reduced in both cases.

The residual error, which is obtained on equalization with fixed correction networks when the line is installed, has in general a more or less irregular character with many small peaks. These always appear superimposed on the aging curves. In practice it is therefore necessary to equalize a rather irregular curve using the cosine network. In fig. 17 is shown a curve with rather large "ripples", which is still possible to equalize reasonably well with a cosine network.

C.T.C. on the Danish State Railways

W WESSEL-HANSEN, DANISH STATE RAILWAYS, COPENHAGEN

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656.257

The Danish State Railways have this year completed the first stage in the modernization of the signalling system on the double-track main line across the island of Fyn. In this article the Head of the Danish State Railways 1st Signal Office, Mr W Wessel-Hansen, describes the new signalling equipment and the problems that have been solved in conjunction with its planning and installation. The new equipment comprises relay interlocking plants, block signalling, and centralized traffic control. The C.T.C. office is located at Odense. The signalling and C.T.C. equipment was supplied by L M Ericsson.

Main Railway Line across Island of Fyn

The Danish State Railways started in 1952 a series of investigations aimed at the progressive modernization of signalling plants. At that time it was, in particular, the main line across the island of Fyn—the section between Nyborg ferry station and Fredericia junction—that had been neglected from the point of view of efficient and up-to-date equipment for train dispatchings.

Fig. 1 gives an idea of the importance of this railway in relation to the main Zealand railway, Copenhagen–Korsør. The movement of every train from, for example, Nyborg to Fredericia demanded 33 persons on train dispatching and supervision of level crossings.

The investigations that were made showed that the simultaneous modernization of station track layouts, interlocking, block signalling, and telecommunication plants, and the introduction of automatic signals at level crossings, would not only lead to improved traffic conditions but also to such savings as would ensure a reasonable profit and depreciation on the capital invested in the new equipment.

In the following an account is given of the problems that have been solved either in connection with the preliminary investigations or as a result of the experience acquired.

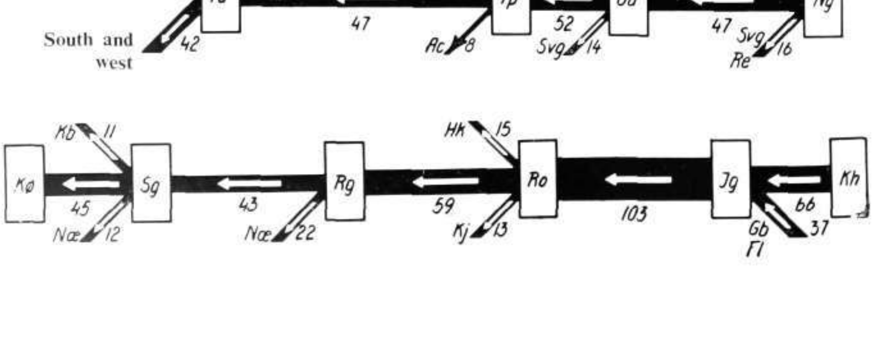


Fig. 1
Train headway, week-day 1955, Copenhagen—Fredericia

X 8050
X 8051

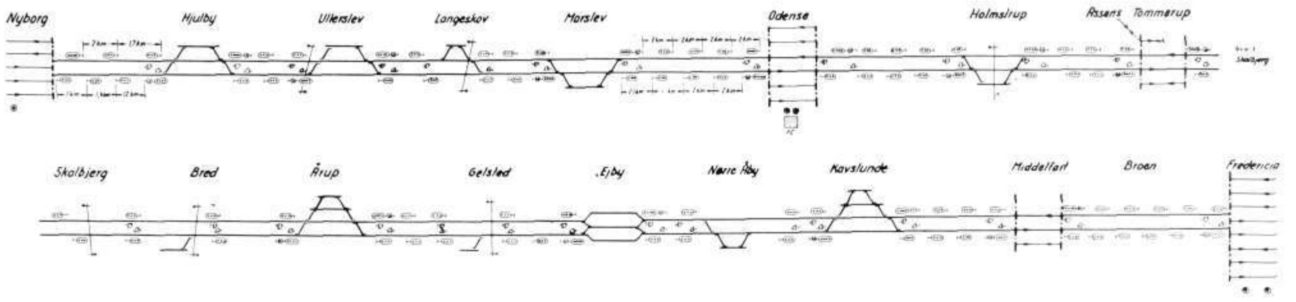


Fig. 2 X 7725 X 9142

Track and signal layout after completion of modernization

- ⁕ Attended signal plant
- ⌶ Level crossing

Station Track Layouts

An economic study was made, covering every station, of whether the station track layouts should be reconstructed, for example by reducing the number of side tracks or possibly by eliminating them altogether. In a single case a station was changed to stopping place. A study was also made of the requirement of sidings, both as regards their number and length. It may be mentioned that in recent years the Danish State Railways have replaced a large number of steam locomotives by diesels, which has generally conduced to quicker and longer trains so that a reduction in the number of sidings might be expected. Fig. 2 shows the track and signal layout as it now is or will be in future. One of the stations, Ejby, has a central siding, roughly 1 kilometre in length, which provides the best conceivable passing facility.

Interlocking Plants

The earlier mechanical interlocking plants had become highly unsatisfactory, both from the safety and operational points of view, and were therefore to be replaced by electrical plants. In 1952, however, there were only four quite small, experimental relay interlocking plants in operation. It was not until the Glostrup interlocking plant was put in service (in 1953) that the State Railways achieved a standard design of relay interlocking plant. In conjunction with the installation of this plant, moreover, it was found that the station signalling system used hitherto must be substantially modified to ensure greater safety and more flexible utilization of the track layouts. The main improvements at the stations were the division of the main tracks into signal-controlled sections and the use of speed signalling for approaching trains.

Standardization has had the benefit that interlocking plants for all minor stations (including C.T.C. stations) are now supplied ready-wired and tested from the railway signalling workshop in Copenhagen. At C.T.C. substations signalling, telecommunication and C.T.C. equipment is installed in a relay house which is sent by rail from the workshop to the site of erection.

Since most of the stations that were to be C.T.C. operated did not possess interplatform tunnels, it was necessary to supplement the interlocking plants by entirely new apparatus for the protection of passengers crossing the tracks. A dual system was chosen (fig. 3) consisting of automatically controlled signs, showing "Look out for train" under danger conditions, and automatically controlled loudspeakers which on the approach of trains announced: "Do not cross the track, a train is coming."

Block Systems

In 1952 the Fyn line was equipped solely with manual block, and that only to a small extent. For the most part train movements were directed by telephone. An extension of the manual block system would obviously not meet the present requirements and would be uneconomical, but experience of automatic block was lacking both in regard to the distance over which reliable track circuits can be established and what types of track relay were most suitable.

Fig. 3 X 8052

Protection of passengers when crossing tracks is provided by automatic signs combined with loudspeakers

At certain sites, therefore, 4–6 kilometre track circuits were installed on trial, and a theoretical calculation of long track circuits was started. The aim was to introduce a method of calculation and regulation such that all planning and design work could be left to non-engineering personnel. This standardization work has so far been completed only as regards track circuits of up to 6 kilometres. The standard that has been introduced (for non-electrified areas) is shown in fig. 4. There now remains only the completion of the investigations into 5–10 kilometre track circuits which will be required when single track sections are to be equipped with C.T.C.

The choice of a suitable type of track relay was extraordinarily difficult, the various alternatives being code following relays, frequency-controlled relays, phase-controlled relays or D.C. polarized relays. The latter were selected since on D.C. track circuits fairly simple emergency power plants can be arranged. It had been expected that such plants would be required, as they later proved to be, in view of the fact that the normal power supply would come through small "undependable" transformer stations. The selected track relay is a polarized telegraph relay, in parallel with a neutral D.C. relay (fig. 4). The contacts of the two relays are in series and actuate three auxiliary relays, which are the control relays for signal aspects etc. The operate and release functions of all relays are checked.

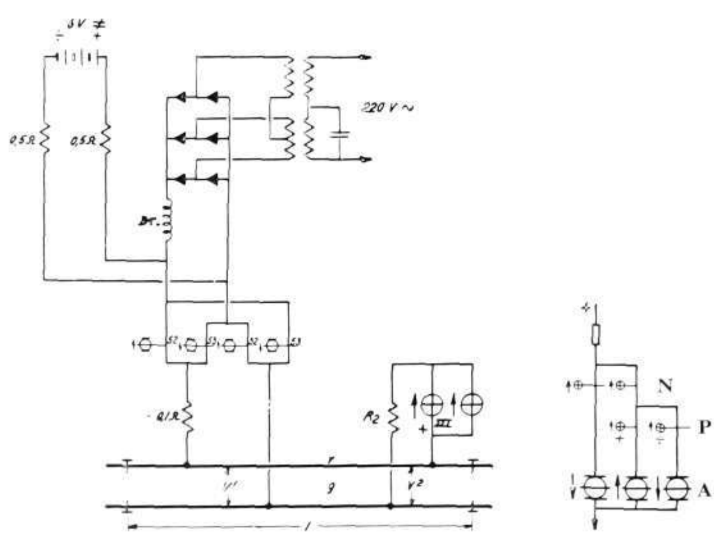


Fig. 4 X 8059

Circuit for automatic block signalling

The rectifier circuit ensures that the feed voltage is maintained constant as long as the current does not exceed 9 amps. At this amperage (train on track) the feed voltage swiftly diminishes.

In order that the emergency supply battery shall not disturb the above-mentioned characteristics of the rectifier, two 0.5 ohm resistors are placed in the battery leads.

On the longest track circuits the emergency supply cannot hold the track relay operated when the ballast resistance assumes the most unfavourable value.

By means of contacts on relays 52 and 53 code impulses are sent from the feed end to the relay end after every train passage.

Length of track circuit	l_{max} = 10 km
Rail resistance	r_{max} = 0.1 ohm/km
Leakage	g_{max} = 0.625 S/km
Track voltage, relay end	v_{2min} = 1.25 V
Relay data:	
Pick-up voltage	1.0 V
Drop-out voltage	0.7 V

N Neutral D.C. relay
P Polarized relay
A Auxiliary relays

The relay racks, power supply equipment etc. is built into factory-made cabins, which are erected and fully tested at the railway signal workshop at Copenhagen before being despatched to the site of installation.

The standardization of the automatic block system necessitated the introduction of new block signals, the basic principle of which is that a signal shall also indicate the aspect of the following signal.

The arrangement of the block system, moreover, is that trains can run both on the right and left-hand tracks, but for movement on the left-hand track the number of block sections is only about half as great as on the right-hand track. The purpose is to use left-hand track movement only in the event of breakdown and during maintenance work on the track.

Level Crossings

The manual operation of gates at level crossings is inefficient in conjunction with automatic block signalling on high headway lines. The level crossings should either be eliminated or automatic safety arrangements should be installed. Our earlier experience was limited to automatic short-arm gates on single track lines, but in 1953 the decision was made to introduce automatic long-arm gates on double track railroads. In view of the division of the Fyn line into comparatively short block sections (1.5–2 kilometres) it was undesirable to use special control signals for the gate installations. It was therefore necessary to interlock the gate installations and block signals, with the latter checking the operation of the gates. It may be said without exaggeration that the introduction of the automatic long-arm gate installations was the most troublesome part of the whole project.

Telecommunication Installations

The automatic block installations required the laying of cables along almost the entire line. It therefore seemed natural to investigate the desirability of simultaneous cabling of all telecommunication circuits. It was in fact found that, under the existing circumstances, it would be economical to construct a separate telecommunication cable in which long distance calls would be made on carrier circuits. The service interruptions that had hitherto been so common on overhead lines during winter periods would thereby be eliminated.

C.T.C.

During the preliminary investigations of the conditions on the Fyn line it was considered that certain stations might well be controlled from a neighbouring station. A variety of circumstances, however, suggested that even greater advantages would be gained—smaller staff requirements and improved operation—if all stations on the line were controlled from a central location. In 1953 the Danish State Railways decided to introduce centralized traffic control of all stations between Nyborg and Fredericia, with the C.T.C. office located in Odense. The installation work was divided into two stages: Nyborg—Tommerup (exclusive) and Tommerup (inclusive)—Fredericia.

The complete project comprised:

9 stations with sidings

4 stations without sidings

about 77 automatic block sections and

7 automatic gate installations.

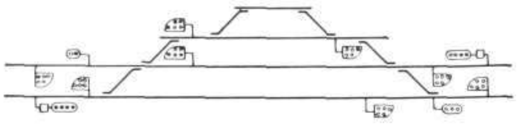


Fig. 5 X 2246

Example of station with siding on double-track line (Hjulby)

CONTROLS
4 entrance routes, right-hand track
4 exit routes, right-hand track
4 routes for left-hand track running
6 call-on-signal aspects
4 stop aspects for entrance and exit signals
4 emergency release of routes
4 selection of method of operation
3 permission for local control of points
7 point lighting and heating, night illumination etc.
3 new complete indication and lock-out of indication transmitter
2 manual intervention in automatic gate functions
19 initiation of telephone calls
7 spares
(7 of the above controls are twin controls)

INDICATIONS
7 station track circuits
8 block track circuits
12 signals for right-hand track running
4 signals for left-hand track running
6 call-on-signal aspects
8 route lockings
20 point positions (every point is indicated in duplicate)
3 methods of operation
4 point illumination and heating etc.
2 announcements of fault in interlocking plant
3 check of automatic gate functions
18 reception of telephone calls
3 spares

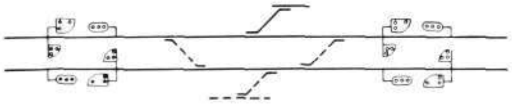


Fig. 6 X 2247

Example of station without sidings on double-track line (Bred)

CONTROLS
2 automatic block through the station
2 entrance routes, left-hand track
2 exit routes, left-hand track
1 stop aspect for entrance and exit signals
2 emergency release of routes
2 permission for local control of points
4 point illumination etc.
2 new complete indication and lock-out of indication transmitter
2 manual intervention in automatic gate functions
13 initiation of telephone calls
4 spares
(6 of the above controls are twin controls)

INDICATIONS
2 station track circuits
8 block track circuits
4 signals for right-hand track running
8 signals for left-hand track running
3 point positions (every point is indicated in duplicate)
2 methods of operation
1 point illumination and heating etc.
1 announcement of fault in interlocking plant
4 check of automatic gate functions
12 reception of telephone calls
2 spares

The work was allocated as follows:

L M Ericsson: Delivery of signals, safety relays, etc. for interlockings and block signalling and all C.T.C. apparatus.

Danish State Railways: Installation of signalling and telecommunication plants.

The contract for the C.T.C. equipment was signed with L M Ericsson at the end of 1954, but it was stipulated that the design should be capable of standardization in the event that The Danish State Railways should desire to extend the use of C.T.C. This decision had the effect of to some extent slowing up construction, but it has brought the advantage that the type of plant now installed can be used for practically all existing C.T.C. purposes.

The centralized control of individual stations was progressively brought into operation as interlocking plants and automatic block installations became completed during the period June 1, 1956 to July 10, 1957.

There now follows a brief description, based on operating experience, of the now standardized installations and of the various factors affecting them.

C.T.C. Installations of The Danish State Railways

Types of C.T.C. Field Stations

Figs. 5, 6 and 7 show the three types of station track layout that have now been standardized in as far as this has been possible in consideration of the many varieties of installation that may occur in practice. The figures also provide information of the required numbers of controls and indications per station. It should be observed that all telephone communications between the C.T.C. office and field locations pass through the C.T.C. apparatus. Since L M Ericsson's transmitters and receivers are supplied for 36 control transmissions and 49 indications, it will be seen that the three standardized types of station require 2, 1 and 1 units respectively.

Methods of Operation of Field Stations

Field locations are equipped with a control board from which the interlocking plant can be operated under exceptional conditions when released for such method of operation. The field locations are normally controlled by one of the following methods:

Automatic operation. The interlocking plant operates automatically, that is to say that trains approaching the station establish route lockings and signal indications without action from the control office. Automatic operation can be employed for one train direction at a time, or for both directions.

Manual centralized operation. The interlocking plant is operated from the control office. Under conditions of manual centralized operation the control office can release portions of the railroad for local operation by means of special local operation push buttons.

In both forms of operation the field location sends indications to the control office, which is thereby enabled to follow the traffic situation at the location. Controls are provided to enable the office to change over from one method of operation to another. Without action from the control office, field operation can be established by means of a Yale key in the field location's control machine. The Yale key is normally kept under seal at the field location.

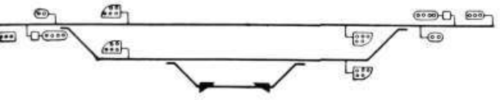


Fig. 7 X 2248

Station with siding on single-track line. The station tracks are long enough to permit simultaneous entrance of trains from both sides

CONTROLS
2 entrance routes
2 exit routes
2 locking of block system for movement from neighbouring station
2 call-on-signal aspects
1 stop aspect for entrance and exit signals
2 emergency release of routes
1 permission for local operation of points
2 operation of points
6 point lights and heating, night illumination etc.
2 new complete indication and lock-out of indication transmitter
2 manual intervention in automatic gate functions
9 initiation of telephone calls
3 spares
(7 of the above controls are twin controls)

INDICATIONS
4 station track circuits
6 block track circuits
8 signals
2 call-on-signal aspects
2 route lockings
10 point operations (every point is indicated in duplicate)
4 point lighting and heating etc.
1 announcement of fault in interlocking plant
2 check of automatic gate functions
8 reception of telephone calls
2 spares

Automatic Recording of Train Times

The C.T.C. equipment incorporates a traingraph for automatic recording of train movements, so relieving the C.T.C. operator of the necessity of keeping a train journal or similar record. It should be observed that all vehicles used on the line are uninsulated, so that all traffic is reported, including trolleys etc.

The traingraph comprises:

a recording chart moving at 60 mm per hour
a colour ribbon with red and blue sections
a number of electromagnetic hammers, one for each block section.

Trains on one track are marked in red, and on the other track in blue. This is accomplished by the hammers striking the red or blue ribbon against the underside of the paper at 30-second intervals, so producing marks on the chart at every 1/2 mm.

The marks punched by the hammers on the chart produce broken lines showing the progress of every train; red for one direction of movement, blue for the other. On a double-track line trains are not recorded on sidings. The graphic timetable is printed on the chart, so that deviations from the timetable can be immediately observed.

Automatic Indication of Classes of Train

The usual indications have been supplemented by automatic indication of train class by means of indicating lamps on a miniature track diagram at the top of the control machine. On each station track and each station-to-station section there is a lamp for each class of train, the present classes being as follows:

green lamps for express through trains
yellow » » slow » »
red » » local trains

The individual train class indication moves automatically as the train advances from one section of line to the next. The indication of a train is started by the pressing of a button on the control board, representing the class of train departing from the terminal station. When the train enters the line, the indicating lamps light accordingly. If there are several trains following one another between two adjacent stations, only the first train is shown. On all panel sections there are buttons for indication of train class, and cancellation buttons which permit cancellation of an indication if a train ends up at an intermediate station. When a train enters a station siding on a double-track route, the train is marked on the siding.

The relay equipment for indication of train class is located in the control office and is actuated by the indications for track circuits.

At future installations it is expected that the number of train classes will be increased, probably to 10, and the "train class" will be used for automatic establishment of routes (to through tracks or sidings) at the individual stations.

Announcements of Train Passages to Terminal Stations

The C.T.C. system is also provided with announcement equipment which enables the C.T.C. office to inform the terminal stations of the "class" of trains approaching those stations.

Connection of Telecommunication Circuits to C.T.C. System

As mentioned above, controls and indications are used to set up telephone connections and to indicate that they have been established. The telecommunication buttons and lamps are placed on the control panel.

Centralized control is used, in particular, for the telephones on the line and at field locations to which, for example, permission can be given for trains to pass "stop" signals. Such telephone calls, passed on in the normal manner to the nearest station in the direction of movement, are connected to the control office via the C.T.C. equipment.

C.T.C. Controls

a. At the first C.T.C. operated stations transmissions of "dangerous" controls (signalling to proceed on call-on-aspect) were effected by means of two "control numbers" in order to avoid the execution of "false" controls. This procedure has now been entirely abolished since the coded control system employed by L M Ericsson has proved to be extremely safe. The Danish State Railways are convinced that in future, the C.T.C. equipment —and, in particular, the transmission of controls—should have roughly the same degree of safety as employed in the normal operation of interlocking plants. It has in fact proved that rules governing the signalling at a station where the interlocking plant fails (fault in point or signals) must inevitably be based on the use of telephonic communication to place the responsibility of safety on the C.T.C. operator. The Danish State Railways assume that C.T.C. operated stations will be unattended and that train drivers cover so large an area of the country that they cannot have local knowledge of individual stations.

A control code is shown in fig. 8. In order that a field location may be able to transmit its "answering impulse", it must have received correct impulsing from the C.T.C. office, that is to say that it must have received 4 groups of impulses, and in each group only one impulse must be of opposite polarity and one must be long.

The execution of the control is carried out only when the C.T.C. office has received the answering impulse and has sent back an execution impulse. If there is the least disturbance in impulsing, the control will not be executed.

b. For certain controls use will in future be made of "twin controls", by which is meant that one control is employed for two objects: for example the first transmission of the control can be used for the changing of a point from normal to reverse, whereas the next transmission of the same control can be used to change it from reverse to normal. An increase in the capacity of the C.T.C. equipment (in some cases by as much as 30 per cent) can be achieved by the use of twin controls.

c. A distinction is made between "blocked" and "stored" controls. If a station receives a *blocked* control, which for one reason or another cannot be executed at the given moment (for example establishment of a route that conflicts with an already established route), the control is immediately marked in the C.T.C. office as blocked without the office needing to await the corresponding indication. *Stored* controls are controls which cannot be immediately executed, but which will be stored for execution when the situation at the station permits.

X 8055

Control: 1,750 ms

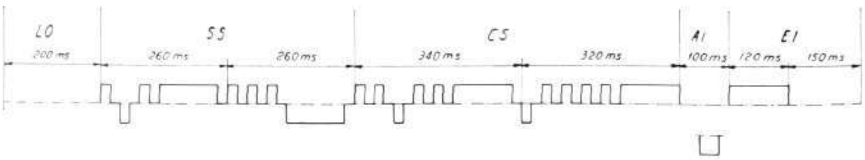


Fig. 8

Code for a control transmission

LO Line occupation
SS Station selection
CS Control selection
AI Answering impulse from field station
EI Execution impulse from C.T.C. office

This method of splitting up the controls has brought with it many advantages, one being the great simplification of instructions to C.T.C. operators. The storing of controls relieves the staff of much work and, in conjunction with the aforementioned automatic operation, means that a single person can without difficulty be in charge of the C.T.C. for a very long railway section.

d. Controls are used to give permission to trains at terminal stations to enter the line before trains can be dispatched. In order to tie up the C.T.C. operator as little as possible, storage equipment is provided permitting the release of three successive trains. The storage equipment is located in the C.T.C. office, which means that a control for clearing the exit signal for the following train is automatically transmitted when the office receives an indication that the first train has departed.

e. A control asking for "new complete indication" can be transmitted to every station. At the C.T.C. office all earlier indications for the particular station are first cancelled, after which all indications assume the most restrictive aspect, indicating, for example, that points are not closed. When the station has received the control, it sends a complete indication transmission to show the position of all signalling equipment. This ensures that the C.T.C. office staff can obtain completely fresh indications at any moment, which is essential if telephonic information or permission is to be given that places the responsibility of safety on the C.T.C. office.

f. At the automatic short-arm gate installations the Danish State Railways have considered it important that the automatic functions of the gates be kept under observation, so that the necessary action can be taken in the event of failure of an automatic function (either up or down). At gate installations on a C.T.C. section certain of the C.T.C. controls have been utilized to put the automatic gate equipment out of action, so as to retain the gates either up or down. This facility has proved an advantage in view of the large amount of work-train traffic for installation and maintenance work that has been necessary up to now on the Fyn line. The C.T.C. office receives an alarm if the gates are not fully raised or lowered within 45 seconds, and when the gates have been lowered for more than 8 minutes.

C.T.C. Indications

The number of indications is considerably greater than the number of controls. An investigation of the C.T.C. circuits on the Odense–Nyborg line (4 field locations, 25 block sections, about 60 trains in each direction) showed that 7,000 indications and 350 controls were transmitted in a 24-hour period.

At the time of planning the Fyn installation there was no experience of how high a level of occupation could be permitted on a pair of C.T.C. wires. If the occupation is too high, an indication may be delayed; in unfavourable circumstances this may mean that it is entirely lost or that two indications are transmitted in wrong sequence. Considerable emphasis was therefore laid on reducing the number of transmissions, which was achieved on the following principles.

If the 60 + 60 trains had transmitted indications corresponding to all signals and track circuits that they pass, the number of indications per 24 hours would have been about 13,000.

The number of indications has been reduced by omitting to indicate the block signals but only the associated track circuits. At the stations, indications are given of the track circuits passed by the train, not singly but in groups of 3 for each direction of movement. By this means the number of indications is reduced from 13,000 to about 10,000.

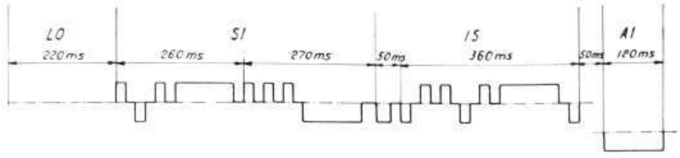
The coded indication system used by L M Ericsson permits the quick successive transmission of several indications from the same field location, so that two or more indications require only one occupation of the circuit. This brings the aforementioned 10,000 indications down to about 7,000 per 24 hours.

Fig. 9 X 8056

Code for an indication transmission

LO Line occupation
SI Station indication
IS Indication selection
AI Answering impulse from C.T.C. office

Indication: 1,330 ms



In assessing the occupation of the line wires experience has been drawn from telephony, which has possessed efficient methods of calculation since Erlang's first investigation of the theory of occupations, congestion and waiting times. It must be remembered that individual occupations of the C.T.C. circuit are of the order of seconds, whereas on a telephone circuit they are of the order of minutes. In analogy with the "busy hour" employed in telephony, the "busy minute" may be used for the present purposes.

Measurements on one of the C.T.C. operated lines showed the following figures:

24-hour period,	average occupation	4	secs.	per	minute
60-minute period,	» »	9	»	»	»
1-minute period,	» »	30	»	»	»

In view of the aforementioned condition that several indications can be transmitted for one occupation of the C.T.C. wires, the indication transmitting capacity of the line rises automatically with higher level of occupation. At times of light traffic there may be 6 seconds of occupation in one minute, with 4 indications transmitted, whereas under heavy traffic conditions, 30 seconds of occupation per minute, about 40 indications can be transmitted.

The waiting times caused by the fact that several field locations work on the same line are of an order such that a delay of some 5–10 seconds occurs once a month. So rare a delay causes virtually no trouble. And experience shows that the C.T.C. operators have up to now noticed no delay of indication transmissions, so that a higher load than 30 seconds per minute may undoubtedly be accepted.

The process of coded transmission of an indication is illustrated in fig. 9. The indication transmitter first sends two D.C. impulse groups with 4 impulses in each, so informing the C.T.C. office from which field location the transmission comes. In the same way as in the transmission of controls, each of these groups must include one impulse of opposite polarity and the last impulse must be long.

Thereafter follows the impulsing which informs the C.T.C. office which function or functions have changed position since the last indication. The relays which repeat the position of functions are divided into seven groups with seven relays in each group, so that 49 functions (each with two positions) can be indicated. For every 7-relay group there is a common relay which, when picked up, indicates that no change has occurred in the group, whereas the down position indicates a change. To communicate the position of the functions, the transmitter sends a series of D.C. impulses of which every seventh impulse is long. In the case of a relay group in which no function has altered position since the last indication, a normal polarity impulse is transmitted for the entire group. In the case of a group in which one or more functions have altered position, on the other hand, there is transmitted first a reversed polarity impulse after which, for each relay of the group, an impulse is transmitted that is of normal polarity if the relay is up but of reversed polarity if the relay is down. The subsequent relay groups are indicated in a similar manner. But if no alteration has occurred in them, the transmitter stops and awaits a reversed polarity answering impulse from the indication receiver at the C.T.C. office, after which the indication transmitter is disconnected.

Thus, apart from the station selection impulsing, the transmission of an indication does not consist of a given number of impulses. If a function

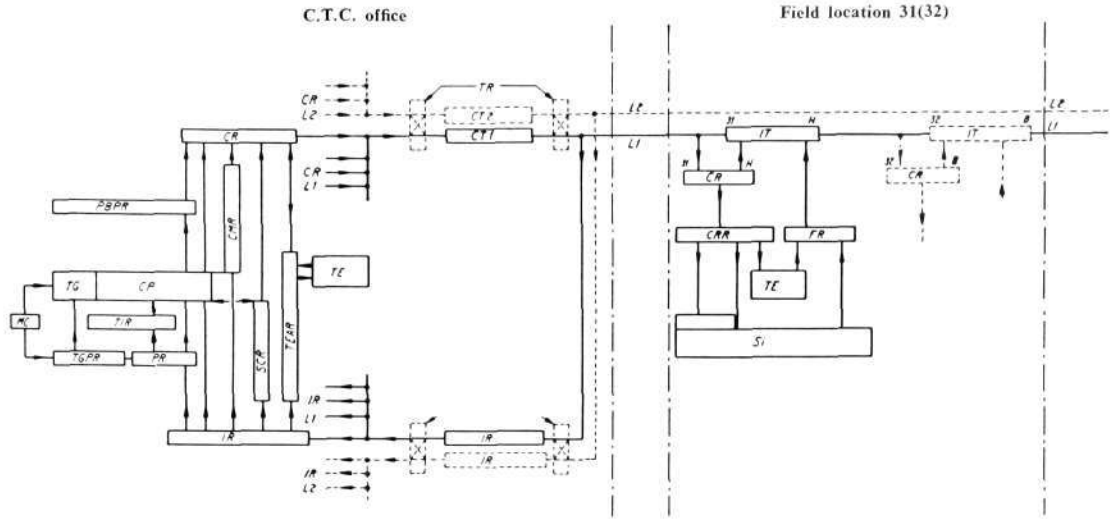


Fig. 10 X 8057

Skeleton diagram of Odense C.T.C. office

CMR	Control memory relays
CP	Control panel
CR	Control register
CRR	Control receiver relays
CT1, CT2	Control transmitters 1 and 2
FR	Function relays
IR	Indication receiver
IT	Indication transmitter
L1, L2	Line 1 and 2
MC	Master clock
PBPR	Push button repeater relay
PR	Repeater relays
SCR	Storage control relay
Si	Signal plant
TE	Telephone equipment
TEAR	Telephone equipment auxiliary relays
TG	Traingraph
TIR	Train class relay
TR	Transfer relays

associated with a relay in the first relay group has changed position, the indication transmitter sends altogether $2 \times 4 + 1 + 7 = 16$ impulses. If the function belongs, for example, to the third relay group, $2 \times 4 + 3 + 7 = 18$ impulses are transmitted. If one or more relays in each of the groups has changed position, $2 \times 4 + 7 \times 8 = 64$ impulses are transmitted.

On the transmission of indications the C.T.C. office checks that the station impulsing is correct, i. e. that the correct number of reversed polarity (2) and long (2) impulses have been received. During indication impulsing, on the other hand, the C.T.C. office checks merely that every seventh impulse is long. Thus the indication system does not possess the same measure of safety as the control system, and it cannot be expected that false impulses will always be discovered. In addition, a sticking group relay will distort the indication of the position of associated functions. The Danish State Railways, therefore, as previously mentioned, have introduced dual indications of the position of important functions, by which is understood that every such function is represented by two relays in different groups.

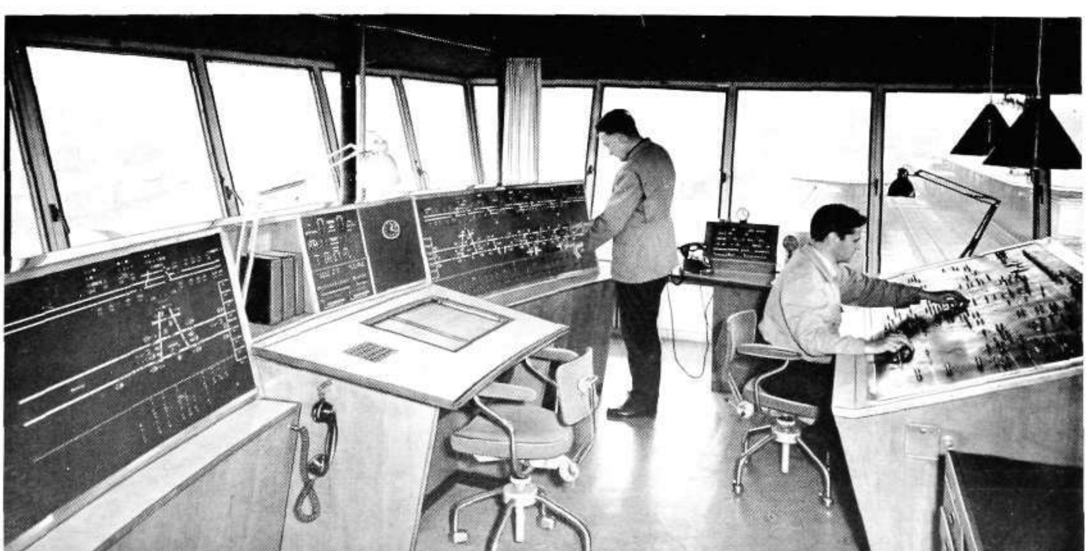
The Final Arrangement of the Fyn Installation

The C.T.C. plant is shown diagramatically in fig. 10, the left-hand side representing the C.T.C. office and the right-hand side a field location.

The control machine (fig. 11) consists of a common panel and one panel for each field location. In the common panel are the controls and indicating

Fig. 11 X 8054

Control desk in Fyn C.T.C. office. In the middle is the common panel and the desk with traingraph



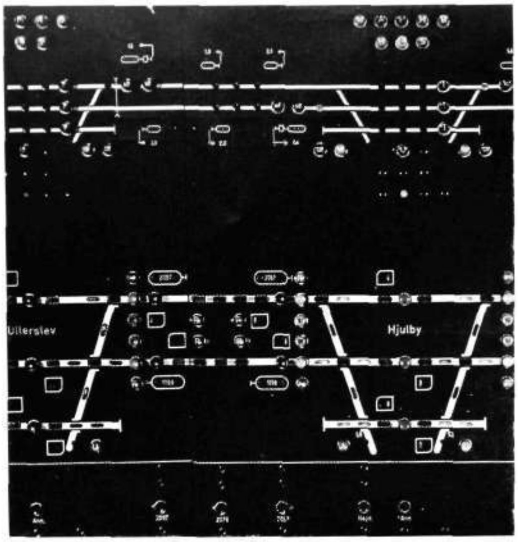


Fig. 12 X 2249

Close-up of control panel. At the top is seen the miniature track network with lamps for indication of class of train. Below are the control buttons and lamps for the interlocking plants at Hjulby and Ullerslev. At the bottom are telephone buttons and lamps.

lamps for all common parts of the installation; for example, the point lighting is switched on and off from the control panel, and faults in operation of the installation are indicated there.

Controls are transmitted from the common and field location panels by pressing two buttons simultaneously (with the exception of telephone controls), fig. 12. When two corresponding buttons are depressed, the control is stored in one of the control registers until the control transmitter has passed it on to its destination. There are two control transmitters and two indication receivers, which normally operate on separate lines. But by means of transfer relays each can be connected to both lines in the event of breakdown of either a transmitter or receiver.

On the desk in front of the common panel is the traingraph, telephone switchboard, and the C.T.C. buttons which do not place responsibility of safety on the C.T.C. operator; for example the marking of train class and the methods of station operation are controlled from keysets on the desk.

The first stage of the project was completed in July 1957. Stage 2 will be partly commenced in 1957, but new stations will not be C.T.C. operated until 1958. How long it will take to install C.T.C. right through to Fredericia will depend upon the progress of reconstruction of the sidings, but it is expected that this will take place in 1960.

Future C.T.C. Projects

The extremely good experience obtained with the C.T.C. installations already in service has encouraged the Danish State Railways to introduce the system on other important lines.

Remote control of Masnedø station on the 15-kilometre line from Orehoved via Storstrømsbroen to Vordingborg was introduced already in July 1956.

The following projects are at present being considered:

Tommerup–Fredericia, 45 km double track with 8 stations
Nykøbing F–Gedser, 23 km single track with 4 stations
Vordingborg–Nykøbing F, 29 km single track with 6 stations
Lunderskov–Padborg, 77 km single track with about 12 stations
Glostrup–Korsør, 99 km double track with about 11 stations.

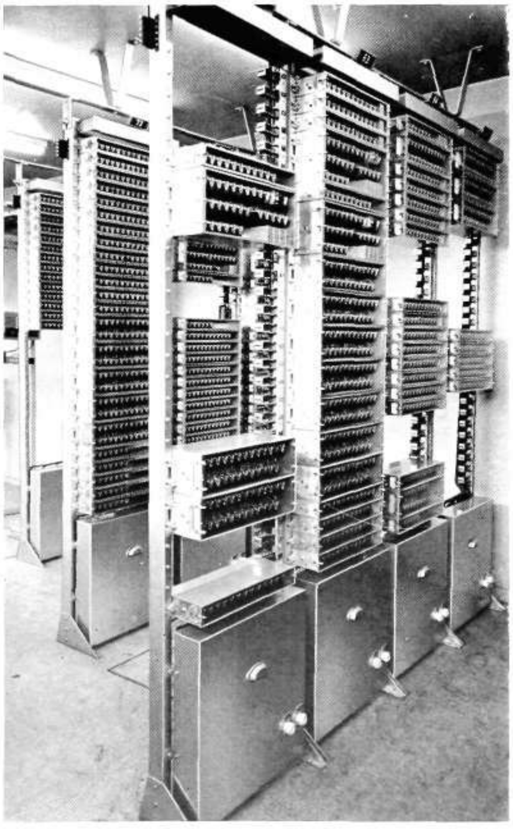


Fig. 13 X 2250

Relay racks in C.T.C. office.

Three-Phase Meter with "Extra Insulation"

H LUNDSTRÖM, AKTIEBOLAGET ERMI, ULVSUNDA

U.D.C. 621.317.785.025.3
621.3.019.34

The Swedish authorities have very strict regulations governing electrical apparatus for use in low voltage supply systems. A special institution, The Swedish Bureau for Testing Electrical Equipment, SEMKO, has been established with the authority to approve equipment that fulfils the stipulated requirements. As a visible sign to the public, approved equipment is marked with the letter Ⓢ. Numerous domestic appliances must have particularly good insulation between live parts and such metal parts as are accessible to contact. Appliances of this kind are subject to stricter regulations and, after approval, are marked with the symbol ▣ in addition. Equipment which fulfils the conditions for marking with Ⓢ and ▣ must not be earthed. Earlier, it was not considered necessary to range kWh meters under the sphere of SEMKO, but for certain reasons the matter has been actualized during the past year.

Fig. 1 X 2261
Three-phase meter type VKN 12

On grounds of personal safety, certain electricity undertakings have earthed their meters when placed out of doors or in premises with wet floors. But earthing may involve a danger to the public if the meters are placed immediately adjacent to fuses. In the process of changing a fuse, the subscriber may come into contact with live metal while at the same time inadvertently touching the meter. It has also been found that earthed meters are subject to greater stresses from lightning voltages than meters that are not earthed. Since lightning is very common in Sweden, it is naturally extremely important that the design of meters should render them as far as possible insensitive to the overvoltages occurring in a distribution network during thunderstorms. If the meters fulfil SEMKO's Ⓢ and ▣ marking requirements, and consequently need not be earthed, there is less risk of personal damage and also of damage to the meters themselves by overvoltages caused by lightning.

On these grounds ERMI has had its three-phase meter *VKN 12* for balanced or unbalanced loads tested by SEMKO. The result was that the meter was approved as extra insulated, meaning that it can carry the marks Ⓢ and ▣.

The extra insulation of the meter has given it the following additional advantages:

1) Great resistance to overvoltages from lightning and similar causes, partly because the meter itself has a high level of insulation and partly because the stresses are smaller when the meter is not earthed.
2) Reduced work on erection of meters.
3) Meters that are marked Ⓢ and ▣ guarantee that the normal safety interests of the public are provided for.

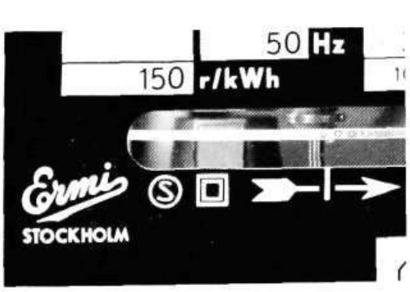


Fig. 2 X 2259
Close-up of register plate
showing the placing of the new symbols

What is meant by "extra insulation"? A regulation entitled SEMKO 7-1955 contains stipulations in respect to the design and testing of domestic and similar apparatus with electromechanical drive, different categories of articles being specified and defined. There are no regulations governing electricity meters, but appropriate portions of paragraphs in SEMKO 7 have been used for the purpose. The category of interest in this connection is "domestic and similar appliances, class II", comprising appliances without

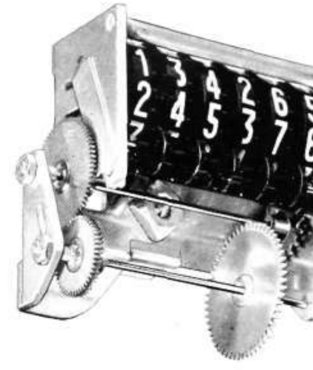


Fig. 3 X 2262

Register of VKN 12

with plastic rollers and pinions, and stainless steel spindles with pivot bearings

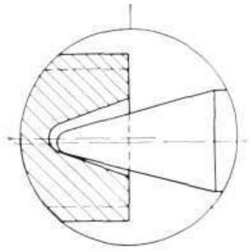


Fig. 4 X 2278

Journal of pivot bearing type register

Cone angle of spindle = 30°

Radius of point of spindle = $0.15^{+0}_{-0.05}$ mm

Axial play = 0.15–0.20 mm

Diameter of cylindrical portion of spindle = 1.2 mm

The pivot bearing reduces the radius of the spindle at the point of contact from 0.6 to 0.15 mm.

earthing device and having all accessible metal parts protected by means of "*extra insulation*" of one or both of the following types:

1) "Double insulation", which denotes that accessible metal parts are protected by means of special insulation to prevent them from conducting electricity in the event of breakdown of the normal functional insulation. By normal functional insulation is meant principally that there shall be an air and creepage path of at least 4 mm between current-carrying parts and inaccessible metal parts; by protective insulation is meant principally that there shall be an air and creepage path of at least 4 mm between inaccessible and accessible metal parts. Normal functional insulation shall withstand a test voltage of 1500 V, 50 c/s, for one minute. Protective insulation shall withstand a test voltage of 2500 V, 50 c/s, for one minute.

2) "Reinforced insulation", which denotes insulation between current-carrying parts and accessible metal parts with such mechanical and electrical properties that it can be regarded as equivalent to double insulation. The requirements covering reinforced insulation are chiefly that the apparatus shall have a creepage and air path of at least 8 mm between current-carrying and accessible metal parts and, furthermore, that it shall withstand a test voltage of 4000 V, 50 c/s, for one minute.

Several regulations cover both types of insulation jointly. Examples of such requirements are those relating to limitation in rise of temperature in windings etc.; insulation tests for equipment operating in rooms having a relative humidity of 95 %; resistance of insulating material to heat and creepage currents; protection of PVC-insulated conductors by an additional layer of PVC if in contact with accessible metal parts; conductors terminated by soldered connections must be prevented from working loose, for example by being passed through a hole and bent short of the soldering point.

Especially for electricity meters, SEMKO stipulates that every individual meter shall undergo a shock voltage test with 8 kV between current-carrying parts and accessible metal parts.

If a meter fulfils SEMKO's requirements, it may be marked with the international symbol ▣. It is also marked with the letter Ⓢ as a sign that it has passed SEMKO's approved type test.

Design of the Meter

The three-phase meter with neutral, type VKN 12, has won considerable appreciation among electricity undertakings on account of its following advantages among others:

Pivot bearing type register with plastic rollers and stainless steel spindles (figs. 2 and 3). No lubrication required.

The pivot bearing and plastic rollers reduce the friction to one tenth of that normally encountered in sliding bearing type registers with tin rollers.

The register can be cleaned with petrol in the normal manner.

Voltage coils equipped with plastic covering of polyethylene withstand a shock voltage of about 13 kV (fig. 4). The entire meter is shock voltage tested at 8 kV prior to delivery.

Low voltage error, which means that a meter with rated voltage 380/220 V can also be used at 220/127 V.

Fig. 5 X 2263

Voltage coil for VKN 12

Temperature-compensated Alnico magnet which maintains its good magnetic properties during the entire life of the meter.

Strong terminal block with conical holes which greatly facilitate wiring work.

Robust metal case. The front cover is of aluminium and the rear cover of sheet iron.

The meter is produced for current ratings 5, 10, 20, and 50 A. Its load capacity is tabulated below:

Rated current	5 A	10 A	20 A	50 A
Measurement limit	14 A (280 %)	28 A (280 %)	56 A (280 %)	125 A (250%)
Thermal limit	20 A (400 %)	45 A (450 %)	75 A (375 %)	130 A (260%)
Max. fusing	15 A	35 A	60 A	100 A
Max. connector area	16 mm^2	16 mm^2	16 mm^2	35 mm^2

The measurement limit is the maximum current with which the meter can be loaded without the error exceeding ± 2.5 %.

The thermal limit is the maximum current with which the meter can be continuously loaded at rated voltage and normal temperature without its characteristics changing after disconnection of the load.

To be approved as "extra insulated", only minor alterations required to be made in the VKN 12 meter since its insulation had been of a very high order previously. In fact, every meter had always been tested at 8 kV shock voltage before delivery from the factory.

Only VKN 12 meters for rated voltages of and below 380/220 V may be marked Ⓢ and ▣, since SEMKO's regulations are limited to apparatus for connection to supply voltages of below 250 V to earth. Meters not marked with the symbols are provided with earthing terminal.

Notes for Repair and Adjustment

Repair and adjustment of electricity meters should always be done by qualified electricians and, as regards the Ⓢ ▣ -marked extra insulated three-phase meter VKN 12, the qualification requirements are naturally not less stringent.

The repairman must ensure that he does not change the existing air and creepage paths of the meters. Furthermore, only spare parts supplied or approved by ERMI for this type of meter should be used. Special renovation and adjustment instructions have been prepared, and we recommend that they be carefully followed.

New Cordless P.M.B.X. for C.B. Operation

W ADENSTEDT, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.23

An earlier article in Ericsson Review No. 2, 1954, contained a detailed description of L M Ericsson's cordless C.B. switchboards types ADD 1311, ADD 1321 and ADD 1331.

Thanks to their simplicity of management, low maintenance cost and exclusive design, these switchboards have been in great demand. The need soon arose for a larger switchboard of this type. L M Ericsson is now able to offer such a switchboard, likewise designed for offices in which the operator's services are combined with other work.

The attractive appearance and small dimensions of these switchboards harmonize well with most modern office furnishings.

The new switchboard, coded *ADD 1342*, has a capacity of 16 extensions and 4 exchange lines with 3 internal and 4 external connecting circuits and 1 connecting circuit for the operator.

The switchboard features the same technical finesses as those described earlier, viz.

automatic holding of exchange line on incoming call,
ringing current generated by pole changer under control of dial,
ringing automatically interrupted when extension answers,
individual through-connection for every exchange line.

This switchboard, like the remainder in the series, can naturally be connected to any type of public exchange, and the same C.B. telephones can be used as in the remainder of the network.

Every exchange line is equipped with a key for manual holding under queuing conditions. It is also possible to connect an extra bell for audible calling and clearing signals. The operating voltage is as usual 24 V. The construction and operation are largely similar to switchboards ADD 1321 and ADD 1331.

The dimensions and weight of the new switchboard are: length 571 mm, height 304 mm, depth 230 mm, weight 20.5 kg. The length dimension does not include the handset hooks which project about 50 mm.

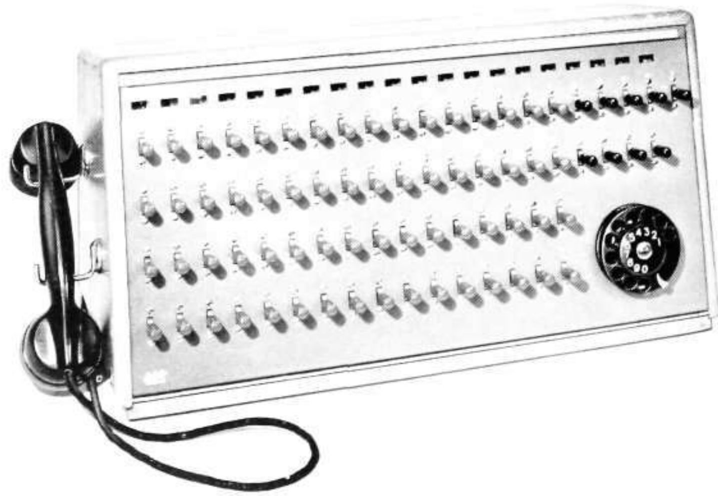


Fig. 1
Cordless switchboard ADD 1342

X 8043

Developments of the L M Ericsson Combine-Unit System of Sound Distribution

H EKSTRÖM, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 681.84

Ericsson Review No. 2, 1955 contained an introduction of the L M Ericsson combine-unit system of sound distribution. In addition to the units already described L M Ericsson has recently marketed a 10-watt amplifier, ZGA 3905, and a radio receiver unit, KTE 1002, with additional facility for FM reception. The following article presents the main features of these two units.

The standard L M Ericsson equipment for sound distribution is based on the combine-unit system, which provides a satisfactory method of meeting the requirements of flexibility at a reasonable capital cost. Small systems require, however, an amplifier lower in price and with lower output effect than the present units. The recently developed 10-watt amplifier, *ZGA 3905*, supplements the earlier amplifier types and covers a most varied number of applications.

Following the development in the wireless transmission the combine-unit system has been supplemented with a new radio receiver unit, *KTE 1002*, with four wave-bands including FM-band.

Amplifier Unit ZGA 3905

The amplifier unit has two individually adjustable input channels for connection of high impedance microphone and high impedance pick-up respectively as well as a non-adjustable input channel for connection of the radio receiver unit. By means of separate input transformers, screw connected to the input terminals, the input channels can be readily modified for low impedance dynamic microphone and magnetic or dynamic pick-up.

The output side has terminals for impedances of 4 ohms and 16 ohms as well as for 250 ohms at 50 V constant output voltage. There are also terminals for 100 ohms, 1 V for the feeding of booster amplifier units.

Fig. 1 X 7727
Amplifier unit ZGA 3905
right with base plate removed

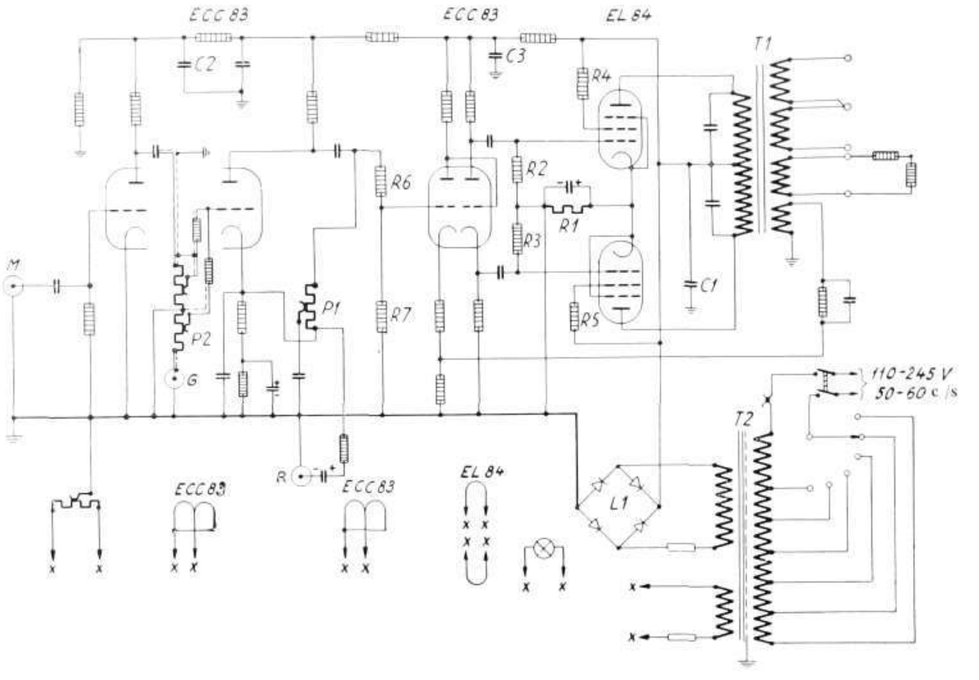


Fig. 2 X 8060

Circuit diagram for amplifier unit ZGA 3905

The power consumption of the amplifier is 50 W. The unit can be connected to common mains voltages 50—60 c/s. Connection for different voltages is carried out by means of a voltage switch at the rear of the unit.

The circuit diagram is shown in fig. 2. All amplifier stages are resistance coupled and the output stage is push-pulled coupled in class AB.

At full output the microphone channel *M* requires 5 mV, the pick-up channel *G* 200 mV and the non-adjustable radio receiver channel *R* 1 V max.

To counteract non-linear distortion the amplifier has a powerful negative feed-back. The output voltage at no-load is only about 15 % higher than at full load.

The amplifier output at 1000 c/s is 10 W with a 1 % harmonic distortion. The distortion curve is shown in fig. 3. The values have been obtained at 50 and 400 c/s with a load of 16 ohms. The distortion is practically independent of the frequency and exceptionally low even at full volume.

The amplifier unit has a wide adjustable range for base as well as treble. With the tone control in neutral position the frequency range is 50—15000 c/s with a deviation of ± 0.7 db from the value at 1000 c/s.

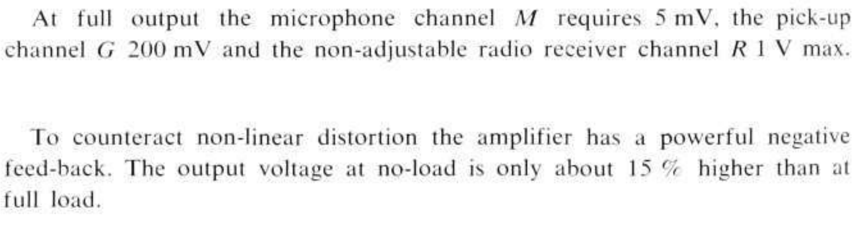


Fig. 3 X 6915

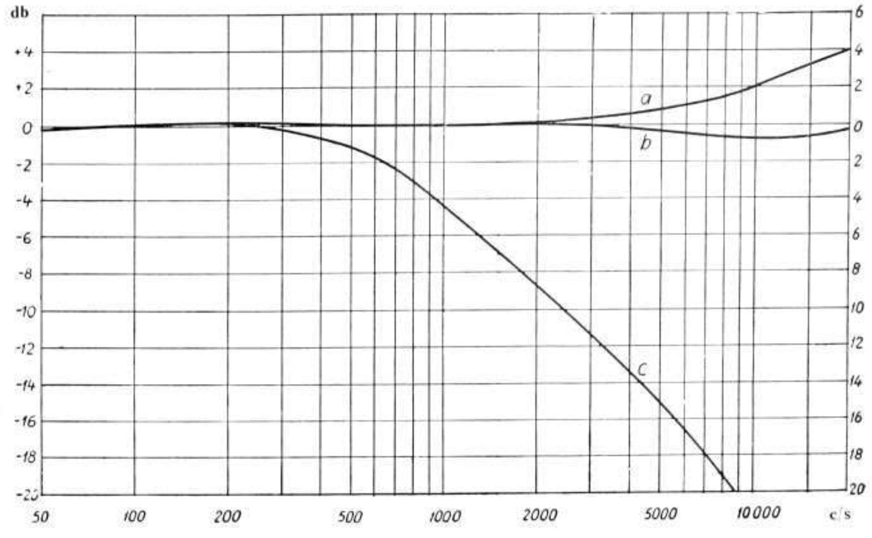
Distortion curve for amplifier ZGA 3905

a at 50 c/s
b at 400 c/s

Fig. 4 X 6914

Frequency curve for amplifier ZGA 3905

a high treble setting
b neutral setting
c strong base setting



The frequency curve is shown in fig. 4.

In order to obtain maximum reliability the rectifier tube has been replaced by a selenium rectifier. The components of the amplifier are all carefully selected in order to obtain high reproduction quality and long life.

ZGA 3905 is a high-class amplifier for the most exacting requirements and is intended for small loudspeaker installations, for instance in restaurants and small outdoor theatres. Where the requirements of output power are reasonable it will provide a good foundation for a flexible and attractive sound distribution system.

Radio Receiver Unit KTE 1002

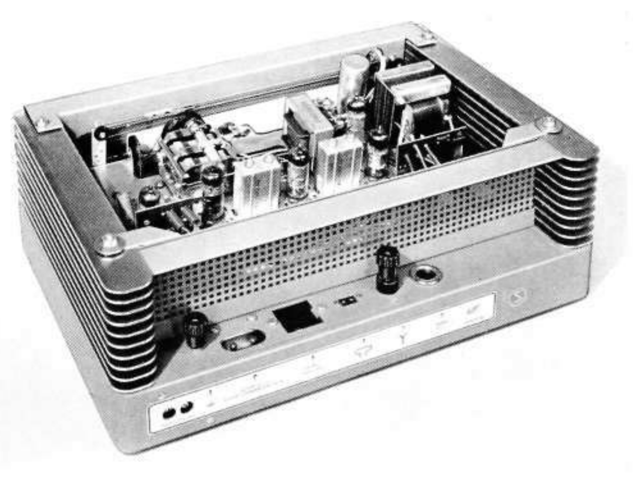
Radio receiver unit, *KTE 1002*, is replacing KTE 1001 previously described. It has four wave-bands 18—51, 190—570, 690—2000 metres as well as FM-band 87—100 Mc/s.

The connection of wave-bands and separate gramophone unit as well as disconnection takes place by means of keys on the front of the unit. The station scale is provided with two pointers, one for the FM-band and one for the AM-bands. The pointers are operated by one common tuning knob with a mechanical coupling automatically operated by the appropriate waveband key (Auto-duplex).

Fig. 5 X 7728

Radio receiver unit KTE 1002

right rear view with top cover removed



The receiver unit is provided with separate controls for base and treble and visual tone indication. The proportion between base and treble setting is shown in apertures on the station scale.

The unit is provided with tuning indicator (magic eye) to facilitate tuning.

The selectivity is 18 kc/s band width at – 40 db. The number of tuned circuits is 6 + 9.

The power consumption is 45 W.

The radio receiver unit can be connected to A.C. mains 110—245 V, 50—60 c/s. The different mains voltages are connected by means of a voltage switch at the rear of the unit.

The output side has terminals for 4 ohms.

Tubes and their functions:

RF mixer ECC 85, MF mixer ECH 81, MF valve EBF 89, TF detector EABC 80, output EL 84 and tuning indicator EM 80. Selenium rectifier 250 V, 100 mA.

Ericsson LM NEWS *from All Quarters of the World*

New Automatic Exchange for Tripoli, Lebanon

A new automatic exchange at Tripoli, second largest city of Lebanon, was opened at the beginning of September. It is equipped with L M Ericsson's 500 line switches, the present capacity being 6000 lines. The intention is to extend the exchange by a further 2000 lines within a not too distant future.

The opening ceremony was attended by the President of Lebanon, Camille Chamoun, the Minister of Defence and Communications, Majud Arslan, the Swedish Minister, Brynolf Eng, and other high dignitaries.

The new exchange forms an important link in the full automatization of Lebanon's telephone network, which is to be accomplished during the next eight years. It is the first automatic exchange to be installed outside the capital of Beyrouth. Next year the work on installation of the first crossbar exchange in Lebanon, L M Ericsson's type ARF, is planned to start. It is to be built at the town of Alyh.

Selective Calling Telephone System on Stockholm Underground

Since the joining up of the western and southern lines this autumn, the Stockholm Underground now has a total length of 25 kilometres. The trains are directed and controlled from two interlocking posts.

The part of the telephone traffic that concerns actual train operation and related questions is handled by L M Ericsson's selective calling system ATA 10. The last portion of this equipment has now been delivered in conjunction with the linking up of the western and southern lines. The selective calling system is constructed in three sections with control equipments in each interlocking post.

In the event of a breakdown, the Underground Traffic Centre informs the public of the necessary redirection of the traffic and arranges for the setting in of emergency vehicles. The connection of the Traffic Centre to the selective calling telephone system ensures rapid information and correction of faults.

LM Ericsson Equipment on Europe's Largest Train Ferry

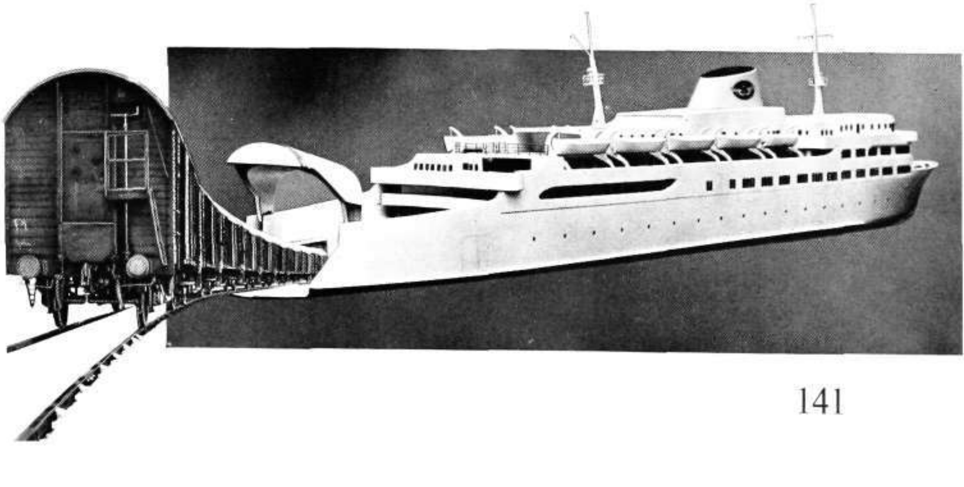
Europe's largest train ferry, the "Trelleborg", is now being completed at the Helsingör Shipyard. The new ferry, 455 ft. in length and 58 ft. max. width, is to operate on the Trelleborg—Sassnitz route. It is expected to be ready for the 1958 tourist season.

The "Trelleborg", with its four parallel tracks, is something of a floating railway station. The fully 440 yards of rail accommodate 40 ordinary rail cars, while some 40 motor cars can be "garaged" on another deck. The top speed is 19 knots, which will cut the time from Trelleborg to Sassnitz by one hour to 3 1/2 hours.

L M Ericsson deliveries to the new ferry comprise a P.A.X., a ship's master communicator system, ship's telephone system, public address system, and a large loudspeaker system for music and entertainment.

(Above) The President of Lebanon, Camille Chamoun, inaugurates the automatic exchange at Tripoli.

(Right) A model of the new train ferry.



Vehicle-Actuated Road Signals Relieve Stockholm Traffic Jam

Immediately to the north of St. Erik's Bridge, which links the western and northern quarters of Stockholm, lies the heavily trafficked junction at St. Eriksplan, where Torsgatan, St. Eriksgatan and Odengatan form a triangle. This has long been a serious bottleneck in the Stockholm traffic, despite successive improvements. The entire site has now been radically altered, and the crossing between Karlbergsvägen and St. Eriksgatan has been incorporated into a giant signal-controlled circulation system as shown in the map above.

The importance of this junction will be understood when it is realized that, in the rush hour, some 2100 motor vehicles per hour pass the one-way section of St. Eriksgatan (A), some 1200 the one-way section of Torsgatan (B), and some 1700 the two-way section of St. Eriksgatan (C). About 3300 motor vehicles per hour pass the St. Eriksgatan—Torsgatan crossing. It should be noted that, in addition to motor vehicles, a very large number of cycles and auto-cycles are in circulation and that the site accommodates bus stops as well.

The entire site will be equipped with L M Ericsson's vehicle-actuated signal system, comprising six installations interconnected as a progressive system.

It will be possible to alter the progressive control system automatically from one programme to another according to the existing volume of traffic as revealed by vehicle detectors.

The signal system comprises 24 vehicle detectors, 144 signals, and other equipment.

The vehicle detectors will be of the magnetic type, embedded in asphalt and so entirely protected against external damage.

Large Line Material Order for Iran

A large delivery to Telephone Company of Iran has just been completed. It comprised line material, including gas control equipment, for the extension of the Teheran telephone network, and was the first order of this size for L M Ericsson line material to Iran.

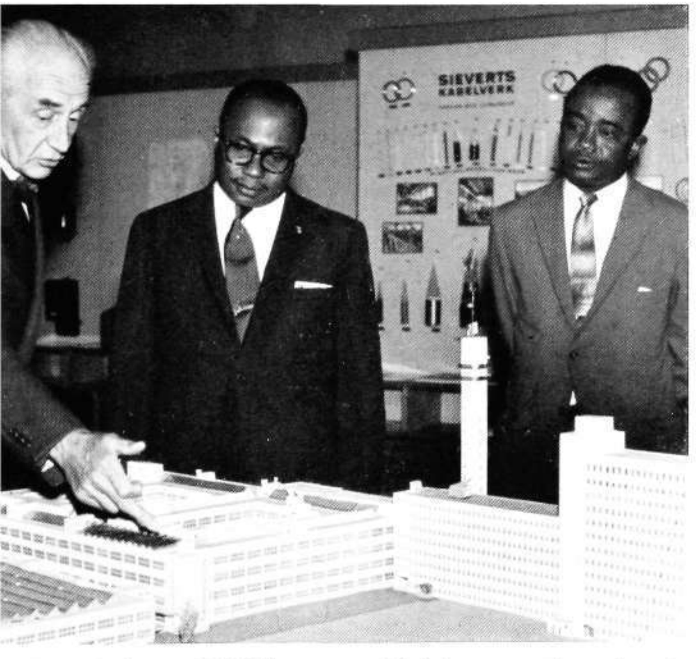
In the photograph above is seen the Minister of the Iranian P.T.T., His Excellency Amir Ghassem Echragi, with the president of L M Ericsson, Sven T Åberg, during a visit to Midsommarkransen. A team of Iranian line engineers have also spent time with the company to study L M Ericsson equipment and methods of cable construction.

Ericofon Makes Screen Debut

The Ericofon has now made its entry into the film world. The photograph (left) is from an Indian film, showing a scene in which a telephone conversation on the Ericofon forms the dramatic highlight. As far as is known, this is the first appearance of the Ericofon in a commercial film.

From the Visitors' Book

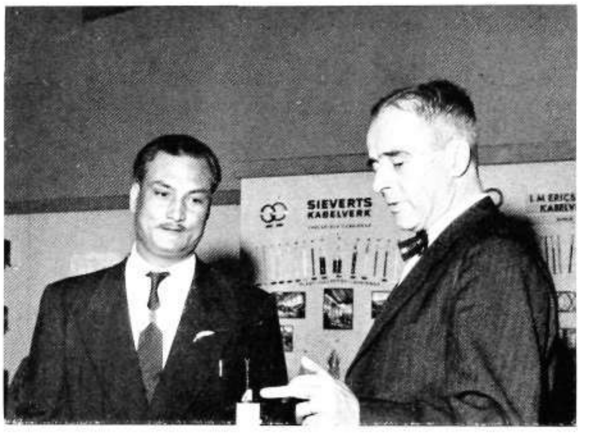
One of L M Ericsson's customers in U.S.A., Mr Pierre F Goodrich from Indianapolis, visited Midsommarkransen at the end of September, being seen (above right) with vice-president Holger Ohlin. Mr Goodrich was the first American to order a crossbar exchange of L M Ericsson design. The exchange is installed at Seymour, Indiana.



In early August L M Ericsson was visited by two gentlemen from the Republic of Liberia, Vice President William R Tolbert Jnr. and Secretary Carlos McGee. Mr Hans Thorelli shows them the model of the Midsommarkransen factory.

A congress of the National Banks of the four Scandinavian countries was assembled in Stockholm in October. In one of the intervals between discussions the four gentlemen (right) took the opportunity of a visit to L M Ericsson at Midsommarkransen. They are (from left) Jörgen Hegelund, Denmark, Toivo Kallio, Finland, Tage Odiin, Sweden and Lorang Lund, Norway.

A group of journalists from Montevideo, Uruguay, on a goodwill journey to Sweden, paid a call at L M Ericsson at the end of October. This was the only Swedish industry they had time to visit.



A recent visitor to L M Ericsson was the Head of the Nepal Telecommunications Administration, Udaya Bahadur, who was in Sweden to study Swedish telecommunications.

"New LM Day" with Car Rally

It is L M Ericsson's custom to hold an LM Day every year for employees and their families. L M Ericsson pensioners are also invited on that day, which for many years has been celebrated at Skansen in the late summer.

This year, on October 6, a new type of LM Day was arranged. At 9 a.m. a car rally started on a rebus hunt around Stockholm. More than 430 vehicles took part, and 355 completed the course. It was the largest competition of this kind yet arranged in Sweden. There was no doubt of its being a popular feature. The victor of the rally was Klas-Göran Dahlberg, Erga.

In the staff dining rooms, where a hobby exhibition was on show, an electric train on a miniature railway of gigantic length was the great attraction. The truth of the many jokes of Daddy playing with his little son's trains was fully borne out—it was really all the children could do to get near enough for a peep.

Popular Swedish actors and vocalists had been invited to entertain the visitors.

Within the factory area a "train" made round trips with mothers and children; in the fire pond frogmen gave a demonstration of work under water. Here, too, was a display of miniature racing boats. Model aeroplanes cruising at over 60 m.p.h. were a further attraction.

Anyone wishing to see a large factory at work had the chance to do so; tours were arranged throughout the day. Certain machine shops had work in progress, so that visitors could get an idea of how L M Ericsson works.

The fine autumn day brought nearly 10000 visitors.

Power and Telecommunications Engineers Visit L M Ericsson

CMI, an organization affiliated to CCITT, consisting of power and telephone engineers, visited Sweden in September at the invitation of the Board of Telecommunications and the State Power Board. The group assembled first at Västervik to study the conditions of d.c. transmission. They thereafter visited L M Ericsson at Midsommarkransen. Among the visitors were the director of CCITT, Mr Rouvière, Conseiller of CCITT, Mr Lalou, and Mr L. J. Collet, chairman of one of the study commissions.

Ericsson Technics No. 2, 1957

Ericsson Technics No. 2, 1957, has just appeared. The issue opens with an article by Dr. Anders Elldin of L M Ericsson, "Further Studies on Gradings with Random Hunting", in which equations of state are formulated for a three-group grading with random hunting. An approximate solution of the equations is compared with the exact values, and the accuracy, which is very great, is evaluated by means of transition coefficients. The importance of asymmetrical loading and the number of selector groups in a grading can be explicitly evaluated by means of a formula. An iterative method adapted to data processing machines is presented.

Professor Stig Ekelöf of the Chalmers University of Technology, Gothenburg, contributes a third part in the series "A Study of Telephone Relays" under the title "The Development and Decay of the Magnetic Flux in a Non-Delayed Telephone Relay". Parts 1 and 2 were published in Ericsson Technics Nos. 1 and 2, 1953. Part 3 shows how use can be made of operational values of magnetic reluctances for calculation of magnetic circuits incorporating eddy currents, with applications of the method to telephone relays. Curves are derived for the magnetic flux on breaking of an L M Ericsson RAB relay and show close conformity with experimentally recorded oscillographs.

Adam Dattner of the Royal Institute of Technology, Stockholm, presents in his article, "The Plasma Resonator", a study of the interaction between an ionized gas column and electromagnetic waves in a waveguide, the plasma resonance being studied in detail. He discusses the measurement results and certain conceivable technical applications of the plasma resonator.

An article by Ingemar Olsson, Royal Board of Swedish Telecommunications, and Kaj Sigstam, SAAB Aircraft Company, Stockholm, is entitled "An Approximate Method of Solution to a Problem of Power Supply in Carrier Frequency Systems". The paper answers the question of how many stations it is possible to feed, for a given cable and a desired power output per station, and how a feeding chain should be calculated. The theory is approximate, but the errors are shown to be practically negligible. The results are given partly by formulae and partly graphically. The methods of calculation are illustrated by means of practical examples.

U.D.C. 621.395.44
621.395.521

JOHANNESSON, N O, OLOFSSON, E & TANGEN, N O: *L M Ericsson's 960-Circuit System for Coaxial Cables. II. HF Line Equipment: Cosine Equalizer.* Ericsson Rev. *34* (1957) No. 4, pp. 110—121.

Continuing the description of the h.f. line equipment for the coaxial system ZAX 960/2 in Ericsson Review No. 3, 1957, this article deals with equipment for manual equalization of the variations in loss on the h.f. line. The design is based on an all-purpose equalizer, a so-called cosine equalizer, together with a computer with the help of which the correct setting of the equalizer can be calculated from measurements on pilot levels. A brief description is given of an inter-supergroup pilot sending equipment, for sending out measuring pilots in the frequency spaces between supergroups, and a portable inter-supergroup pilot measuring set, which is used for measuring pilot levels. Several examples of equalization of loss curves are given for a ZAX 960/2 coaxial system h.f. line.

U.D.C. 621.398
656.257

WESSEL-HANSEN, W: *C.T.C. on the Danish State Railways.* Ericsson Rev. *34* (1957) No. 4, pp. 122—132.

The Danish State Railways have this year completed the first stage in the modernization of the signalling system on the double-track main line across the island of Fyn. The article describes the new signalling equipment and the problems that have been solved in conjunction with its planning and installation. Interlocking and block signalling equipment and all C.T.C. apparatus was delivered by L M Ericsson.

U.D.C. 621.317.785.025.3
621.3.019.34

LUNDSTRÖM, H: *Three-phase Meter with "Extra Insulation".* Ericsson Rev. *34* (1957) No. 4, pp. 133—135.

The ERMI single-tariff three-phase meter, type VKN 12, for balanced or unbalanced loads with neutral, has been approved by the Swedish Bureau for Testing Electrical Equipment (SEMKO) as "extra insulated". Brief description of the meter and significance of this approval.

U.D.C. 681.84

EKSTRÖM, H: *Developments of the L M Ericsson Combine-Unit System for Sound Distribution.* Ericsson Rev. *34* (1957) No. 4, pp. 137—140.

Ericsson Review No. 2, 1955 contained an introduction of the L M Ericsson combine-unit system of sound distribution. In addition to the units already described L M Ericsson has recently marketed a 10-watt amplifier, ZGA 3905, and a radio receiver unit, KTE 1002, with additional facility for FM reception. The article presents the main features of these two units.

U.D.C. 621.395.23

ADENSTEDT, W: *New Cordless C.B. Switchboard.* Ericsson Rev. *34* (1957) No. 4, p. 136.

L M Ericsson's cordless C.B. switchboards ADD 1311, ADD 1321 and ADD 1331 were described in Ericsson Review No. 2, 1954. A larger switchboard in the ADD series, ADD 1342, also designed for offices in which the operator's service is combined with other work, is described in this article.

The Ericsson Group

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

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

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AB Alpha *Sundbyberg*, tel: 28 26 00, tgm: aktiealpha-stockholm

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

AB Ermi *Ulvsunda 1*, tel: 26 26 00, tgm: ermibolag-stockholm

AB Rifa *Ulvsunda*, 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 9*, tel: 68 07 00, tgm: signalbolaget

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

Sieverts Kabelverk *Sundbyberg*, tel: 28 28 60, tgm: sievertsfabrik-stockholm

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

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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, tgm: ericsson

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Perú

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

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

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

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Ireland

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Island

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

Yougoslavie

Merkantile Inozemna Zastupstva *Zagreb*, P. O. B. 23, tel: 25—222, tgm: merkantile

Österreich

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

• ASIA •

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Vulcan Trading Co. Ltd. *Rangoon*, P. O. B. 581, tel: S. 878, tgm: suecia

Ceylon

Vulcan Trading Co. (Private) Ltd. *Colombo 1*, 19 York Street, tel: 3636, tgm: vultra

China

The Ekman Foreign Agencies Ltd. *Shanghai*, P. O. B. 855, tel: 16242-3, *tgm: ekmans*

Hongkong

The Swedish Trading Co. Ltd. *Hongkong*, Prince's Building, Ice House Street, tel: 20 171, tgm: swedetrade

Iran

Irano Swedish Company AB *Teheran*, Khiaban Sevom Esfand 201-203, tel: 36761, tgm: iranoswede

Iraq

Koopman & Co. Technische Handel Maatschappij N.V., c/o Messrs. Dwyer & Co. (Iraq) Ltd. *Baghdad*, P.O.B. 22, tel: 86 860

Israel

Jos. Muller, A. & M. Engineer (Representations & Import) Ltd. *Haifa*, P.O.B. 243, tel: 3160, tgm: mullerson

Japan

Gadelius & Co. Ltd. *Tokyo*, Shiba Park No. 7 Minato-ku, tel: (43)-1847, tgm: goticus

Jordan

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

Kuwait

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

Liban

Swedish Levant Trading Co. *Beyrouth*, P. O. B. 931, tel: 31624, tgm: skefko

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Thoresen & Co. (Malaya) Ltd. *Singapore*, P. O. B. 653, tel: 6818, tgm: thoresenco

Pakistan

Vulcan Trading Co. (Pakistan) Ltd. *Karachi City*, P. O. B. 4776, tel: 32506, tgm: vulcan

Philippines

Koppel (Philippines) Inc. *Manila, P. R.*, P. O. B. 125, tel: 3-37-53, tgm: koppelrail

Saudi Arabia

Mohamed Fazil Abdulla Arab *Jeddah*, P. O. B. 39, tel: 405, tgm: arab

Syrie

Georgiades, Moussa & Cie *Damas*, Rue Ghassan, Harika, tel: 10289, tgm: georgiades

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Viêtnam

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Congo Belge

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Ghana (Gold Coast)

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Marruecos

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

Moçambique

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

Rhodesia & Nyasaland

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Union of South Africa

Reunert & Lenz, Ltd. *Johannesburg*, P. O. B. 92, tel: 33-5201, tgm: rockdrill

• AMERICA •

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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

República Dominicana

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Guatemala

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Haïti

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Jamaica and Brit. Honduras

Morris E. Parkin *Kingston*, P. O.B. 354, tel: 4077, tgm: morrispark

Nicaragua

J. R. E. Tefel & Co. Ltd. *Managua*, Apartado 24, tel: 387-1169, tgm: tefelto

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Productos Mundiales, S. A. *Panama, R. P.*, P. O. B. 2017, tel: 2 2003, tgm: mundi

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