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On cover: L M Ericsson's Plastics Laboratory

Maintenance Work and Reliability for Automatic Telephone Exchanges with the L M Ericsson 500-Line Selector in Stockholm

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U.D.C. 621.395.343.004.5

The following paper describes the maintenance work and operation reliability for the L M Ericsson automatic telephone exchanges in Stockholm, supplied during the period 1924—1951. The paper has been published in the Kungl. Telestyrelsen magazine TELE, no. 2, 1954 and is reproduced by kind permission of the Swedish telephone administration.

The Aim of the Maintenance

An automatic telephone exchange consists of a complicated and expensive mechanism intended to serve the general public in a satisfactory way. The maintenance work in a telephone exchange aims on the one hand to keep the equipment in such a condition that wear and tear does not necessitate it being replaced by a new one at a comparatively early age and on the other hand to keep the number of faults in the equipment at a satisfactory level. Let us therefore confine ourselves to these two aims.

The earliest automatic exchanges in Stockholm have now been in operation for a time sufficiently long to draw certain conclusions from the experiences gained. The oldest exchange has been in operation for 30 years and another five exchanges have been operating for more than 20 years. A certain amount of wear has taken place in these exchanges but it is not of great importance. The experiences gained so far indicate that they do not cause any difficulties in the maintenance and that the exchanges can operate satisfactorily for 30 years or more.

The maintenance work required in an automatic telephone exchange depends on the reliability of operation which is considered adequate for the equipment in the exchange. This reliability of operation will be expressed below as the percentage of connections with equipment faults, traced and untraced, in relation to the total number of connections. There are no international recommendations for a permissible value of this kind and it has, therefore, been up to the individual administrations to decide on a suitable value in view of the requirements of the general public and of the maintenance costs. The estimate of a suitable value no doubt varies very much from country to country and the matter does not seem to have been sufficiently considered so far. As far as Stockholm goes the number of connections with equipment faults is at present 0.04 % for the exchanges in the central parts of the city and approximately 0.15 % for outer areas and the suburbs. These figures are obtained by automatically operating equipment selecting calls at random and by these calls being supervised from a central control station common for the whole area.

When semi-automatic or fully automatic traffic is introduced between different countries, the matter of operation reliability will no doubt be a pressing subject for international discussions.

The Lay-Out of the Maintenance Work

The tasks of the maintenance staff can be divided up as follows:

1. Planning and management.
2. Clerical work such as collecting statistics, time and fault reporting,

receiving and recording faults reported by subscribers (over the complaints office) or by other exchanges.

3. Prophylactic work such as cleaning and oiling of the automatic connecting devices in order to prevent wear and faults.

4. Periodical routine tests for the purpose of tracing faults and weaknesses in the automatic equipment and by this means forestalling faults in normal operation.

5. Tracing and repair of faults reported or indicated by the alarm system in the exchange.

6. Special tasks in connection with extension or completion of the exchanges.

7. Supplementary training in various subjects such as reading circuits and descriptions of new exchange equipment introduced from time to time.

8. Special investigations.

A considerable part of these tasks can be defined and controlled by instructions and this method has also been used. The instructions specify the extent of the work, method to be used and, where possible, a time schedule. The remaining tasks are either current routine work or fault tracing and repair based on training.

Working Hours Required for the Maintenance

In view of the methods used for the maintenance work in the telephone exchanges in Stockholm, the following categories of work are treated separately:

A. The main bulk of the maintenance work.

B. Cleaning and oiling of 500-line selectors, cleaning of multiple frames and special work on mechanical components if this is extensive.

C. Special investigations and actions when the exchanges are not manned.

The working hours stated below refer to all maintenance specified in points 1—8 above and covers the whole of the equipment in the automatic exchange including the power equipment with batteries but excluding the cleaning of the premises and work in the distribution frames with connection and disconnection of subscribers' lines and junction lines as well as tests required in this connection.

It should be noted that the times also include the time for the superintendent of each exchange.

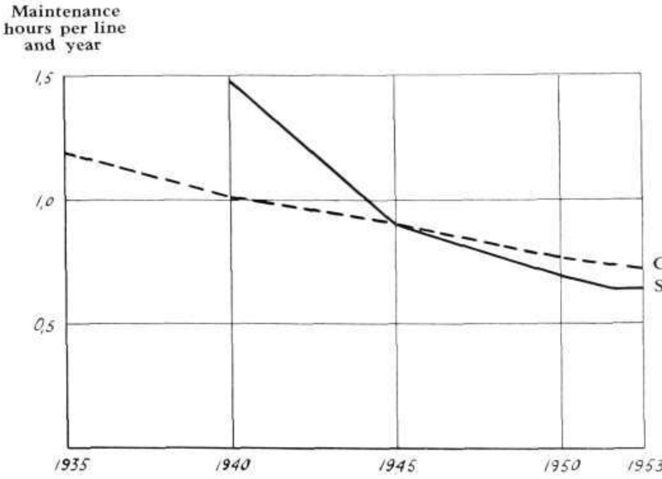


Fig. 1 X 6900

Number of maintenance hours per connected line and year for the Stockholm telephone exchanges during the period 1935—1953

Table I

Type of exchange	Year	No. of exchange	No. of connected lines		Number of maintenance hours per connected line and year
			total	average per exchange	
Central area exchanges	1935	6	103,990	17,332	1.19
	1940	7	142,879	20,411	1.01
	1945	7	168,625	24,089	0.915
	1950	7	190,669	27,238	0.775
	1952	8	198,543	24,818	0.745
	1953	8	200,018	25,002	0.733
Suburban exchanges	1940	6	27,357	4,560	1.29
	1945	13	64,543	4,965	0.915
	1950	14	107,397	7,671	0.711
	1952	14	123,468	8,819	0.654
	1953	15	134,952	8,987	0.655

A. *The main bulk of the maintenance work.*

In table 1 above and in fig. 1 the exchanges are divided in two categories: *central area exchanges* comprising exchanges in the centre of the city of Stockholm and *suburban exchanges* covering exchanges in the periphery of the town and some adjacent districts. The central area exchanges are connected with 3-wire and 4-wire junction lines. The suburban exchanges are connected to other exchanges with 2-wire junction lines. The 2-wire junction lines are provided with special relay sets for transmission of the required signals.

From table 1 and the diagram in fig. 1 it follows that the number of maintenance hours per connected line and year in the course of the years has fallen considerably; for the central area exchanges from 1.19 in 1935 to 0.733 in 1953 and for the suburban exchanges from 1.29 in 1940 to 0.655 in 1953. How then can this remarkable decrease in the expended maintenance work be accounted for? For the central area exchanges the duty chart has gradually been altered, the number of duty hours at night-time and on Sundays being reduced. A considerable part of the decrease, however, depends on other actions which will be explained further below. For the suburban exchanges the duty charts have not been altered during the specified period 1940—1953 and the decrease in the maintenance hours must, therefore, be entirely due to the simplification of the work. Part of the gain is explained simply by the fact that the exchanges have been extended from an average of roughly 4,600 to about 9,000 connected lines. This means that the staff gradually has been more efficiently utilized.

A few other actions and circumstances, which have contributed towards the reduction in the number of maintenance hours, may be mentioned. During 1942—1943 the exchanges were equipped with new registers provided with crossbar switches instead of selectors with sliding contacts. This was done in connection with the introduction of automatic trunk dialling when the registers had to be replaced anyhow. As a whole all equipment installed from 1942 has relays provided with twin contact spring sets. Improved testing equipment has successively been added simplifying the test procedure. The power system has gradually been changed from parallel operation to direct operation which has meant a simplification of the power maintenance. The maintenance operations have in certain respects been simplified. Great efforts have been spent on the development of new uniform instructions.

In order to qualify the figures quoted the following facts will be given. When calculating the number of maintenance hours for an exchange, absence due to holidays, illness, leave, etc. has been deducted using the average values for office staff as calculated by the administration. All deputy work carried out in the exchanges to cover absences or accumulation of work has been included on basis of actual hours. For staff attending training courses the first month has been excluded as being training time but all time from then on is counted as actual maintenance time. When exchanges are extended or altered and when old exchanges are supplemented, the maintenance work is considerably increased and it is then often necessary to make temporary additions in the number of maintenance men. These additions are included in the values quoted for the number of maintenance hours.

B. *Cleaning and oiling of 500-line selectors, cleaning multiple frames and extensive special work referring to mechanical components.*

Most of this work consists of cleaning and oiling of 500-line selectors. In the course of the years these operations have been simplified. In the largest exchanges the selectors are now cleaned by varnolene spraying and in the remaining exchanges, where manual cleaning is carried out, considerable simplifications have been made. The work is now carried out on piece-rate basis. The interval between two cleaning and oiling operations is 2—3 years. For all exchanges covered in this paper approximately 11,600 maintenance hours are required per year, i.e., an average of 0.035 maintenance hours per connected line. Calculated per selector this amounts to about 1/7 of the time spent on cleaning and oiling of the 500-line selectors during the first years of the operation of the exchanges.

The cleaning of the multiple frames is carried out by means of special tools and on piece-rate. The interval between two cleaning operations has varied between 1 and 15 years depending on the need for cleaning in the exchange in question. The average interval amounts to 7 years and the corresponding number of maintenance hours per connected line and year is 0.0056 approximately.

Special work on mechanical parts of such magnitude that specially trained staff has to be called in, can be put to about 0.008 maintenance hours per connected line.

C. *Special investigations and actions when the exchanges are not manned.*

In normal operation as well as when new exchange equipment is connected, faults will appear which require special measuring and investigating. For such tasks special staff is employed. The order of this work can be put to about 0.005 maintenance hours per year and line.

During the periods when the exchanges are not manned it is sometimes necessary to take certain actions. Such work amounts to approximately 0.001 hours per year and line.

Summary

The extent of the total maintenance work will be obtained by totalling the values under headings A—C. The values quoted above for B and C refer to conditions during 1953 and amount to 0.055 maintenance hours per connected exchange line and year. It should have been desirable to quote the corresponding figure for all years stated in the table and diagram above. These figures would, however, not be definite and it can only be stated here that the reduction in the proportionate value for B + C has been greater than the value for A. The values under A represent about 92 % of the maintenance work and the table and the diagram under A must, therefore, alone illustrate the trend over the years.

For 1953 the total number of maintenance hours per year and connected line will be:

for central area exchanges 0.79 and for
suburban exchanges 0.71

Calculated per year and connected telephone set the corresponding figures are:

for central area exchanges 0.63 and for
suburban exchanges 0.65

The rate of maintenance increases in a certain proportion to the traffic load and it may, therefore, be of interest to know the number of maintenance hours in relation to the number of calls in the exchange. The number of maintenance hours per 10,000 calls was 1952:

for central area exchanges 3.6 and for
suburban exchanges 4.2

The number of calls are taken as equalling the number of first group selector operations.

These values include all maintenance work in the exchanges: management, clerical work, fault tracing and repair, different kinds of tests, cleaning and oiling and dusting. Jumpering operations and the cleaning of the premises have on the other hand been excluded as mentioned above.

When assessing the figures from different exchanges several factors must be taken into account which considerably affect the maintenance work required. It is thus not possible to compare discriminately a modern uniformly equipped exchange with old exchanges having been extended with old and new equipment. In the Stockholm region a considerable part of the equipment is more than 20 years old and provided with sequence switches as auxiliary devices and with relays and selectors having single contact spring sets. These conditions are increasing the maintenance work considerably.

Another important matter to be considered is what proportion of the traffic takes place within the exchange itself. When the tracing of a fault can be pursued in one exchange one man is as a rule sufficient for the work. Otherwise at least two persons have to take part and the required working hours will be about twice as many. For the exchanges in the Stockholm area the amount of traffic confined in the exchange areas is only about 17 % for the central area exchanges and about 30 % for the suburban exchanges. In the case of the large central area exchanges fault tracing may necessitate going from one floor to another or to several others.

In addition it should be pointed out that there is considerably more maintenance work in an exchange where building operations are in propers than in one where no building takes place. During the period investigated most exchanges have been extended 5—10 times and the old exchanges have whilst in operation been modified and supplemented in certain respects such as for the purpose of automatic trunk dialling.

Duty Charts

When planning the maintenance work it is very important that the number of men on duty is adjusted according to the day in the week and according to different times during the day. In general it is true to say that the duty charts have been reduced in the course of the years. None of the local exchanges in the Stockholm area investigated in this paper have had a night duty man on its own. The largest central area exchanges have been attended on week-days 7.00—21.00 and on Sundays and public holidays 9.00—17.00. The suburban exchanges have during the period investigated had staff on duty only on week-days 7.00—17.00 in spite of the exchanges having expanded considerably. The largest suburban exchange has in fact 33,000 numbers.

Major faults, which occur when an exchange is unattended, release a special alarm signal after which action is taken. Such cases are, as mentioned above, rare.

Special Exchanges

On account of the size and lay-out of the network some of the investigated local exchanges have to be connected over special tandem exchanges.

An area inside a distance of 40—50 km from the centre of Stockholm is converted to automatic operation and in addition there are several automatic traffic routes over longer distances. For this traffic special transit exchanges are arranged. The manual part of the trunk exchange is provided with extensive auxiliary automatic exchange equipment.

These special exchanges have not been included in the investigation. The lay-out of these exchanges is in part more complicated than the local exchanges and the cooperation with personnel in quite different departments and in distant exchanges puts a heavy burden on the staff.

The Reliability in the Stockholm Central Area Exchanges During 1931—1950 and 1953

In Ericsson Review No. 1, 1937, the former telephone director A. Lignell has given an account of the reliability in the Stockholm central area exchanges for the period 1931—1935. The continued development up to 1953 will below be outlined in brief. The investigation refers to the following exchanges.

	In operation		On 15/12 1953	
			Age	No. of subscribers
Norra Vasa	Jan.	1924	30 years	8,827
Kungsholmen	June	1928	25 ½ »	38,797
Centralen	Jan.	1929	25 »	17,984
Söder	July	1931	22 ½ »	45,279
Södra Vasa	March	1932	21 ¾ »	31,544
Östermalm	April	1933	20 ¾ »	37,320
Norr	April	1938	15 ¾ »	15,598
Högalid	Jan.	1951	3 »	7,090

Table 2 shows the reliability during the period in question. During the years 1951 and 1952 and the first quarter of 1953 no comparable checks were made and statistical figures for these 2 ¼ years cannot, therefore, be stated. The figures quoted for 1953 are, therefore, based on the checks taken during the three last quarters of that year. They may nevertheless be taken as representative for the whole year.

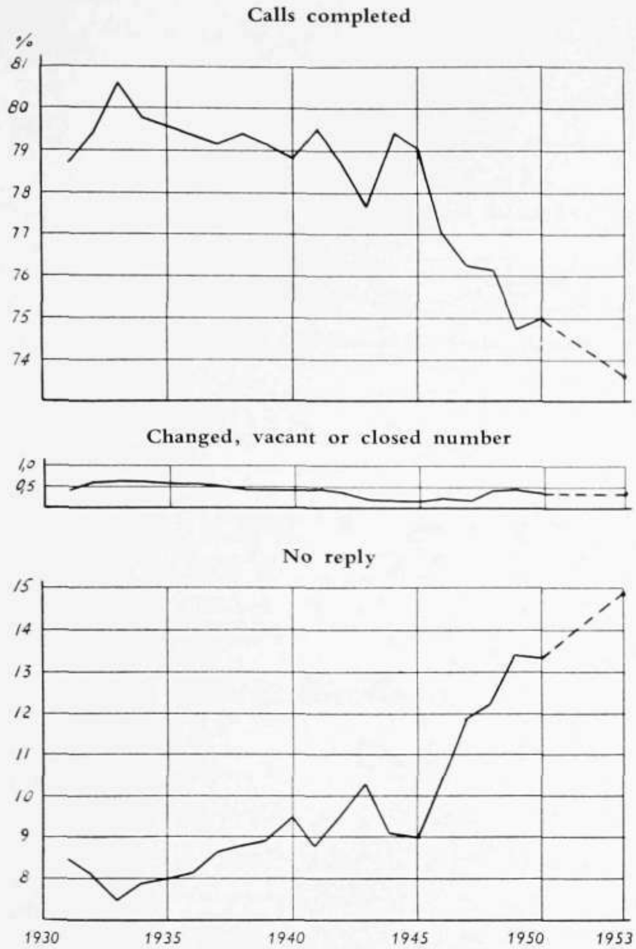
To present a more clear picture the values in table 2 are plotted in graph form in figs 2—4. A division has been made into main groups according to table 2, group "no faults" being found in fig. 2, "subscriber faults" and "operator faults" in fig. 3 and finally "equipment faults or faults not traced" in fig. 4

In fig. 2 the progressively increasing tendency "no reply" rate is particularly marked. The increase is accelerated after 1946 and this may to a great extent depend on the introduction of free school lunches. Already prior to 1946 school lunches were provided by the City of Stockholm but only on a limited scale. Through an act of Parliament such meals were obligatory in Council schools as well as in High schools. The ruling was to be executed over a transition period of 5 years starting 1946. The first autumn 22,000 children in the Stockholm schools were provided with meals but 1953 the number had risen to 92,000. It is evident that many housewives in this way have received opportunities to utilize the mornings in another way than previously when the meal at home for the children had to be prepared. Some have taken some kind of extra work and some are able to do their shopping etc. in the mornings to

Table 2. Reliability checks in the Stockholm central area exchanges 1931—1950 and 1953

Year	No. of exchanges	No. of Subs.[1]	No. of checked connections	No faults: Calls cpt'd	No faults: Changed, vacant or closed number	No faults: No reply	No faults: Number engaged	No faults: Total	Subscriber fault	Operator fault	Equipment faults: Traced: Within the exchange	Equipment faults: Traced: To other exchange	Equipment faults: Traced: To line or instrum.	Equipment faults: Traced: Total	Equipment faults: Not traced	Equipment faults: Total
1931	4	63 556	241 466	190 078	1 113	20 568	20 906	232 665	8 024	99	247	55	14	316	362	678
%				78.718	0.461	8.518	8.658	96.355	3.323	0.041	0.102	0.023	0.006	0.131	0.150	0.281
1932	5	84 908	434 403	345 113	2 720	35 231	38 207	421 271	12 019	152	334	90	16	440	521	961
%				79.446	0.626	8.111	8.795	96.977	2.767	0.035	0.077	0.021	0.003	0.101	0.120	0.221
1933	6	100 956	644 830	520 214	4 102	48 375	58 957	631 648	12 037	231	322	73	21	416	498	914
%				80.675	0.636	7.502	9.143	97.956	1.866	0.036	0.050	0.012	0.003	0.065	0.077	0.142
1934	6	101 726	690 277	551 271	4 183	54 677	67 088	677 219	11 714	320	310	84	44	438	586	1 024
%				79.862	0.606	7.921	9.719	98.108	1.697	0.047	0.045	0.012	0.006	0.063	0.085	0.148
1935	6	104 523	756 286	602 283	4 477	61 073	75 409	743 242	11 649	285	325	101	44	470	640	1 110
%				79.637	0.592	8.075	9.971	98.275	1.541	0.037	0.043	0.013	0.006	0.062	0.085	0.147
1936	6	108 468	667 056	529 846	3 679	54 470	67 436	655 431	10 415	269	269	92	14	375	566	941
%				79.430	0.552	8.166	10.109	98.257	1.562	0.040	0.040	0.014	0.002	0.056	0.085	0.141
1937	6	114 232	699 317	553 796	3 625	60 399	70 319	688 139	10 149	306	192	108	18	318	405	723
%				79.191	0.518	8.637	10.056	98.402	1.451	0.044	0.027	0.015	0.003	0.045	0.058	0.103
1938	6	132 438	754 435	599 094	3 592	66 404	74 821	743 911	9 621	185	175	100	13	288	330	618
%				79.410	0.476	8.802	9.917	98.605	1.275	0.038	0.023	0.013	0.002	0.038	0.044	0.082
1939	7	139 914	746 224	590 790	3 360	66 697	75 611	736 458	8 821	309	285	121	11	317	319	636
%				79.171	0.450	8.938	10.132	98.691	1.182	0.042	0.024	0.016	0.002	0.042	0.043	0.085
1940	7	144 116	629 790	496 745	2 797	59 781	62 655	621 978	7 058	212	182	97	6	285	257	542
%				78.875	0.444	9.492	9.948	98.759	1.121	0.034	0.029	0.015	0.001	0.045	0.041	0.086
1941	7	149 559	472 513	375 791	2 101	41 768	46 797	466 457	5 375	153	197	108	7	312	216	528
%				79.530	0.445	8.839	9.904	98.718	1.138	0.032	0.042	0.023	0.001	0.066	0.046	0.112
1942	7	155 582	513 722	404 576	1 868	48 703	52 101	506 248	5 669	157	227	95	—	322	326	648
%				78.753	0.364	9.480	10.142	98.739	1.104	0.031	0.044	0.019	—	0.063	0.063	0.126
1943	7	158 124	508 298	395 090	1 027	52 580	53 640	502 237	5 065	136	339	173	4	516	344	860
%				77.728	0.202	10.325	10.553	98.808	0.996	0.027	0.066	0.034	0.001	0.101	0.068	0.169
1944	7	164 000	324 206	257 705	590	29 516	34 063	321 874	1 803	69	117	113	7	237	223	460
%				79.488	0.182	9.105	10.507	99.282	0.556	0.021	0.036	0.035	0.002	0.073	0.068	0.141
1945	7	169 105	226 968	179 540	432	20 498	24 889	225 359	1 183	45	125	56	1	182	199	381
%				79.104	0.190	9.031	10.966	99.291	0.521	0.020	0.055	0.025	—	0.080	0.088	0.168
1946	7	173 606	217 012	167 264	446	22 679	25 167	215 556	1 031	59	114	63	—	177	189	366
%				77.076	0.205	10.451	11.597	99.329	0.475	0.027	0.053	0.029	—	0.082	0.087	0.169
1947	7	181 180	267 271	203 882	539	31 705	29 544	265 670	1 235	36	101	58	4	163	167	330
%				76.283	0.202	11.862	11.054	99.401	0.462	0.013	0.039	0.021	0.001	0.061	0.063	0.124
1948	7	185 239	301 105	229 346	1 355	36 892	32 136	299 729	1 218	27	79	38	—	117	104	221
%				76.145	0.450	12.249	10.669	99.513	0.405	0.009	0.026	0.012	—	0.039	0.034	0.073
1949	7	189 036	304 958	227 941	1 389	40 877	33 001	303 208	1 347	21	121	79	1	201	181	382
%				74.745	0.455	13.404	10.822	90.426	0.442	0.007	0.040	0.026	—	0.066	0.059	0.125
1950	7	191 636	242 716	182 022	942	32 413	25 910	241 287	1 084	14	83	65	3	151	180	331
%				74.994	0.388	13.354	10.675	99.411	0.447	0.006	0.034	0.027	0.001	0.062	0.074	0.136
1953	8	201 881	235 953	173 750	815	35 100	25 344	235 009	848	7	30	19	1	50	39	89
%				73.638	0.345	14.876	10.741	99.600	0.359	0.003	0.013	0.008	—	0.021	0.017	0.038

[1] The number of subscribers is in table 1 somewhat lower than that in table 2 for the corresponding year owing to the figures having been calculated by different methods.



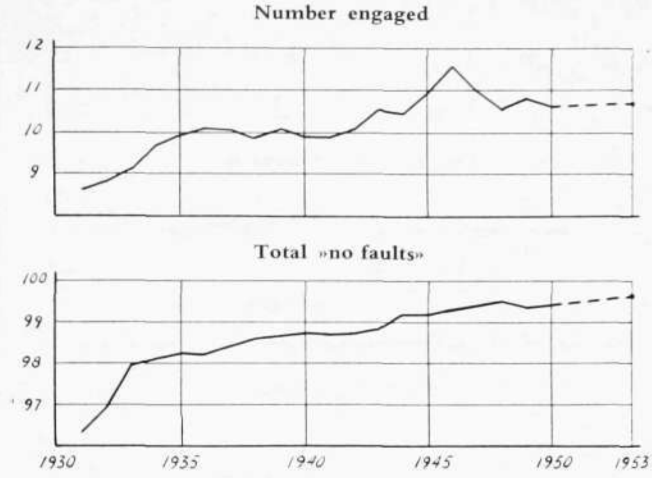


Fig. 2 X 6901 X 6902

Percentage of »no faults» for Stockholm central area exchanges, divided in main groups according to table 2, during the period 1930—1953

a greater extent than before. No doubt the free school lunches have caused the homes to be left empty at certain times of the day and with this the rate of "no reply" will naturally increase. The increased standard of living may also to a certain extent have contributed to the rising tendency of the curve as far more single householders nowadays can afford a telephone than earlier. The "no reply" frequency from single people will naturally be higher than that from family households.

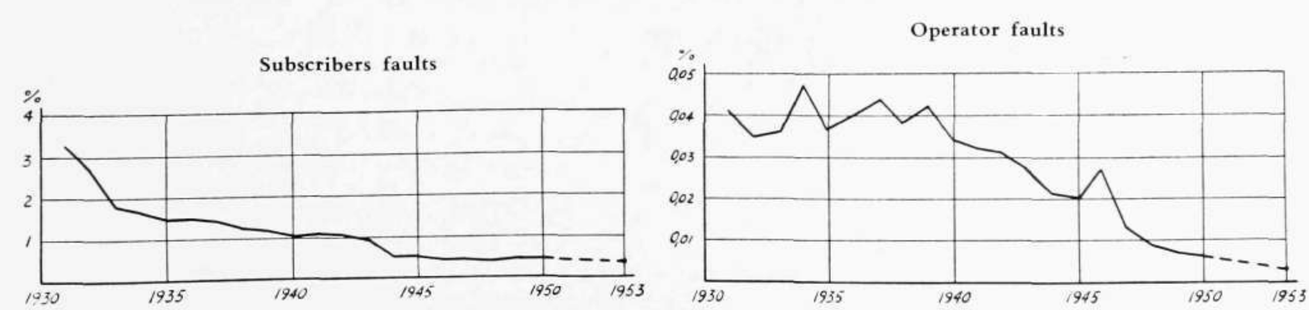
If the graph for "call completed" is compared with the graph "no reply", it will be found that the tendency is right opposite. In other words, when the former falls, the latter will rise and vice versa and it is also quite natural that this must be so.

"Changed, vacant or closed number" keeps round 0.5 %. The low values between 1942 and 1947 are probably due to the low number reserve which during the war years was reduced to a minimum. Usually the exchanges have a number reserve between 5 and 10 %.

Fig. 3 X 6903

Percentage of faulty operations

"Number engaged" has in the main been rising up to 1946 when a maximum was obtained. From then on it has fallen to take up an equilibrium round



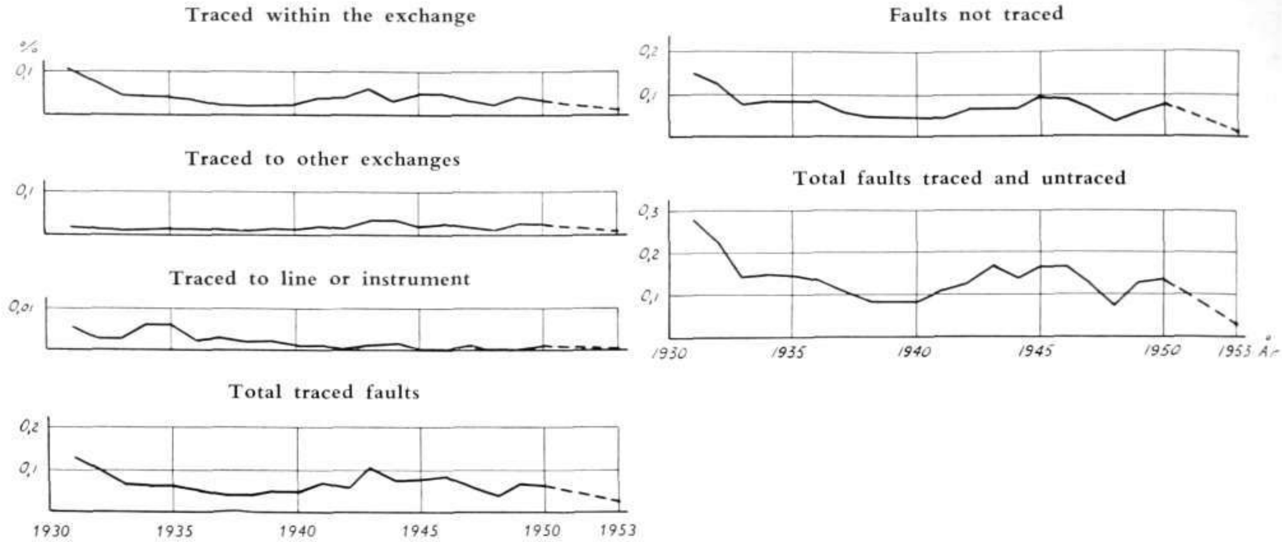


Fig. 4 X 6904 X 6905

Percentage of equipment faults or faults not traced

10.7 % from 1948. The "number engaged" rate is of course associated with the calling frequency which in 1946 was particularly high.

"Total of no faults" now appears to have stabilized in the neighbourhood of 99.5 %. The increase from 1931 when the rate was just below 96.5 depends mainly on the reduction in "subscriber faults" which have fallen from 3.323 to 0.359 during the same period.

Fig. 3 shows that "subscriber faults" now have stabilized just below 0.5 % after an earlier continually falling tendency. This development is due to the fact that the general public now has become accustomed to dialling. Now only unavoidable faults remain which are due to carelessness and errors.

"Operator faults" have fallen due to the gradual disappearance of the operators owing to the successive conversion to automatic operation of the Stockholm district for local as well as toll traffic. The conversion of the entire district was completed by the autumn of 1953.

From table 2 and fig. 4 will follow that the number of equipment faults together with faults not traced in relation to all checked calls during 1953 was lower than at any time previously, viz 0.038 % which shows that the reliability of the Stockholm telephone exchanges still is very high.

The figures quoted in this paper for the number of maintenance hours can, of course, not be taken indiscriminately as a standard for other fully automatic telephone exchanges. There are wide differences in conditions which will result in lower as well as higher figures. The values obtained in Stockholm are, furthermore, maintenance hours *spent* and do not necessarily indicate the *actual requirement*.

At present investigations are in progress in Stockholm for the purpose of simplifying the maintenance work further still.

Distribution System with Through-Connected Basic Load

N SIDENMARK, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.743:621.315.67

In Ericsson Review No. 2, 1947, a description was made of a new distribution system with through-connected basic load as applied to urban telephone networks. Subsequent experiences have proved that the principle of through-connection may have been carried too far, and the through-connection system has, therefore, been modified to a certain extent. In the following paper a short description will be given of such a modified system.

Original Through-Connection System (Full Through-Connection)

The principle of the through-connection system originally suggested will follow from fig. 1. From each distribution box with 10 pairs, 5 pairs are, as shown, connected to the exchange. The cable pairs to the exchange are run over the distribution cabinet but they are there through-connected in a by-pass box with two cable entries. One of these entries takes an incoming 50-pair cable from the exchange and this cable is fully through-connected. The other takes an outgoing 100-pair cable to the distribution boxes consisting of 50 through-connected pairs from the exchange and 50 pairs from the secondary terminals in the by-pass box. All exchange pairs are, thus, through-connected in the cabinet and this is referred to as full (complete) through-connection.

With boxes through-connected by this method alone where each by-pass box of 50 pairs covers ten 10-pair distribution boxes, the ratio between cable pairs on the primary side and cable pairs on the secondary side will be 1 : 2 and an average load of 5 subscribers per each 10-pair distribution box can, therefore, be received.

In order to cover the additional exchange lines required when the average load in the network exceeds 5 subscribers, a suitable number of direct exchange cable pairs are connected to the distribution cabinet. These are connected to separate primary cable boxes in units of 50 pairs.

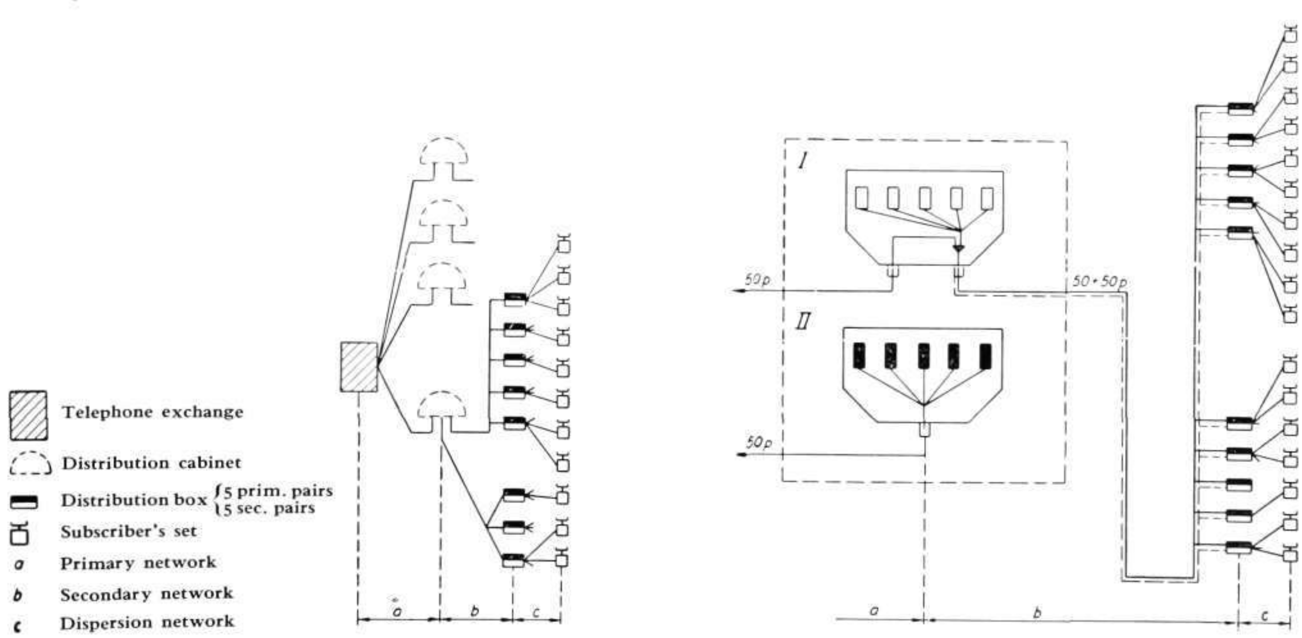
Fig. 1 X 9129 X 7669

Skeleton diagram for full through-connection

Left, general lay-out, right, detail of by-pass box (in principle)

I By-pass box with 50-pair through-connected exchange cable and 50 pairs connected to secondary cable (incoming 50 pairs, outgoing 100 pairs)

II Separate primary cable box with 50-pair exchange cable to cover subscriber lines if the average load exceeds 5 subscribers per 10-pair distribution box



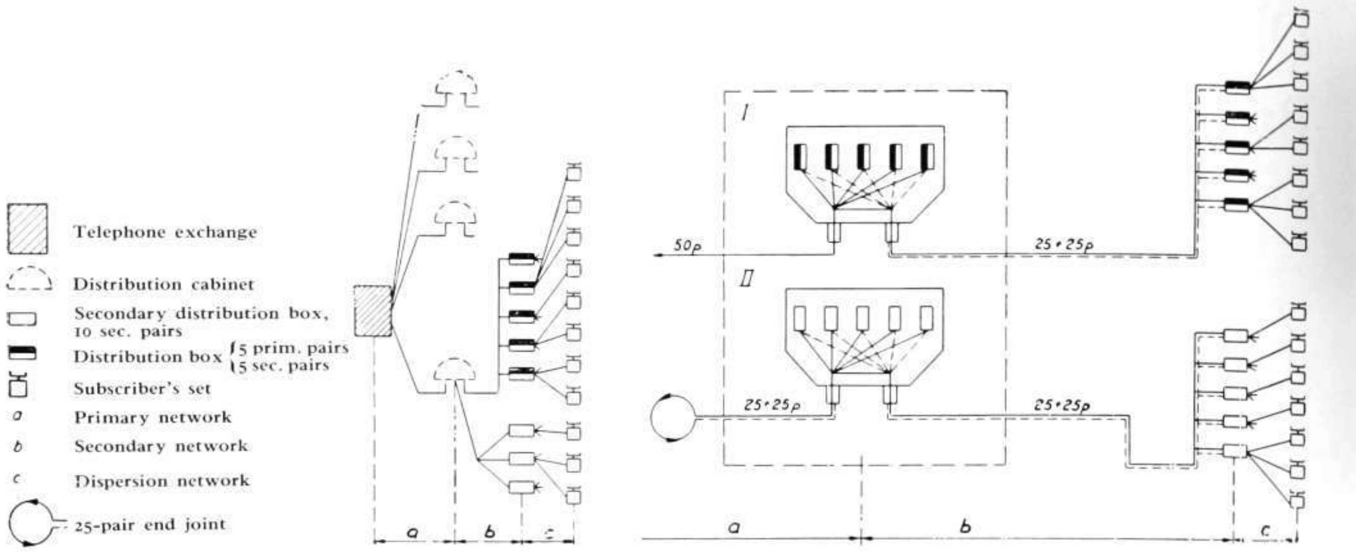


Fig. 2 X 9128 X 7670

Skeleton diagram of partial through-connection

left, general lay-out, right, detail of by-pass box (in principle)

- I By-pass box with exchange cable of 25-through-connected pairs and 25 connected pairs (incoming 50 pairs, outgoing 50 pairs)
- II Separate secondary box with 50-pair secondary cable for connection to secondary distribution boxes. (The box can be rearranged to by-pass box by the connection of the end-jointed left hand cable end)

As mentioned above experience has proved that the through-connection by this system has been carried too far and some modifications have, therefore, been made.

Modified Through-Connection. (Partial Through-Connection)

The principle of the new system, NAB 12, follows from fig. 2. From a distribution box with 10 pairs 5 pairs are, as before, connected to the exchange and the remaining 5 pairs connected in the cabinets. The 5 pairs to the exchange by-pass the cable distribution cabinet in a by-pass box with 2 entries in the same manner as in the original system. One cable entry takes an incoming 50-pair cable from the exchange, 25 pairs being connected in the box and 25 pairs only being through-connected. The other cable entry takes an outgoing 50-pair cable to the distribution boxes consisting of 25 through-connected pairs from the exchange and 25 secondary pairs from the terminals in the by-pass box. In the modified system half of the exchange cable pairs only are, thus, through-connected (partial through-connection).

A by-pass box with 50 pairs will, therefore, be connected to five 10-pair boxes on the secondary side and the cable pair ratio between the secondary and the primary side is 1 : 1.

As a secondary side naturally is required which is larger than the primary side, the distribution network is provided with a suitable number of secondary distribution boxes containing line pairs from the distribution cabinet only. These are terminated in the cabinet by separate secondary boxes which, however, also are provided with two cable entries enabling them to be re-connected to by-pass boxes in case of a subsequent increase of the load. By varying the number of separate secondary boxes in each cabinet in proportion to a certain number of by-pass boxes any required ratio may be obtained between the primary and the secondary side.

The appearance of a by-pass box will be seen in figs 3 and 4. Of these boxes one size only is used *viz.* for 50 pairs. Each cable entry is similarly made for 50 pairs. The connection of such a box follows from fig. 4 and the connection details from fig. 5. The incoming 50-pair cable from the exchange enters through the left cable entry. Half of this cable, 25 pairs, is connected in the usual manner to the soldering tags in the box with 5 pairs to the left hand row of terminals in each 10-pair terminal block. The remaining 25 pairs are top-jointed with the corresponding number of pairs in the secondary cable running through the right hand cable entry and similarly containing 50 pairs. The remaining 25 pairs in the secondary cable are connected to the soldering tags with five pairs to the right hand row of terminals in each 10-pair terminal block.

Fig. 3 X 4985

By-pass box with two cable entries

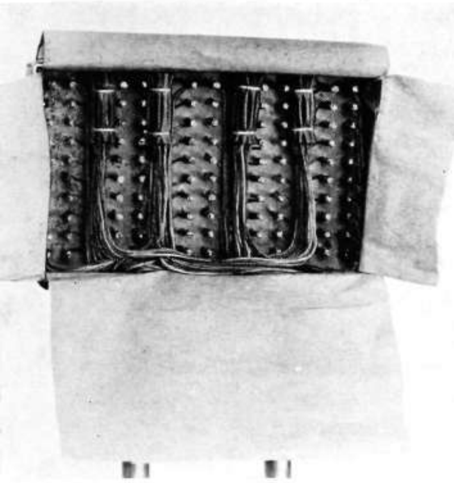


Fig. 4 X 4984

By-pass box with cable connected

rear view

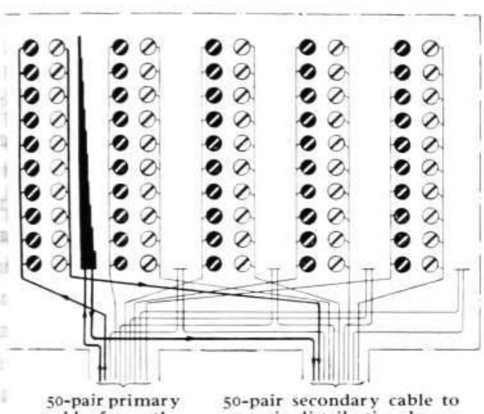


Fig. 5 X 4981

Connection of a by-pass box with two cable entries

front view

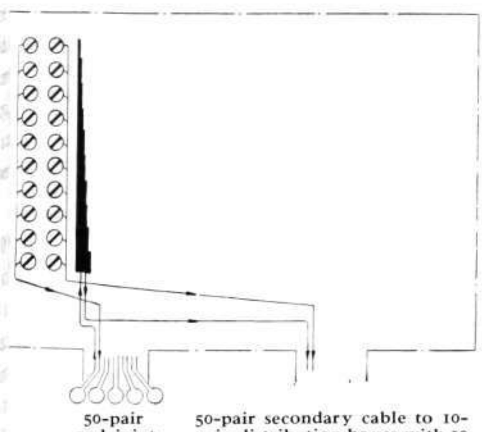


Fig. 6 X 4980

Connection of secondary cable box with two cable entries

front view

In actual practice the connection of the boxes is preferably carried out in the stores where the by-pass boxes are provided with two cable ends with 50 pairs in each which are connected and jointed as described above. The length of these cable ends should be such that they will cover the distance from the box position in the distribution cabinet down to the man-hole for the underground duct system. The primary as well as the secondary cable is connected to the network by means of ordinary straight-through joints. The primary and the secondary cables need not be jointed at the same time but can be laid and jointed at separate time which may be of importance as the building of the primary and the secondary network often has to take place independently of each other.

The connection of the separate secondary boxes, which as mentioned above also consist of boxes with two cable entries, will be seen in fig. 6. Also for these boxes the connection is carried out in the stores. Two cable ends are connected and jointed in exactly the same manner as that used for the by-pass boxes. The only difference is that the left hand cable end, which in case of the by-pass boxes was intended to be connected to the primary cable from the exchange, is end-jointed in such a way that the 25 cable pairs from the left hand rows of terminals in each terminal block are connected to the 25 pairs in the outgoing secondary cable which are top-jointed to the remaining 25 pairs in the incoming cable and in the distribution boxes are connected to the left-hand rows of terminals. When the secondary boxes are fitted in the cable distribution cabinets the secondary cable only is jointed to the right hand cable end, whereas the left hand cable end remains disconnected. By means of the end-jointing the full capacity of the secondary cable will be connected to the 50 terminal pairs in the box.

If the load on the network subsequently is increased necessitating the laying of a new primary cable two conditions may arise. On one hand extension of the primary as well as the secondary side is required and a new by-pass box is then fitted. If on the other hand extension of the primary side only is required, the new primary cable may be connected to the end-jointed left hand cable end in an existing secondary box, which will then serve as a by-pass box.

Comparison Between Full and Partial Through-Connection

An advantage of full through-connection is that all 10-pair distribution boxes will be similar i.e. with 5 primary pairs and 5 secondary pairs. There are no separate secondary boxes. Each box can consequently take up to 5 subscribers without any cross connections in the box being necessary. In case of unbalanced load all subscriber lines over 5 per box are connected back to the exchange over the cabinet by jumpering from the secondary pairs in a cabinet terminal block to free pairs in a separate primary box. (The original intention was to connect back free exchange pairs from distribution boxes with less than 5 subscribers but this scheme was soon abandoned as it proved too troublesome.) The cross connection in case of unbalanced load, which always has to be carried out with jumpering wire, is naturally a disadvantage especially in tropical climates as it will mean a deterioration in the insulation. In case of a low average load there is also a tendency for an excessive number of reserves not to be utilized in the direct exchange pairs to the distribution boxes. The system with full through-connection can, however, still be used with advantage for average loads which are not too low. The economy in cabinet boxes and cabinet space is naturally higher for this system than that for partial through-connection.

In most cases, however, it seems to be more practicable to limit the extent of the through-connection, and this principle has been applied in the partial through-connection system. The ratio between primary and secondary side in the by-pass boxes is here 1 : 1. Of the primary pairs half the number only is through-connected and the other half is connected up in the cabinet to be utilized by any of the distribution boxes in the cabinet area in case of un-

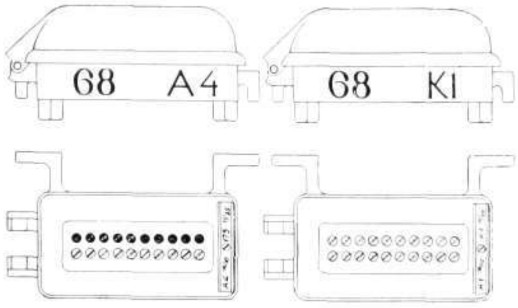


Fig. 7 X 4979

Registration of distribution boxes

balanced load. The secondary side in the network is varied in extent by the fitting of a suitable number of separate secondary boxes and the ratio between the primary and the secondary side can in this way be varied as required. In case of unbalanced load in the distribution boxes subscriber lines above five per box must also with this system be cross-connected in the cabinet. This connection from one secondary pair can, however, in most cases take place to an immediately adjacent pair in the same cabinet terminal block and it can, therefore, be carried out by strap connection which from insultation point of view is of importance in tropical climates. Jumper wire must, however, be used for cross-connection to separate secondary boxes.

Another advantage is that the system is less rigid than the full through-connection system and there is, therefore, less tendency for exchange pairs in the secondary network as a whole not to be utilized. It is also of some importance that a local extension of the network in a cabinet area can easily be made, for instance for a new building, as the new distribution boxes at least initially can be arranged as separate secondary boxes and a simultaneous extension of the primary cable network is, therefore, not always necessary.

A simple recording system has been devised which completely eliminates the inconvenience of having two different kinds of distribution boxes.

Advantages and Disadvantages of a Through-Connected System

Finally a short comparison will be made between the through-connection system and the pure distribution system.

Reduced Capital Expenditure

The cabinet division is maintained. By the introduction of cable boxes with two cable entries and by the method of jointing inside these the primary and the secondary networks may be built in separate stages. The advantages of the pure distribution system remain, therefore, intact.

On the other hand the through-connection method results in a considerable reduction of the disadvantages held up against the distribution system, *viz.* the cost of the distribution cabinet with corresponding man-holes in the duct system, the cost of the boxes in the distribution cabinets and finally the cost for the cross-connection in the distribution cabinets.

Simplified Operation

For new subscribers' installations the work has been further simplified with the through-connection system owing to reduced cross-connection operations in the cable distribution cabinets. 50 % of the primary pairs are, as mentioned above, connected direct to the distribution boxes and the cross-connections, which have to be made, can in most cases be carried out by means of ordinary strapping, which as pointed out above may be of considerable importance in tropical climates.

It may be argued that the cable records will be more complicated with the through-connection system. The decimal graduation is, however, on the whole maintained and the record is equally clear owing to a fully defined registration of each terminal on the primary side as well as on the secondary side.

Conclusion

A general application of the through-connection system has now started for all networks erected in L M Ericsson's management. The first large scale network, 15,000 exchange lines, to be completed according to this system was that in Beyrouth which was recently put into operation.

The experiences gained there also bear out the advantages of the through-connection system.

The through-connection system can also be applied with advantage to already existing network reducing the cost of required extensions in the network. The system is, therefore, likely to be used on an increasing scale in future.

The Multicoil Relay — a New Switching Device

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U.D.C. 621.318.5:621.395.65

The multicoil relay RAM 100, the new switching device described in this article, has been designed to replace a number of simple relays in certain multi-wire circuits. Thus the multicoil relay eliminates the complicated labour and heavy costs involved in multiple wiring. Furthermore, the relay saves space and makes for simplification of equipment.

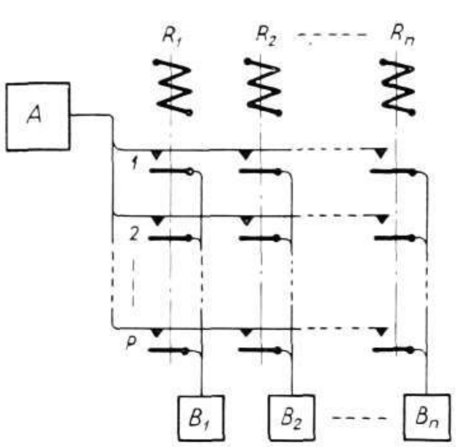

Fig. 1 X 4933
Circuit diagram of multicoil relay RAM 100
Example 1

The modern by-path systems have further accentuated the need, already felt in telephone technique, of a single switching device that can replace a number of simple relays in circuits of, for instance, the types illustrated in figs 1 and 2. Thus the aim may be to effect a multi-wire connection between a device (A) and one of a group of devices (B_1—B_n), fig. 1, at the least possible cost.

Alternatively, connection may be desired between one of a group of devices (A_1—A_n) and one of another group of devices (B_1—B_n), fig. 2.

These requirements have been met by a new relay design, the multicoil relay type *RAM 100*, fig. 3. Fig. 4 shows the schematic build up of this switching device. It possesses ten separate magnetic systems, each of which controls a maximum of twelve make contacts. The making of every contact is effected between one make spring and a strip common to five or ten make springs.

The chief advantage of the multicoil relay is the avoidance of the complicated work involved in multiple wiring. In addition, space and simplification are gained.

The greatest utilization of the multicoil relay will, of course, be in such circuits as are exemplified in figs. 1 and 2. It can also be used to advantage, moreover, for the storage of digits in registers or markers. One complete multicoil relay can be employed for every digit, the particular digit being indicated by operation of one of ten relays. Alternatively, one half of a multicoil relay can be utilized per digit, the value of the digit being supplied in code by the operation of, for example, two relays out of five.

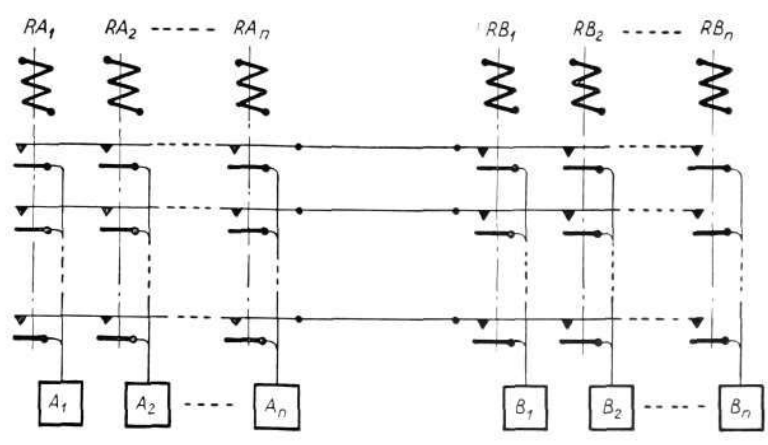

Fig. 2 X 6783
Circuit diagram of multicoil relay RAM 100
Example 2

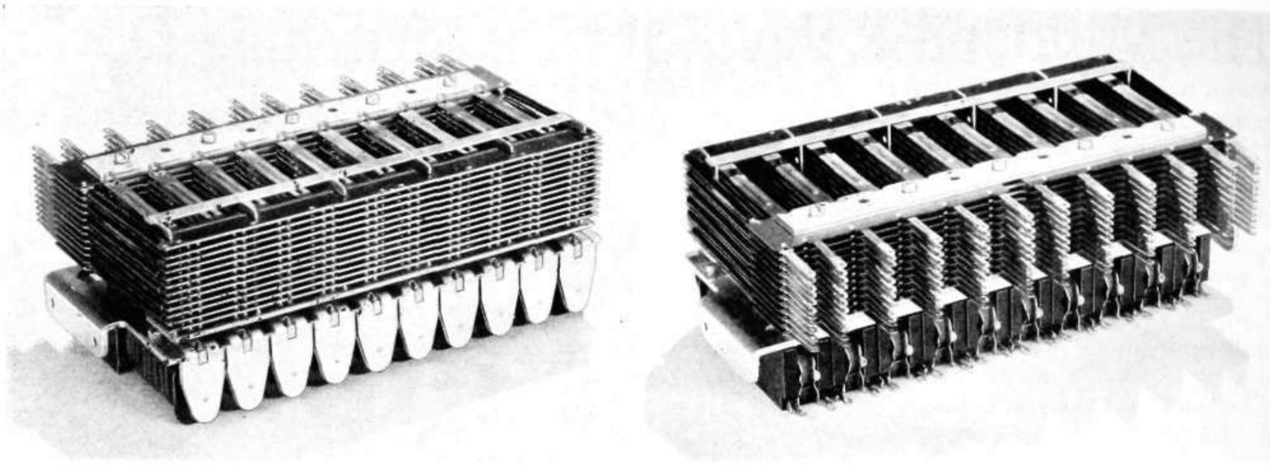

Fig. 3 X 7661
Multicoil relay RAM 100
Right: View from wiring side

The principal components of the multicoil relay are the plate and magnet systems, the bank and the set of contact bars, fig. 5.

Magnet System

Riveted to the base plate are ten rectangular cores. A coil fits over each core. Opposite the face of every core is an armature resting on knife edges formed in the frame. The armatures are held in position by grooves in the base, by the guide bar fixed on the base, and by their return springs.

The body of the coil is formed of a plastic casting and is fitted with a pocket for the accommodation of a spark quench resistance. In the rear is space for four soldering tags for connection of the windings.

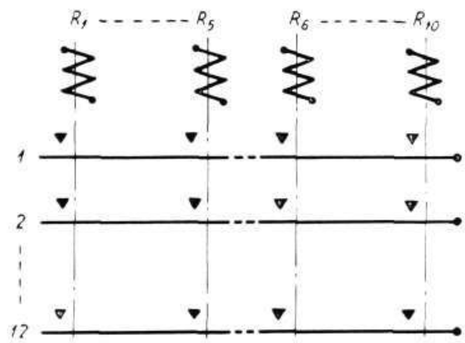

Fig. 4 X 4934
Schematic diagram of multicoil relay

The Bank

The bank consists of ten contact springsets. Every springset contains a maximum of twelve moving springs fitted with twin silver contacts. The bank is made up of layers of contact springs separated by insulators and spacers and mounted directly on the base plate. Each layer consists of ten springs and two bar connectors riveted to insulators.

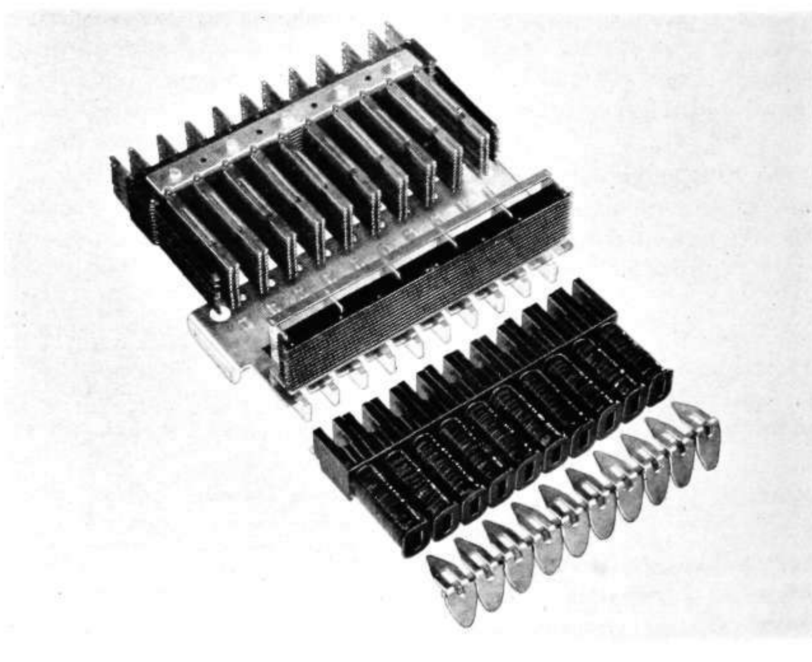

Fig. 5 X 6785
Main components of multicoil relay
From rear: bank, set of contact strips, frame carrying magnet cores, coils and armature

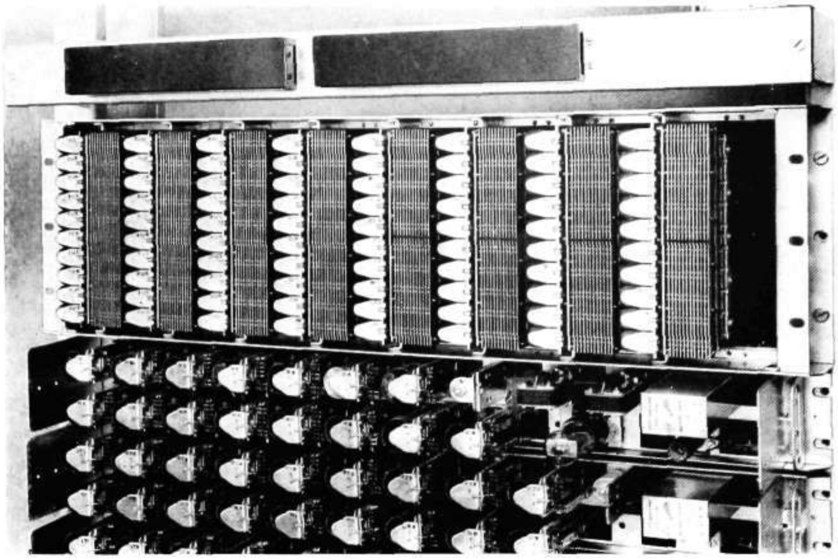

Fig. 6 X 6786
Multicoil relays mounted in relay set

The contact springs of each springset are mechanically linked to a lift comb which causes simultaneous movement of the springs whenever the group is actuated. The comb is guided by the upper spring in the set and by a slotted plate fixed to the base plate below the set. The lower part of the comb is acted upon by the armature which lifts all springs in the set whenever current is applied to the coil of the particular magnet. When the contact springs are lifted, they make contact with the contact strips running along all ten springsets. The number of contact strips is equal to the number of springs in the set.

The contact strips are of silver and are fixed to strips of insulating material. The strips are assembled in a composite unit which is screwed to the relay base plate. The unit is contained in a frame in which spaces with open grooves are secured. The contact bars are inserted in the open grooves of the spacers and are held fast by two pins, each of which passes through all bars and two of the spacers. The pins are locked by a tongue on the spacers being folded over the ends of the pins.

Every contact bar is divisible in the centre and at each end is connected to a bar connector which, as said earlier, is formed integral with the multiple.

Multicoil relays are usually mounted in relay sets, fig. 6, or at the top of racks.

The L M Ericsson Parking Meter

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U.D.C. 681.175.9:351.754.21

The car parking facilities are in most large cities inadequate especially in central parts. In U.S. the parking problem became acute earlier than in Europe and about twenty years ago the first parking meters were tried out there. By now well over 1 million parking meters are in use in U.S. and Canada.

The development in Europe has been slower, possibly due to legislation difficulties, but in recent years a few towns, among them Stockholm, have begun to install parking meters.

A new type of parking meter has been designed by Division ERGA of Telefonaktiebolaget L M Ericsson. In the course of the development attention has been paid to specific Scandinavian requirements and requests which have been raised from time to time.

The parking meter is a slot machine selling time, *viz.* the time during which a specified parking space is available to the buyer. One machine is required for each car space. This type of machine can, of course, be used to hire out space for other purposes such as cleaning and self-service repairs.

When parking a car, one or more coins are inserted in the meter according to the parking time required and to the specified rate. A crank handle is turned one revolution, for several coins one revolution after each coin. A pointer indicates the parking time paid for and travels towards a zero position. When the paid time has expired this is signalled in one way or another. Cars parked at meters with zero position are considered as violating the parking regulations.

The L M Ericsson parking meter consists of a *coin identification device* with crank handle, a *clock movement* with pointer and signal flag and a *coin receptacle*.

Fig. 1 X 6912
The L M Ericsson parking meter
front view

Fig. 2 X 6911

The L M Ericsson parking meter

rear view with lid and coin receptacle removed

The red circular flag indicates that the paid parking time has expired and the pointer shows that it has been exceeded by about five minutes. In the centre the clock movement is seen and below this space for the coin receptacle which is secured in the machine by means of the collection lock in the right hand corner. Centrally in the bottom of the meter is a hole for the mounting screw which is inaccessible when the receptacle is fitted.

The coin identification device is normally dissociated from the clock movement and the crank handle can, therefore, be moved freely without other parts of the mechanism being affected.

If a coin is inserted the identification device is coupled to the clock movement. When the crank is turned the pointer is moved forward a distance corresponding to the value of the coin and the clock movement is started.

Two or three different coins can be used in the same machine and these are inserted through the same slot. The coins are differentiated by a sliding member in the identification device, which takes up different positions depending on the diameter of the coin and which couples the crank handle to the clock movement during different rotation angles. The machine will accept coins with a diameter below 1″ (25.5 mm) hand above 19/32″ (15 mm). The difference between two coin diameters must not be less than 3/32″ (2.5 mm).

If a faulty or worn coin is inserted the movement of the identification device is halted by a slotted bracket. The crank handle is provided with a friction clutch and the mechanism will, therefore, not be subjected to excessive strain. Faulty coins are rejected from the machine by the crank handle being turned in the opposite direction.

The coins last inserted are visible through a window. The number of visible coins corresponds at least to the maximum parking time. It is, thus, not possible to operate the machine with spurious coins without the user running the risk of discovery.

Parking time can be bought by any combination of coins. A shilling's-worth of time can be obtained by inserting a shilling piece, two sixpences or four silver threepenny bits and usually corresponds to a parking time of two hours. One hour's parking time is similarly obtained for one sixpence or two threepenny bits etc.

The machines can also be made to reject any of the three coins mentioned above *i. e.* to accept two or one size of coin only.

Fig. 3 X 4983

The L M Ericsson parking meter

front view

The pointer indicates that 50 mins. approx. remains of the parking time. On the left hand side the coin slot, which is used for several sizes of coins. The crank handle on the front is turned one revolution for each coin inserted. The coins which have last operated the machine are visible in the oblong window. At the bottom to the left rejection aperture for faulty coins.

The paid parking time is indicated on a dial by a pointer which is moved by the clock movement towards a zero position. On reaching the zero position, *i. e.* when the paid parking time has expired, a red flag is released into the dial space. A parking inspector can, therefore, at a glance spot possible offenders in a row of parking places. The dial, the pointer and the flag are visible from two opposite directions. The pointer continues to travel for ten minutes on the opposite side of the zero position indicating "overtime". By this arrangement controversies are avoided as to whether the parking time expired "only a few seconds ago".

The coins are collected in a receptacle holding 30 coins with a diameter of 1" (25.5 mm) or the corresponding amount in small change even in case of unfavourable pile-up of the coins.

The parking meter is enclosed in an aluminium alloy die-cast cover consisting of two halves screwed together and sealed watertight. The front portion carries the mechanism with crank handle, lock, window for visible coins and inspection window for coin receptacle as well as an aperture for rejected coins. When the key for opening the meter is inserted in the lock and turned, the visible coins are released and drop into the coin receptacle.

The rear portion is provided with a lid held by the lock on the front side. Inside the lid is the coin receptacle which is secured in position by a separate collection lock. This lock becomes accessible after the removal of the lid. The screw fixing the meter to the mounting post is placed underneath the coin receptacle and the meter can, therefore, not be dismounted unless the receptacle has previously been removed for which operation a collection key is required.

The mechanism and the front portion of the cover on the other hand can be detached without removing the coin receptacle. A maintenance man can, therefore, get at all parts of the mechanism for repairs or replacement by means of one key, *viz.* that for the lock on the front side of the machine. He has not access to the coin receptacle and consequently cannot dismount the machine complete with receptacle unless he is accompanied by a person possessing a collecting key.

For collection two keys are required, one to open the lid in the cover and one to detach the receptacle, as well as a number of empty receptacles depending on how many meters are covered on a collection round, for instance 50. The collection is carried out simply by replacing the old receptacle by a new one and requires one man only. The cash is not accessible to the collector as each receptacle is provided with a lid locked with a separate key, the receptacle key, and has an automatic slot cover.

The meter cover is furthermore provided with a window through which it is possible to ascertain that the coin receptacle has been replaced.

The coin receptacles are handed by the collector to the cash office. The counting of the contents is carried out in the presence of one or more controllers which are the only ones who possess the required special receptacle key.

The standard parking meter is intended for a maximum parking time of 2 hours, but this time can be varied by replacing or resetting certain parts in the machine.

The L M Ericsson parking meter is very sturdy and robust and will stand up to rough treatment. Most parts are made of non-corrosive material and are otherwise zinc plated.

Dimensions: Width 7 7/8" (200 mm), height 14 9/16"
Depth 4 3/16" (106 mm)

Weight: 8 1/8 lbs (3.7 kg)

All-Relay Interlocking Plant for Danish State Railways

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U.D.C. 656.257

Preliminary tests of all-relay interlocking plants were undertaken by the Danish State Railways in 1948. These tests were successful from the start. A rapid development in relay interlocking plants took place in the next few years, and the Danish State Railways now build no other types. The largest interlocking plant hitherto built in Denmark — and, in fact, in Scandinavia — is that at Odense, which was brought into service in May 1954. It is specially designed for operation in a CTC system to extend from Fredericia to Nyborg, that is to say right across the island of Fyn.

In 1948 the Danish State Railways made the important decision to install all-relay interlocking plants, by way of experiment at certain minor stations. There were no means of predicting at that time whether the experiment would be a success or failure. The only possible course was to construct these plants on the basis of experience from the already existing types of electrical interlocking plants and, to start with, the relays and other material designed for those plants had to be used in the new types.

It is now agreed that the experiments succeeded beyond all expectation, and the all-relay interlocking plants being built to-day by the Danish State Railways are even better fitted to operate efficiently, since the materials now employed — relays, contacts etc. — are designed specifically for such plants.

The object of the experimental plants was to provide experience in regard to the reliability of the relay contacts and to the circuit arrangements, while traffic functions were assigned a second place.

As said, the test plants showed remarkably good results. By 1951 the General Directorate fully realized that the all-relay interlocking plants possessed all the advantages that could be hoped for and that they revealed hardly any weakness compared with the previously used types.

In co-operation with Dansk Signal Industri A/S, therefore, the State Railways started to construct new types of all units in use at that time which were not particularly suited for relay interlocking plants, i.e. such parts as relays, press buttons, indication lamps and cable fittings. The main consideration in this work was to produce apparatus that would improve traffic control with the aim of speeding up and increasing the safety of train and shunting movements and of effecting a saving in staff.

The new equipment was completed by the beginning of 1953, and in June of that year was put into service for the first time in a somewhat larger relay interlocking plant at Glostrup Station. The new relays had, however, already been used in a few other plants. The decision was made at the same time that the very much larger plant at Odense should operate on the same lines as at Glostrup, but that improvements were required in respect to certain units.

Fig. 1 X 4988

The interlocking plant at Odense

The building has sloping windows to avoid the trouble caused by reflection of light. A special type of glass is employed with two panes hermetically sealed together at the sides; the space between the panes is filled with absolutely dry air. One pane is coloured pale green to reduce heat transmission.

Odense Relay Interlocking Plant

The new interlocking plant at Odense, put into service in May 1954, has only one interlocking machine which is contained in the building shown in fig. 1. Thus all train and shunting movements are controlled from this building. The plant comprises:

25 dwarf signals and exit signals on platforms
17 speed, numerical and alphabetical signals
71 train routes
5 shunting routes
76 centrally controlled points
76 track circuits
35 local switches for centrally controlled points

As is seen from the lay-out in fig. 2, the number of dwarf and exit signals is quite large, their primary purpose being to prevent shunting on to train routes. Only signals G2, G3 and E govern shunting routes proper. When the remaining signals are used for shunting work, they show the aspects "stop" and "shunting movements permitted".

Operation of Control Panel

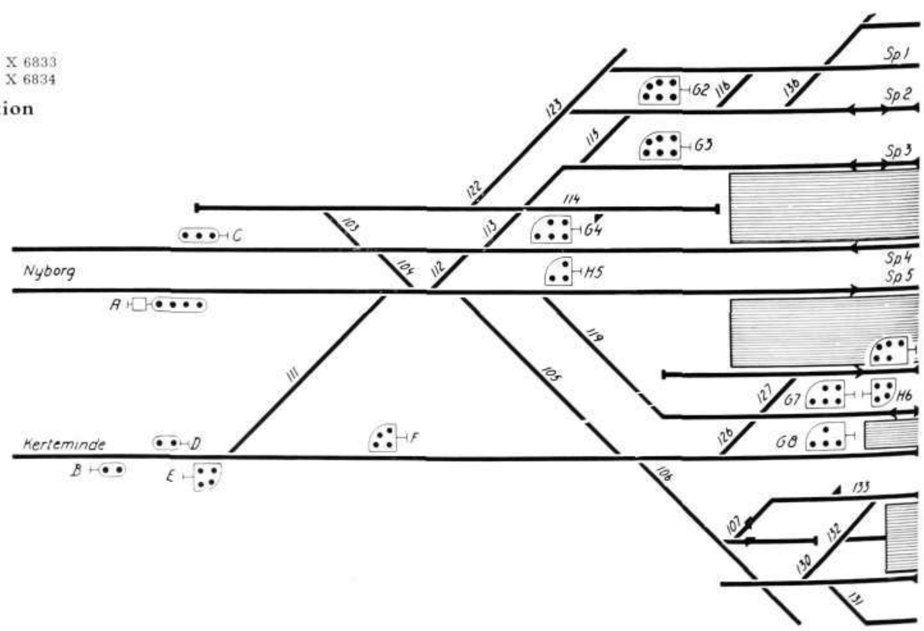
The main features of the control panel shown in fig. 3 are that all switches for points, routes and signals are placed on the track diagram and that they are correctly placed "geographically" in relation to the tracks. The control panel with track diagram is 2½ metres in length and is inclined at an angle of about 20° to horizontal. The white lamps on the track diagram serve to indicate both the state of the centrally controlled points and that a track circuit on a locked route is unoccupied. Red lamps indicate that a track circuit is occupied. Finally, the state of signals is indicated by lamps of the same colours as the signal lamps. The various switches are placed as close as possible to the corresponding lamps in the track diagram, so that the signalman can, in fact, not fail to observe the lamps which indicate the correctness or advisability of performing an operation immediately prior to its being carried into effect. All switching operations are done by means of non-locking push buttons which only need to be depressed momentarily — less than one second.

Point Operation

Points are operated by depressing two buttons, one of which is placed beside its particular point on the track diagram, the other being common to a group of points. The object of this two-button method of operation is to eliminate unintentional switching of points. The time at which points should be operated is indicated both acoustically by a bell and visually by the flickering of the lamp corresponding to the new position of the point. The completion of the operation is indicated by the bell ringing a second time and by the lamp

X 6833
X 6834

Fig. 2
Schematic lay-out of Odense Station



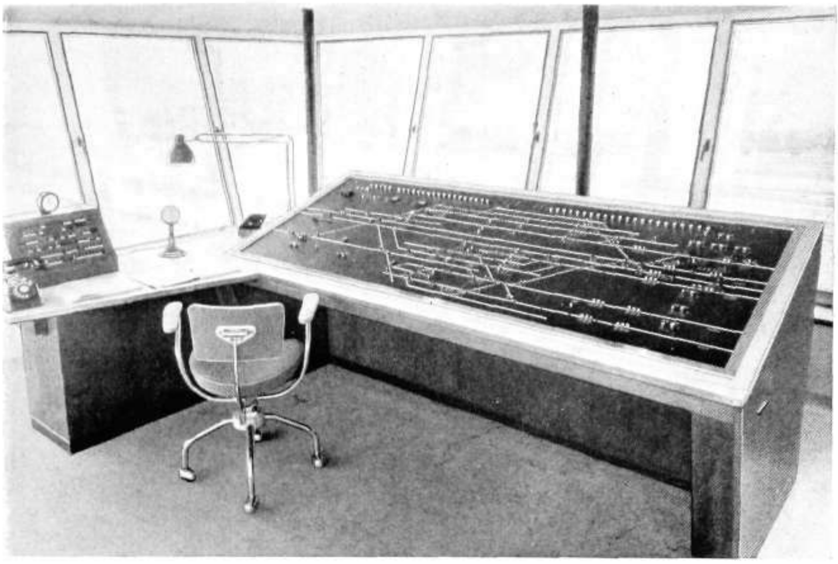


Fig. 3 X 6831

Control panel

On the left is seen the telephone switchboard and loudspeaker microphone

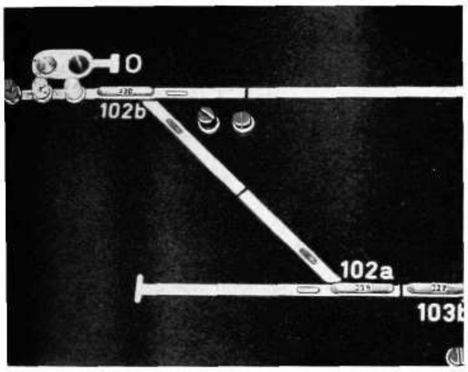


Fig. 4 X 4987

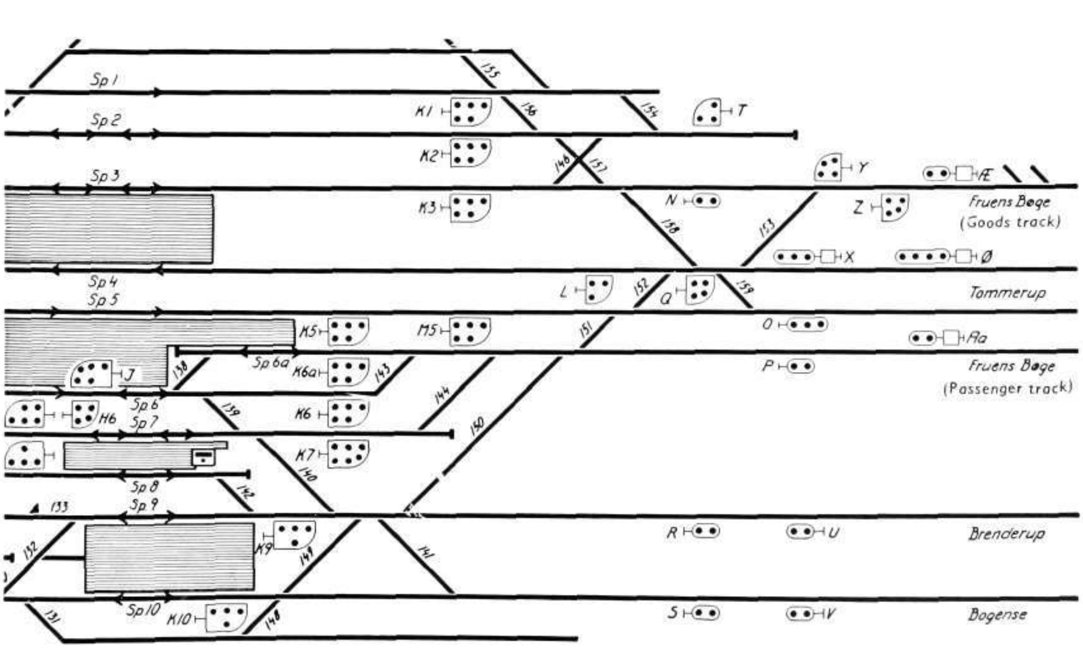
Section of control panel

for the new position of the point remaining continuously alight. The button is used for switching points in both directions. Every point, moreover, is represented by a lamp which is normally extinguished, but can show a red or white light. If the track circuit at the point is occupied, the red lamp lights to warn the signalman not to operate the point. The white lamp lights when the point is in a locked route, the lamp then also serving to indicate that the track circuit at the point is occupied.

To provide for shunting movements and to facilitate the removal of snow from the points, some points have local switching arrangements. The change-over to local operation is done by turning a button (black with white stripe), which is placed beside the ordinary point push-button on the track diagram. Before local operation can take place, any dwarf signals in the group of points must be set to "shunting movements permitted".

Since it may happen, that a point does not fully switch over, especially when operated locally, and that the operator fails to notice the fact, every point is supplied with a time relay which automatically breaks the motor current if the operation is not completed within a time of 15—20 secs.

If the relay of a point's track circuit remains deenergized, the point can nevertheless be operated by depressing a special sealed button (blue with white



stripe) placed beside the point on the track diagram. The operation of the points is now effected by depressing the individual point push-button in the ordinary way, but this time in association with another button common to a group of points. In this way the staff are reminded that special precautions must be taken every time point-operation of this kind takes place, and a counter records the number of times that such point-operation occurs.

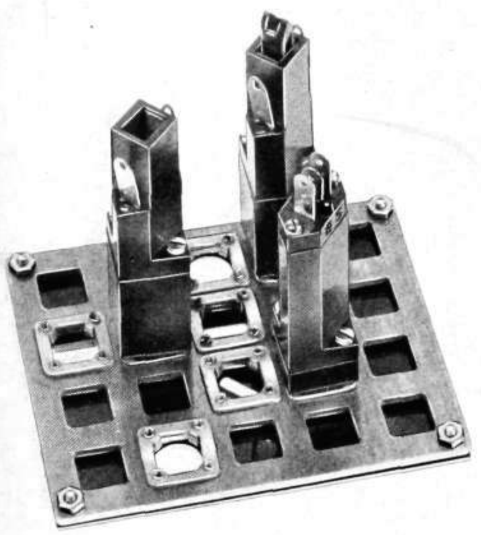


Fig. 5 X 4986

Press-buttons and indication lamps are mounted in identical fittings on a perforated aluminium plate forming the base of the control panel.

Train Routes

After the points concerned have been laid in the correct position for the route of the train, a signal button (yellow) is depressed on the line track in approach of the respective signal, and also a route button (green) on the platform track. By this means the relay system locks the points on that particular route. The condition is indicated on the track diagram by the lighting of the white lamps of the track circuits. The relay equipment thereupon investigates whether the route is unoccupied. If it is, the "proceed" signal appears.

When the train has entered the station, the route is released in the normal manner after the signalman has indicated that he has observed the train's rear end signal by momentarily depressing a red stop button beside the signal on the track diagram. This operation is not performed for outgoing trains, nor for incoming trains from lines that are equipped with automatic blocks.

Shunting Route

It is intended that shunting routes shall be arranged in order to facilitate the constant shunting movements that occur at some stations and to carry them out with the greatest amount of safety. At Odense, however, there is little need of such arrangements. A shunting route is locked by the simultaneous operation of a yellow signal button beside the appropriate dwarf or exit signal and of a route button at the end point of the route. When the cut passes a track circuit immediately after the signal, the signal automatically switches to "stop". The points in the route are automatically and successively unlocked as the train passes. Unlocking can also be effected by hand by simultaneous pressing of buttons at the beginning and end of the route.

At stations where more extensive shunting takes place than at Odense it is intended that longer marshalling tracks shall be established by joining together a number of shorter tracks.

Automatic Blocks

Until the automatic block installations are brought into service on the Odense—Marslev and Odense—Holmstrup sections, manual blocks are being used on those sections. These manual blocks are specially designed to the replacement of the ordinary block apparatus at Odense by combinations of relays, and the block controls and indication lamps have been placed on the track diagram. This gives signalmen a much better control of train movements than they had previously. At the other stations on the section the normal blocks have been preserved unmodified.

Design of Interlocking Equipment

The track diagram is mounted on a perforated plate on which push-buttons and lamps are secured in fittings as shown in fig. 5. The plate is covered by a multilayer insulating material in which the track system is engraved, with tracks and lamp symbols in white on a black background. The control panel is divided into sections. A bunch of max. 200 wires are connected to each section. There is no direct connection between sections. At the rear are cable boxes and terminal boards. Each of the bunches of wires is taken to a terminal board and to one or two cable boxes. The terminal boards are connected both to one another and to the cable boxes of the other sections.

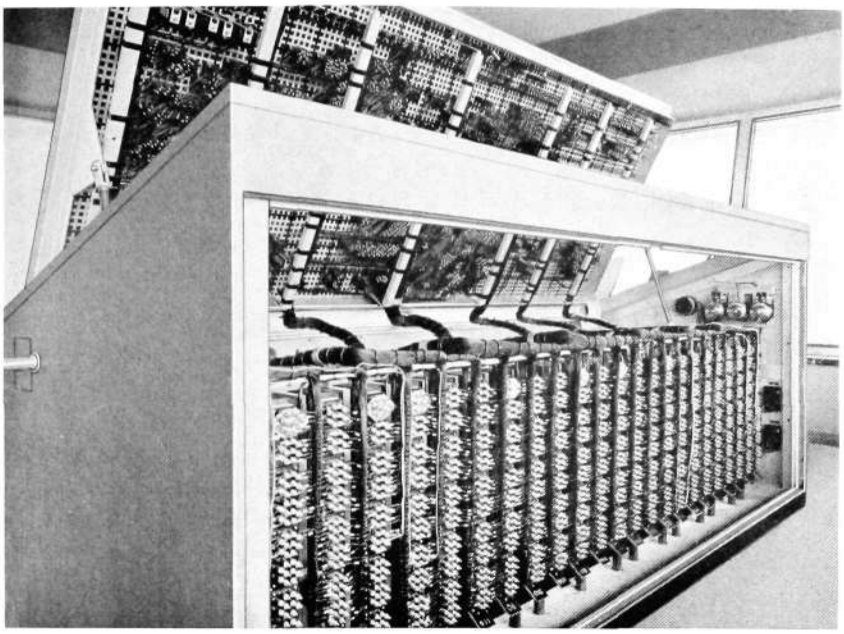


Fig. 6 X 6830

Rear view of control panel

The entire control panel can be wound up into the vertical position by means of a crank acting upon a horizontal shaft

The push-buttons have only one transfer contact, and the contact system is entirely enclosed. The buttons may be of the locking or non-locking type, and different colours and engravings can be arranged.

The control panel rotates about a horizontal shaft running along its front edge. Gearing arrangements are employed for erecting it into the vertical position, fig. 6.

The Relay Racks

The relays are mounted in six racks in a separate room, fig. 7. All relays with the exception of the track circuit relays and certain feed relays are placed in groups, the relays that operate and control the points forming one group and those that operate and control signals another group, and so on.

Every group is built up in six rows, one above the other. The top row, No 0, contains fuses, negative terminals and resistances. Each of the other groups, Nos. 1—15, has two positions in which a relay, resistances or negative terminals can be accommodated. The cable boxes are placed underneath the racks. The Odense interlocking plant comprises some 1 000 relays with about 7 500 contacts, of which roughly 60 % are used. The internal wiring between the various units of the plant is, in round figures, 50 000 metres in length.

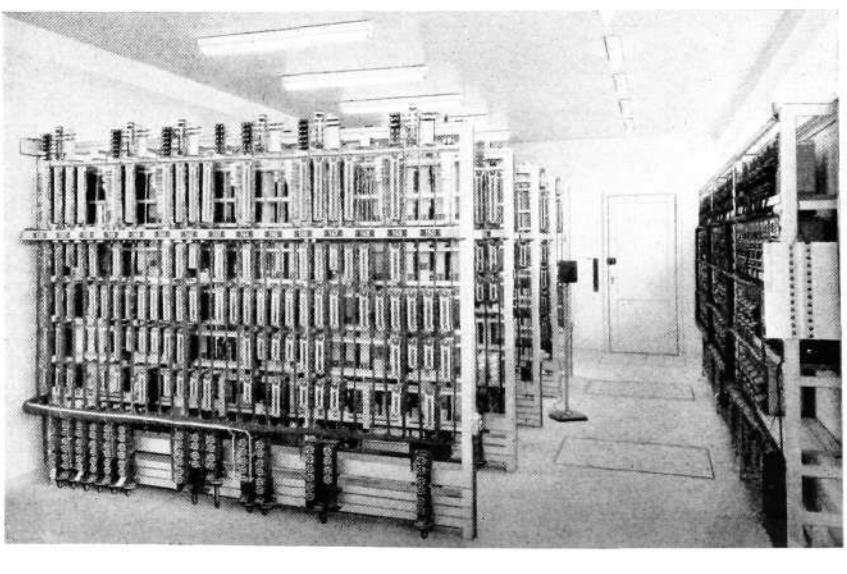


Fig. 7 X 6832

The relay room

(Right.) Track relays, (left) two racks with point relays and three with signal relays.

Modern Long Life Electron Tubes for Telephony Purposes — Some Experience of Life Tests

S EDSMAN & G LAGERHOLM, AB SVENSKA ELEKTRONRÖR, STOCKHOLM

U.D.C. 621.385.1:621.395

Ericsson Review No 2, 1954, contained a brief account of the electron tubes manufactured by S. E. R. The present article reports the results of life tests carried out on long life tubes 18J6 (6J6L), 403B (18AK5) and 404A.

At the request of L M Ericsson's Transmission Department a number of tube types were developed for use in new carrier systems employing coaxial cables. As the systems required large numbers of tubes, the need of reliability over long periods was even greater than previously. A few types of standard tubes with the appropriate data were selected from the standard tube series (6J6, 6AK5 and 6AQ5) and were subjected to every improvement which might increase their reliability. It was decided from the start that the operating conditions should be made as favourable as possible. The heater voltages were stabilized, the heaters parallel-connected, the grid bias was obtained by cathode resistor, and the mechanical and thermal wear on the tubes was reduced by avoiding vibration and on-off operation. The heater power was brought down to such low values that an undervoltage of max. 5 % could be tolerated without jeopardizing operation. This measure in itself affords a greatly increased life: tests made on 18AK5 showed that a 10 % increase in heater voltage may shorten the life to half or even one third.

The lowered cathode temperature is, however, attended by two disadvantages. Firstly, it is more difficult to manufacture tubes with the cathode activity required to maintain the transconductance within given limits; secondly, the interface resistance formed between the cathode coating and the nickel sleeve is greatly heightened. The interface is created by reaction between the barium oxide in the emission paste and the silicon in the nickel of the cathode. It is essential that the silicon content shall not exceed 0.01 % if this latter cause of error is to be eliminated. In tube type 18AK5 (403B) this represents 0.000002 gm. silicon in a cathode sleeve. The large scale production of cathode sleeves with this low silicon content was successfully commenced some five years ago, and the material was tried out by S. E. R. in tube type 18J6 (6J6L).

Curve *a* of fig 1 shows the change in transconductance with time in a group of tubes with cathode sleeves made of the material used previously. This material, Inco 220, containing a maximum of 0.10 % magnesium and max. 0.05 % silicon, has been employed by many manufacturers of long

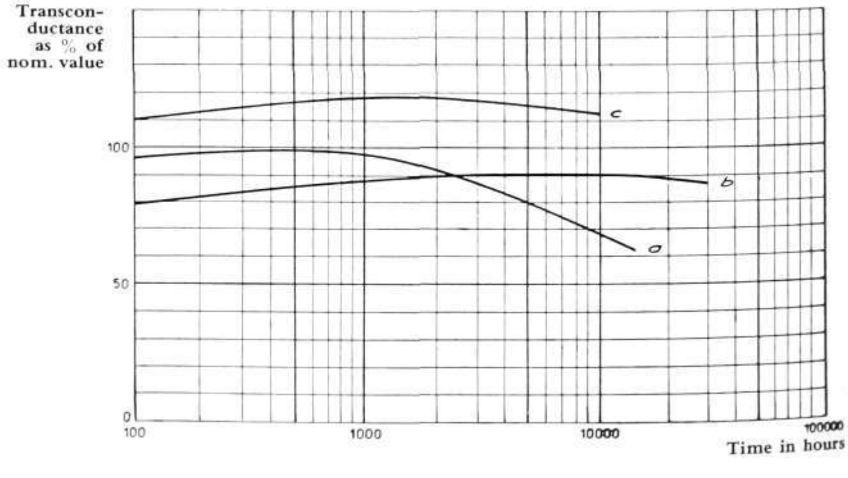


Fig. 1 X 6910

Life of 18J6 (6J6L)

a Cathode of INCO 220, mean of 10 tube systems

b Cathode of DH 499, mean of 10 tube systems

c Cathode of DH 499, grid redesigned for higher nominal transconductance, mean of 96 tube systems. (After 10 000 hours 100 % of the tubes are still within the functional limits.)

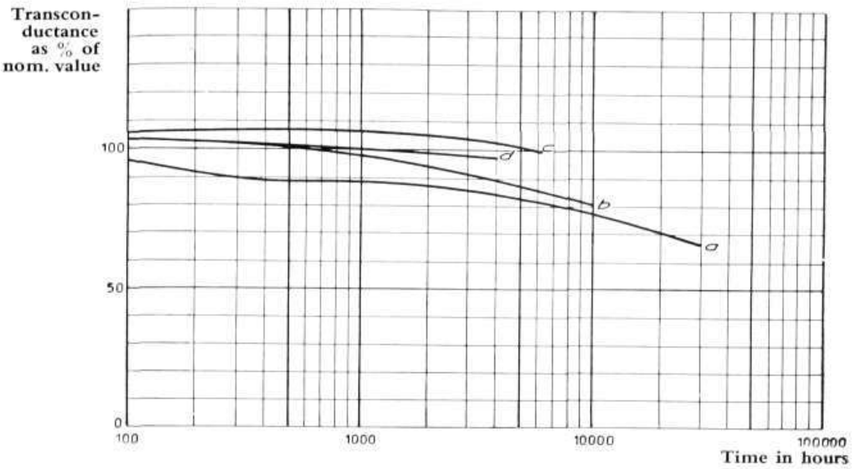


Fig. 2 X 6909

Life of 403B (18AK5)

a Cathode of INCO 220, mean of 5 tubes
b Cathode of INCO 220, mean of 48 tubes
c Cathode of DH 499, redesigned grid, mean of 48 tubes
d Cathode of DH 499, redesigned grid, mean of 48 tubes, later production

life tubes, and is still being used in some places. The decline in transconductance in these tubes is due to two phenomena, one being that the silicon content is sufficiently high to give an extra cathode resistance in the interface layer referred to above, the second that the magnesium content is reduced by evaporation, so lowering the cathode activity. The magnesium sublimes on the mica and glass base and may at times cause faults in the insulation.

Curve *b* in fig 1 shows the behaviour of tubes with the so-called passive nickel DH 499 (containing max. 0.01 % silicon and max. 0.01 % magnesium). It is seen that, to start with, the transconductance is very low, reaches a maximum after 5 000—10 000 hours and then slowly falls again. A simultaneous test was carried out to determine whether interface would form as described above. This test was made on 18J6, which is a double triode with common cathode for the two systems. One system had normal plate current throughout, and the other no plate current. A greater interface resistance is obtained with the latter mode of operation, and the difference in transconductance between the two systems in the same tube will therefore indicate whether the interface has been formed or not. No difference between the systems has been found after 35 000 hours (about 4 ½ years) and, moreover, as the transconductance has only changed to an insignificant degree, the cathode material may be considered proof against the phenomenon of interface at the cathode temperature employed. This is also confirmed by qualitative measurements made by pulsing technique.

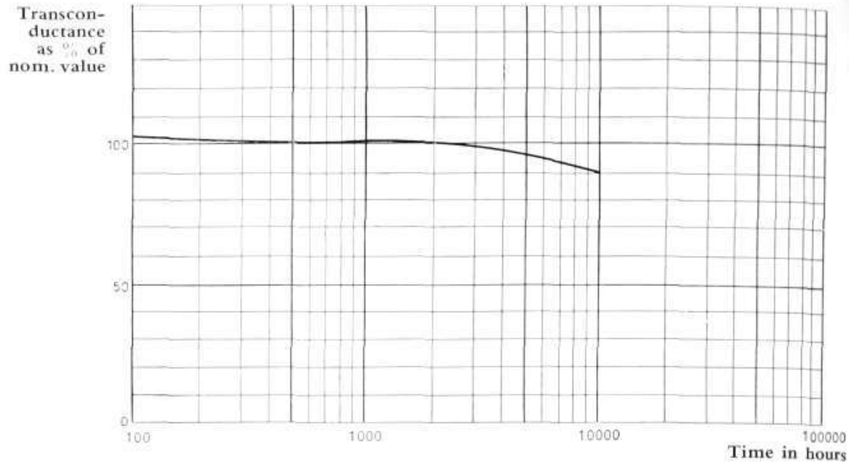
Since such good results were found with batch *b* in fig 1, S. E. R. decided to redesign their long life tubes. This passive nickel was now adopted as cathode material. But the time required for activation usually proved too long at the low cathode temperature employed. If large scale production of long life tubes was to be possible, the activation time must be reduced from the thousands of hours, shown by curve *b* in fig 1, to below 48 hours. This problem is simplified by, among other measures, constructing the control grid with a smaller diameter of lateral wire (about 70 % of the normal). The transconductance can then be kept within the tolerance limits with lower cathode activity, which makes is easier to attain the initial data and means that the transconductance can be kept constant for longer periods of service. The cathode current will also be more uniform over the whole surface. The result of these changes including, in the case of 18J6, an increase in the nominal transconductance by decreasing the distance between grid and cathode, is shown in curve *c* of fig 1.

Indentical changes were later made in the construction of 403B (18AK5). In this case very much greater manufacturing problems were involved in adapting the tube to passive nickel cathode, among other things, the grid lateral wire had to be reduced from 0.025 mm diameter to 0.018 mm, which gives a tensile strength of only about 75 gm. Fig 2 shows the results of tests in progress: a) and b) with active cathode material INCO 220, c) and d) each comprising two different life tests on 48 tubes with passive nickel

Fig. 3 X 6908

Life of 404 A

The cathode material was from the start DH 499, so that experience of passive nickel alone is available



DH 499. None of these tubes has fallen below the end of life point (65 % of nominal transconductance) after 6 000 and 4 000 hours respectively.

Fig 3 shows the life curve of the broad band tube 404A, which may be considered a fairly advanced construction since the specific cathode current must be high to obtain good broad band properties. The grid lateral wire, however, which in this case is only 8 μ in diameter, provides an even distribution of cathode current over the whole surface, and the life tests now in progress show that the life of the tube is comparable to that of 403B.

Reliability is not solely dependent on the change in transconductance with time, since it may be affected by sudden faults such as shorts, opens, defective vacuum caused by a crack in the glass bulb, and so on. These faults must be precluded by appropriate design, good materials, strict control over all processing and, finally, strict microscopic control of complete mounts and of the finished tubes. A further reduction in the early failures is attained by a comparatively long activation—stabilization time, since the failure rate is always highest during the first few days.

Fig 4 shows how the number of tubes diminishes as a result of the data falling outside the functional limits or of sudden faults developing of the kind outlined above. After a certain time this curve should tend to become a straight line, and the mean life is obtained by extrapolating the line to 37 % $\left(\frac{1}{e}\right)$. No such tendency is noticable after 15 000 hours, and extrapolation is therefore impossible.

The first portion of the curve represents the sudden faults, and it is quite natural that they should be roughly identical for similar types of tube. It has been found experimentally that, within the limits of measuring error, the curves of 18AK5, 403B and 18J6 are identical. After 10 000 hours 93 percent of the tubes were still serviceable.

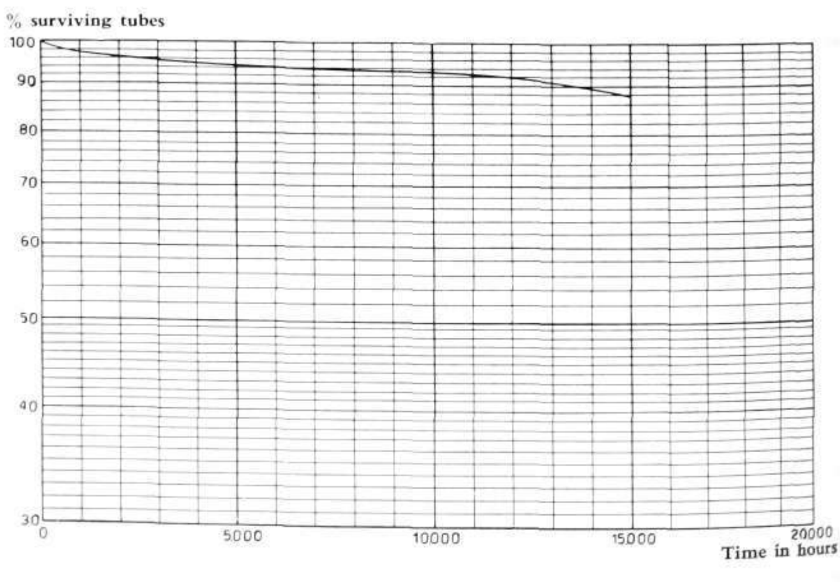


Fig. 4 X 6907

Mortality curve

Due to lack of space in the test equipment the number of tubes was reduced by random removal of serviceable tubes at certain intervals. The number of tubes was reduced in this way from 175 during the first 5 000 hours to 30 at 15 000 hours

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

Fully-Automatic Telephone Traffic Stockholm—Göteborg

With the opening of full-automatic telephone traffic between Stockholm and Gothenburg, which took place in two stages—for calls to Gothenburg in the middle of October and in the opposite direction a month later—the foundations of automatic trunk switching in Sweden have been laid. Apart from the Stockholm central area, other areas to be included in the automatization were Södertälje and some of the groups in the vicinity of Stockholm such as Nynäshamn, Sigtuna, Vaxholm, Värmdö. The automatic connection to Gothenburg from the latter exchanges passes through the full-automatic tandem exchange in Stockholm that has been recently delivered by L M Ericsson.

The introduction of automatic switching between Sweden's two largest cities has, of course, been preceded by very extensive preparatory work which has been carried through in coordination between the Telecommunications Administration and L M Ericsson. Stockholm's second trunk exchange was thus constructed by L M Ericsson with an initial capacity of 750 full-automatic lines. Of these, 300 have been allocated to the traffic between Stockholm and Gothenburg. Calls pass through the coaxial cable plant uniting the two cities, which was opened to traffic at the beginning of 1952 and for which L M Ericsson has supplied certain equipment.

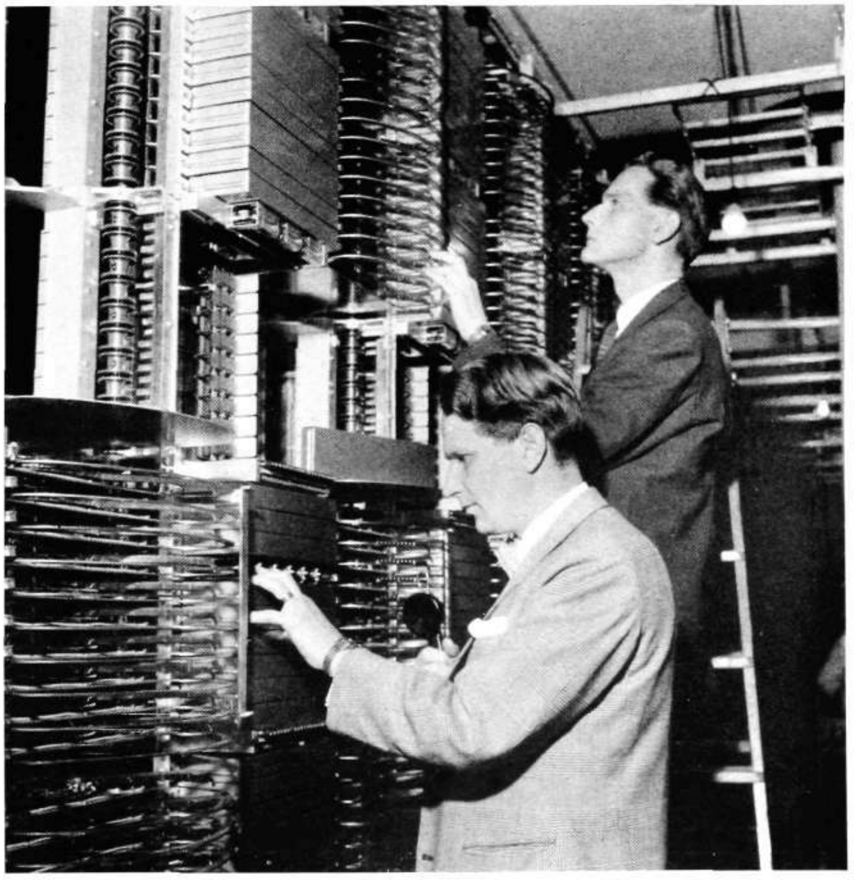
Since the introduction of full-automatic switching, a call between Stockholm and Gothenburg is established in only a few seconds—the distance between the two towns being about 500 kilometres. All the subscriber need do is to deal a routing code, await dial tone and then dial the number he wants.

Another great benefit to subscribers is that automatization has made it possible to lower the charge for calls between the two cities. As the charging of automatic calls is now done by ten-second metering on the calling subscribers meter, the charge is also very much more closely representative of the actual calling time than under the previous method when calls were charged on the basis of commenced three-minute period.

About 5 000 calls were made from Stockholm to Gothenburg on the opening day. The system functioned from the start without a hitch in spite of the traffic that day being about 15 % greater than anticipated.

On the occasion of the completion of automatic-switching between Stockholm and Gothenburg, it might be of interest to think back to the state of affairs when the Telecommunications Administration opened trunk traffic between the two cities in August 1889. At that time there were no two-wire subscriber lines in Stockholm or Gothenburg. If calls on the long two-wire trunk line were to get through satisfactorily, however, the local lines that connected to the trunk line must also be two-wire. The Telecommunications Administration therefore installed ten calling offices with two-wire lines in different parts of Stockholm, from which trunk calls to and from Stockholm had to be made. This arrangement was, of course, extremely troublesome, especially in the case of incoming calls, since the wanted person had to be summoned by one means or another to the nearest calling office to receive the call there.

The photograph shows an interior view of the Stockholm trunk exchange during the testing of the equipment for automatic telephone traffic with Gothenburg. In the foreground is Mr. G Hanses, head of L M Ericsson's Installation Department in Stockholm, and his assistant, Mr. A Svensson.



Sweden's Largest Mobile Telephone Exchange

In cooperation with the Swedish Defence Staff L M Ericsson has constructed the telephone system for the probably largest mobile telephone exchange in Sweden. With a capacity of 600 lines, the system is designed for military use, being entirely contained in a bus constructed specially for the purpose. The bus is to be used chiefly for the training of telephone operators to serve at stationary telephone exchanges in time of war, but it is also anticipated that it may be used at large military staff headquarters.

The exchange differs from its known predecessors in that the whole exchange is contained in a single vehicle. Earlier exchanges of this type have been split between bus and trailer, with switch board and relay equipment in the bus and main distribution frame, multiple and power plant in the trailer. This arrangement naturally involved a very complicated cabling problem, which is completely overcome in the present construction.

Connection can be obtained to all types of Swedish public exchange, so that calls can be made to any part of the country from the mobile exchange. Lines run to public telephone exchanges, military switchboards and stations, usually located in adjacent buildings, air raid shelters etc.

The exchange is designed to operate on all kinds of alternating current supply. In case current should for any reason be unobtainable from the public mains, the bus is equipped with an emergency power plant which charges the battery.

The switchboard equipment occupies two-thirds of the total space in the bus. Plastic-insulated cables are used throughout, which greatly reduces the weight.

The furnishings are completely modern with recessed neon lighting in the ceiling, and the visible parts of walls and ceiling painted in bright colours. The ceiling height is about 190 cm.

New Sales Office in Santiago

L M Ericsson's sales company in Santiago, Compañía Ericsson de Chile, has recently carried out extensive alterations to their sales offices. The adjoining photograph was taken through one of the display windows and shows a section of the premises, which also comprises spacious show rooms.

From the Visitors' Book

A delegation of Italian telephone experts, headed by Sr. Felice Calvanese, Director of the state-owned Company ASST (Azienda di Stato Servizi Telefonici) which operates the trunk services of the country, recently paid a visit to Sweden and to the L M Ericsson plant at Midsommarkransen. In the photograph are seen, from left to right, Dr Giovanni Verlecchi, Mr. Sven Ture Åberg, President of L M Ericsson, Professor Scipione Treves and Sres. Calvanese and Furio Vallese.

A visitor from afar was Mr. S Osmena, Governor of the Island of Cebu in the Philippines. He is seen in the company of his Swedish host, the shipowner Dan Göte Broström.

A ten-man delegation from English Workers' Education paid a visit to AB Alpha, Sundbyberg, in the course of their fortnight's tour of Sweden. Some of the English visitors are seen below watching the grinding of frames for fork jacks.

The Lord Mayor of London, Sir Noel Vansittart Bowater, accompanied by his wife, Lady Constance, took the opportunity during their short stay in Stockholm of visiting L M Ericsson's head factory. (Below right.)

XY-friend from USA visits L M Ericsson

Mr. Harry H. Bates, head of Dixon Home Telephone Co. of Dixon, Illinois, recently paid a visit to the Midsommarkransen factory. Mr. Bates was one of the earliest customers in USA for L M Ericsson's XY system, and up to now he has purchased XY equipment, manufactured in USA., to a value of over 2 million dollars. His telephone company serves some 9 000 subscribers.

Mr. Bates related that he first came into contact with the XY system in Mexico City and that from the start he has had none but the best experience of the system which has purchasers in nearly every town in USA. In his home town, Dixon, there are more telephones per head of population than in any other American town. Mr. Bates ascribes this fact to the first class service offered to subscribers by the staff of his company.

Mr. Bates, who is a man with exceptionally wide experience of telephony, has visited telephone companies in different parts of Europe, but his main interest he found in L M Ericsson. Mr. Bates especially enjoyed his time in the firm's show room examining the instruments dating back to the birth of the telephone.

C.T.C. on Scandinavian Railways

C.T.C. stands for Centralized Traffic Control, which means that all train movements on a section are controlled entirely by signals operated from a central interlocking plant common to the section.

C.T.C. is now to be introduced on the Swedish and Danish Railways—in Sweden on the single track section Ånge—Bräcke, in Denmark on the double track section Nyborg—Holmstrup on the island of Fyn. It is expected that several advantages will be gained from the introduction of C.T.C. Station staffs can be reduced or entirely eliminated, the track system can be utilized more effectively and, finally, there is an increase in safety.

L M Ericssons Signalbolag this summer received an order for the remote control plant for the Swedish system, and later for a similar plant for the Danish system as well.

There is reason to suppose that these first C.T.C. plants on the Swedish and Danish Railways will soon be followed by others as a step in the process of mechanization.

Large Exposure-Clock for Sun Photography

On June 30th this year the much advertised total eclipse of the sun took place, being visible within a nearly 100-mile belt across the south of Sweden. A number of expeditions were at work during the eclipse—not only Swedish, but from Britain, France, Spain, Italy, Switzerland, Germany, USA and other countries as well contingents came to Sweden to study the phenomenon.

For the expedition sent out by the Stockholm Observatory to Löttorp in the north of Öland under the leadership of Professor Yngve Öhman, L M Ericsson had made a clock with an internally illuminated 600 mm dial with second and minute hands. The clock was used for the determination of exposure times and exposure intervals during the total eclipse, which lasted 2 ½ minutes—undoubtedly the shortest time of use so large a clock has ever had.

The photograph shows Professor Öhman (behind the clock) demonstrating the clock to a group including Håkan Sterky, Director General of the Telecommunications Administration.

U.D.C. 621.395.343.004.5

OHRLING, G G & ERIKSSON, H: *Maintenance work and reliability for automatic telephone exchanges with the L M Ericsson 500-line selector in Stockholm.* Ericsson Rev. *31* (1954) No. 3 pp. 70—78.

The article which was published in the Telecommunications Administration journal TELE No. 2, 1954, describes the organization and extent of maintenance done at automatic telephone exchanges with L M Ericsson's 500-line selectors in Stockholm. The article ends with a comparative account of the reliability at Stockholm's inner exchanges at different periods.

U.D.C. 621.395.743: 621.315.67

SIDENMARK, N: *Distribution System with Through-Connected Basic Load.* Ericsson Rev. *31* (1954) No. 3 pp. 79—82.

In Ericsson Review No. 2, 1947, a description was made of a new distribution system with through-connected basic load as applied to urban telephone networks. Subsequent experiences have proved that the principle of through-connection may have been carried too far, and the through-connection system has, therefore, been modified to a certain extent. In the following paper a short description will be given of such a modified system.

U.D.C. 621.318.5: 621.395.65

WIBERG, E A: *The Multicoil Relay — a New Switching Device.* Ericsson Rev. *31* (1954) No. 3 pp. 83—85.

The multicoil relay RAM 100, the new switching device described in this article, has been designed to replace a number of simple relays in certain multi-wire circuits. Thus the multicoil relay eliminates the complicated labour and heavy costs involved in multiple wiring. Furthermore, the relay saves space and makes for simplification of equipment.

U.D.C. 681.175.9: 351.754.21

AHLBERG, F: *The L M Ericsson Parking Meter.* Ericsson Rev. *31* (1954) No. 3 pp. 86—88.

A new type of parking meter has been designed by Division ERGA of Telefonaktiebolaget L M Ericsson. In the course of the development attention has been paid to specific Scandinavian requirements and requests which have been raised from time to time.

U.D.C. 656.257

WESSEL-HANSEN, W: *All-Relay Interlocking Plant for Danish State Railways.* Ericsson Rev. *31* (1954) No. 3 pp. 89—93.

Preliminary tests of all-relay interlocking plants were undertaken by the Danish State Railways in 1948. These tests were successful from the start. A rapid development in relay interlocking plants took place in the next few years, and the Danish State Railways now build no other types. The largest interlocking plant hitherto built in Denmark — and, in fact, in Scandinavia — is that at Odense, which was brought into service in May 1954. It is specially designed for operation in a CTC system to extend from Fredericia to Nyborg, that is to say right across the island of Fyn.

U.D.C. 621.358.1: 621.395

EDSMAN, S & LAGERHOLM G: *Modern Long Life Electron Tubes for Telephony Purposes — Some Experience of Life Tests.* Ericsson Rev. *31* (1954) No. 3 pp. 94—96.

Ericsson Review No. 2, 1954, contained a brief account of the electron tubes manufactured by S. E. R. The present article reports the results of life tests carried out on long life tubes 18J6 (6J6L), 403B (18AK5) and 404A.

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Norge

A/S Elektrisk Bureau *Oslo*, P. B. Mj 2214, tel: Centralbord 46 18 20, tgm: elektriken-oslo

A/S Industrikontroll *Oslo*, Teatergaten 12, tel: Centralbord 33 50 85, tgm: indtroll-oslo

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

Portugal

Sociedade Ericsson de Portugal, Lda. *Lisboa* 7, Rua Filipe Folque, tel: (PPC-2 Linhas) 57193, tgm: ericsson-lisboa

Schweiz

Ericsson Telephone Sales Corp. AB, Stockholm, Zweigniederlassung Zürich *Zürich*, Stampfenbachstrasse 63, tel: 051-26 00 80, tgm: telericsson-zürich

Suomi

O/Y L M Ericsson A/B *Helsinki*, Fabianinkatu 6, tel: A 8282, tgm: ericssons-helsinki

Sverige

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

AB Alpha *Sundbyberg*, tel: 28 26 00, tgm: aktiealpha-stockholm

AB Ermex *Solna*, tel: 27 27 25, tgm: elock-stockholm

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

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

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

L M Ericssons Svenska Försäljningsaktiebolag *Stockholm*, Kungsgatan 33, tel: 22 31 00, tgm: ellem-stockholm

L M Ericssons Mätinstrumentaktiebolag *Ulvsunda*, tel: 26 26 00, tgm: elmix-stockholm

L M Ericssons Signalaktiebolag *Stockholm 9*, tel: 19 01 20, tgm: signalbolaget-stockholm

Mexikanska Telefonaktiebolaget Ericsson *Stockholm 32*, tel: 19 00 00, tgm: mexikan-stockholm

Sieverts Kabelverk *Sundbyberg*, tel: 28 28 60, tgm: sievertsfabrik-stockholm

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

• ASIA •

India

Ericsson Telephone Sales Corporation AB *Calcutta*, P. O. B. 2324, reg. mail: *Calcutta 22*, 5 Commissariat Road, P. O. Hastings, tel: Alipore 2951/2952, tgm: inderic-calcutta

New Delhi, 45, Indra Palace, Connaught Place, tel: 444 90, tgm: inderic-newdelhi

Indonesia

Ericsson Telephone Sales Corporation AB *Bandung*, Djalan Dago

javeric—

Liban

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

Türkiye

Ericsson Türk Ltd. Şirketi *Ankara*, Âdil Han, Safer Meydani, Yenisehir, tel: 28379, tgm: ellem-ankara

• AMERICA •

Argentina

Cía Sudamericana de Teléfonos L M Ericsson S. A. *Buenos Aires*, Belgrano 894, tel: 332071, tgm: ericsson-buenosaires

Corp. Sudamericana de Teléfonos y Telégrafos S. A. *Buenos Aires*, Belgrano 894, tel: 332071, tgm: cartefe-buenosaires

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

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

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

Industrias Eléctricas de Quilmes S. A. *Quilmes FCNGR*, Eva Perón 1090, tel: 203-2775, tgm: indelqui-buenosaires

Brasil

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

São Paulo C. P. 5677, tgm: ericsson-saopaulo

Empresa Sul Americana de Telefones S. A. *Rio de Janeiro*, C. P. 4684, tel: 43-0990, tgm: emsulatel-riodejaneiro

Canada

Ericsson Telephone Sales of Canada Ltd, *Montreal 2, Quebec*, Castle Building, 1410 Stanley Street, tel: AVenue 8-8169, tgm: caneric-montreal

Toronto, 18, Ontario, P.O.B. 161, tel: BElmont 1-1306

Cía Ericsson de Chile S. A. *Santiago*, Casilla 10143, tel: 82555, tgm: ericsson-santiagodechile

Colombia

Cía Ericsson Ltda. *Bogotá*, Apartado Aéreo 4052, tel: 11-100, tgm: ericsson-bogotá

México

Cía Comercial Ericsson S. A. *México D. F.*, Apartado 9958, tel: 18-12-14, tgm: coeric-mexicocity

Teléfonos de México S. A. *México D. F.*, Paseo de la Reforma 107 Bis, tel: 21-91-00, tgm: telmex-mexicocity

Perú

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

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

United States of America

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

The North Electric Mfg. Co. *Galion, Ohio*, 501, South Market Street, tel: 24201, tgm: northphone-galionohio

Uruguay

Cía Ericsson S. A. *Montevideo*, Uruguay 1258, tel: 844 33, tgm: ericsson-montevideo

Venezuela

Cía Anónima Ericsson *Caracas*, Apartado 3548, tel: 57467, tgm: ericsson-caracas

Teléfonos Ericsson C.A. *Caracas*, Apartado 3548, tel: 57467, tgm: ericsson-caracas

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L M Ericsson Telephone Co. Pty. Ltd. *Melbourne C 1 (Victoria)*, Kelvin Hall, 55 Collins Place, tel: Cen. 5646, tgm: ericmel-melbourne

Agencies

• EUROPE •

Belgique

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

Grèce

»ETEP», S. A. Commerciale & Technique *Athènes*, 41 Rue W. Churchill, tel: 31 211, tgm: aeter-athenes

Ireland

E. C. Handcock, Ltd. *Dublin, C 5*, Handcock House, 17 Fleet Street, tel: 76 534, tgm: forward-dublin

Island

Johan Rönning H/F *Reykjavik*, P. O. B. 883, tel: 4320, tgm: rönning-reykjavik

Schweiz

RIBAG — L M Ericsson Generalvertretung *Basel 9*, Türkheimerstrasse 48, tel: (061) 38925, tgm: ribag-basel

Österreich

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

• ASIA •

Burma

Vulcan Trading Co. Ltd. *Rangoon*, P. O. B. 581, tel: S. 878, tgm: suecia-rangoon

China

The Ekman Foreign Agencies Ltd. *Shanghai*, P. O. B. 855, tel: 16242-3, tgm: ekmans-shanghai

Hongkong

The Swedish Trading Co. Ltd. *Hongkong*, Prince's Building, Ice House Street, tel: 20 171, tgm: swedetrade-hongkong

Indochine (Viet-Nam)

Compagnie Internationale de Commerce *Saigon*, P. O. B. 204, tel: 20253, tgm: intercom-saigon

Iran

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

Iraq

Swedish Oriental Company AB *Baghdad*, Mustansir Street, 5 A/38, tel: 848 19, tgm: swede-orient-baghdad

Israel

Jos. Muller, A. & M. *Haifa*, P.O.B. 243, tel: 3160, tgm: mullerson-haifa

Japan

Gadelius Co. Ltd. *Tokyo*, Shiba Park No. 7 Minato-ku, tel: (43)-1847, tgm: goticus-tokyo

Jordan

H. L. Larsson & Sons Ltd. Levant *Amman*, P. O. B. 647, tgm: larson-hus-amman

Liban

Swedish Levant Trading *Beyrouth*, P. O. B. 931, tel: 6142, tgm: skefko-beyrouth

Malaya

Thoresen & Co. (Malaya) Ltd. *Singapore*, P. O. B. 653, tel: 6818, tgm: thoresenco-singapore

North Borneo

Thoresen & Co. (Borneo) Ltd. *Sandakan*, P. O. B. 44, tgm: thoresen-sandakan

Pakistan

Vulcan Trading Co. (Pakistan) Ltd. *Karachi City*, P. O. B. 4776, tel: 2506, tgm: vulcan-karachi

Philippines

Koppel (Philippines) Inc. *Manila, P. R.*, P. O. B. 125, tel: 3-37-53, tgm: koppelrail-manila

Saudi Arabia

Mohamed Fazil Abdullah Arab *Jeddah*, P. O. B. 39, tel: 405, tgm: arab-jeddah

Syrie

Georgiades, Moussa & Cie *Damas*, Rue Ghassan, Harika, tel: 10289, tgm: georgiades-damas

Thailand

Thoresen & Co. (Bangkok) Ltd. *Bangkok*, Radio and Electrical Appliances Dept., Thoresen Bldg, Suriwongse Road, tel: 30730, tgm: thoresen-bangkok

Türkiye

Genel Sanayi Techizati T. A. O. *Istanbul*, P. K. Galata 455, tel: 44510, tgm: telotomat-istanbul

• AFRICA •

British East Africa

Transcandia Ltd. *Nairobi, Kenya*, P. O. B. 5933, tel: 3312, tgm: transcandia-nairobi

Egypt

Swedish Industries *Cairo*, P. O. B. 1722, tel: 51408, tgm: ecoproduct-cairo

Ethiopia

Swedish Ethiopian Company *Addis Abeba*, P. O. B. 264, tel: 1447, tgm: etiocomp-addisabeba

Moçambique

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

Nigeria

Scan African Trading Co. *Yaba Lagos* 32, Commercial Avenue, tgm: swedafrica-yabalagos

Tangier

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

Union of South Africa and Rhodesia

Reunert & Lenz, Ltd. *Johannesburg*, P. O. B. 92, tel: 33-5201, tgm: rockdrill-johannesburg

• AMERICA •

Bolivia

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

Costa Rica

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

Cuba

Mc Avoy y Cía *Havana*, Apartado 2379, tel: U-2527, tgm: macavoy-havana

Curaçao N. W. I.

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

República Dominicana

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

Ecuador

Ivan Bohman & Co. *Guayaquil*, Casilla 1317, tel: Centro 208, tgm: boman-guayaquil

Guatemala

Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: 3311, tgm: nilspiraguatemala

Haïti

F. Georges Naudé *Port au Prince*, P. O. B. A 147, tel: 3075, tgm: nodeco-portauprince

Honduras

Cía de Comisiones Inter-Americana, S. A. *Tegucigalpa D. C.*, P. O. B. 114, tel: 15-63, tgm: inter-tegucigalpa

Jamaica

Morris E. Parkin *Kingston*, P. O.B. 354, tel: 4077, tgm: morrispark-kingston

Nicaragua

J. R. E. Tefel & Co. Ltd. *Managua*, Apartado 24, tel: 387-1169, tgm: tefelto-managua

Panama

Productos Mundiales, S. A. *Panama, R. P.*, P. O. B. 2017, tel: 2 2003, tgm: mundi-panama

Paraguay

H. Petersen S. R. L. *Asunción* Casilla 592, tel: 268, tgm: pargtrade-asunción. (Agent of Cía Sudamericana de Teléfonos L M Ericsson S. A. *Buenos Aires*)

El Salvador

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

Surinam

C. Kersten & Co. N. V. *Paramaribo*, P. O. B. 216, tel: 2541, tgm: kersten-paramaribo

• AUSTRALIA & OCEANIA •

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