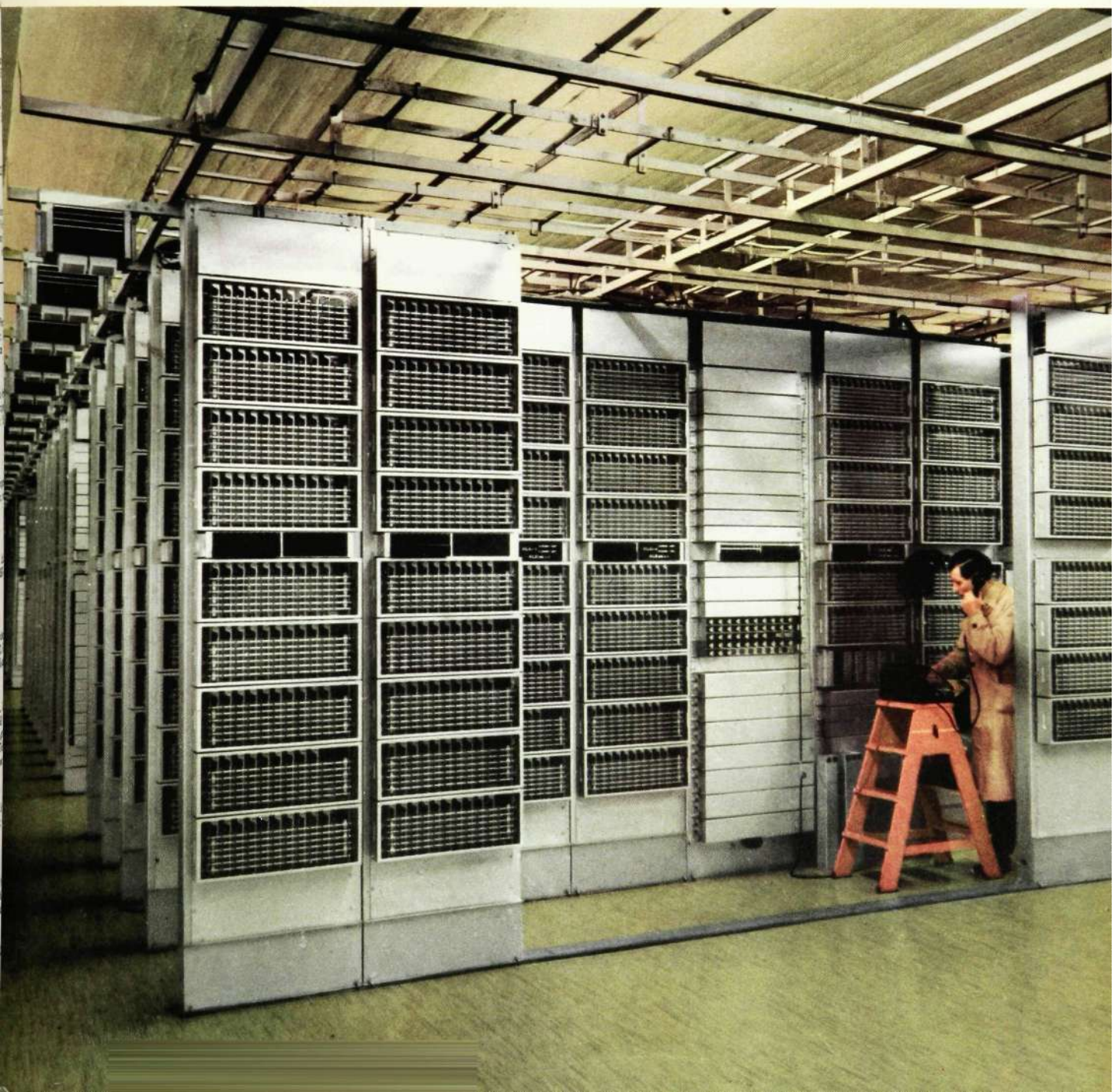


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Review



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Traffic Reliability for the L M Ericsson Crossbar System in Helsinki

B AHLSTEDT, HELSINKI TELEPHONE CORPORATION, HELSINKI

U.D.C. 621.395.364
621.395.344(471.1)

An article in Ericsson Review No. 4, 1950 outlined the fundamental construction of the crossbar system, which L M Ericsson is supplying to the Helsinki Telephone Corporation for the extension of the Helsinki telephone system. Up to now crossbar equipment for 22,800 numbers has been put into operation in Helsinki out of which 4,400 are PBX connections. The article below describes the experiences of these installations as regards traffic reliability. The author has selected the investigation results from the last twelve months from the comparatively heavily loaded PBX groups. The article also outlines the principles and methods applied by the Helsinki Telephone Corporation to determine the traffic reliability in their installations.

Definitions of Traffic Quality and Traffic Reliability

The traffic quality in automatic telephone operation is deteriorated by all such factors which in one way or another hinder the connection procedure or the speech transmission. It seems, however, reasonable to differentiate between losses caused by temporary shortage of connecting devices due to economical considerations, viz. *congestion*, and disturbances caused by purely technical deficiencies. The congestion which mainly occurs during peak load makes itself known by delayed or lost calls depending on the construction of the circuit. The disturbances caused by technical deficiencies may be divided into definitely unsuccessful connections on the one hand and faults of lesser importance on the other. The latter may affect the connections but not to the extent of endangering the establishment or continuance of the connections.

In automatic telephone operation a resulting congestion during peak load of 1% to 10% or even more is generally acceptable whereas the average loss due to technical faults generally can be maintained between 0.1—1% during busy hours. The traffic quality in a wider sense can, therefore, be considered as an economical matter where the quality of service demanded by the subscribers must be balanced against interest and amortization on the capital spent on technical equipment.



Fig. 1
Section of the traffic bureau
Helsinki Telephone Corporation

N 6796



Fig. 2
Equipment for traffic observations
(random checks)
Helsinki Telephone Corporation, the traffic
bureau

X 6797

A fault rate of the order of 1 % cannot, however, be justified under all circumstances. For a critical opinion of a guaranteed or measured fault rate it is necessary to consider *the character of the fault*. It is natural that 1 % faults in the form of uncompleted connections can be justified and hardly will give cause for complaints. Calls to wrong number due to technical faults may be placed in a different category but a rate of 0.1—0.2 % may nevertheless be accepted in view of the dialling faults generally amounting to 5 or 10 %, approximately half of which result in calls to wrong number. Cut-in on a foreign connection must on the other hand be considered as a very serious fault as it would jeopardize the preservation of the telephone secrecy and the occurrence of such faults must, therefore, be limited to a minimum.

The question can be summed up as follows. Technical faults which can be caused by the subscribers themselves owing to negligence or improper use form a group with comparatively wide allowances whereas faults of the opposite character must be regarded more severely.

The importance of the fault rates intimated above must not be underestimated. A fault rate of, say, 0.1 % for an assumed traffic of 500,000 calls per day implies 500 daily faults, a fact which, for instance, as regards crosstalk connections no doubt would result in very severe comments.

Traffic Observations and Test Connections

The subscribers' valuation of the traffic quality of a telephone system is obviously based on their opinion of the use of the telephone as a means of communication. An estimate in figures of the traffic quality cannot, however, be based on more or less biased individual opinions, and the traffic quality from the subscribers' point of view must, therefore, be clarified by other methods.

A universal and objective valuation of the traffic quality can be based on the one hand on random *tests of subscriber connections* including the connection procedure and on the other on separate *test connections* established by trained personnel. The first method provides not only the rate of "congestion" and "technical failures" but also the "busy" and "no-reply" fre-

quencies as well as "faulty dialling". The former method is, therefore, particularly suited to give the public at large information regarding the general character of the telephone traffic. As the random checks must for practical reasons be taken at a concentrated point, certain parts of the equipment are excluded from the test. It is also difficult in this way to supervise certain functions such as speech transmission, call metering and release. This means that such observations alone will not provide a clear picture of the traffic quality which an ambitious management considers essential for prophylactic purposes. The additional measures required will be found in test connections which, carried out in an efficient manner, will give a comprehensive and reliable picture of the function of the equipment.

Classification of Random Checks

A basis of comparison between the traffic quality in different telephone systems with reference to congestion, economical efficiency and fault rate has for a long time been very desirable but great differences with regard to methods as well as notations have so far made all comparisons illusory.

For classification of random checks or test connections it seems natural to divide these with reference to the *connection process* and the possibilities at the disposal of the inspector to characterize a failure. In order to give the statistics of the results the required consistency in the long run and particularly in view of comparisons of results from different telephone administrations, the classification headings must be made as definite as possible. In this connection particular attention should be paid to the conceptions "failure" and "disturbance". When carrying out a traffic investigation the recording of all "disturbances", i.e. all deviations from normal, is quite in order, but for a completely unbiased valuation of the technical function of the system it is necessary to include undisputably "unsuccessful connections" alone in the principal statistics of results. In this way a doubtful if not impossible definition of "disturbances" is avoided. The significance of the heading "unsuccessful connections" will be clear from sub-headings 121—125 in the following schedule.

1. Subscriber dialling correctly
 11. Normal connections
 111. Connection to required number
 112. Number engaged
 113. No reply
 114. Trunk offering break-in
 12. Unsuccessful connections
 121. Incomplete connection
 122. Connection to wrong number
 123. Speech transmission not possible
 124. Speech cut-in on foreign connections
 125. Established call released
 13. Congestion
 131. Congestion after first digit
 132. Congestion after second digit, etc.
2. Subscriber faults
 21. Advance occupation of first group selector or register
 22. Incomplete dialling
 23. Dialling wrong number

It seems furthermore reasonable in the procental summary to relate the normal and unsuccessful connections as well as congestion to heading 1, viz. "subscriber dialling correctly" as opposed to "subscriber faults" which preferably are related to the total amount of "controlled calls". In this way the rates of 11, 12 and 13 will be independent of the subscriber faults.

Fig. 3

The test room

Helsinki Telephone Corporation, the traffic bureau

X 9790



Fundamental Lay-out of the PBX Group in Helsinki

The junction lines from the private branch exchanges in the Centrum area have been collected into a separate PBX group which at present contains L M Ericsson crossbar equipment for 3,600 lines. This equipment is divided into groups of 400 lines for outgoing traffic and groups of 1,000 lines for incoming traffic in accordance with fig. 4. The connection is, as shown, controlled by 1 AB marker per 400 lines and 3 CD markers per 1,000 lines.

Guaranteed Traffic Handling Capacity and Measured Load

The system has been dimensioned for a peak load of 0.12 Erlang per line for outgoing traffic and 0.20 Erlang per line for incoming traffic, at which load the traffic congestion must not exceed 0.2 %. 80 outgoing and 120 incoming connecting circuits per 400 lines give a nominal load on the connecting devices of 0.60 and 0.67 Erlang respectively.

In the beginning of 1953 about 2,300 subscribers were connected to the PBX system. On December 31st in the same year the corresponding figure was about 2,400. In December 1953 an outgoing rush hour load was measured varying between 31 and 40 Erlang for eight 400-groups and between 110 and 167 Erlang for three 1,000-groups. The rush hour load per line in the outgoing and incoming groups was 0.11 and 0.19 Erlang respectively whereas the load of the connecting devices so far has not exceeded 0.50 and 0.56 Erlang respectively in any group. During the quarter 15.2—15.5.53 the subscribers' meters recorded approximately 3.6 mill. impulses, corresponding to an outgoing traffic of roughly 20 impulse registrations per line and week-day. The number of calls was somewhat lower due to the time registration of toll calls.

The Traffic Reliability for Crossbar Traffic

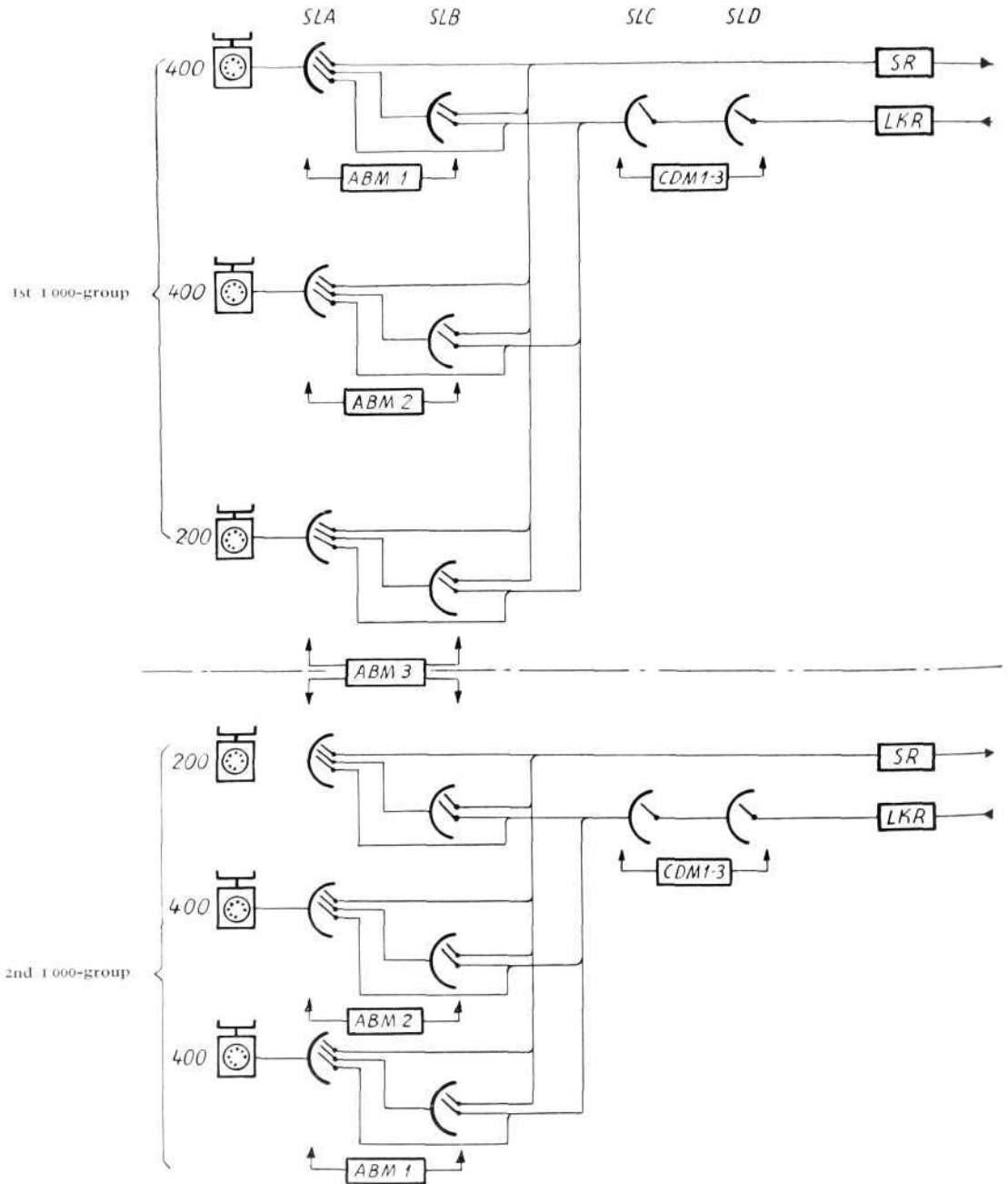
The crossbar system in question was installed by the Helsinki Telephone Corporation and the bulk of the system was put in operation on April 19th 1952. In view of the Olympic Games that summer determining the target date and partly owing to delayed deliveries, the installation had to be pursued at a rate which was very much detrimental to the quality of the workmanship. Neither did the time allow a thorough test of the equipment and the traffic routes before the opening, and the traffic reliability, therefore, left much to

be desired. With an excellent collaboration from the supplier's representatives the difficulties were, however, mastered and the Olympic telephone traffic could in the main be handled satisfactorily. It is only natural that a new system requires trimming of equipment as well as staff and it is, therefore, not surprising that just over a year had to be spent on locating and eliminating all sources of trouble.

The account given below of the traffic reliability for internal traffic in the PBX group mainly refers to the year 1953 and is based on just short of 40,000 test connections established with a dialling frequency of 10 cycles during busy hours (9—12 a.m. and 13—16 p.m.). The test connections have been established in continuously alternating directions between 20 free lines evenly distributed over the three 1,000-groups. To enable efficient check of the continuity of the connection, the 20 test lines were connected to a separate device capable of supervising 10 simultaneous test connections. In this way the testing time per connection was 5 mins. approximately. The test connections have been established by staff specially trained for the purpose and each deviation from normal has been recorded. Congestion and

Fig. 4
X 6799
Principle routing plan of the PBX group in Helsinki

- SL line finder and final selector stages
- SR line finder relay set
- LKR final selector relay set
- ABM marker for the AB stage
- CDM marker for the CD stage



failures have been classified in accordance with the schedule quoted above and the chief results are shown in the following summary which is divided into three time periods.

	19/1—9/4 1953	13/4—19/5 1953	20/5 1953—5/1 1954
	%	%	%
11. Normal connections	97	99	99
12. Unsuccessful connections	1.4	0.36	0.09
13. Congestion	1.6	0.94	0.64

During the period 19.1—9.4.1953 a number of “releases” on established connections were recorded, where the source of the fault initially could not be traced. Later on it was found that releases of this type could be caused by a trunk operator effecting regular disconnection. The exchange equipment enables permissible disconnection of a local call in favour of a trunk call, a requirement which was cancelled by the Post and Telegraph Board in Finland on 1.7.52. These initially unaccountable releases were recorded as “unsuccessful connections” during the first time period and the fault rate 1.4 % is, therefore, somewhat too high.

As a result of the test connections during the first investigation period it appeared otherwise that the faults mainly were caused by remaining installation faults in the form of inferior soldering connections, a fact that emphasizes the importance of a high workmanship in the installation and a meticulous inspection test. A repeated revision of all tag strips was started and as an immediate result of this the frequency of “unsuccessful connections” was reduced to 0.36 % for the second investigation period and during the first half of May the fault rate was already of the order 0.10 %.

The third and last investigation period covered the latter half of 1953 and gave a *fault rate of 0.090 %* based on just over 20,000 test connections, a result which must be considered very satisfactory particularly in view of the statistics referring to a comparatively heavily loaded exchange group during rush hour periods.

General Views

Fault statistics based on signalled or otherwise established exchange faults, usually gives quite a different picture of the fault circumstances than that obtained by test connections and it is remarkable that the fault total according to the first mentioned method transferred into fault rate represents a very small fraction (in Helsinki about 1/100) of that established by test connections or traffic observations. This fact has a quite natural explanation in so far as the test connections, as opposed to visual alarms and different types of equipment tests, show the occurrence not only of remaining faults but also intermittent faults. Irrespective of this, statistics regarding localized exchange disturbances are of indubitable value as a basis for traffic improving measures providing, however, that the fault sources are recorded in detail.

In conclusion it can be stated that the test connections represent the only method of evaluating the functioning of the equipment which can be relied on under all circumstances. In order to fulfil its purpose, however, the test connections be carried out by specially trained personnel and by means of equipment specially devised for the purpose and, in addition, preferably by a department separate from the other technical service organization, a department with the main task of supervising and examining the telephone traffic in all its aspects.

Automatic Call Distributors for Information, Booking and Similar Offices

M LINDEROTH, THE SWEDISH ROYAL BOARD OF RAILWAYS, STOCKHOLM

U.D.C. 621.395.341.8:654.152.06

Telephone exchanges for reception services such as information and booking offices take to a great extent the character of call distributors. It is, therefore, very important from economical as well as service point of view to arrange waiting facilities and connection to the clerks (or group of clerks) in proper rotation. According to the nature of the service and the working conditions of the clerks the call distribution can be fully automatic or semi-automatic.

In the following article a few view points are given with reference to the arrangement of the call distribution as well as a brief description of the fully automatic call distributors which have been delivered by Telefonaktiebolaget L M Ericsson to the information office of the Swedish State Railways in Gothenburg.

General

Telephone branch exchanges and exchange lines are as a rule arranged for two-way traffic. Switchboards and other equipment are, therefore, in the main constructed with the same consideration for the incoming and the outgoing traffic. The conditions are, however, different when it comes to telephone systems for reception services such as quoted above which are specially designed to provide particular services to calling clients. The traffic will in this case chiefly be directed from the clients to a number of clerks in the office which contrary to ordinary subscribers mainly receive telephone calls. The automatic switch board equipment, which establishes the connection between the inquiring caller and the clerk, will in character actually more resemble a call distributor than an automatic exchange in the proper sense.

The lines connected to the call distributor consist on the whole of *incoming lines* and *clerk station lines*. If the clients are calling over a public exchange the incoming lines correspond essentially to the exchange lines in a PABX



Fig. 1
Service clerk's desk
at the booking office for sleeping car accommodation, Swedish State Railways in Stockholm



Fig. 2 X 6788
 Operator's direction set for semi-automatic call distribution at the booking office for sleeping car accommodation, Swedish State Railways in Stockholm

connected to the public telephone system although the relay equipment is different. The incoming lines may also originate from a large or small private service telephone system and will then operate as lines from an automatic exchange (single line or PBX connected group lines), from a manual exchange or from an extension. In this way different traffic groups are formed. In principle the station lines will also carry one-way traffic from the distributor to the reception clerk. It is, however, generally required that the clerk should be able to initiate a call on a local system even while an incoming call is waiting.

The minimum requirement on the equipment for a reception clerk will, thus, be an ordinary automatic telephone instrument or corresponding apparatus. It has, however, been found expedient to adapt the equipment according to the nature of the service and the working conditions for the clerks. For this purpose signal lamps, keys and similar equipment are required and the clerk station equipment will, therefore, take the form of a specially designed unit.

It is clear that this type of call distributor can be applied to a great number of differently connected telephone service offices. The arrangement of the call distributor must, therefore, be adapted individually for the different kinds of such offices. It is, however, possible to distinguish between two basic types of distributors which may be referred to as *fully automatic* and *semi-automatic*. The first can be used when all reception clerks have equivalent tasks i. e. when they have the same resources to their disposal as regards service information and in general are identical cogs in the service machinery. As a rule equivalence is advisable in order to obtain a smaller personnel.

It is, however, not always possible to organize the reception exchanges with equivalent reception clerks. It is then necessary to divide the clerks in groups each group being composed of equivalent clerks. Normally it is not advisable to put the caller («the customers») to the trouble of directing the call to the required group by means of dialling. Particularly when it is a question of a public service such a solution is unsatisfactory. There are also difficulties in arranging dialling transfer at the main exchange and a subdivision of the exchange line would thus be necessary. Instead of this a manual switching position is arranged in the call distributor where an operator directs the calls to the required group by fast key operations. In this way the distributor will operate semi-automatically.

It is of course true that the addition of manual operation of the call distribution has the disadvantage of increasing the staff requirements. But in a reception exchange of such a character and magnitude that a directing operator is required, such an operator will — apart from the simple and routine distribution duties — also provide guidance and advice to the calling »customers». The value of this »customers' service» outweighs the disadvantage of the increased personnel requirement.

The call distributor which has recently been installed for »Railway information» at the Swedish Railways in Gothenburg may serve as an example of a fully automatic distributor. The Swedish Railways exchange for sleeping car booking in Stockholm is since 1947 provided with a semi-automatic call distributor which at present covers 3 reception groups with 7 clerks in each group, fig. 1. Both these call distributors are equipped with crossbar switches on account of the high reliability and circuit properties of this selector.

Traffic Considerations

The variations in the traffic intensity which usually are the stumbling-blocks when solving traffic problems in general, particularly for telephone traffic, are very much noticeable for the systems which are outlined in this article. The call frequency for these systems is very much dependent on the season, the variations during the hours of the day are violent and even when the service hours are limited considerable variations in the call frequency take place during these hours. Added to the balancing between a satisfactory service on one hand and personnel and capital costs on the other one has, therefore, also to consider difficult construction and dimensioning problems. As regards the operation the requirement of well adapted manning is of the greatest importance.

For a new system traffic figures are generally not available as a basis for the dimensioning. It is, therefore, important that adequate facilities are arranged for traffic recording in the call distributor and that extensions are anticipated both with regard to the call distributor and the service in general. It should be mentioned, however, that the traffic recording equipment is not only intended as a basis for system dimensioning. Continuous statistical traffic data is also of great assistance when estimating the required manning, a problem which is particularly difficult during peak hours.

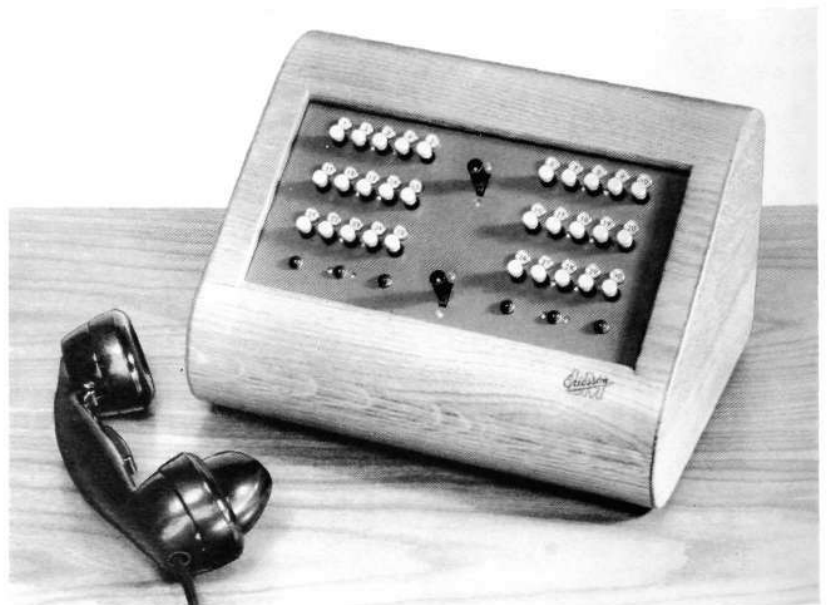


Fig. 3
Superintendent's instrument
Fully automatic call distribution

X 6789



Fig. 4
Self contained station instrument
Fully automatic call distribution

X 6790

The purpose of the call distributor is to enable satisfactory personnel utilization and at the same time to provide a good service as regards answering time. The distributor is, therefore, arranged with waiting provisions for the calling party. The number of incoming lines, answering positions, cord circuits &c must be estimated very thoroughly in order to reduce the waiting times to reasonable values even during rush hours. It should be noted that for extreme traffic peaks congestion can occur on the incoming lines, the calls usually being turned away by busy signal. The waiting system then changes into a busy-signal system.

The fully automatic call distributor at the information office for the Swedish State Railways in Gothenburg, mentioned above, has been provided with a queuing device which in proper rotation distributes the incoming calls to free stations. A talking machine is co-operating with the queuing device and announces the name of the service office and, if waiting is necessary, the request »hold the line, please». During the waiting time the caller is kept assured that the connection is being maintained by means of a ticking signal transmitted on the line. The queuing device as well as the signal mentioned are new features which were not included in the semi-automatic distributor of 1947. The queuing device is, however, very valuable also in case of semi-automatic distributors with regard to equalization of distribution. It is then preferably arranged between the directing operator and the service groups.

In modern call distributors a fair distribution between the clerks is promoted as the calls are equally directed to all manned clerk stations. The stations are marked manned or not manned by a key on the station unit.

To supervise the traffic handling in the system a separate instrument, fig. 3, should preferably be arranged. This is provided with signal lamps which for instance may indicate when all lines in each service group are engaged, when all queuing devices are engaged and also when calls are waiting outside the distributor. Furthermore the instrument can indicate the number of manned clerk stations and can be provided with means for individual disconnection of a traffic group. It has also provisions for cut-in and listening to enable supervision of the service clerks. The instrument is placed in the superintendent's office.

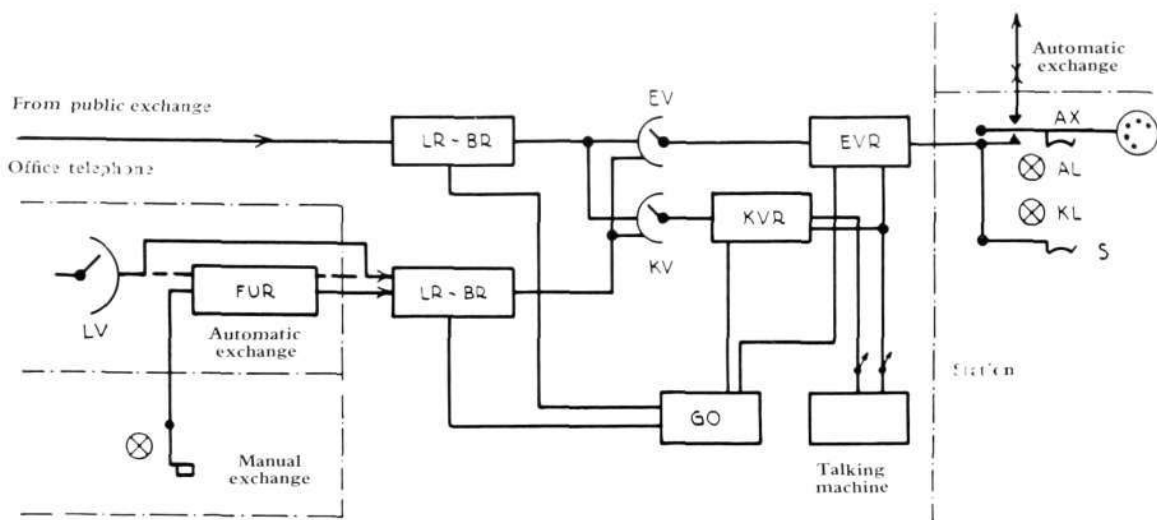


Fig. 5 X 7659
Traffic route diagram for fully automatic call distribution

Construction

A short description of the LM Ericsson modern fully automatic call distributor will be given below. This has been installed at the information office for the Swedish Railways in Gothenburg.

The relay and crossbar equipment for this call distributor is mounted in rack units which have a width of 961, depth 425 and height 2,200 mm. Such a rack unit takes equipment for 10 clerk stations, 10 queuing facilities (= 10 simultaneously waiting calls in the distributor), 90 incoming lines and the necessary common equipment. If more than 10 service positions are required rack units are added containing the necessary station selectors and relays. Each added rack unit increases the station capacity by 20. By means of a special circuit connection the utilization of the crossbar switch has been increased in such a way that each selector (*EV*), see fig. 5, corresponds to 30 lines and 10 stations. The relay sets as well as the crossbar switches are connected over plug and jack providing convenient facilities for extensions as and when such are required. The comparatively simple line equipment (*LR-BR*) is mounted in units of 10 lines. The more complicated station and queuing relay sets (*EVR* and *KVR*) are individual units.

The clerk station equipment is arranged in a separate special instrument as per fig. 4. It is in many cases an advantage to have a station instrument separate from the remaining office equipment. The instrument contains a key indicating if the station is manned or not, an answering key, acoustic call signal and call lamp, pilot lamp, key with holding resistance and buzzer for extension line to a local automatic exchange, dial and plug connected handset or headgear.

The operating voltage for the call distributor is 24 V. As a rule available power supply for a public branch exchange or similar equipment can be used. Otherwise accumulators and charging units are arranged as for ordinary automatic exchanges.

Functions

Fig. 5 is a traffic route diagram for the fully automatic call distributor which has been described above. In the diagram *LR-BR* represents the line equipment, *EV* and *KV* station and queuing selectors, *EVR* and *KVR* relay sets for speech and queue connections, and *GO* relay sets for various auxiliary devices for distribution and rotation.

An incoming call effects *LR-BR* which connects a queue unit distributor included in *GO*. The calling line is then connected over selector *KV* to a free queue relay set *KVR* which in its turn and with the assistance of a station

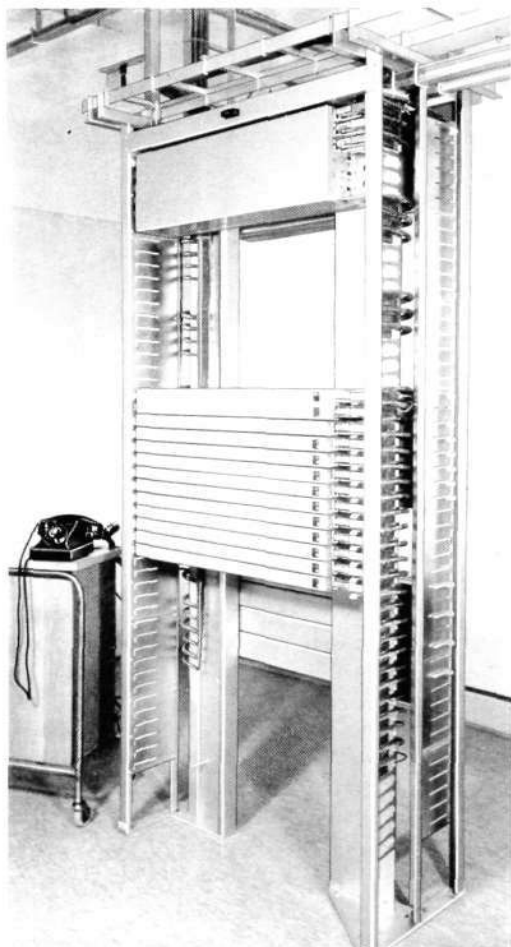


Fig. 6 X 4936
Rack for fully automatic call distributor
Swedish State Railways, Gothenburg

Fig. 7
X 6793
Interior view of the information office,
Swedish State Railways, Gothenburg



distributor also in *GO* connects the call over selector *EV* to a free clerk station provided that such a station is available. The call lamp *AL* in the called station instrument is operated and the clerk operates the answering key *S* and receives the call. Lamp *AL* is extinguished but pilot lamp *KL* is operated. At the same time the talking machine is connected announcing the name of the office which can be heard also by the answering clerk. When the call has been terminated the clerk restores key *S* releasing *EV* and *EVR*.

If all manned stations are engaged the call remains in the queue relay set *KVR*. The talking machine is connected and announces the name of the office and »hold the line, please«. A queuing device included in *GO* then connects the call in its proper rotation to a station becoming disengaged.

The left of the diagram shows the connection to the call distributor of the lines from an automatic or a manual exchange in the local telephone system. As the call distributor operates with loop control, i. e. repeated short interruptions take place in the loop against the calling line during the waiting time, a relay set *FUR* has to be arranged in the lines from the manual or automatic exchange with first party, not delayed release. The main purpose of the relay sets is to prevent the short loop interruptions from effecting false releases.

The right of the diagram indicates how an ordinary extension to a local exchange is arranged in the station instrument. This line is mainly intended as an enquiry line for the clerk but can also be used for incoming calls.

Coaxial Trochotron for Pulse Counting

O STERNBECK, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.385.832:621.218.572

The action of the trochotron is based on the characteristics of an electron beam in a magnetic field that is crossed by an electric field. An electron beam, which moves in a trochoidal path perpendicular to the directions both of the magnetic and electric fields, is characterized primarily by its easy deflectability and its capacity to maintain its width even at high currents and low voltages.

The principle of the trochotron originates in an invention of H. Alfvén and H. Romanus.¹ A number of types of electron tubes have been developed by Telefonaktiebolaget L M Ericsson on the trochotron principle. One of them, designated RYG 10, manufactured by AB Svenska Elektronrör, is described below.

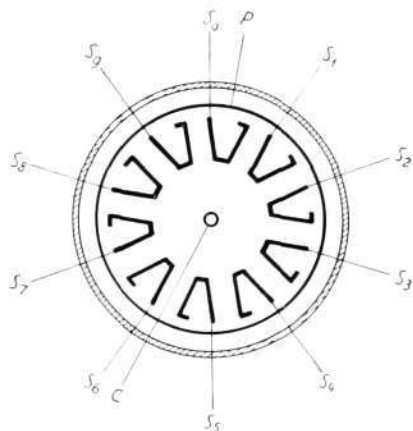


Fig. 1 X 4928

Schematic cross-section of coaxial trochotron, type RYG 10

S₀—S₈ control electrodes
P receiving electrode
C cathode

Method of Operation

The coaxial trochotron RYG 10 (previously called AD-3) is a high-vacuum tube, in which the electron beam can be guided into ten different positions or "boxes" and which, when suitably connected, can retain the electron beam in one box until it is moved on to another. A cross-section of the tube is shown in fig. 1. Round an oxide-coated cathode forming the axis are ten V-shaped control electrodes (called spades) so arranged as to form boxes with parallel sides between them. The control electrodes are surrounded by a cylindrical receiving electrode which encloses the control electrodes forming the bottom of the boxes. For the correct functioning of the tube the space enclosed within the receiving electrode must be permeated by a magnetic field with its lines of force parallel to the longitudinal axis of the cathode (perpendicular to the plane of the paper in fig. 1).

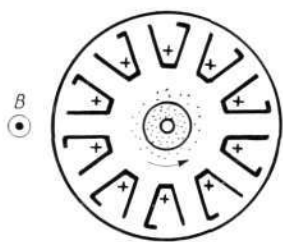


Fig. 2 X 4929

The coaxial trochotron with all control electrodes positive

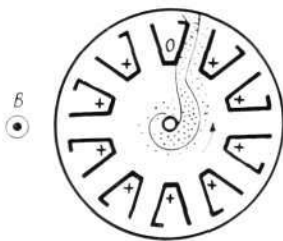


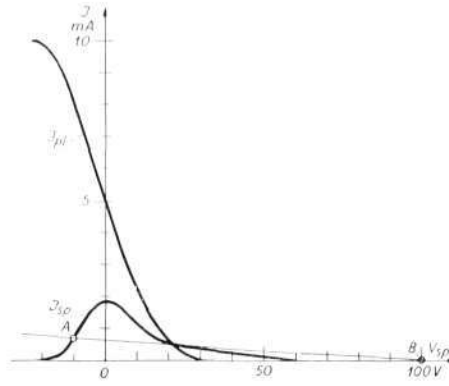
Fig. 3 X 4930

The coaxial trochotron with 1 control electrode on cathode voltage and the remainder positive

If all control electrodes are made positive in relation to the cathode and the strength of the magnetic field is properly balanced, the magnetic field repels the electrons emitted from the cathode before they reach the control electrodes and compels them to return to the cathode. The returning electrons form a negative space charge around the cathode which further suppresses the emission of electrons, fig. 2. In that condition no current flows in the tube, but around the cathode there circles a swarm of electrons, the direction of movement of which is determined by the direction of the magnetic field. When the potential of one of the control electrodes is now lowered to, for example, that of the cathode, the swarm of electrons can no longer circle around the cathode, but is deflected in the direction of the negative control electrode and into the box between the negative control electrode and the positive control electrode immediately preceding it, finally striking the receiving electrode, fig. 3. An electron current is thus obtained in the tube, the strength of which is determined by the geometry of the tube, the voltage of the control electrodes and the strength of the magnetic field. The transition from dead to live condition due to lowering of the potential of a control electrode is continuous, as will be seen from fig. 4, which shows the current-voltage conditions in the tube. It is observed that the characteristic of the control electrode is negative, i.e. that the current increases if the voltage of the control electrode is decreased. The negative characteristic of the control

¹ ALFVÉN, H. & ROMANUS H.: *Valve with trochoidal electronic motion*. Nature 160 (1947) p. 614.

Fig. 4 X 4931
Control electrode current (I_{sp}) and receiving electrode current (I_{pl}) as function of the control electrode voltage (V_{sp}). The voltage of the remaining control electrodes is 100 V.



electrodes permits automatic locking of the beam if every control electrode is connected in series with a sufficiently high resistance. In fig. 4 a load line is drawn, and it is manifest that there will be two stable points of operation for the control electrode in series with such a resistance, viz., point A in the neighbourhood of the cathode potential and point B at the feed potential. Thus in a trochotron with control electrodes connected in series with high resistances, if the potential of a control electrode is momentarily lowered to the neighbourhood of the cathode potential, the voltage drop in the series resistance takes over the task of holding the potential of the control electrode at a sufficiently low level, and so-called locking is obtained. To ensure locking with a 100 V control electrode feed voltage, a resistance of about 200,000 Ω will be required.

As is seen from fig. 4, only part of the current in the tube is received by the control electrode, the major portion passing on to the receiving electrode. If the potential of the receiving electrode is reduced below the cathode potential, the electrons are unable to reach the receiving electrode but go to the immediately preceding control electrode. If a resistance of sufficient magnitude is connected in series to the control electrode, the latter undergoes a drop in voltage and takes over the locking of the beam. If the potential of the receiving electrode is still below that of the cathode, the beam continues to the previous control electrode, and so on. Thus the beam itself advances from control electrode to control electrode in the opposite direction to the electrons. On the other hand if the potential of the receiving electrode is again made positive after the beam has moved one step, the beam is retained in the position it last assumed. The normal use of the coaxial trochotron RYG 10 as pulse counter is mainly based on its ability to compel the beam to move one step at a time by means of short negative pulses on the receiving electrode. The condition necessary for stable stepping is that the time during which the receiving electrode is negative coincides with the time required by the beam to lower the voltage of the control electrode from feed voltage to cathode voltage.

Design

The aim has been to make the design of the tube as simple as possible. The number of components has therefore been kept low. The possibility exists of offering an inexpensive product in the event of large scale manufacture.

The tube is in the form of an all-glass bulb with 14-pole button stem with lead-in wires of the same type as in miniature tubes. The tube is 25 mm in diameter and 52 mm long. The electrode-system, which forms a composite unit kept together by the receiving electrode, is spot-welded direct to the lead-in wires. The material used in control and receiving electrodes is a non-magnetic nickel-chromium alloy. The cathode is of the oxide-coated type and is heated by a 6.3 V, 0.3 A coiled filament. The magnetic field required for operation is generated by a separate cylindrical, axially magnetized permanent

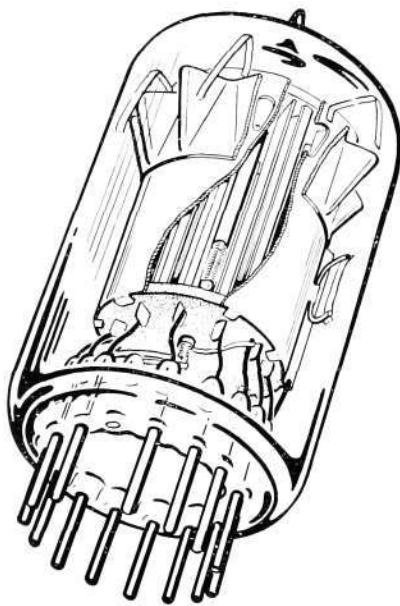


Fig. 5 X 4932
Perspective drawing of RYG 10

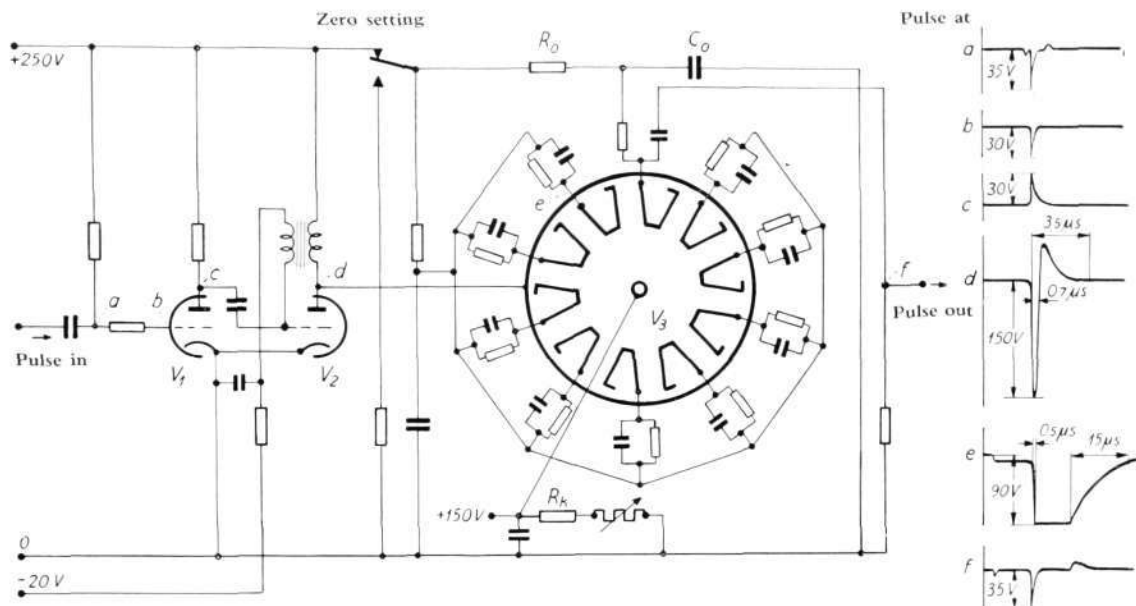


Fig. 6
Wiring diagram for decade counter
using RYG 10

magnet surrounding the tube. At a control electrode voltage of 100 V the requisite magnetic field is about 345 gauss.

The position of the beam in the tube is indicated by the voltage drop on the control electrode which locks the beam. A visual indication is often sufficient and, in order to save the roundabout method involved in using separate glow-lamp indicators, the tube has been provided with a fluorescent screen. The fluorescent screen is formed integral with the receiving electrode in such a way that 10 boxes, open at the top, are formed between screen and receiving electrode. Each of these boxes is connected to the corresponding box between the control electrodes by means of holes in the receiving electrode. A voltage of about 100 V is required for clear indication.

Decade Counter

Simultaneously with the tube, a basic circuit suitable for pulse counting has been developed (fig. 6). The stepping principle employed is that described above, involving the movement of the beam one step by means of a short negative pulse on the receiving electrode. To make the required pulsing time comparatively independent of tube and coupling capacitances, all control electrode resistors are coupled in parallel to 25 μF capacitors. A drop in voltage of 100 V for a locked control electrode at a total control electrode capacitance of 40 μF corresponds to a charge of

$$C\Delta V = -100 \cdot 40 \cdot 10^{-12} = -4 \cdot 10^{-9} [\text{As}]$$

At a control electrode voltage of 100 V the beam current is about 10 mA and, if the current in the resistance is disregarded, the requisite pulsing time will be

$$t = \frac{C\Delta V}{I} = \frac{-4 \cdot 10^{-9}}{-10^{-2}} = 4 \cdot 10^{-7} [\text{s}]$$

The above-mentioned pulsing time will determine the capacity of the counter to distinguish between two successive pulses. For counting longer trains of pulses the speed is limited also by the time constant of the control electrode circuit. The time taken by one revolution (10 steps) must not be less than four times the time constant of the control electrode circuit if the tube is to count irregular trains of pulses.

The pulse is generated by a blocking oscillator V_2 which is started by the phase changer and the amplifier V_1 . The pulses to be counted enter V_1 in

the form of negative voltage pulses. If the counter forms part of a larger counting unit, the pulse arrives from the preceding counter. The grid circuit of V_1 has been made insensitive to negative pulses below a given amplitude, and also to all positive pulses. The blocking oscillator is a stable and simple pulse generator of sufficiently low impedance. Unfortunately it limits the speed of the counter to about 400,000 pulses per second, while RYG 10 with a more complex pulse generator comes up to 10^6 pulses per second.

In order that an outgoing pulse shall be obtained on every tenth incoming pulse, the shunt capacitor of control electrode no. 0 is connected in series with a resistance. Every time the beam enters box 0, a sharp negative outgoing pulse is received.

At zero-setting the feed to all control electrodes is first broken and no current flows in the tube. Thereafter feed voltage is again applied to all control electrodes. Control electrode No. 0 does not reach full voltage until rather later due to the delay in its combined resistance and capacitance R_0C_0 . Since the potential on control electrode 0 is at first lower than on the remaining control electrodes, the beam to control electrode 0 is locked.

Thanks to the complete symmetry of the tube, zeroing can be performed in any of the ten positions. Reading and zeroing arrangements may be considerably varied to meet different requirements of speed and amplitude.

The counter is extremely reliable in operation. Despite the absence of precision components it functions at variations in feed voltage of from 200 to 300 V. No adjustment is necessary on replacement of tubes, nor trimming of individual units. On the other hand the magnet must from the start be magnetized to the proper field strength and the magnetic field must be parallel to the axis of the tube.

Summary

RYG 10 is up to this time the only commercial decade pulse counter tube which permits direct setting to a desired position, indication of the beam position in the form of an electric potential from all positions, and a high counting speed. Its simplicity, small dimensions and clear indication, and its applicability in simple coupling arrangements, give promise of its finding wide use within the fields of mathematical machines and other instruments.

New Rack Mounting Capacitor

T B O H L I N, A B R I F A, U L V S U N D A, S T O C K H O L M

U.D.C. 621.319.414

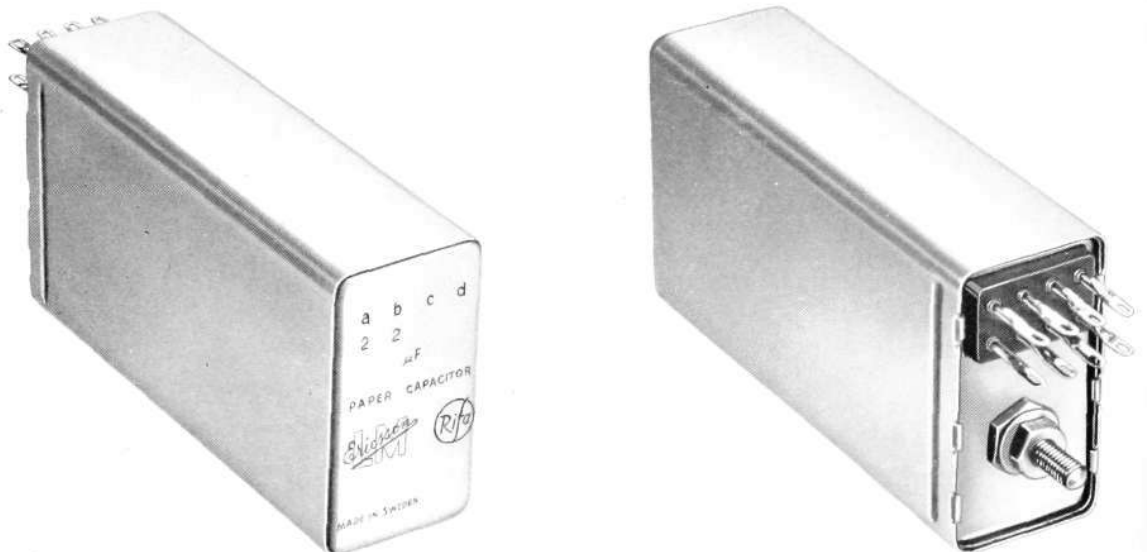
One of the chief components of a telephone switchboard is the relay, another important part being the capacitor. For convenience of assembly, L M Ericsson have for a long time designed their rack mounting capacitors to match the physical shape of the relay. Thus four capacitors have been assembled in a case of the same length, width and height as the ordinary relay, and even with the same mounting bolt. The unit can therefore be mounted in the rack in the same way as a relay. A consequence of this practice was that the switchboard capacitor became set in the mould determined by its external dimensions and failed to follow the developments that capacitors have undergone in general.

RIFA have now produced a new type of rack mounting capacitor. This capacitor has an aluminium case, and the seal is arranged on the wiring side, i.e. on the side of the capacitor facing the rack. The old type of case with its always expensive and unreliable soldered joints has thus been eliminated and the moisture protection of the capacitor made more efficient. The appearance of the capacitor is also improved by this design. The original type of asphalt compound seal has been retained, since practically no trouble has been experienced from this source. The sealing of the end facing the rack is arranged by a plate pressed directly against the compound, at the same time holding the terminal block in position. The terminal block has been redesigned to incorporate flat solder tags which offer greater convenience in soldering.

Fig. 1
Rack mounting capacitor
Right: View from wiring side

X 6800
X 7662

At the same time it proved necessary to redesign the case and cover in order that the weight of the capacitor may be effectively transferred from the case to the bolt. A patent application has been filed for this construction.



Key-set Operated Staff Locator System with Sequence Paging

R SKOG, TELEFONAKTIEBOLAGET L M ERICSSON, TELESIGNALFABRIKEN, STOCKHOLM

DK 654.938

In recent years there has been an increasing demand for a reasonably priced staff locator system allowing the paging of a comparatively large number of persons.

The L M Ericsson range of staff locator systems has, therefore, been augmented by a new visual system which enables the paging of up to 100 alternatively 200 persons with flash signals on five-lamp panels. The paging signal is initiated by tapping a two-digit or alternatively a three-digit number on a key-set with 10 keys.

Staff locators according to this system may be supplemented with absence indication.

Special equipment has been developed for transmission of the signals over a two-wire circuit and earth to remote premises, remote paging.

A modern staff locator system requires in the first place a signal of such a nature that it will be immediately observed and identified by the wanted person without disturbing other people. The signals should be initiated in the simplest possible way. It should be possible to extend and supplement a system without altering existing equipment.

At the same time the equipment, installation and operating costs must be kept at a reasonable level. All these requirements have been met in the key-set operated staff locator system with sequence paging.

The Principle of Sequence Paging

In conventional staff locator systems each person requiring paging is allotted one of the practicably possible combinations which can be formed by the lamps in the locator panels.

In sequence paging several persons are allotted the same combination but are differentiated by a one-lamp group signal. The group signal and the combination signal are flashing alternately and are constituting a well-defined identification.

If the number of lamps in the panels are limited to five and the number of utilized combinations to 20, the number of persons that can be called will be 100. If in addition the group lamp is operated twice in succession a further 100 can be called, i. e., a total of 200 persons.

The Lay-out and Function of the System

The skeleton diagram, fig. 1, shows the lay-out of the new locator system.

The key-set unit, KEM 3291, fig. 2, is preferably placed at the telephone switchboard. It consists of a key-set with 10 keys, a three-way lever key and three pilot lamps mounted in a box of cellulose lacquered, polished oak. Paging is initiated by tapping two or three-digit numbers on the key-set. In systems for 100 persons the number series 00—99 is used, whereas 100—199 and 200—299 are used for systems up to 200 persons. Each digit which is tapped

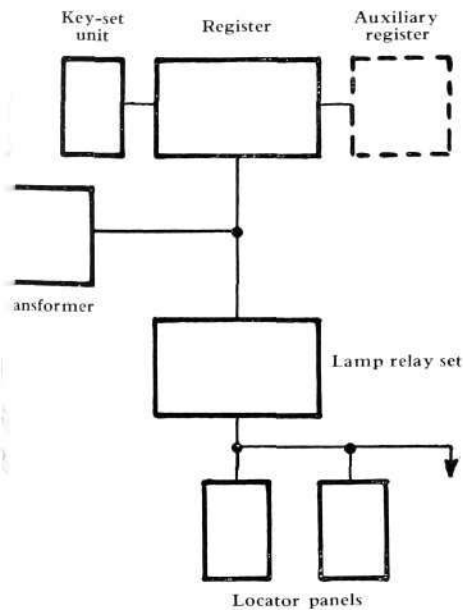


Fig. 1
Skeleton diagram for staff locator system with sequence paging

X 4926



Fig. 2
Key-set unit KEM 329T

X 4954

on the key-set is indicated on the pilot lamps in the unit. If a key is operated in mistake this is immediately noticed. Keys pressed when paging is in progress have no effect. Systems with two-digit numbers do not utilize the centre pilot lamp.

The key is used to restore the system after paging or after a key having been operated in error (position A) and to transmit a buzzer signal in the lamp panel (position S) for instance, between two successive signals to indicate a change in the paging. The two key positions are non-locking.

The key-set unit is connected over a black silk braided cord to a wall terminal box provided with terminal screws for 10 outgoing conductors. The dimensions of the unit are: width 115 mm, length 210 mm, height 120 mm.

The register, *KFB 15311*, fig. 3, contains the relays required for translation of the key-set digits to impulses for the operation of the corresponding lamp relay set. The alternation between the group signal and the combination signal is controlled by a step-by-step cam disk relay. The total time for a cycle amounts to about 1 second. The register also contains a rectifier supplying D. C. for the relay circuits, a fuse and terminal blocks. The register is made for wall mounting and is protected by a grey frost enamelled cover. The dimensions are: width 390 mm, height 190 mm and depth 165 mm.

The auxiliary register, *KFB 1115*, is only required for systems paging 200 persons and is used together with register *KFB 15311*. It is protected by a cover similar to that of the register with the following dimensions: width 150 mm, height 200 mm, depth 105 mm.

The lamp relay set, *KFB 15304*, fig. 4, contains five relays each supplying the same lamp position in the locator panels, as well as a relay for buzzer signals. Each relay can take a load up to 4 A for 24 V or 48 V distributed on two spring sets with tungsten contacts. Each spring set is protected by a 2 A fuse. The set is provided with large robust terminals for connection of the conductors to the locator panels.

The number of locator panels which can be connected to a relay set depends on the type of locator panel used and the operating voltage.

The following table indicates the maximum number of locator panels which can be connected to one lamp relay set.

number of locator panels with 1.2 W lamps type KNH 950, KNH 951, KNH 952		number of locator panels with 3 W lamps type KNH 831, KNH 953, KNH 954	
operating voltage 24 V	operating voltage 48 V	operating voltage 24 V	operating voltage 48 V
80	—	32	64

When additional lamp relay sets are required, type *KFB 15302* or *KFB 15303* are recommended. These supply an operating voltage to the locator panels of 24 V and 48 V respectively. The relay sets are connected to the system as a locator panel and can, therefore, be placed in the best possible position in relation to the wiring. The additional relay sets have the same properties as relay sets *KFB 15304*. The exterior of the lamp relay sets is identical with that of the register.

The locator panels are provided with five lamps and are made in a number of variations for different premises such as office rooms, corridors, work shops, out of doors etc. Some locators are supplied with an enclosed buzzer for 24 V D. C. which may be sounded as an indication that the paging has changed from one signal to another. The panels are operated by 24 V and 48 V alternatively, depending on the type of panel and the size of the system. In an article on page 23 a few types of locator panels are illustrated.

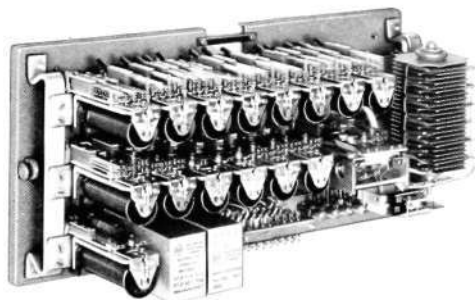


Fig. 3
Register KFB 15311

X 4937

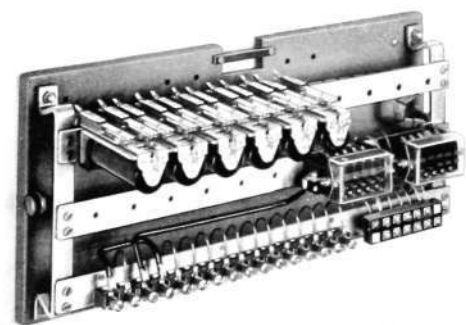
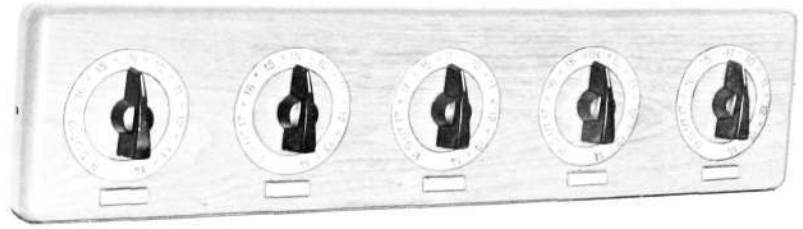


Fig. 4
Lamp relay set KFB 15304

X 4936

Fig. 5
Marking panel KEM 5501

X 6795



The transformer is connected to the A. C. mains and is provided with tapings for 32 V, 2 A, supplying the key-set unit, register and the lamp relay set, as well as tapings for 24 V and 48 V alternatively for the operation of the locator panels.

The wiring between the lamp relay set and the locator panels consists of five separate conductors and a common return conductor. All panels are connected in parallel.

The voltage drop in the wiring must not exceed 10% at maximum load. If this cannot be maintained the panels have to be divided in groups each group being connected directly to the lamp relay set. In certain cases additional lamp relay sets may be required.

Absence Indicators

A staff locator system can be supplemented with equipment for absence indication covering up to 100 persons. With such a system the telephone operator will receive immediate information as to when an absent person covered by the scheme will be available and in certain cases also the reason for his absence. Paging of a person marked absent will not take place.

The absence indication equipment consists of one or more marking panels and an indicating panel. The skeleton diagram, fig. 5, shows a complete staff locator system with absence indication.

The marking panel, KEM 5501, fig. 6, is placed in positions where the scheduled persons are passing on their way from or to the office. The panel contains a dial switch for each person. This dial is set to an appropriate position by each scheduled person leaving or arriving. When a staff locator call is initiated the operator obtains information according to the position of the corresponding dial. If the person is absent the indication covers expected

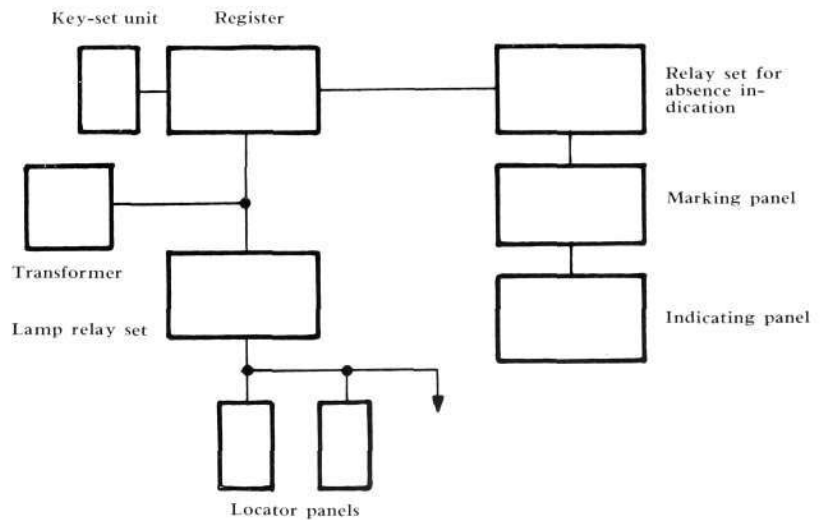


Fig. 6
Skeleton diagram for staff locator system with sequence paging supplemented with equipment for absence indication

X 6824

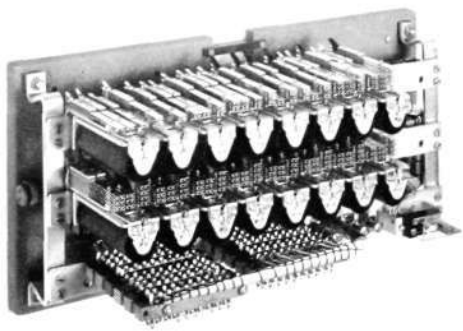


Fig. 7
Relay set KFB 15312

X 4941

time of return or the reason for the absence. The paging signal is not transmitted.

The relay set, KFB 15312, fig. 7, contains the required marking relays for identification of the initiated paging and the corresponding dial switch as well as terminals for connection to the other equipment. The set is intended for wall mounting and is protected by a grey frost enamelled cover. The dimensions are: width 390 mm, height 190 mm, depth 165 mm.

The indicating panel, KAC 11X01, fig. 8, is made as a slave clock and is provided with lamps and lenses for the different marking positions. Indicating panel KAC 11X02 has no clockwork or hands and is used when no slave clock system is available.

In many cases the clock-type panel can be substituted by a lamp strip, mounted in the telephone switchboard and provided with appropriate designations.

Remote Paging

A company with premises spread over a comparatively wide area, maybe over a whole town, will often require a staff locator call from one place to be displayed in several distant positions. As a rule this is impossible with a standard system due to the necessary wiring. Special equipment has, therefore, been designed by means of which paging signals for up to 100 persons can be transmitted over two wires and earth. The equipment is designed according to usual P. T. T. specifications for connection to public telephone network. For a reliable operation the line resistance should not exceed 2,000 ohms. Paging can take place in one or several remote localities simultaneously.

The skeleton diagram, fig. 9, shows the fundamentals of the lay-out for such a system.

The key-set unit is in the main identical with KEM 3291 but is in addition provided with the necessary keys for directing the calls to the required premises.

The transmitter transforms the digits from key-set to polarity combinations on the two wires and earth which are transferred to the receiver.

The receiver translates the polarity combinations into impulses operating the relays in the lamp relay set which correspond to the key-set digits.

The lamp relay set is similar to the standard set described above but contains in addition equipment for the alternation between group and combination signals on the locator panels.

The locator panels are identical with those used for standard systems. The system is connected to the A. C. mains over separate power units for each transmitter and for each receiver.



Fig. 8
Indicating panel KAC 11X01

X 4942

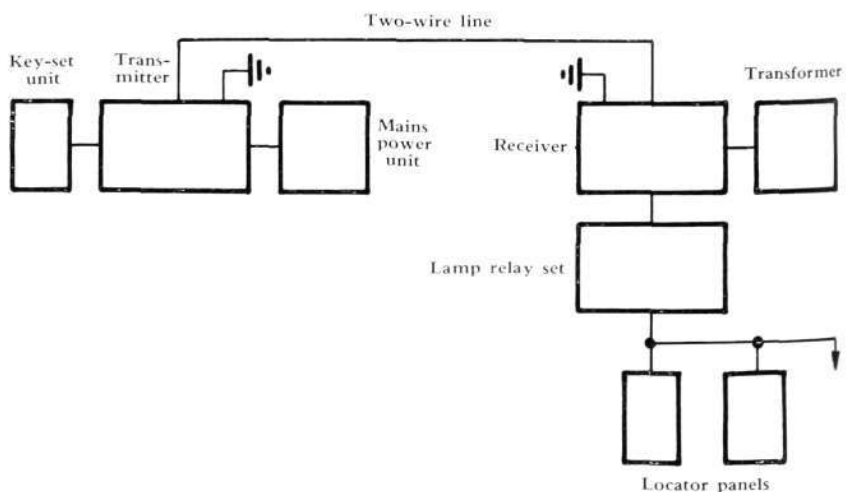


Fig. 9
Skeleton diagram for staff locator with remote control and sequence paging

X 6782

Staff Locator Panels

R SKOG, TELEFONAKTIEBOLAGET L M ERICSSON, TELESIGNALFABRIKEN, STOCKHOLM

U.D.C 654.938

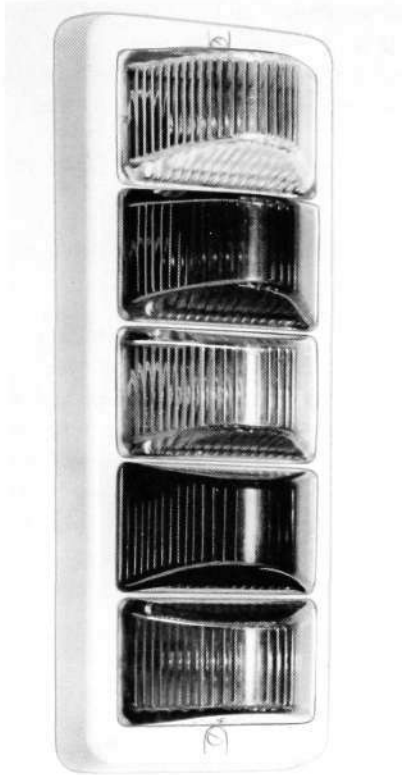


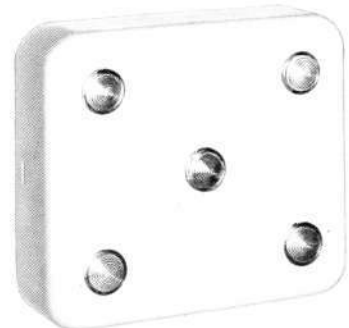
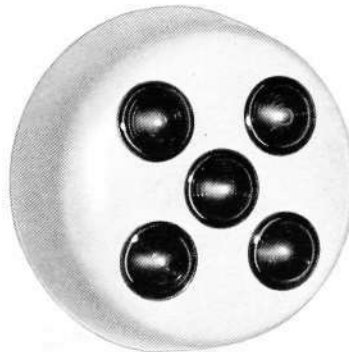
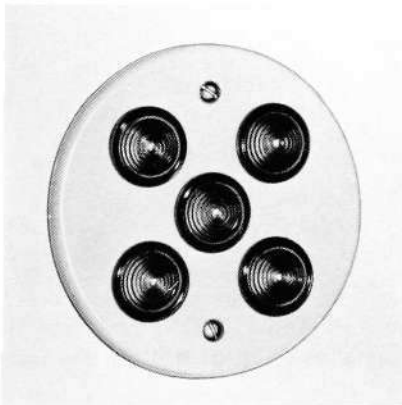
Fig. 1 X 4939
Staff locator panel KNH 831

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

Fig. 2 X 4943
X 4940
X 4944

Staff locator panels KNH 950 for recessed mounting (left), KNH 951 for surface mounting and KNH 953 for large rooms (right)

Dimensions:
KNH 950: diameter 85 mm, depth 53 mm
KNH 951: diameter 92 mm, depth 41 mm
KNH 953: width 153 mm, height 133 mm, depth 45 mm



Telefonaktiebolaget L M Ericsson has recently marketed a number of new types of staff locator panels. These are all provided with five lamps and are suitable for small and straightforward systems as well as large and complicated ones.

The first requirement of a visual staff locator panel is that the signals form a conspicuous and recognizable picture which is immediately identified by the wanted person even in bright daylight without disturbing other people in any way.

A staff locator panel must often be regarded as part of the office fixtures and it should, therefore, also have a pleasing appearance suitable for different kinds of premises and appointments.

The above considerations can be well covered by means of a suitable lens design and by utilizing the properties of the modern plastic materials with regard to refraction and colours, as in the case of the panels described below.

At the same time it has been possible to reduce the lamp effect to about half of that required for older types with the same range. This means a considerable reduction in the wiring cost which for visual staff locators represents a considerable part of the total installation cost.

All panels are intended for standard lamps with miniature centre-contact snap or Edison cap.

Indoor Panels

Locator panel *KNH 831*, fig. 1, is a conventional vertical type with differently coloured lamps one on top of the other. It consists of a base plate and a cover with five lenses. The base plate is fixed on the wall with two screws and carries lamp holders with lamps and in certain cases a buzzer. The cover is moulded in ivory coloured melamine. The lenses are provided with vertical grooves on the inside and are injection—moulded in white, red, yellow, green and orange polysterene. The cover is secured to the base plate by means of two captive screws.



Fig. 3 X 4945
 Double sided staff locator panel, pendulum type KNH 954
 Length of pendulum about 300 mm



Fig. 4 X 4946
 Double sided staff locator panel, pendulum type KNH 952
 Length of pendulum about 300 mm

In spite of the low lamp effect, 3 watts per lamp, the signals are well visible from the front and from the side even if the panel is exposed to bright daylight. Normal range is about 30 metres. The operating voltage is 24 V and 48 V alternatively. As mentioned above the panel can be provided with a buzzer which is sounded at the start of each signal to call the attention of the wanted person. The buzzer is operated by 24 V A.C.

Panels *KNH 950* and *KNH 951*, fig. 2, differ in principle from older panels in so far as the lamps are placed as shown in figs. 2—4. The five lamp lenses have the same colour and it is, therefore, the positions of the operated lamps that alone decide the signal combination. (In the conventional panels the colours of the operated lamps assist the reading of the signal.)

Locator panel *KNH 950* is intended for recessed mounting and *KNH 951* for surface mounting.

The panels have as a common part a lamp assembly consisting of lamp holders with lamps and in certain cases a buzzer.

The lamp unit is fitted in a conduit-box of standard type or straight on the wall surface. In the first mentioned case the box is covered by a lid secured by two captive screws and in the latter case by a cover snapped over the lamp assembly. The lid and the cover are moulded in ivory coloured melamine and are provided with five round red lamp lenses injection-moulded in polystyrene. The inside of the lamp lenses are provided with concentric refraction grooves. The lamp effect for these panels is as low as 1.2 watts per lamp maintaining satisfactory identification for a normal range of about 10 metres.

The operating voltage for the lamps is 24 V.

The panels can be supplied with an enclosed buzzer operated by 24 V A.C.

For large rooms where the range of *KNH 950* and similar types is insufficient a locator panel *KNH 953*, fig. 3, is recommended. This is provided with a large lamp assembly fitted on the wall with two screws. The lenses are of the same type as those on *KNH 950* and are fitted in a rectangular drawn mild steel cover, ivory enamelled. The cover is snapped over the lamp assembly. The lamp effect is 3 watts per lamp giving a normal range of about 30 metres. The operating voltage for the lamp is 24 V.

The panel can be supplied with enclosed buzzer for 24 V A.C.

In certain cases the double sided pendulum types *KNH 952* and *KNH 954*, fig. 4, are recommended. These panel types are assembled from two panels *KNH 951* or *KNH 953* mounted on opposite sides of a mounting plate with pendulum, which is provided with a ceiling cap. The mounting plate, pendulum and ceiling cap are ivory enamelled.

The length of the pendulum is about 300 mm but it can be detached and shortened if required. The panels are normally intended as pendants and are fixed with three screws. Otherwise the same data applies as for *KNH 951* and *KNH 953*.

Outdoor Panels

In certain cases a staff locator system may have to be supplemented with occasional panels for outdoor use. Such panels require considerably higher lamp effect (about 30 watts per lamp) in order to give an adequate range. They are, therefore, preferably operated from the mains over separate repeater relays. Panels of this type are as a rule constructed on site from suitable standard lamp fittings.

Portable Radio Equipment, Type P-11

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

U.D.C. 621.396.73

An easily portable radio equipment, type P-11, providing telephone communication over a range of a few miles, has been brought out by Svenska Radioaktiebolaget. The new equipment is adapted to a multitude of uses, by the police, fire brigades, power stations, industry, air and civil defence.

The new radio equipment P-11 is designed for simplex operation in the 34—41 Mc's band and is provided with conventional frequency modulation (FM). Thus P-11 can communicate not only with stations of the same type, but also with other normal types of frequency-modulated equipments such as car radio stations and fixed stations. As a rule a considerably greater range is obtained when communicating with a fixed station than with another portable unit.

Here are a few examples of the uses of P-11:

- Speed checks and other forms of road traffic control.
- Police reconnaissance, when motor vehicles cannot be used.
- Firefighting: passing orders and reports to hosemen, smoke divers etc.,
- Erection of cables and the like on power line construction,
- Patrol work on power lines,
- Supervision of extensive factory areas for protection against fire, theft or sabotage,
- Air defence: fire fighting and salvage operations.

Apart from its coverage, the usability of a portable radio station is determined by its

- “portability”, i.e. its weight, shape and carrying arrangements,
- ability to withstand mechanical impact and climatic conditions,
- operating time,
- operating economy.

P-11 has been designed for convenience in carrying without loss of manoeuvrability when placed on the ground or on a stand. The handset holder is shaped as a handle for carrying of the equipment. When the station is not in use, the telescopic aerial can be retracted into the instrument. The weight of the unit is 5.3 kg. For moving short distances, it can be carried by the handle, and otherwise by a shoulder strap. For more difficult transport P-11 can be supplied with strapping for carrying on the back, and fitted with additional equipment such as volume control box, single earphone and flexible aerial for use on the march. P-11 is designed for field conditions and use in tropical climates.

P-11 is fed by three 10 Ah silver-zinc accumulator cells with which the set can be operated for 7 hours with 25 % transmitting time. Among the available power sources, the silver-zinc accumulator stands in a class of its own due to its low weight and economy.

Transmitter, receiver and power unit are mounted on a single vertical chassis attached to a panel which forms the cover of the equipment case. On-off switch, volume control, plugs for connection of aerial, handset and handset holder are fitted on the panel. Change of battery can be done through an opening in the panel. With the unit removed from its case all parts are easily accessible for inspection and service.



Fig. 1 X 4935
Portable radio equipment, type P-11



Fig. 2 X 6791
X 6792.
The portable radio equipment in use
Left: by police; right: by civil defence

The oscillator of the transmitter is directly crystal-controlled. Its frequency is 1/18 of the output frequency. The output from the oscillator is phase-modulated directly by the microphone, and the frequency is then multiplied up to the output frequency in three successive stages. The transmitter power stage, containing two valves in parallel, delivers a power of 0.3 W to the aerial, which is connected to the circuit through a send-receive relay.

The incoming signal is amplified in two stages, after which it is mixed with the signal from a local oscillator. The resulting intermediate frequency signal is amplified in three stages and demodulated in a discriminator. After further low frequency amplification the signal passes to the handset or earphone.

Of the three battery cells one supplies power to the valve filaments. The other two cells supply the anode voltage power unit which incorporates a vibrator for rectification.

Technical Data

Frequency range:	34—41 Mc/s
Aerial power:	0.30 W
Frequency multiplication (transmitter):	× 18
Frequency tolerance:	± 0.01 %
Modulation:	FM
Maximum frequency deviation:	± 15 kc/s
Receiver sensitivity (10 db signal noise ratio):	1.5 μ V
Power supply:	3 silver-zinc cells, each 1.5 V, 10 Ah
Power consumption:	6.5 W, reception 7.5 W, transmission
Dimensions:	Length 245 mm Height 185 mm (incl. handset 270 mm) Width 95 mm
Weight:	5.3 kg (incl. battery, aerial, handset and shoulder strap)
Range (depending on terrain, obstructions etc.):	1—4 km

LM Ericsson Exchanges Cut into Service 1953

Exchanges with 500-line selectors

Town	Exchange	Number of lines
<i>Argentina</i>		
Concepción del Uruguay		500
<i>Brazil</i>		
Itararé		200
Mafra		500
Nova Friburgo	(extension)	500
Pelotas		5000
Ribeirão Preto		2500
Tupã		500
Vitória	Central	1000
Vitória	Praia	500
Volta Redonda	1 PABX (extension)	300
<i>Chile</i>		
Arica		500
<i>Colombia</i>		
Bogotá	Centro (extension)	2000
Bogotá	Chapinero (extension)	1500
Bogotá	Las Cruces (extension)	1000
Bogotá	Ricaurte (extension)	1000
Bogotá	Teusaquillo (extension)	500
Medellín	America (extension)	1000
Medellín	Centro (extension)	4000
Pasto		1500
Salamina		300
Santa Rosa de Cabal		500
<i>Denmark</i>		
Copenhagen	2 PABX	700
Copenhagen	2 PABX (extension)	60
<i>Finland</i>		
Helsinki/Helsingfors	1 PABX (extension)	90
Jyväskylä	(extension)	500
Nokia		700
Oulu	(extension)	500
Pori	(extension)	500
Tampere	1 PABX	200
<i>The Faroes</i>		
Torshavn		1500
<i>Indonesia</i>		
Gambir		1000
<i>Italy</i>		
Bergamo	(extension)	500
Brescia	(extension)	1000
Cremona	(extension)	500
Legnago		1000
Mantova	(extension)	500
Messina	(extension)	500

Town	Exchange	Number of lines
Mogliano		200
Napoli	Centro	7000
Napoli	1 PABX (extension)	500
Padova	(extension)	1500
Palermo	Polacchi (extension)	1000
Ragusa	(extension)	260
Reggio Calabria	(extension)	500
Rovigo	(extension)	500
Salerno	(extension)	500
Sarezzo		300
Schio		900
Thiene		700
Treviglio	(extension)	100
Treviso	(extension)	1000
Valdarno		800
Venezia	Centro (extension)	1500
Venezia	Mestre (extension)	1300
Vicenza	(extension)	1000
<i>Mexico</i>		
Mérida	(extension)	2000
México D. F.	Apartado (extension)	500
México D. F.	Chapultepec (extension)	3000
México D. F.	Coyacán (extension)	500
México D. F.	Peralvillo (extension)	2500
México D. F.	Piedad (extension)	2000
México D. F.	San Angel (extension)	500
México D. F.	Tacuba (extension)	1000
México D. F.	Tacubaya (extension)	1000
México D. F.	Valle (extension)	1000
México D. F.	Zócalo	4000
<i>Morocco</i>		
Tanger	(extension)	1000
<i>Netherlands</i>		
Rotterdam	Centrum (extension)	4500
Rotterdam	Noord (extension)	2000
Rotterdam	1 CABX (extension)	460
Rotterdam	1 PABX	400
Rotterdam	3 PABX (extension)	130
<i>Netherlands West Indies</i>		
Curaçao	Otrabanda (extension)	500
Curaçao	Punda (extension)	500
<i>Norway</i>		
Bodø		2500
Kristiansund N	(extension)	500
Moss	(extension)	500
Oslo	2 PABX (extension)	40
Sarpsborg	1 PABX (extension)	40
Selbak	(extension)	240
Trondheim	1 PABX (extension)	80
<i>Peru</i>		
Arequipa	(extension)	1000

Town	Exchange	Number of lines	Town	Exchange	Number of lines
<i>Poland</i>			Stockholm	Örby (extension)	2000
Katowice	18 PABX	6600	Stockholm	11 PABX	2000
<i>Sweden</i>			Stockholm	16 PABX (extension)	1300
Borås	(extension)	3500	Uppsala	(extension)	2000
Göteborg	Vasa (extension)	2000	Värnamo	(extension)	500
Göteborg	Partille (extension)	1000	Västerås	(extension)	2500
Göteborg	Västra Frölunda	9500	Åmål	(extension)	500
Göteborg	3 PABX	480	Ängelholm		3500
Göteborg	4 PABX (extension)	100	Örebro	(extension)	2500
Huskvarna	(extension)	1000	Östersund	(extension)	1500
Hälsingborg	(extension)	500	Various places	12 PABX	4490
Jakobsberg	(extension)	500	Various places	16 PABX (extension)	810
Jönköping		13000	<i>Turkey</i>		
Karlskoga	(extension)	1500	Adana		3500
Karlstad	(extension)	500	Ankara	Merkez Santral	
Kiruna	(extension)	1000		(extension)	1000
Lidköping	(extension)	500	Kayseri		1000
Lund	(extension)	1500	Konya		1500
Norrköping	(extension)	4000	Mersin		1000
Stockholm	Kungsholmen (extension)	4000	Samsun		1500
Stockholm	Enskede (extension)	3000	<i>Venezuela</i>		
Stockholm	Hanviken (extension)	500	Barcelona		600
Stockholm	Huddinge (extension)	6000	Coro		600
Stockholm	Hässelby (extension)	2500	Valera		600
Stockholm	Råsunda (extension)	3000			
Stockholm	Saltsjöbaden (extension)	500			
Stockholm	Sundbyberg (extension)	2500			
				Total	191080

Exchanges with crossbar switches.

Town	Exchange	Number of lines
<i>Denmark</i>		
Aarhus	Aabyhöj	3000
Aarhus	Brabrand	800
Aarhus	Centrum	20000
Aarhus	Risskov	3000
Aarhus	Skaade	1000
Aarhus	Syd	4000
København	Valby	2000
<i>Finland</i>		
Helsinki/Helsingfors	(extension)	4600
	Total	38400

Exchanges with crossbar switches and with 100-, 25- and 12-line selectors. (Extension to existing plants are not included in the figures.)

	Number	Number of lines
Exchanges with 100-line selectors	6	1030
Switchboards with 100-line selectors, system AHD	148	15630
Switchboards with 25- and 12-line selectors, system OL	457	12324
Total	611	28984

Ericsson
LM

NEWS from

All Quarters of the World

Telephone Exchanges for Venezuela New Agreement

Automatization of Maracaibo, Barquisimeto, and Ciudad Bolívar

The Republic of Venezuela has once again shown its confidence in L M Ericsson as a representative of Swedish quality. An agreement has recently been concluded for the delivery of material to a value of nearly two million dollars for automatic exchanges in the towns of Maracaibo, Barquisimeto and Ciudad Bolívar.

Maracaibo is Venezuela's second city and oil-shipping port. Barquisimeto the third largest city and the

centre of all trade in the western part of the country, while Ciudad Bolívar is a rapidly growing town centred in an enormous iron ore district round the Orinoco river.

Ciudad Bolívar was the recipient of L M Ericsson's first delivery to Venezuela in 1916 in the form of a manual telephone exchange. The automatization of the above-named three towns will mean that no less than eighteen towns in Venezuela will

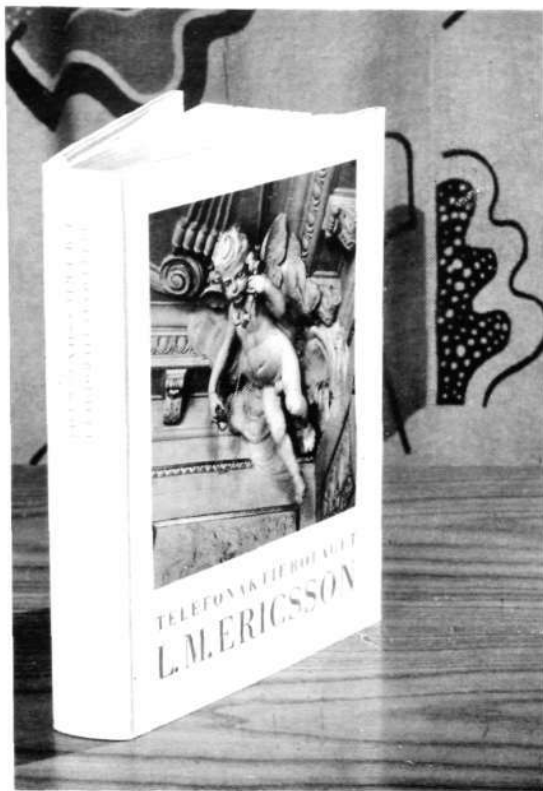
be served by L M Ericsson's automatic telephone systems.

Venezuela has been called the land that floats on oil. Oil has brought prosperity to the country and made its currency among the hardest in the world. It also constitutes the main export item. Venezuela is the largest oil exporting country in the world, with a figure of 70 million tons a year, while as producer it ranks second only to USA.

The shafts lie thick in the oil areas, and oil is even pumped up from the floor of the Maracaibo Sea with ships winding in and out between the derricks. The great oil rush following upon the second world war, and since gaining speed at an accelerated rate, has brought fantastic progress to Venezuela. Great efforts are being made by the government to further industrial and agricultural development and to improve educational and medical facilities. A large part of the national budget is assigned to these purposes and to the extension of roads and railways.

In the vicinity of Caracas, capital city of Venezuela, lies Ciudad University, which with its cultural and social institutions forms a whole town in itself.





The Story of L M Ericsson

Volume I in Print

»Telefonaktiebolaget L M Ericsson» is the title of the first volume in a series of books describing the company's activities through its various stages of development. The compilation of the present volume, with the sub-title »Narratives from the Company's History», was undertaken at the request of the Board by Hemming Johansson, President of the Company from 1909—1925. It reviews the historical development from 1876 to 1918, when the present Telefonaktiebolaget L M Ericsson was formed by the amalgamation of the manufacturing company founded by Lars Magnus Ericsson in 1876 and Stockholms Allmänna Telefonaktiebolag founded by H T Cedergren in 1883.

Instead of confining himself to a chronological account, the author depicts different aspects of the development and at times makes excursions away from the subject in order to obtain a broader view of it. In his accounts of the early history of the company the author has many a time been able to fall back upon his own recollections, where the sources of information were deficient. He started his telephone career in 1893 as engineer with Allmänna Telefonaktiebolaget and during that period his work brought him into contact with L M Ericsson on numerous occasions.

Venezuela's 912 000 square kilometers provide a livelihood for 5 million people, of whom 750 000 live in Caracas, the capital, which has grown rapidly since the war. There has been intense building activity, and the hypermodern autostrada between the port of La Guaria and Caracas—covering a distance of 18 kilometers with numerous bridges and tunnels en route—is calculated to have cost a good 300 million dollars! This distance is now comfortably covered in a quarter of an hour, while on the

old twisting road of roughly twice the length the journey took five times as long.

The high standard of living in Caracas is obvious from the number of large American cars. There is an enormous motor traffic, and the road system covers some 8,500 kilometers.

Automatic Telephones in Visby

The 5,500-line automatic exchange supplied by L M Ericsson for Visby was cut over, in accordance with schedule, between 5 a.m. and 6 a.m. on Sunday, April 4.

The map below shows Venezuelan towns that already are, or shortly will be, equipped with L M Ericsson's automatic telephone systems.

L M Ericsson has its own company in Venezuela, Cía Anónima Ericsson, with address Apartado 3548, Caracas. The head and managing director of the company is Mr. Ivar Hilfing.

This exchange is designed on the Swedish Telecommunication Administration's marker system, and is the first of a series manufactured by L M Ericsson.



Management Appointments

The Board of Directors of Telefonaktiebolaget L M Ericsson has announced the appointment of two new Executive Vice-Presidents of the Company. Nils Sterner and Hans Thorelli are to be joined by Hugo Lindberg and Holger Ohlin, the new appointments taking effect as from April 1, 1954.

At the same time Cornelius Berglund and Göte Fernstedt have been appointed Vice-President in charge of Sales with Dr Yngve Rapp as Assistant Vice-President.

Dr Christian Jacobaeus becomes Vice-President (Technique and Research) as from the same date. In addition, Olof Hult and Edvin Jons-son have been appointed Vice-Presidents in charge of questions relating

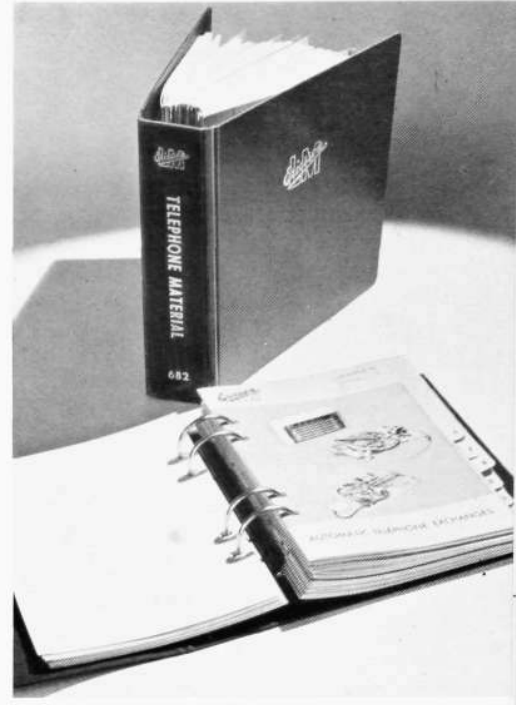
to foreign and Swedish production respectively.

Malte Patricks and Eric A Ericsson were at the same time appointed Vice Presidents in charge of the two Telephone Exchange Departments. Ragnar Stålemark has been appointed Vice-President in charge of the Transmission Department.

New Export Catalogue

L M Ericsson's Export Catalogue of Telephone Material has now been issued in an English edition, No. 682.

This catalogue replaces the earlier No. 632 and has been divided into 12 sections containing altogether 19 separate parts. This has been done in order to give a clearer arrangement to the catalogue and to provide means of keeping it up to date by the insertion of new parts.



From the Visitors' Book

At the beginning of April L M Ericsson's Midsommarkransen factory was visited by a French delegation sent to study Swedish industrial conditions. The delegation included representatives both of the French Government and Trades Unions. In the picture to the right the delegation is being «shown round» the model of the factory in the demonstration room.



L M Ericsson recently had the pleasure of receiving distinguished Turkish visitors in the persons of Arif Demirer, Director General of the Turkish P.T.T. (second from right in the picture to left) and Adnan Börü, Technical Director (extreme left), who had a look round the factory.

(Right.) A 500-line selector in process of manufacture being demonstrated to the Argentine Minister, Enrique Plate, the Commercial Secretary Italo Brero and former Commercial Secretary Ramón Meira Serantes. The Argentinean guests were accompanied by Mr Göte Fernstedt, left, and Mr Eric Carnell, Director of Compañía Sudamericana de Teléfonos L M Ericsson S.A.



L M Successes in Turkey

L M Ericsson has recorded notable successes in Turkey, which is at present going through a process of transformation with striking expansion of the country's industrial power.

At the beginning of 1953, as mentioned in a previous issue, extensive contracts were signed with the Turkish Telephone Administration, and another important contract followed in the autumn of the same year. The latter contract comprised the extension of the automatic telephone exchanges in Ankara and Izmir (Smyrna) for 13 700 lines. In addition, an agreement has been concluded for maintenance of the already existing automatic exchanges at Eskisehir, Sivas and Old Izmir. At the same time 15 000 telephones are to be delivered to Turkey.



L M Ericsson in Canada

Castle Building, dominating one of the busiest street corners in the centre of Montreal, houses the offices of L M Ericsson's Canadian company, Ericsson Telephone Sales of Canada Limited.

The Managing Director is Mr E J L Kühn.



Beyrouth Automatic Exchange Opened by the Lebanon President

The recently completed automatic exchange and trunk exchange at Beyrouth, the capital of Lebanon, has been put in operation. It was opened on May 1st in the presence of the president of the republic, Camille Chamoun who was accompanied by

the head of the government, Abdallah Yafi, the PTT minister, Nicolas Salem, and the general directors for the telephone, post and telegraph administrations. The illustration shows the president starting the power equipment for the exchange.

New Applications for the L M Ericsson Telephone Answering Machine

The L M Ericsson telephone answering machine has been very favourably received by the public and is of indispensable assistance to professional persons such as doctors, solicitors and dealers who are dependent on their telephones being attended in one way or another.

Certain departmental stores have now applied this gadget for another purpose. The »Nordiska Kompaniet» in Stockholm each day supplies special advice to the customers by means of a telephone answering machine placed in the large entrance hall. A poster reads: »Lift the receiver for to-day's N. K. special offers» an invitation that the contented N. K. customer in the picture has just availed herself of.

Another application for the telephone answering machine has been found by the newspaper offices. In Gothenburg the answering machine provides the »voice that gives you the tip». The newspaper »Aftonposten» has opened a new service for the general public, based on the telephone answering machine, which reports the latest news, On Sundays

these news mainly consist of the football results for the football pools or the home team matches. Soon after close of play it is thus possible to phone the newspaper and receive the result figures for the favourite team or what the case may be.



U.D.C. 621.395.341:654.152.06

LINDEROTH, M: *Automatic Call Distributors for Information, Booking and Similar Offices*. Ericsson Rev. 31 (1954) No. 1 pp. 8—13.

Telephone exchanges for reception services such as information and booking offices take to a great extent the character of call distributors. It is, therefore, very important from economical as well as service point of view to arrange waiting facilities and connection to the clerks (or group of clerks) in proper rotation. According to the nature of the service and the working conditions of the clerks the call distribution can be fully automatic or semi-automatic. A few view points are given with reference to the arrangement of the call distribution as well as a brief description of the fully automatic call distributors which have been delivered by Telefonaktiebolaget L M Ericsson to the information office of the Swedish State Railways in Gothenburg.

U.D.C. 621.395.364
621.395.344(471.1)

AHLSTEDT, B: *Traffic Reliability for the L M Ericsson Crossbar System in Helsinki*. Ericsson Rev. 31 (1954) No. 1 pp. 2—7.

An article in Ericsson Review No. 4, 1950 outlined the fundamental construction of the crossbar system, which L M Ericsson is supplying to the Helsinki telephone system. Up to now crossbar equipment for 22,800 number has been put into operation out of which 4,400 are PBX connections. The article describes the experiences of these installations as regards traffic reliability. The author has selected the investigation results from the last twelve months from the comparatively heavily loaded groups. The article also outlines the principles and methods applied by the Helsinki Telephone Corporation to determine the traffic reliability in their installations.

U.D.C. 621.385.382:621.318.572

STERNBECK, O: *Coaxial Trochotron for Pulse Counting*. Ericsson Rev. 31 (1954) No. 1 pp. 14—17.

The action of the trochotron is based on the characteristics of an electron beam in a magnetic field that is crossed by an electric field. A number of types of electron tubes have been developed by Telefonaktiebolaget L M Ericsson on the trochotron principle. One of them, designated RYG 13, manufactured by AB Svenska Electronrör, is described in the article.

U.D.C. 621.319.414

BOHLIN, T: *New Rack Mounting Capacitor*. Ericsson Rev. 31 (1954) No. 1 p. 18.

AB Rifa have produced a new type of rack mounting capacitor with many advantages, which are shortly described in the article.

U.D.C. 654.938

SKOG, R: *Key-set Operated Staff Locator System with Sequence Paging*. Ericsson Rev. 31 (1954) No. 1 pp. 19—22.

In recent years there has been an increasing demand for a reasonably priced staff locator system allowing the paging of a comparatively large number of persons. The L M Ericsson range of staff locator systems has, therefore, been augmented by a new visual system which enables the paging of up to 100 alternatively 200 persons with flash signals on five-lamp panels.

U.D.C. 654.938

SKOG, R: *Staff Locator Panels*. Ericsson Rev. 31 (1954) No. 1 pp. 23—24.

A short survey of a number of new types of staff locator panels, which are to be used in the L M Ericsson visual staff locator systems.

U.D.C. 621.396.73

BEHR, K: *Portable Radio Equipment, Type P-11*. Ericsson Rev. 31 (1954) No. 1 pp. 25—26.

An easily portable radio equipment, type P-11, providing telephone communication over a range of a few miles, has been brought out by Svenska Radioaktiebolaget. The new equipment is adapted to a multitude of uses, by the police, fire brigades, power stations, industry, air and civil defence.

The Ericsson Group

Associated and co-operating enterprises

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AB Rifa Ulvsunda, tel: 26 26 10, tgm: elrifa-stockholm
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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
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Sieverts Kabelverk Sundbyberg, tel: 28 28 60, tgm: sievertsfabrik-stockholm
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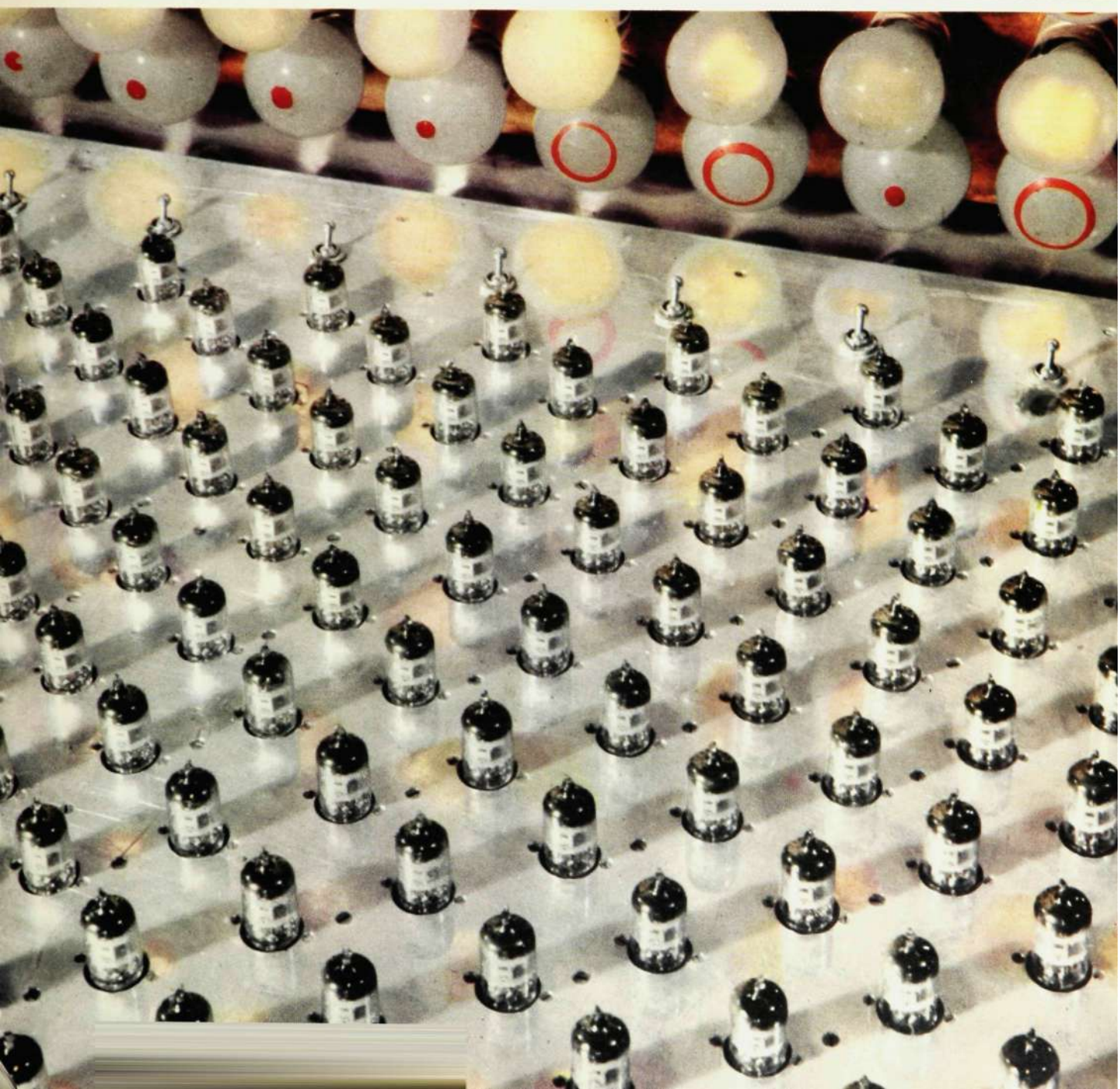
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ERICSSON

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Review



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Gas Control on Telephone Cables by Gas Flow Meters and Automatic Pressure Compensation

A HENCKEL, TELEFONAKTIEBOLAGET L MERICSSON, STOCKHOLM

U.D.C. 621.315.211.4

In an article entitled »Gas Control on Telephone Cables» published in the Ericsson Review No. 4/1952 a new method was described by means of which, on the occurrence of a leak, gas is also fed into the cable automatically simultaneously with the gas control, whilst at the same time the drop of pressure in the gas is recorded. The following article describes this method in greater detail as well as the necessary apparatus and materials employed. The method itself and a part of the apparatus have been patented.

General

In the two systems employed hitherto for gas control on telephone cables the principle followed has consisted in dividing up the cable or cable network into a number of pressure-tight sections separated from one another, each such section being provided with a suitable number of pressure sentinels and valves. When a leak occurs an alarm is given, whereupon an approximate localization of the fault can be undertaken either by plotting a pressure curve for the faulty section, or by the bridge measurement of the resistance up to the pressure sentinels sending out an alarm, depending upon the type of pressure sentinel installed in the system. In the two systems mentioned above the pressure drops along the whole section on the occurrence of a leak. In the case of a large leak two days are usually available for repairing the fault after the alarm has been received. For smaller leaks it is permissible to wait for a longer period; when the leak is very small it may even be worth while in certain cases to allow the cable to remain untouched, and feed in gas instead from time to time from both end points of the section.

In L M Ericsson's new system the cable or cable network is provided with a suitable number of gas cylinders which, via reducing valves and pressure regulators, maintain the cables under a constant pressure continuously. When a leak occurs gas flows in from both sides and fresh gas is fed in automatically from the gas cylinders which maintain the cable section under pressure. In this system, therefore, the pressure at the ends of the section is always constant. As the gas leaves the gas cylinder, it passes a signal manometer which gives an alarm. Thus pressure sentinels are not required. At the same time that the signal manometer closes an alarm circuit it sends out an impulse to an indicating receiver, which then records the volume of the gas flowing out. When the gas flow becomes stationary, readings are taken from the counters on both sides of the fault; direct information concerning the position of the fault is then obtained (with the same accuracy as in the older system, that is to say, to within about 2 % of the section's length). It will be realized from what has been said above that the new system possesses many advantages over the older one:

1. The cables are more effectively protected against the penetration of moisture since the over-pressure cannot fall to 0 (as long as any gas remains in the cylinders) but assumes a certain value depending upon the size of the leak and the distance of the fault from the gas cylinders.
2. Gas refilling takes place automatically which is accompanied by the fact, amongst other things, that small leaks can be neglected entirely until it is desired to repair them, or they may be left alone altogether since the cost of the gas is very small, whereas the costs for repairs may be considerable in some cases (as for example, when it is necessary to break up the street paving).

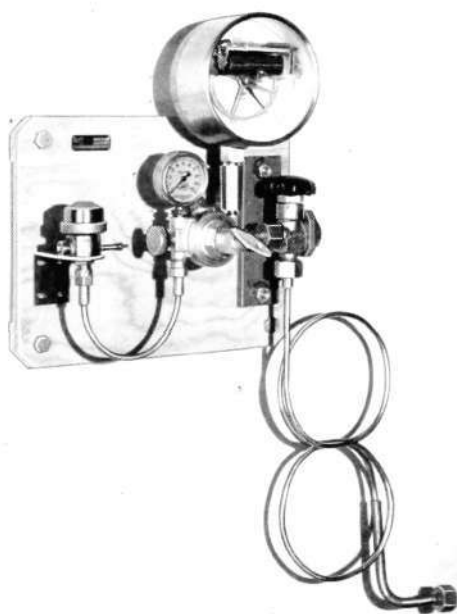


Fig. 1
Pressure control unit NVB 3001

X 4952

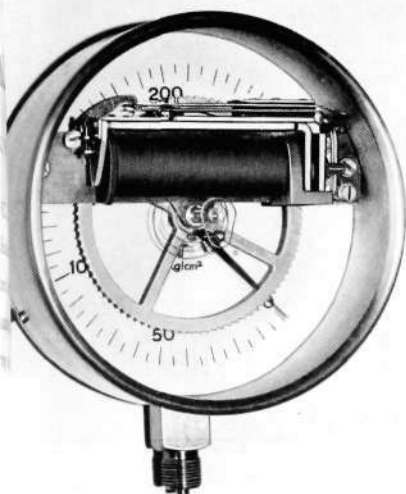


Fig. 2
Signal manometer
LTP 2061

X 4953

3. The supervisory equipment is conveniently accessible in amplifier stations or automatic stations or in similar premises. No pressure sentinels are required.
4. Fault localization is simplified and rendered cheaper. No pressure curves need be plotted along the cable and no bridge resistance measurements made.

EQUIPMENT

I. Stationary Installation

1. PRESSURE CONTROL UNIT NVB 3001

The pressure control unit *NVB 3001* is mounted nearest to the gas cylinder, and consists of the constant regulator *LTP 2124* with signal manometer *LTP 2061*, fig. 2, pressure regulator *VAN 2301*, cut-off cock *NVB 1021*, high pressure pipe unit (for connection to the gas cylinder) *NVB 1351* and pipe units for the connections between the different parts. The whole equipment is mounted on a teakwood panel.

a. Signal Manometer *LTP 2061*

The signal manometer constitutes »the brain» of the system and sends out alarm impulses and impulses to a separate indicating receiver. It consists of an ordinary hydraulic pointer manometer graduated from 0 to 250 kgs/cm^2 * and is provided with a signal mechanism which mainly consists of a pilot relay and a ratchet-wheel with a spiral spring, see fig. 2. The protective plate is provided with an opening at the centre through which the ratchet-wheel can be wound up by means of a screw driver.

A plate is placed on the pointer and makes contact with a pin on the ratchet-wheel, whereupon a circuit is closed. When the pressure in the gas cylinder to which the manometer is connected begins to fall, the pointer moves over the scale in a counter-clockwise direction. After the pointer has moved for a certain distance in this direction the contact between it and the ratchet-wheel is closed and the pilot relay then operates and feeds the ratchet-wheel forward a half-step in the same direction. At the same time an impulse is transmitted to the nearest attended station where an alarm is given simultaneously with the recording of the impulse. The impulse relay has now been deenergized which thus causes the ratchet-wheel to be moved forward a further half-step. After this first contact has been established, with the resulting forward movements of the ratchet-wheel totalling a whole step, the pressure must now fall further to a given value which has been selected as 3.75 kgs/cm^2 before a new contact can be set up between the pointer's plate and the ratchet-wheel pin, and also subsequently when the pressure falls further. A newly filled gas cylinder normally has a pressure of 150 kgs/cm^2 so that a pressure drop to 0 would correspond to 40 impulses.

Immediately above the text, " kg/cm^2 ", on the scale dial a small contact strip is mounted which establishes contact with the pin on the ratchet-wheel when the pressure in the cylinder has fallen to about 30 kgs/cm^2 . The circuit of an observation lamp can thus close and an indication is given that it will soon be necessary to change the cylinder.

b. Pressure Regulator *VAN 2301*

If the signal manometer constitutes the »brain» of the system, the pressure regulator may be regarded as its »heart», since it pumps in gas when a leak occurs. The gas then flows from the gas cylinder through a constant regulator, the high pressure manometer for which is the previously described signal manometer *LTP 2061*, and passes on through the pressure regulator

* According to the international agreement reached on the conclusion of the second world war, the pressure unit kg/cm^2 should be replaced by kp/cm^2 (kiloponds/cm²). Since 1 kg as a unit of power varies according to the gravitational acceleration of the latitude, by introducing a unit of 1 $\text{kp} = 980,665 \text{ dynes/cm}^2$, a standard value has been obtained for power irrespective of the latitude. In this respect the difference is insignificant, however, (the gravitational acceleration varies about 5‰ from the equator to the pole) and it is still most customary to indicate pressure in kg/cm^2 even when—as in this case—the manometer indicates a pressure which is independent of the latitude.

VAN 2301 before it flows into the cable. The pressure regulator can be set with great accuracy for the over-pressure to be applied to the cable. As long as the cable is sound the pressure regulator remains in the stationary position, but as soon as the pressure in the cable begins to fall a valve is opened and allows the gas to flow into the cable. When the over-pressure in the cable has been restored, the valve cuts off the gas supply.

The pressure regulator is constructed in such a way that an eventual fault in it can not entail that the over-pressure in the cable exceeds the normal.

2. INDICATING RECEIVERS

For long distance cables and in branched cable networks the relay set *BCV 21001* is used as the indicating receiver, while for smaller networks the relay set type *BCV 212* is employed. Both relay sets can either be mounted on a wall or a framework. They can be pivoted out to permit convenient access to the relays' soldering tabs. The rectifier *BMA 1704* is employed for a 24 V operating voltage.

a. Relay Set *BCV 21001*

This relay set which is constructed in the form of a counting mechanism, contains 6 relays and a maximum of 6 impulse counters, depending upon the number of pressure control units used. Simultaneously with the recording of an impulse a red control lamp lights up. An alarm bell may be connected to the relay set by means of special alarm wires. The alarm bell is disconnected and the control lamp switched out by a spring push-button. The operating voltages usually employed are 130 V and 24 V D. C. 130 V was chosen on account of the fact that this voltage is generally available in amplifier stations. The apparatus can also be constructed for other voltages than those mentioned above.

b. Relay Set Type *BCV 212*

This relay set is constructed solely in the form of an indicating mechanism and therefore has no impulse counter. It contains 8 relays, two of which are cam-disc relays. Two control lamps are included in this set; a red one for indicating large leakages, that is to say, when the leak is so large that the signal manometer transmits more than one impulse within a certain time, for example per day, and a green lamp that lights up when the pressure in the gas cylinder has fallen to 30 kgs/cm².

The relay set is also provided with two pairs of contacts for connecting the alarm conductors to the 220 V network.

The red lamps is switched out by a spring push-button. On pressing this push-button which is fitted with a locking device, the lamp or bell connected

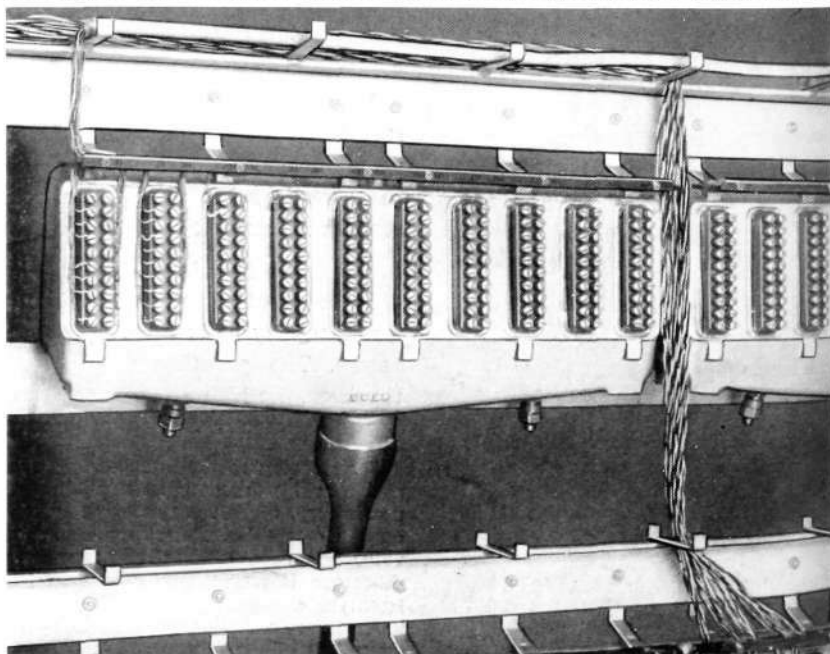
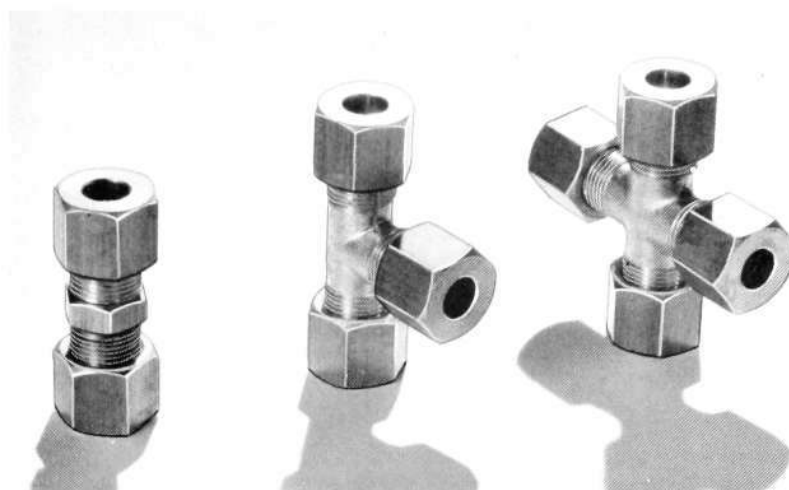


Fig. 3
Cable terminal boxes mounted on a
frame

X 6802

Fig. 4
Pipe couplings, from the left,
NVB 13001, NVB 13011, and NVB 13021

X 6803



to the extra alarm conductors is disconnected. The green lamp is not switched out, and this only takes place after a new gas cylinder has been inserted.

Only 24 V D. C. is required for this relay set.

c. Rectifier BMA 1704

The operating voltage is 24 V and the rectifier can be reconnected for single-phase alternating current, 110, 127, and 220 V, 40—60 c/s. The rectifier is mounted on a wall.

3. BOXES

If the cables are fitted with, or are intended to be fitted with gas-tight plugs, they can terminate in L M Ericsson's standard connection boxes. If this is not the case one of the following pressure-tight boxes may be selected:

<i>NCL 4513</i> (30-pairs)	<i>NCL 4515</i> (50-pairs)
<i>NCL 4514</i> (40-pairs)	<i>NCL 4516</i> (60-pairs)
<i>NCL 4520</i> (100-pairs)	

The boxes are provided at the bottom with two threaded holes, in one of which the nipple *NVB 1171* can be inserted and the control valve *NVB 1181* in the other (see further on). The boxes may either be mounted on a wall or on a framework, see fig. 3.

For coaxial cables so-called coaxial boxes are used, these now being of the cylindrical type. The operating conductors are connected to protector terminal boxes, usually *NCN 2501* or *NCN 2502*.

4. PIPING MATERIAL

The piping consists of 8 mm tombac or copper pipes having an internal diameter of 4 mm. All the other material is adapted for use with pipes of these dimensions.

For jointing and branching the piping the pipe couplings *NVB 13001*, *NVB 13011*, and *NVB 13021* are used, see fig. 4. No brazing is necessary at the site when installing the couplings. When drawing the nut tight it is forced by means of a tightening ring provided with a cutting edge into the cone of the nipple, whereupon the front part of the tightening ring is crushed together and cuts into the pipe. The material which is thus pressed up round the pipe forms a shoulder which holds the pipe in position.

The connection produced in this way fulfils the highest demands with regard to pressure, fatigue stresses and tightness provided that installation is carried out correctly.

For disconnecting the individual cables separately, cut-off cocks *NVB 1011* are employed, and these are fitted with the same tightening system as the pipe couplings described above. For connecting the pipes directly to the cables connecting washer type *NVB 112* (with a radius of curvature corresponding to that of the cable or jointing sleeve) is soldered to the cable, the nipple *NVB 1171* being screw-threaded into the washer after a hole has been drilled in the cable sheath with a cable sheath borer *LTP 2161*. A packing *SCG 20001* is used

Fig. 5

X 6804

Material for gas pressure-protected cables from the left, connecting washer *NVB 1121*, plug *NVB 1151*, nipple *NVB 1171*, control valve *NVB 1181*, and packing *SCG 20001*.



for tightening. In certain cases connecting washers only are soldered to the jointing sleeves along the cable section and terminate in a plug *NVB 1151*. A control valve *NVB 1181* can subsequently be screwed into the washer when desired for purposes of control. The nipple *NVB 1171* and control valve *NVB 1181* are also used for the pressure-tight boxes. The above-mentioned parts are illustrated in fig. 5.

At the transition points between the pressure control unit and piping system and between the latter and the connections to the cables or boxes the piping must terminate in a sealing extension which is brazed to the pipe. In order to avoid brazing at the installation site as mentioned above, special pipe units are available, *NVB 1331* (15 cm long) and *NVB 1332* (25 cm long) which are previously fitted at one end with a brazed sealing extension of this kind and a box nut, see fig. 7. These pipe units are jointed to the other piping by means of the pipe coupling *NVB 13001*.

The separate piping for each cable should be provided, via a pipe coupling *NVB 13011*, with an attachment which in turn is fitted either with a cut-off cock *NVB 1011* (as shown in fig. 13) and a pipe with a hose socket *NVB 1341* (fig. 7) suitable for a plastic hose having the external and internal diameters of 14 and 8 mm respectively, such as Polva SSY 84, or with a pipe coupling *NVB 13031* and valve *1/NVB 1101*, fig. 6. The valve *1/NVB 1101* forms part of a bayonet coupling the other part of which consists of a nozzle *2/NVB 1101* which is screwed to the apparatus to be inserted in the attachment. When the nozzle is pressed into the valve the passage is open for the flow of gas, but as soon as it is withdrawn from the valve, the latter cuts off the gas.

The clamps *NSV 2829* are employed for fixing the piping to a wall.

Fig. 6

X 4978

Bayonet coupling *NVB 1101* from the left, valve *1/NVB 1101* and nozzle *2/NVB 1101*.

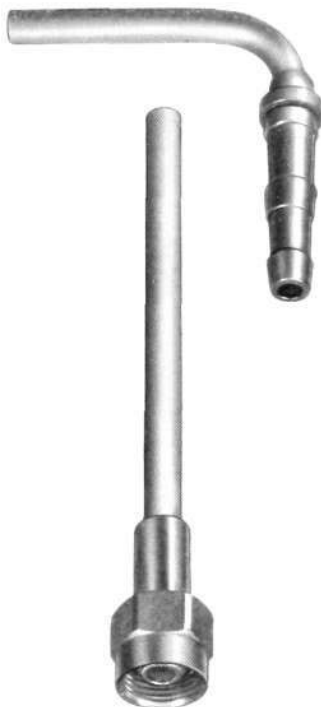


Fig. 7

X 4981

Pipe units *NVB 1341* (above) and *NVB 1331*.

II. Apparatus for Fault Localization

1. PRESSURE TESTING UNIT LTP 2001

This unit is designed for portable use, see fig. 8, and consists of a box containing the same parts as those included in the pressure controlling unit *NVB 3001* with the exception of the 8-shaped high pressure pipe unit which here bears the designation *NVB 1352* and the signal manometer *LTP 2061* which is here replaced by a high pressure manometer *LTP 1501*. In the cover, which can be completely removed, a hose pipe *NVB 2221* for connection to the cable and the high pressure pipe unit for connection to the gas cylinder are fixed. The hose pipe *NVB 2221* consists of a plastic hose 2 metres in length with a sealing extension at each end.

2. RADIATION INTENSITY METER LMK 3001

For accurate fault localization (see page 45) radon is used and is traced with the help of a radiation intensity meter *LMK 3001*. The latter consists of a radiation detector *1/LMK 3001* and a radiation indicator *2/LMK 3001*, see fig. 9.

The detector is housed in a rainproof metal casing equipped with a change-over switch for three different sensitivity ranges and for controlling the battery voltage. It has non-loosable screws and can be easily opened for changing the batteries or tubes. The detector is very small and light, having dimensions of 21 cm × 8.5 cm × 8 cm and a weight of 1.75 kgs.

The radiation indicator is a pointer instrument calibrated in radiated impulses per minute. The instrument is built into a small and robust leather case fitted with a strap. The connecting cord is also placed in the case.

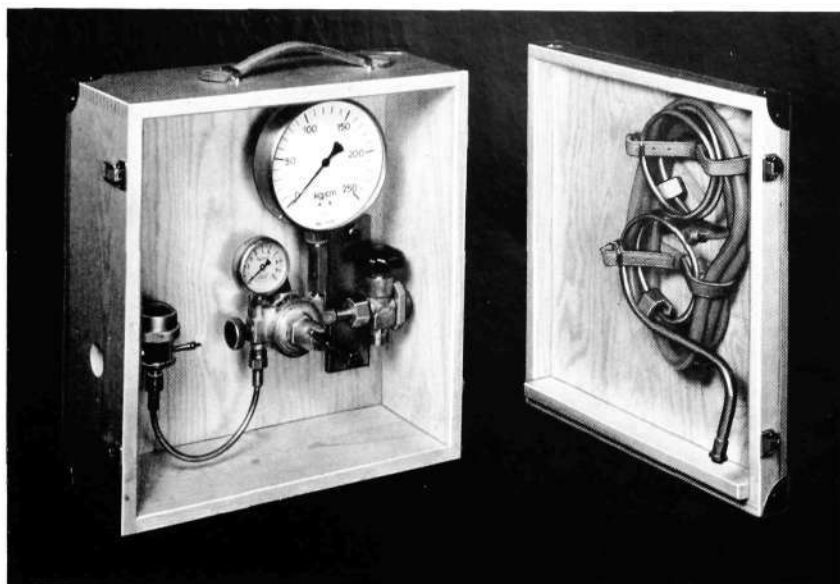


Fig. 8
Pressure testing unit LTP 2001

X 6805

3. INJECTION EQUIPMENT

For the injection of radon (see section on Accurate Fault Localization further on) the following are employed: gas cylinder LTP 2043 (1 litre nitrogen cylinder) a constant regulator LTP 2123, a hose pipe LTP 2221, a connecting washer of the type NVB 112, a plug NVB 1151, nipples NVB 1171 and NVB 1172, a valve 1/NVB 1101 with a nozzle 2/NVB 1101, together with hose clamps LTD 2401, a copper cloth No. 50, protective gloves (preferably of thin rubber), pliers LSD 32402 or LSD 32404, pincers with milled ends LSH 2003 and radon ampoules.

The above parts are placed in an injection toolbox type *LTT 206* which also contains general tools and jointing material. The dimensions of the toolbox are 55 cm × 32 cm × 17 cm.

A connecting washer and plug remain at each injecting point after injection. In addition, two hose clamps, a radon ampoule and a pair of protective gloves are required for every injection. Furthermore, a part of the copper cloth and a part of the hose are used. When the latter has been used up, the sealing extensions are moved over to a new two-metre plastic hose, such as Polva SSY 84. Care must be taken to see that the hose fits tightly over the sealing extensions. For this purpose the ends of the hose may be heated up carefully when they are being fitted on, for example.

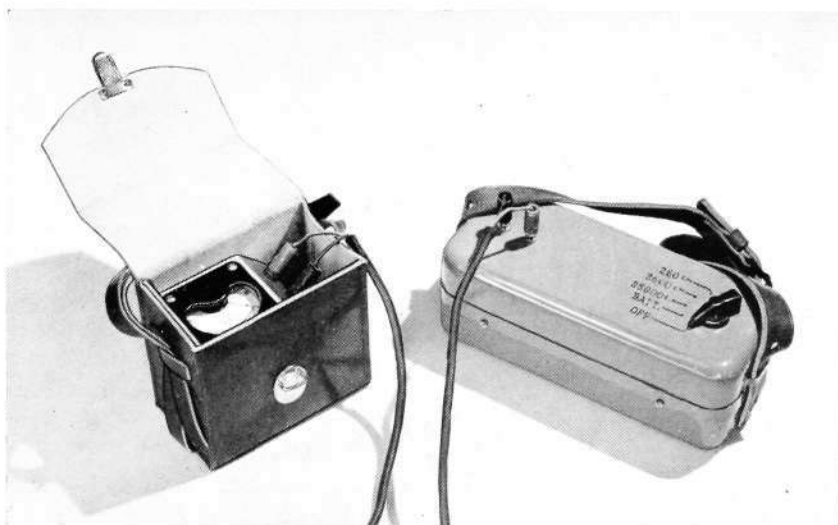


Fig. 9
Radiation intensity meter LMK 3001
right, radiation detector 1/LMK 3001, left,
radiation indicator 2/LMK 3001

X 6806

INSTALLATIONS IN SERVICE

General

In order to ensure that a gas entirely free from moisture is available, nitrogen is always employed nowadays. This gas is supplied in gas cylinders and is sold in most countries by AGA, for example. The purity never falls below 995 ‰ and is generally as high as 999 ‰.

The gas pressure should be chosen with regard to the construction and size of the cables; thus, for example, the following values of overpressure may be found suitable:

0.7 kg/cm² for coaxial cables and large cables (external diam. $d > 5.5$ cm)

0.6 kg/cm² for medium-size cables (3 cm $< d < 5.5$ cm)

0.5 kg/cm² for small cables (2 cm $< d < 3$ cm)

0.4 kg/cm² for the smallest cables ($d < 2$ cm)

These values hold good for a temperature equal to the mean annual temperature of the soil.

The requirements will not be met, however, if the cables are leak-proof but the ends are not sealed. The simplest method of sealing the cable ends consists in leading them into pressure-tight boxes. Nevertheless, it may be found desirable in many instances to retain the cable boxes already available, or to employ »standard» boxes, i.e. boxes that are not pressure-tight, for some reason or other. In such cases a gas-tight plug must be inserted in the cable a short distance from the box. A description of these gas-tight plugs will be found in the Ericsson Review No. 4/1952 in the article »Gas Control on Telephone Cables». Detailed instructions for producing gas-tight plugs are given in special directions for installation.

In the following description of cable installations under gas control in accordance with L M Ericsson's new method particulars are given of three types of installations, namely, for long distance cables, for small cable networks and for large, branched networks, since both the equipment and its method of functioning vary somewhat in the different cases.

I. Gas Control Installation for Long-distance Cables

The term, long-distance cable, here implies a cable that is at least ten kilometres in length. The construction of a gas control installation according to the new method for a coaxial cable with two manned terminal stations S_1 and S_{12} and ten unattended amplifier stations S_2 — S_{11} is described below. The distance between the stations is usually about 10 kms. Each station is equipped with a gas cylinder and a pressure control unit NVB 3001, see fig. 10, while the terminal stations alone are provided with indicating receivers, in this case counting mechanisms (relay set BCV 21001).

The electrical circuit diagram may be seen from fig. 11. The nearest half of the number of unattended stations is supervised from each of the two manned terminal stations. The pilot relays are distributed over 4 operating wires which may, however, be used at the same time as service conductors. The diagram in fig. 11 may best be explained by means of the following example. At station No. 6 the pressure in the gas cylinder has fallen to such an extent that the pointer on the signal manometer makes contact with the pin on the ratchet-wheel. A circuit is then closed from the plus pole through R_1 , the pilot relay at station No. 6 and R_4 to the minus pole. All three relays operate. The pilot relay moves the ratchet-wheel forward a half-step and is at the same time held in position. By the operation of R_1 and R_4 positive passes through make contacts to IR_6 which operates. R_5 is thereby energized and breaks the circuit of the pilot relay at station No. 6. The pilot relay will thereupon drop out and move the ratchet-wheel a further half-step. The plus side is simultaneously connected to R_6 which closes different alarm circuits. The relays R_1 and R_4 released when R_5 was energized whereupon IR_6 released and the counter mechanism recorded an impulse. R_5 is deenergized at the end of the delayed action period while R_6 must be reset manually.

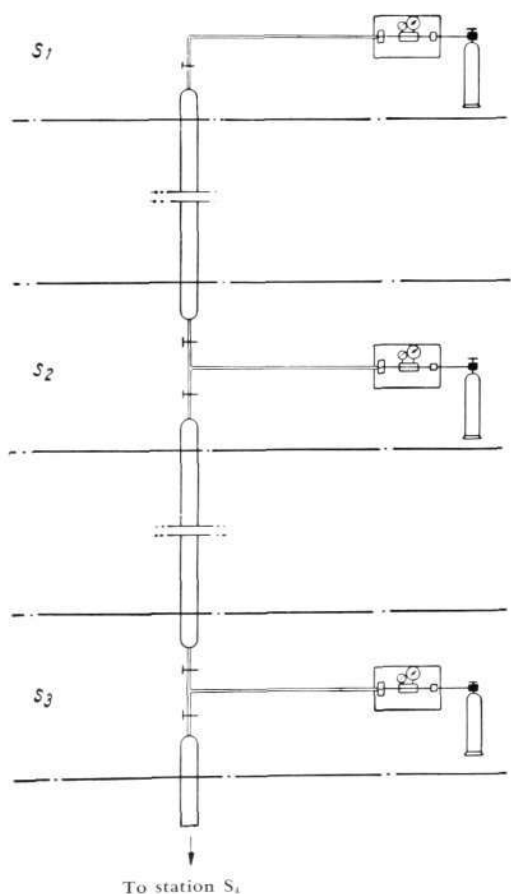


Fig. 10

Schematic diagram of gas controlled cables in coaxial cable installations

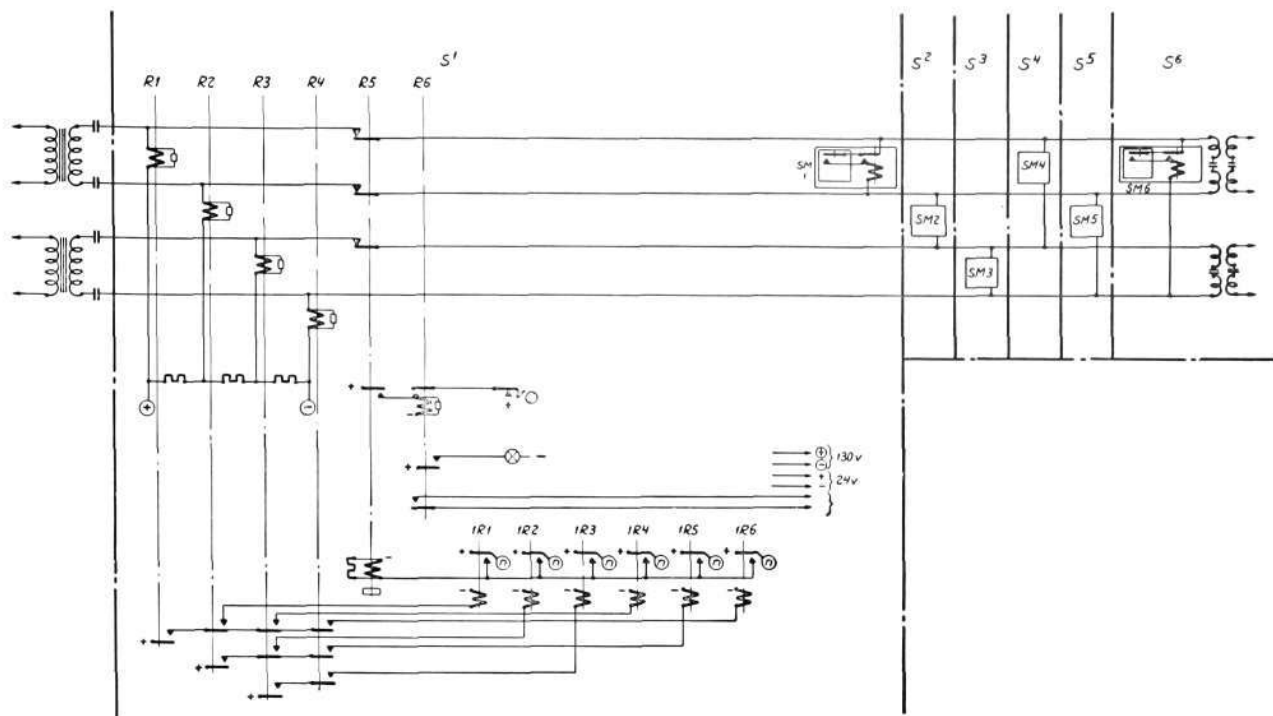


Fig. 11 X 7665
Schematic diagram of the relay equipment for long distance cables

In the above example the cable connects two manned terminal stations between which there are ten unattended stations. If the length of the cable exceeds 110 km it is customary to have a larger number of manned stations; usually there is a maximum of 12 unattended stations between two manned ones. A terminal station need not, of course, always be manned, but in such a case one of the intermediate stations is provided with a staff. In this event it is usual to place a maximum of 6 unattended stations beyond this intermediate station.

As is shown in fig. 11 four operating wires are required in the cable, which, however, need not be used in a manned station as the gas cylinder and pressure unit are located in the same building as the relay- and alarm equipment. Thus, by means of the 4 operating wires in the cable, 6 unattended stations can be supervised in each direction. In the event of there being more than 12 unattended stations in sequence, it is possible with the help of 2 additional operating wires to supervise up to 30 unattended stations in sequence (i.e. 15 stations in each direction).

II. Gas Control Installation for Small Branched Cable Networks

In a city an administrative body such as an electric supply company frequently has a private external telephone network between its head office and branches or substations. The telephone cables between these offices or stations are usually of relatively small dimensions and are not very long. In order to place a telephone network of this description under gas control it is only necessary to employ one pressure control unit with gas cylinder and one indicating mechanism, in this case of the type BCV 212. This apparatus should preferably be installed in the main station. All distribution of the gas to the cables will then take place from the main station. The pressure control unit is connected through a pipe distribution system either directly to the cables as illustrated in fig. 12, or to the connections at the pressure-tight boxes. Fig. 13 shows an example in which connection is made to twelve terminal boxes.

In a gas control system of the type discussed under I a daily record must be kept of the readings from the impulse counters. In a smaller system, on the other hand, which is only equipped with one gas cylinder, it is desirable to be able to dispense with this routine control, on which account the relay- and alarm equipment is so designed that no alarm is given on the occurrence

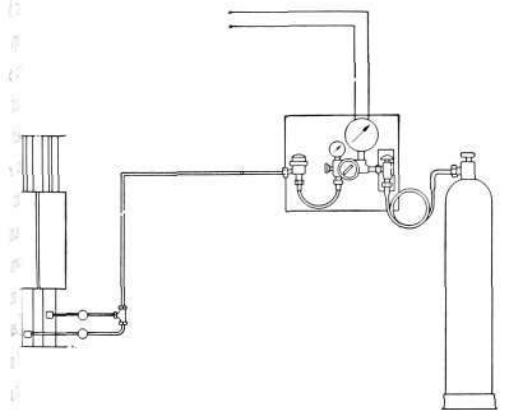


Fig. 12 X 4956
Gas control equipment in an amplifier station for a coaxial cable installation

- 1 gas cylinder LTP 2042
- 2 high pressure pipe unit NVB 1351
- 3 pressure control unit NVB 3001
- 4 pipe coupling NVB 13021
- 5 " " NVB 13011
- 6 " " NVB 13001
- 7 cut-off cock NVB 1011
- 8 nipple NVB 1171
- 9 packing SCG 20001
- 10 tombac or copper pipe, 8 mm external, 4 mm internal diameter
- 11 pipe unit NVB 1332
- 12 pressure-tight box, type NCL 45
- 13 pipe unit NVB 1341
- 14 clamp NSV 2829
- 15 pipe unit NVB 1331

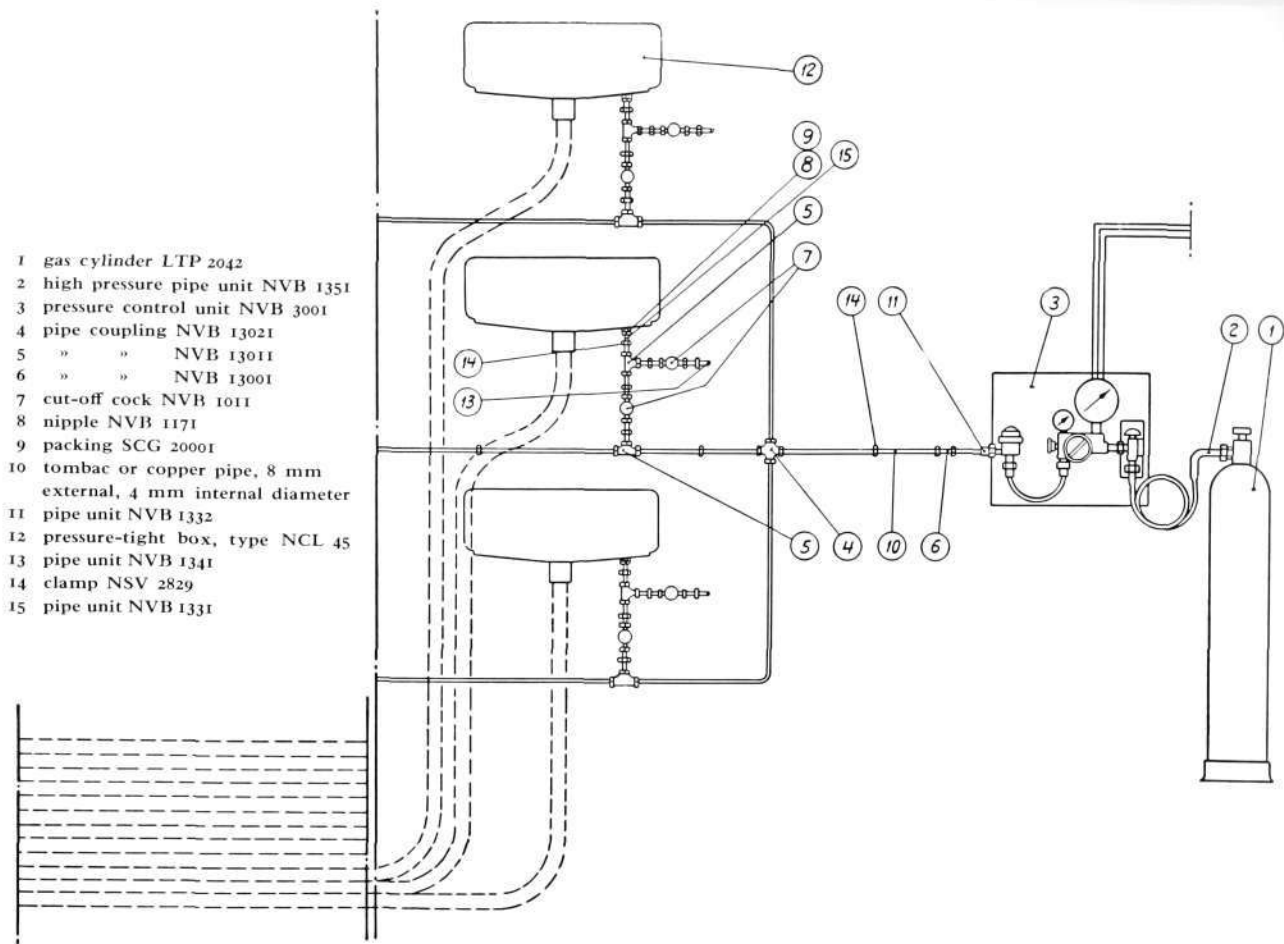


Fig. 13
Central station in a branched cable network

X 7666

of leaks which are regarded as so insignificant that a continuous supply of the gas is found preferable to the repairing of the damaged cable sheath. In this case, therefore, it is unnecessary to control the fall of pressure in the gas cylinder continuously since a separate alarm is given when the gas in the cylinder is nearly exhausted. For the same reason an impulse counter is not needed.

The electrical circuit diagram for the alarm system is shown in fig. 14. As may be seen, the system includes a thermal springset and two cam-disc relays the purpose of which is to transmit an alarm signal when more than one impulse is received within a given time, such as 24 hours. The requirements regarding the limits which should be set between an insignificant leak and one which should transmit an alarm may naturally vary from case to case. In the example described here a limit of 1 impulse per 24 hours has been selected.

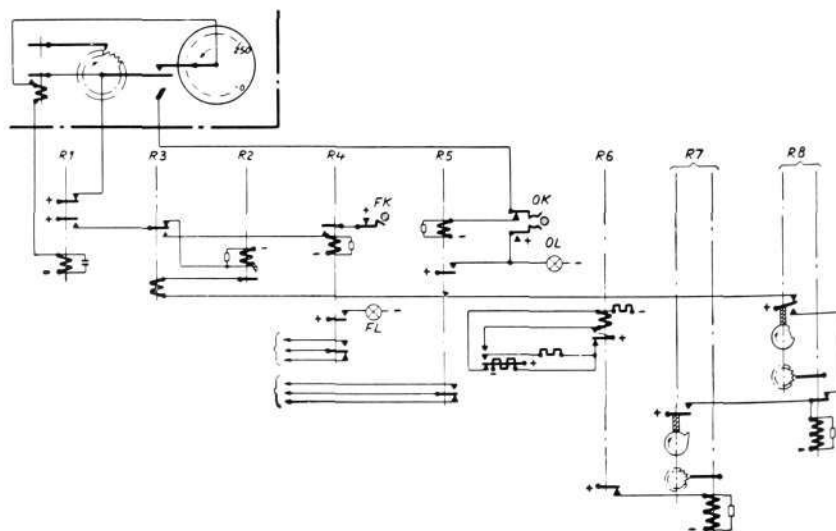


Fig. 14
Schematic diagram of the relay equipment for a small cable network

X 6808

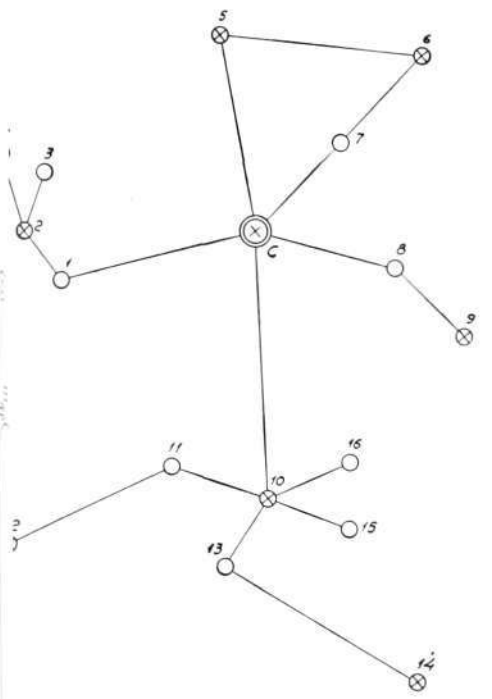


Fig. 15
Large branched cable network

X 4957

When the pointer on the signal manometer establishes contact with the ratchet-wheel a circuit is closed from the plus pole at the breaking contact R_1 , through the pilot relay and R_1 to the minus pole. Both relays then operate whereupon R_2 also operates. On the release of R_1 at the end of the delayed action period, R_3 operates in series with R_2 . If the next impulse is received within 24 hours, R_1 is energized, whereupon the fault lamp FL lights up and the alarm circuit is closed to a bell, lamp panel, etc. If on the other hand, the impulse is first received after, say, 30 hours the upper cam disc will have passed the position at which the roller drops down into the notch in the cam disc and the plus pole is then disconnected from R_3 and R_2 so that these relays are reset. The relay R_1 cannot then operate again, that is to say, no alarm signal is given.

When the pointer on the manometer has fallen to the value 30 kgs/cm^2 the ratchet-wheel makes contact with the contact strip on the scale dial. The plus pole is then connected to R_5 which operates and thereby closes the circuit for the observation lamp OL and the alarm circuit. The lamp OL remains alight even when the push-button OK is pressed. After changing the gas cylinder the ratchet-wheel on the manometer must be wound up until the pin reaches the pointer; otherwise the observation lamp will remain lighted up.

III. Gas Control Installation for Large Branched Cable Networks

Where a larger network is in question a combination of both the previously described types may be employed. Fig. 15 shows an example of a network of this kind. Gas cylinders and pressure control units are also installed in the stations 2, 5, 6, 9, 10, 12, and 14 in addition to those in the main station.

An impulse counter forms part of each pressure control unit, and all the counters are installed in the main station. If a leak occurs between the stations 10 and 13, for example, the fault is recorded by the impulse counters at the stations 10 and 14. With a fault between the stations 10 and 16, however, only the impulse counter for station 10 will be affected.

With regard to the current supply for the three different forms of installations, the electrical equipment is designed for a working current and not for a closed-circuit current; this has been considered most suitable both from a technical and economic point of view. Thus there is no risk of the system ceasing to function if the cable is cut through, for example. It is true that in such a case the operating wires would also be cut off, but this will not prevent the functioning of the signal manometer lying closest to the fault location, reckoned from the main station. On the contrary, the signal manometer will operate very rapidly and will thus transmit a major alarm signal. (A system with impulse counters will record the maximum number of impulses per unit of time, and a system without impulse counters will transmit an alarm which always indicates that a large leak has occurred.)

FAULT LOCALIZATION

I. Approximate Localization

1. LONG-DISTANCE CABLES

When a leak occurs between the stations A and B such as at S_2 and S_3 , see fig. 10, the fault lamp lights up at the supervisory terminal station S_1 . If an alarm bell is connected in circuit it will begin to ring at the same time. One of the counters IR_2 or IR_3 will have recorded an impulse. All the counters are read off and the time noted. The fault lamp is switched off by pressing the push-button, whereupon the alarm bell will cease to ring. After a certain time has elapsed a new alarm will be received while a new impulse will be recorded at the same time on one of the two impulse counters mentioned. Each time an impulse is recorded and read off, it should be plotted on a time-impulse chart. A chart is plotted for each counter, see fig. 16.

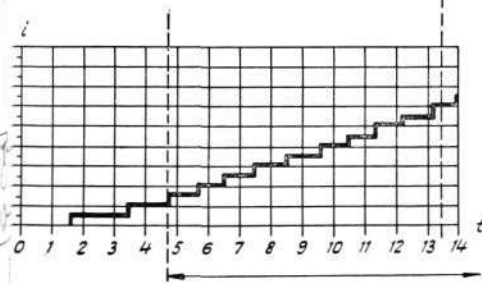
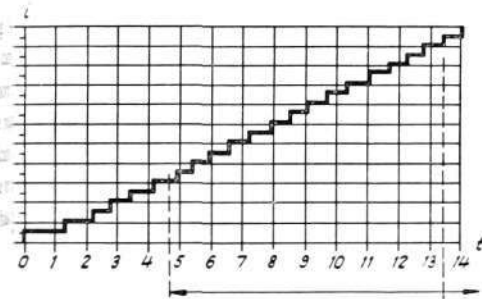


Fig. 16
Time-impulse chart

X 4958

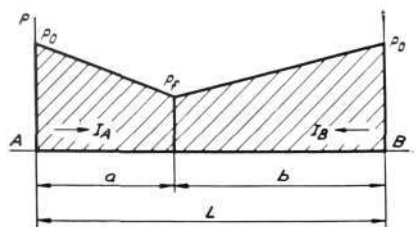


Fig. 17
Pressure distribution curve

X 4959

It is assumed that the upper chart relates to the counter IR_2 and the lower one to IR_3 . The point of time for recording the first impulse by either of the counters, IR_2 for example, is taken as 0 in both charts. The second impulse to IR_2 was received at the time $t = 1.3$ and the first impulse to IR_3 at the time $t = 1.5$, and so on. When the gas flow in the cable becomes stationary, which is indicated by the »steps» in both charts assuming a constant length, it is possible to read off the number of impulses per unit of time from the charts.

If the number of impulses are denoted by n_A and n_B respectively, the location of the fault can be determined with an accuracy of about 2 % of L from the formulas:

$$a = \frac{n_B}{n_A + n_B} \cdot L$$

and

$$b = \frac{n_A}{n_A + n_B} \cdot L$$

where a is the distance from station A (in this case S_2) to the fault, b is the distance from station B (here S_3) to the fault and $L = a + b$, the distance between these stations, see fig. 17.

From the chart, fig. 16, we obtain the number of impulses $n_A = 14.3$ and $n_B = 9.3$. These values have been obtained by calculating the impulses from the stationary condition of flow (the broken line between $t = 4$ and $t = 5$) up to the point of time between $t = 13$ and $t = 14$ (the righthand broken line). On inserting these values in one of the formulas, it is found that

$$a = \frac{9.3}{9.3 + 14.3} \cdot L = 0.395 \cdot L$$

that is to say, the distance from station S_2 to the fault is 39.5 % of the cable section's length.

The derivation of the above formulas may be found in the appendix, page 47.

2. SMALL CABLE NETWORKS

On the occurrence of a large leak in the cable network the fault lamp at the main station lights up with the simultaneous ringing of an alarm bell when such a bell is connected in the circuit. It is first necessary to determine in which of the cables that pass out in different directions the fault has occurred either, 1) by cutting off the gas supply to one cable at a time until the faulty cable is located, or, 2) by employing the halving method in order to save time when several cables are fed from the same gas cylinder. According to the latter method the cables are divided into two groups of equal size and the supply to all cables cut off at one time until the faulty group is located. The latter is then divided up again into two equal groups, etc., until the faulty cable is found.

The reference here to the cutting off of certain cables, implies that they are disconnected from the stationary gas cylinder and the pressure control unit. The cables disconnected from the latter should be placed under pressure from another gas cylinder via a constant regulator so that the full protective effect of the system is maintained.

This cable is then connected at the main station to a gas cylinder and pressure testing unit LTP 2001 via the hose socket 13 and the cock 7 in the attachment for the piping shown in fig. 13.

Another gas cylinder, 1 litre size for example, and another pressure testing unit LTP 2001 are then transported to the other end of the faulty cable and connected up at that point. The pressure drop indicated by both manometers is then checked at both gas cylinders and when conditions of stationary flow (see previous section) have set in, a chart for the fall in pressure is plotted as a function of the time for both manometers. Let it be assumed, for example, that the upper chart in fig. 18 represents the fall in pressure for the gas

cylinder at the main station, and the lower one the fall in pressure for the gas cylinder at the other end of the cable. From the chart we read off:

$$\Delta P_A = 52 \text{ kgs/cm}^2$$

$$\Delta P_B = 28 \text{ kgs/cm}^2$$

On inserting these figures in the formula:

$$a = \frac{V_B \cdot \Delta P_B}{V_A \cdot \Delta P_A + V_B \cdot \Delta P_B} \cdot L$$

where V_A and V_B are the volume of the gas cylinders at A and B respectively, and assuming that a $2\frac{1}{2}$ litre gas cylinder has been employed at the main station and a 1 litre cylinder at the other end of the cable, it is found that:

$$a = \frac{1 \cdot 28}{2.5 \cdot 52 + 1 \cdot 28} \cdot L \approx 0.18 \cdot L$$

that is to say, the distance from the main station to the fault is 18 % of the cable's length. In practice the chart should, of course, be plotted to a larger scale so that ΔP_A and ΔP_B can be read off with greater accuracy. For the derivation of the formula reference should be made to the appendix.

3. LARGE CABLE NETWORK

When a leak occurs at some point in the cable network, see fig. 15, an alarm is transmitted to the main station in the same way as set out under point 1. If the leak occurs in a cable section between two stations with gas cylinders or in a cable section that is only fed with gas from one end, two and one impulse counters will be started respectively and will record the impulses. *In the first case the method of procedure for fault localization is the same as that under point 1 (long-distance cable) and in the second substantially as under point 2 (small cable network).*

II. Accurate Localization

The accurate localization of the fault is effected with the help of the tracer gas method which consists in introducing a gas into the cable the gas being traced to the point of the fault. The tracer gas used is radium-emanation or radon as it is also called.

I. RADON

Radon, Rn, or radium-emanation is the next transmutation product after radium in the uranium-radium chain. Contrary to the other radioactive transmutation products, it is gaseous. The table below shows the periods and forms of radiation for the radioactive products obtained.

Substance	Form of radiation	Period
Uranium I	α	5 000 million years
Uranium X ₁	β, γ	25 days
Uranium X ₂	β, γ	1 minute
Uranium II	α	2 million years
Ionium	α	100 000 years
Radium	α, γ	1 700 years
Emanation (Radon)	α	4 days
Ra A	α	3 minutes
Ra B	β, γ	27 minutes
Ra C ₁	β, γ	20 minutes
Ra C ₂	α	$1.5 \cdot 10^{-8}$ seconds
Ra D	β, γ	20 years
Ra E	β, γ	5 days
Ra F	α	5 months
Ra G (Lead)	none	

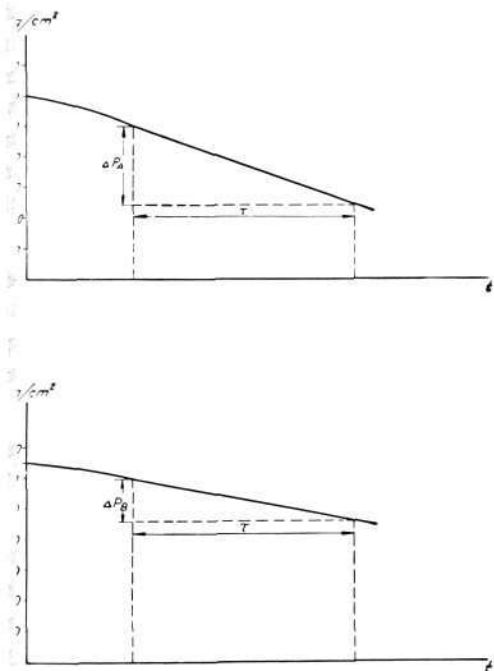


Fig. 18
Time-pressure chart

X 4960



Fig. 19 X 4971
Radiation intensity meter LMK 3001
in use

Only the γ -rays are of significance for the accurate localization. At the point of the fault where the radon gas penetrates into the ground or into the air surrounding the cable the direct β -rays may be indicated in certain cases. On the other hand, the range of the α -particles is too short to allow them to produce a deflection on a radiation intensity meter.

Radon can be purchased from large hospitals in ampoules 1 to 2 cm in length and about 1 mm in diameter. The ampoules sold have already been used for medical purposes and are therefore relatively cheap.

2. INJECTION

Injection is carried out with the help of a gas cylinder and a pressure unit (NVB 3001 or LTP 2001). One end of the cable or a joint in the latter is selected as the point for the injection.

In order to inject the gas into the cable the ampoule is crushed and the radon is passed into the cable with the gas stream; it then moves in the form of a plug towards the leak. This plug becomes very attenuated during its passage through the cable, but its front end is always clearly marked.

On long distance cables the injection should preferably be made at the joint nearest to the calculated point of the fault. Where shorter cables are in question or in cases in which it is undesirable to excavate round the joint (as in streets with a heavy traffic) injection can take place from one end of the cable. In installations of the type illustrated in fig. 13 it is unnecessary to braze on a connecting washer and drill a hole in the cable prior to the injection, since a pipe attachment is already available for injection amongst other purposes.

3. LOCALIZATION

A beginning may be made in localizing the fault approximately half an hour after making the injection. For this purpose a radiation detector is moved along the ground over the cable, fig. 19. The radiation intensity meter LMK 3001 is employed for this work. The indicator is supported by a strap suspended round the observer's neck to enable the deflection of the pointer to be conveniently followed. Owing to the cosmic radiation the pointer will always give a certain deflection over the scale. The radiation from the radon in the cable will always be clearly visible, however, and a strongly marked maximum emission will be indicated at the leak. It will sometimes be found of considerable help to dig a number of control pits down to the cable from which the emission is particularly strong.

The above method has been applied both to long distance cables and to armoured lead-covered cables in urban networks. On the other hand, it is not suitable for cables laid in ducts. In the latter case, however, by means of approximate localization and with the help of gas flow direction indicator LTP 2111 the position of the leak can be determined to within a cable section between two cable pits. After drawing out the cable, the fault can be localized in the ordinary manner by using soapy water.

4. THE METHOD FROM THE POINT OF VIEW OF HEALTH

On the conclusion of the injection, the piece of hose cut off should be buried together with the crushed gas ampoule and the gloves. Although no risk is involved for persons carrying out this form of fault localization according to the directions it should be borne in mind that radioactive substances must be handled with a certain caution.

The intensity of a radioactive substance is usually measured in millicuries (mC). 1 curie corresponds to 3.7×10^{10} disintegrations (nuclear transmutations) per second. The shorter the period is, the greater will the intensity be. The radiation dosage, that is to say, the quantity of emitted gamma-rays absorbed by the body, is measured in röntgen (r) or mr (1 r = the amount of radiation that produces an ionizing effect in 1 cm³ of air which is so great that the total charge of the ions produced is 1 E. S. U. of each sign).

The maximum permissible dosage for the vital parts of the body is 100 mr, whereas the hands can withstand up to 1,000 mr per week without risk. The ampoules used for localization usually have an intensity of 10—15 mC. Since

1 C gives an emission of 2 r/h/m, the emission obtained in this case will be 20—30 mr/h/m. Thus at a distance of 1 metre from the preparation 100 mr per 3½ hours is obtained, and at a distance of ½ metre the same emission in a quarter of this time. (The intensity is inversely proportional to the square of the distance.)

It will be realized from the foregoing that as great a distance from the ampoules as possible should be maintained during transport and that the ampoules should not be handled prior to their use. Nor should they be handled by unskilled persons, but otherwise there is no reason to fear the employment of the method described in the article, which has been adopted with success by the Swedish Board of Telecommunications amongst others.

APPENDIX

Derivation of the formulas $a = \frac{V_B \cdot \Delta P_B}{V_A \cdot \Delta P_A + V_B \cdot \Delta P_B} \cdot L$ and analogously for b , and $a = \frac{n_B}{n_A + n_B} \cdot L$ and analogously for b .

Let us consider a faulty cable section AB fed with gas from both ends, A and B respectively. The flow conditions are assumed to be stationary. The gas cylinder at A has a volume of V_A . During the time t_A the pressure in the cylinder has fallen from P_A to $P_A - \Delta P_A$. Denoting the gas flow by I_A , we obtain:

$$I_A \cdot t_A = V_A \cdot \Delta P_A \quad (1)$$

Analogously for the gas container at B :

$$I_B \cdot t_B = V_B \cdot \Delta P_B \quad (2)$$

The distance of the fault from A and B is denoted as a and b respectively. We then obtain:

$$a = \frac{I_B}{I_A + I_B} \cdot L \quad (3)$$

$$b = \frac{I_A}{I_A + I_B} \cdot L \quad (4)$$

On reading the fall of pressure ΔP_A and ΔP_B during the same time $t = t_A = t_B$, we then obtain from (1)—(4):

$$a = \frac{V_B \cdot \Delta P_B}{V_A \cdot \Delta P_A + V_B \cdot \Delta P_B} \cdot L \quad (5)$$

$$b = \frac{V_A \cdot \Delta P_A}{V_A \cdot \Delta P_A + V_B \cdot \Delta P_B} \cdot L \quad (6)$$

The formulas (5) and (6) may suitably be employed where the reading has to take place directly from the manometers. In a system with impulse counters the arrangement is such that each impulse corresponds to a certain fall of pressure. We can then write:

$$\Delta P_A = n_A \cdot p_A \quad (7)$$

and

$$\Delta P_B = n_B \cdot p_B \quad (8)$$

where n_A and n_B indicate the number of impulses indicated in the time t by the impulse counters for A and B respectively. Since in this system a gas cylinder of the same size is used at both ends, $V_A = V_B$ and since $p_A = p_B$, then:

$$a = \frac{n_B}{n_A + n_B} \cdot L \quad (9)$$

and

$$b = \frac{n_A}{n_A + n_B} \cdot L \quad (10)$$

In the derivation of the formulas (1)—(10) the temperature and air pressure have not been taken into consideration. If these differ at A and B , the formulas will not be entirely correct, which is of no significance, however, where approximate localization is concerned.

New Type of Cordless C.B. Private Branch Exchanges

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

U.D.C. 621.395.26
621.395.655

A new line in the range of L M Ericsson's modern manual telephone switchboards has been brought out in the form of cordless C.B. private branch exchanges. These switchboards possess a number of advantageous features which make them simple to handle: they are easy to install and maintain, can be placed independently on a table and are of attractive appearance.

LM Ericsson's new cordless switchboards, type *ADD 13*, can operate in conjunction with all automatic or manual C. B. exchanges of any system.

Automatic holding of the public exchange line permits the operator to leave the connection before the call is answered by extension.

The ringing current required for calling extensions is generated by a pole changer controlled by the dial. The ringing signal is automatically interrupted if the call is answered while the signal is being sent.

The larger switchboards are equipped for individual through-connection on every external line, which permits an executive to have a direct external line on which calls can be answered by the operator in his absence.

Types

LM Ericsson's cordless switchboards, type *ADD 13*, are made in the following standard sizes:

ADD 1311 for 3 extensions and 1 public exchange line with 1 external and 1 internal call facility.

ADD 1321 for 6 extensions and 2 public exchange lines with 2 external and 1 internal call facility.

ADD 1331 for 9 extensions and 3 public exchange lines with 3 external and 2 internal call facilities.



Fig. 1 X 4962
Cordless switchboard ADD 1311
for 3 extensions and 1 public exchange line



Fig. 2 X 6811
ADD 1311 with case removed

ADD 1311

As is seen in fig. 1, *ADD 1311* is designed in the form of a telephone instrument with extended front. The black phenolic case is secured to the base plate by four screws. With the exception of the dial all components are mounted on the base plate, as shown in fig. 2. The keys and indicators are mounted on the front panel, which is easily removed from the base to permit full accessibility of all units for inspection and adjustment.

The positions of the keys on the front panel, and their functions, are shown in fig. 3.

ADD 1321 and ADD 1331

Figs. 4 and 5 show the two cordless switchboards *ADD 1321* and *ADD 1331*. The components of each switchboard are assembled on an oak base and a green-enamelled aluminium front panel. The front panel is hinged and can be folded forwards (see fig. 6), whereby all parts become readily accessible for checking and adjustment. The equipment is enclosed in a light oak case which is secured to the base by two screws. The switchboard handset hangs on the left wall.

The placing of the keys on the front panel, and their functions, are shown in figs. 7 and 8.

Components

The components used in the new series of switchboards are all well-known and tested in different kinds of equipment under operating conditions. The following facts alone are of interest in this connection.

The *signalling devices* consist of visual indicators for the extension lines and drop indicators for the public exchange lines. (The smallest switchboard *ADD 1311* has only one audible signalling device—a buzzer—on the public exchange line). The visual and drop indicators are fairly similar, being incorporated in the same electromagnetic circuit and having recessed shutters. The public exchange line drop indicators are automatically restored when the operator answers the call. Both visual and drop indicators have alarm contacts for audible signal circuits.

The *keys*, which have twin contacts, are of the previously known type *RMA 11*.

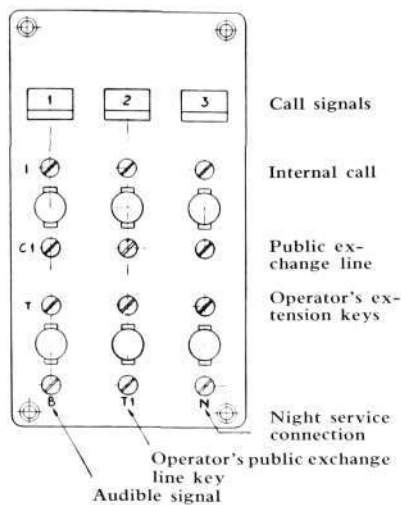


Fig. 3
Front panel of *ADD 1311*

X 4965

Fig. 4
Cordless switchboards *ADD 1321* and (right) *ADD 1331*

X 6809
X 6810

for 6 extensions and 2 public exchange lines (*ADD 1321*) and 9 extensions and 3 public exchange lines (*ADD 1331*)



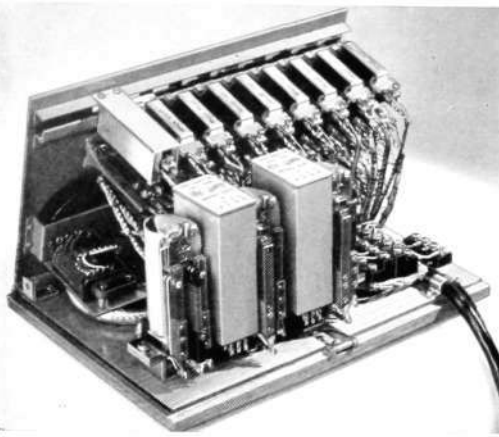


Fig. 5
ADD 1321, case removed

X 4963

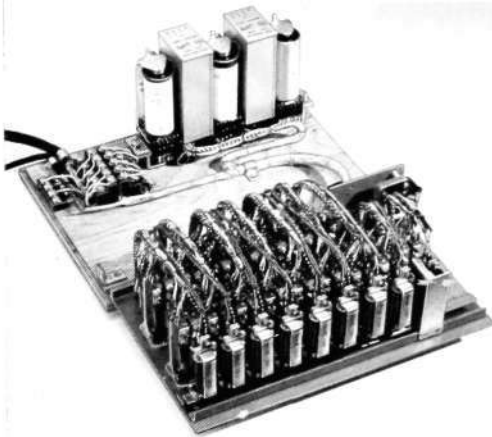


Fig. 6
ADD 1321, case removed
and front panel down

X 4964

Fig. 7
Front panel of ADD 1321

X 6812

- H 1 Holding of external line 1
- H 2 " " " " 2
- N Night service
- N 1 Individual through connection of external line 1
- N 2 Individual through connection of external line 2
- B Audible signal

Relays and capacitors are of normal telephone type. All relays have twin contacts.

Of particular interest is the pole changer relay. Apart from its function of generating ringing current, it has three other functions, viz. as ringing trip relay, operator's transmitter feed relay and audible signalling device (buzzer).

Operation

Internal Call

The switchboard is called by lifting the handset, which operates a visual indicator. The operator answers by throwing the corresponding key to *T*, so restoring the indicator. If an internal call is required, the operator throws the caller's key to *I* and thereafter the called party's key to *T*. The operator rings the called party by dialling one digit, a ringing signal being transmitted until the dial has returned to rest. The called party's key is then thrown to *I* and the connection is established.

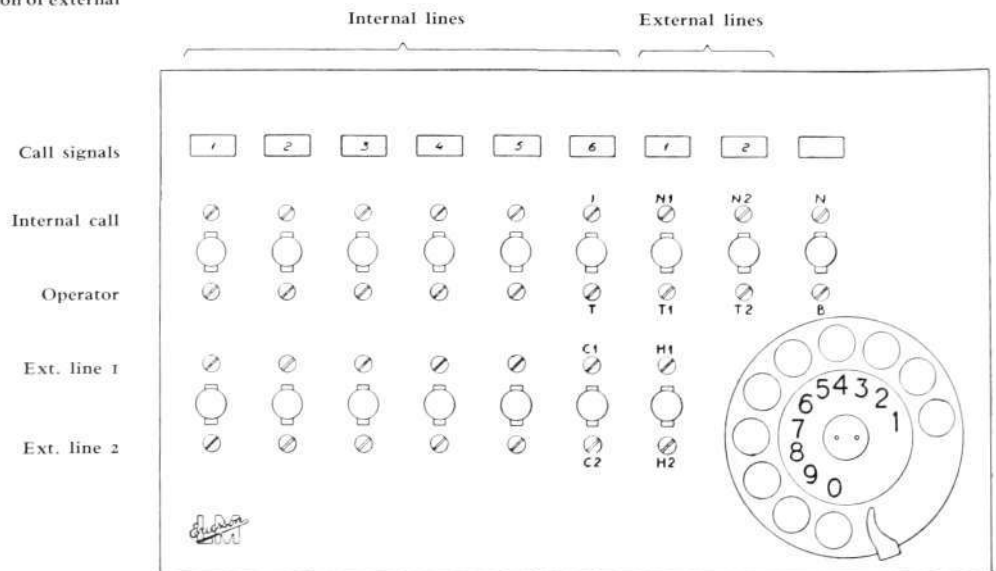
If the extension replies during the ringing signal, the signal immediately ceases. Thus the extension can never be irritated by a ringing signal when the handset is raised.

The replacing of both handsets on completion of a call is signalled on the respective visual indicators, whereupon the operator restores both keys.

Incoming Calls from Public Exchange

An incoming call on, for example, external line 1 is answered by the operator throwing the key to *T1*. After receiving the order, she throws the external line key of the wanted extension to *C1*, which actuates the visual indicator of that extension. The upper key of the extension is then thrown to *T* and the external line key is restored from *T1*. The operator next rings the extension as described above. After ringing she restores the upper key and, when the extension replies, the indicator returns to rest. The connection is now through.

From the time the lower key is thrown to *C1* until the called extension answers, the external line is held over a holding circuit in the switchboard.



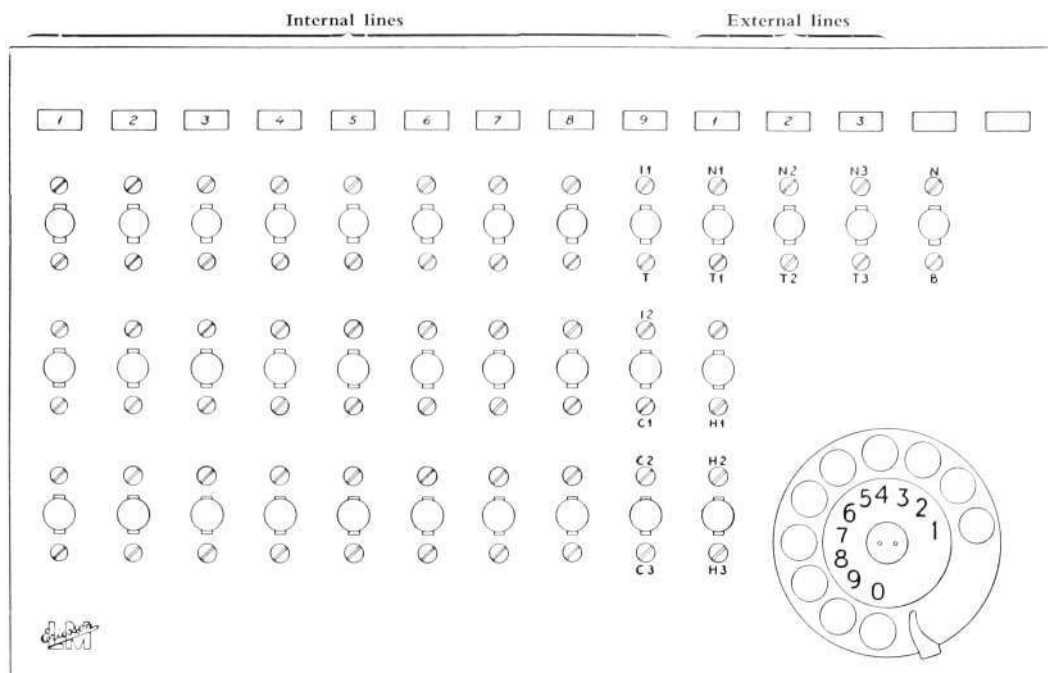


Fig. 8 X 6826

Front panel of ADD 1331

- H 1 Holding of external line 1
- H 2 " " " " 2
- H 3 " " " " 3
- N Night service
- N 1 Individual through connection of external line 1
- N 2 Individual through connection of external line 2
- N 3 Individual through connection of external line 3
- B Audible signal

The replacing of the extension's handset is signalled on the visual indicator and the external line is released. The operator restores the external line key from C1 and the indicator signal disappears. If a new call comes in on the external line before the operator has restored the above-mentioned key, the calling device of the external line is actuated nevertheless.

Outgoing Calls to Public Exchange

The extension calls the switchboard and the operator answers as described above. The connection is extended to the public exchange by the operator throwing a free public exchange line key to C, after which the extension's upper key is restored. The extension can then dial the required number.

The end of a call is signalled on the extension's visual indicator, and the operator disconnects the call by restoring the key from C.

The operator can also establish an outgoing call by means of her dial.

Audible Signal

If the operator is unable to keep the visual signals under observation, she throws an audible alarm key to B, whereupon a subdued tone is heard both on call and clearing signals.

Night Service

Night service connection is obtained by throwing the night service key to N and the public exchange line keys to C1, C2 and C3 respectively for the extensions who wish the night service connection. When key N is thrown, the current supply to the switchboard is cut off.

The public exchange lines in ADD 1321 and 1331 have been supplied with individual through connection facility, allowing direct connection of the respective public exchange line to the desired extension. This means that an

executive can have a directly connected exchange line on which calls can be answered by the operator in the executive's absence. The individual through connection can also be utilized when an extension desires a number of outgoing calls in succession. Thus the operator is not troubled by any signals.

Current Supply

When the operator or an extension is speaking on an external line, the current to the transmitter is obtained from the public exchange. Only on internal calls between extensions or between an extension and the operator is a local current supply required. The switchboard is designed for 24 V, but variations between 15 and 30 V may be tolerated. The current consumption at 24 V is

for external calls: 0 mA

for internal calls: abt 40 mA

for calls between operator and extension and ringing to extension: abt 170 mA.

Dry cells, storage batteries or battery eliminators may be used for the power requirements of the switchboards.

Dimensions and Weights

The dimensions and weights of the switchboards are tabulated below. The width measurements of ADD 1321 and ADD 1331 do not include the hand-set hooks which project about 50 mm.

Designation	Length mm	Height mm	Depth mm	Net weight kg
ADD 1311	126	154	293	3.9
ADD 1321	303	200	216	8.2
ADD 1331	388	249	226	12.2

Review of SER Electron Tubes: Standard and Long Life Types

S E D S M A N & G L A G E R H O L M, A B S V E N S K A E L E K T R O N R Ö R, S T O C K H O L M

U.D.C. 621.385.1

This article presents a summary description of the range of standard and long life electron tubes at present being manufactured by AB Svenska Elektronrör.

In a following series of articles some of the more recent types of tubes will be discussed, as also new types to be incorporated in SER's manufacturing programme at a later date.

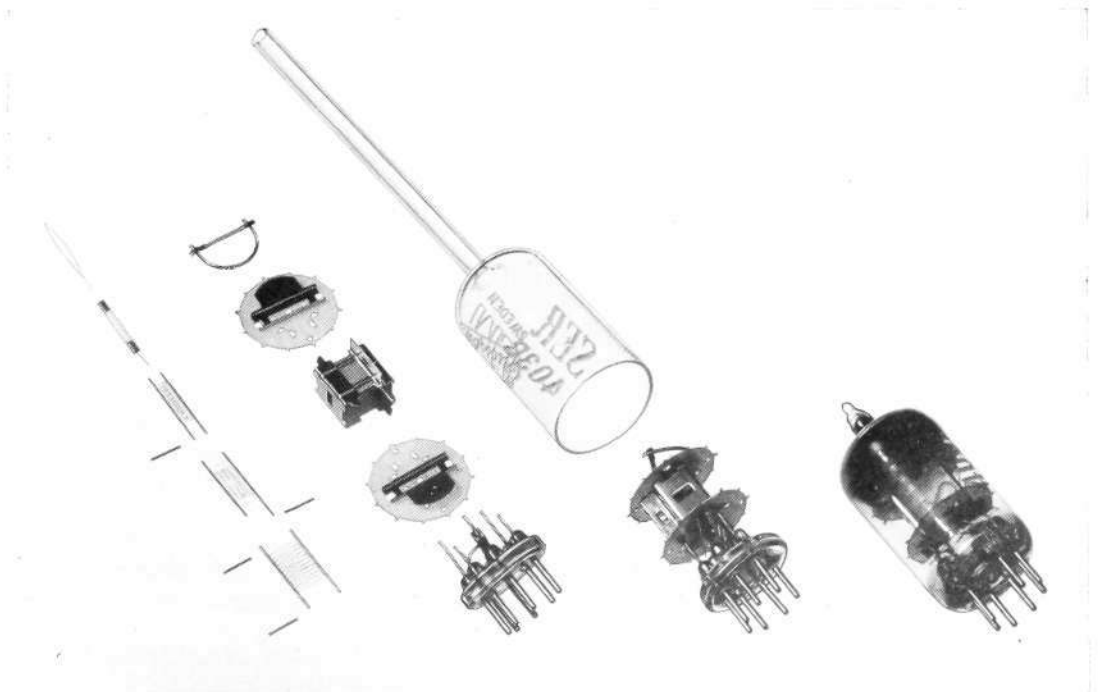
The developments in the manufacture of electron tubes in latter years have tended towards smaller sizes, and the majority of modern designs of tube are of all-glass miniature type. In addition to the obvious saving of space and the opportunity afforded for more compact apparatus, the miniature design has other advantages over the older types of tubes. The most important of these are the improved mechanical stability of the tube structure, the possibility of using the tubes within a higher frequency range and the lower cost of manufacture.

SER's manufacture of tubes has been adapted to these trends and for some years has been concentrated to miniature types. Apart from special purpose tubes, the programme comprises two categories: standard tubes and long life tubes.

Standard Types

The standard types are designed for purposes for which normal demands are placed on the life and reliability of the tubes and a low price is essential. In view of the moderate productive capacity and the low price of the tubes the number of types has necessarily had to be comparatively limited. Among

Fig. 1
Design of an electron tube
From left: Individual parts, assembled tube system, final electron tube



the types at present being manufactured complete series are available for radio receivers, both for a.c. and a.c./d.c. operation. Some of the types are designed especially for amplifiers and radio communication equipment. All types listed below are equivalent to the corresponding American tubes.

Pentodes

6AK5 is a high-frequency pentode, especially suited for wide band amplifiers. The input conductance is only 125 μ mhos at 100 megacycles and the transconductance is 5,000 μ mhos. Owing to the fact that the cathode has two separate terminals, the tube, by means of appropriate circuits, can be used at frequencies up to 400 megacycles.

6BA6, *12BA6* are high-frequency remote-cutoff pentodes. Due to the high transconductance and low grid to plate capacitance, the amplification obtainable with these types of tubes is as high as conventional circuits can provide.

6AU6, *12AU6* are high-frequency and low-frequency, sharp-cutoff pentodes, but otherwise of the same design as *6BA6*. Used as low-frequency amplifiers, the tubes have excellent properties as regards microphonics and noise.

Converters

6BE6, *12BE6* are converters of pentagrid type. The inner grids are used for the oscillator function, and feed-back is obtained through the cathode current. The tubes have a conversion transconductance of about 500 μ mhos and comparatively small frequency drift.

Twin Triodes

6J6, *19J6* are double triodes with common cathode. These types of tube were originally designed for oscillator circuits for very high frequencies and will operate at frequencies up to 800 megacycles. They are used to a great extent as converters, a conversion transconductance of about 2,000 μ mhos being attainable.

12AT7 is a double triode with separate triode systems. The data of the tube are much the same as those of *6J6*, but wider applicability is obtained as a result of the separate triode systems. Type *6J6*, however, is generally better adapted for use at extremely high frequencies.

Double Diode Triodes

6AT6, *12AT6* have a common cathode for the triode and diode systems. The amplification factor of the triode is 70, which affords good low-frequency amplification. The diodes may be utilized for detection and for automatic volume control.

6AV6, *12AV6* are of the same design as *6AT6*, but the amplification factor of the triode is 100, which permits higher low-frequency amplification.

Power Amplifiers

6AQ5 is a beam power amplifier. The tube is capable of providing a power output of 4.5 W and is chiefly used in the output stages of radio receivers and amplifiers, but can be employed to advantage as oscillator and power amplifier within the high-frequency range.

6AS5 is designed on the same principle as *6AQ5*. The tube is, however, adapted to lower plate and screen grid voltages, thereby handling a power output of 2.2 W, and being used particularly in car radio receivers.

35C5, except for heater ratings, is equivalent in most characteristics to *6AS5* and is used in output stages of a.c./d.c. receivers.

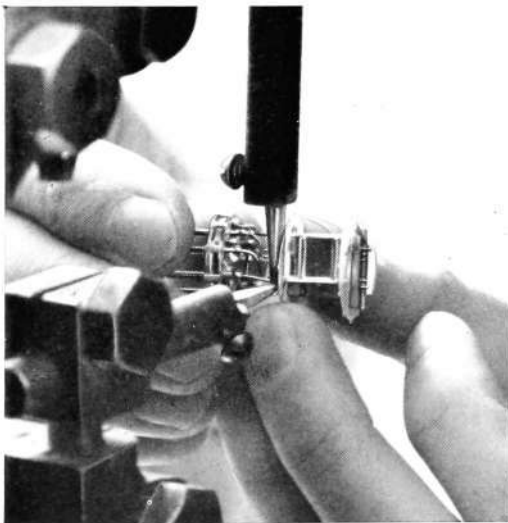


Fig. 2

X 4948

Assembling an electron tube
The parts are joined together by spot welding

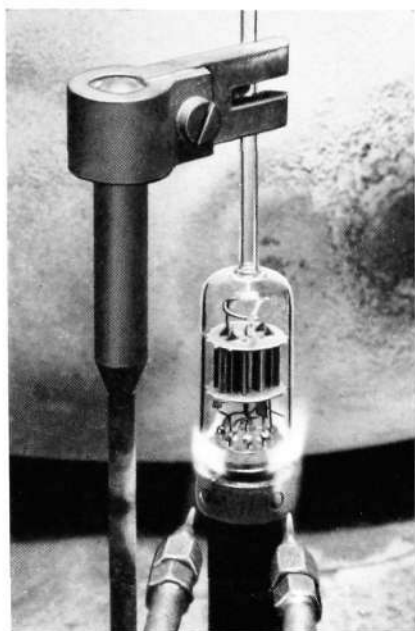


Fig. 3 X 4949
Sealing the bulb to the base of the tube structure

Rectifiers

6X4 is a full-wave rectifier tube with indirectly heated cathode. The tube is suited for a rectified current of max. 70 mA and has a low voltage drop. The insulation between the heater and cathode permits a maximum voltage of 450 V, and the tube does not therefore normally require separate heater circuits.

35W4 is a half-wave rectifier with indirectly heated cathode. The tube is suited for a rectified current of max. 100 mA and is primarily used in a.c./d.c. radio sets. The heater has a tap for operation of a panel lamp.

Long Life Tubes

The reliability of equipment and plant is highly dependent on the durability of the electron tubes. The inconvenience and cost of breakdown can be avoided by employing tubes especially designed for long life service and, though considerably more expensive than standard tubes, they generally prove to be more economical in the long run.

SER manufactures a number of types of long life tubes with a guaranteed mean life of minimum 10,000 hours. Such tubes are primarily intended for telephone transmission systems and their development has been determined by the latter requirements.

The long life types developed during recent years, however, are well suited to other applications as well. It may be mentioned that, apart from the normal 18 V heaters employed for carrier systems, these types are also designed with heaters operating on 6.3 V.

The types at present being manufactured comprise:

403B, 18AK5, high-frequency pentodes particularly suited to wide band amplifiers. The data are identical to those of the standard 6AK5 apart from the heater data and maximum ratings. 403B is used in line amplifiers for coaxial and twisted-pair cables for carrier systems, 18AK5 in terminal equipment amplifiers and oscillators and in two-wire and four-wire amplifiers and certain voice frequency signal receivers.

6J6L, 18J6, twin triodes with common cathode. Apart from heater data and maximum ratings, the tubes are practically equivalent in characteristics to the standard 6J6. 18J6 is used in carrier terminal equipments as audio frequency amplifier.

6AQ5L, 18AQ5, beam power amplifiers. Apart from heater data and maximum ratings, these types are identical to the standard 6AQ5. 18AQ5 is used in various kinds of amplifier, such as line amplifiers and auxiliary amplifiers in carrier systems.

2C51L, 18C51, twin triodes with separate triode systems and intermediate shield. Nominally the transconductance is 5,500 μ mhos and the amplification factor 35. The tubes are suited for amplifiers, particularly in cascode connection, oscillators, converters etc. 18C51 is used in carrier terminal equipment and has replaced type 18J6 in recent designs.

404A, high-frequency pentode particularly adapted for wide band amplifiers. Nominally the transconductance is 12,500 μ mhos and the combined output and input capacitance 9.5 pF. As a pentode the equivalent noise resistance is only about 500 Ω . 404A is used in carrier systems for, among other purposes, line amplifiers on coaxial cable circuits, for which it has replaced type 403B.

Plastic Film Capacitors

P O H A R R I S, A B R I F A, U L V S U N D A, S T O C K H O L M

U.D.C. 621.319.416.3

AB Rifa has for several years been manufacturing capacitors of polystyrene—a plastic material obtainable in thin sheets. Due to their unusual properties these capacitors are now being used for a number of special purposes. The present article describes the capacitors and their properties in the form in which they are manufactured by Rifa.

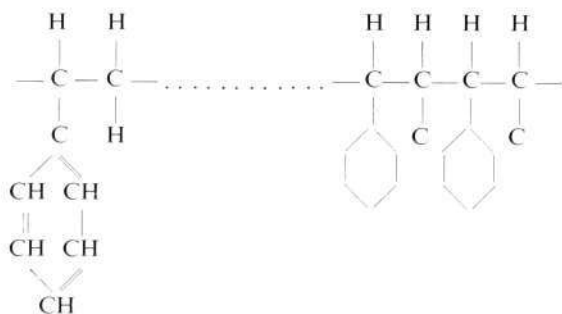
Insulating materials are mainly used in the general electrotechnical field as auxiliary materials for the purpose of separating circuits or parts of circuits from each other electrically. For such purposes the primary requirements are high dielectric strength, high insulation resistance, and dimensional stability in respect both to mechanical and thermal stresses.

In the particular electrotechnical component that is called a capacitor, on the other hand, the insulation material is not auxiliary to, but constitutes the actual material on which the function of the entire component is based. The foremost requirement in an insulation material to be used for this purpose is that it shall have a high dielectric constant and a low loss angle, and good constancy of these two quantities in respect to time, temperature, and frequency. In addition, the material should meet at least some of the requirements normally placed on insulation materials for general purposes. There is therefore a fairly narrow choice of dielectrics that are suitable for capacitors, and in the past only impregnated paper, glass, and mica have been employed to any considerable extent for the purpose.

During the last twenty-five years, however, a veritably fantastic development in the chemistry of plastics has resulted in the discovery of a number of new materials with properties suited for use in capacitors. The material that has been used longest is polystyrene; polystyrene capacitors have been marketed for some 15 years. More recently capacitors have been made of cellulose triacetate, cellulose acetate butyrate, polytetrafluorethylene, and polyethylene terephthalate.

Manufacture of Polystyrene Film

Polystyrene is a plastic made by the polymerization of styrene with the following structure:



In the process of polymerization a transparent material is formed with a molecular weight of the order of 50,000—100,000. Its dielectric constant is about 2.55, which remains unchanged up to very high frequencies. The insulation resistance is almost immeasurably high, of the order of 10^{18} ohm cm. The power factor is of the order of $1 \cdot 10^{-4}$ and is constant over a very great range of frequencies.

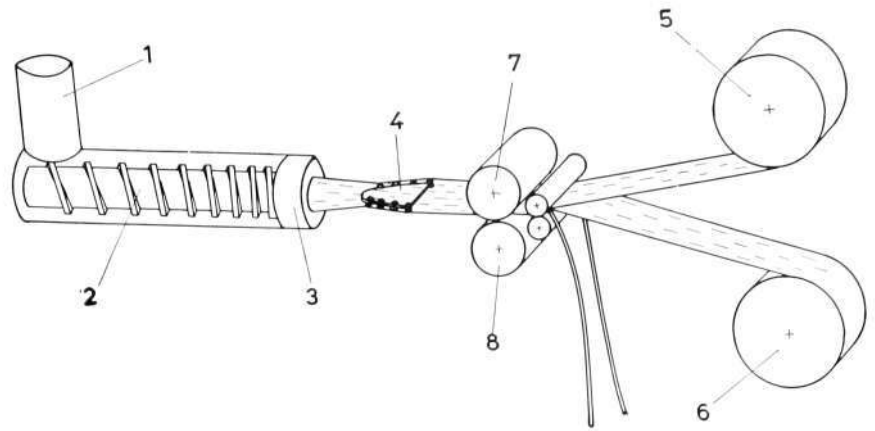


Fig. 1
Machine for production of thin polystyrene film schematic X 6823

Polystyrene has been known since the middle of the 19th century, and electrical engineers have long been attracted by its excellent properties. Due to its brittleness, however, it cannot readily be produced in the form of film and was, therefore, found unsuitable as dielectric in capacitors. Not until the 1930s was a method discovered of stretching the material during solidification, which enabled foil to be produced with good strength characteristics.

The manufacture of thin polystyrene foil is done by extrusion moulding on the principle illustrated in fig. 1. The finely pulverized material is heated in chamber 1 to about 150°C and is compressed by screw 2, being extruded through nozzle 3 in a melted condition, so forming a tube. While the tube is still hot, it is passed over the parabolic spreader 4 the periphery of which is fitted with a series of small wheels. This stretches the tube laterally. The resulting flattened tube is slit into two sheets which are wound up on rolls 5 and 6. The sheets, now cold, have previously passed the two draw-in rolls 7 and 8, which give the foil an orientation strain longitudinally as well. By this process a foil that is flexible in all directions is obtained which is extremely well adapted for the production of capacitors. This foil maintains its elastical properties up to about 70°C , but above this temperature it softens and returns to its original unstretched condition. Fig. 2 shows the change in length of a foil that is slowly heated to 100°C under a load of about 0.01 g/cm^2 .

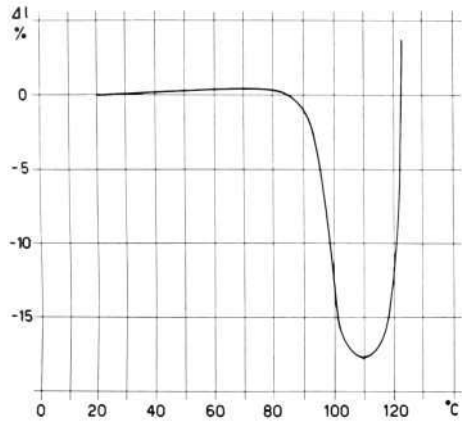


Fig. 2
Change in length of polystyrene film when heated above softening point X 4972

The material is now manufactured by a number of firms and is sold under the name of Styroflex, Styrafoil, etc.

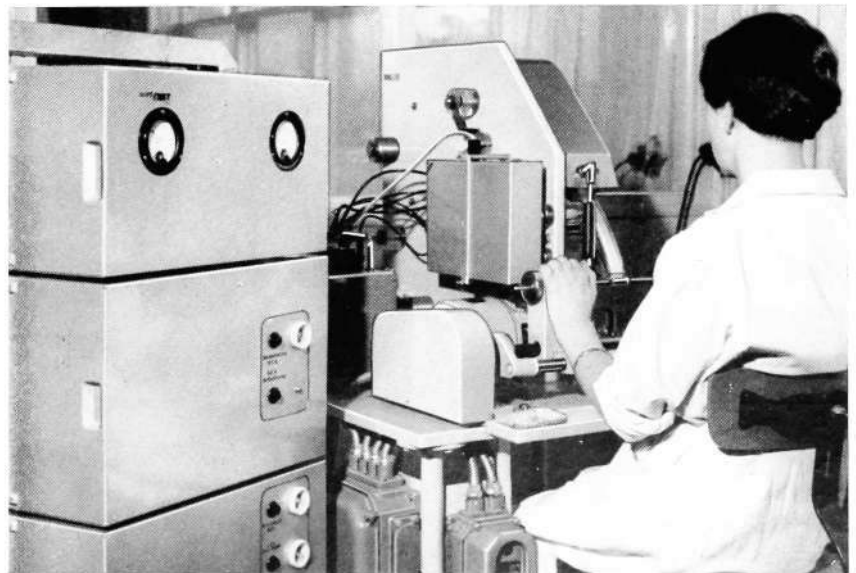


Fig. 3
Winding machine for polystyrene capacitors X 6827

Production of Polystyrene Capacitors



Fig. 4
Polystyrene capacitor roll

- a) before heat treatment
b) after heat treatment

X 4975

A roll is wound consisting of two metal foil electrodes interleaved with one or more polystyrene foils. The foil is subject to comparatively great variations in thickness—up to ± 10 per cent in the same roll—and the normal method adopted for paper capacitors of winding a given length of foil has therefore proved unsuitable. This is because, in view of the good properties of the dielectric, the capacitors are intended for purposes in which high stability is required, and with this follows a need of close capacitance tolerances. The most appropriate winding method has proved to be to carry out capacitance measurements in a bridge during the winding. The winding is stopped as soon as the correct capacitance is obtained, the foils are cut off and the foil ends are glued together. Fig. 3 shows a winding machine with measuring equipment on the left.

The roll obtained in the manner described above does not at this stage possess the good properties that are desirable. Due to the variations in thickness small air inclusions exist between the metal and plastic foils. The roll is also comparatively soft and changes capacitance when it is pressed. By means of heat processing at $90\text{--}95^\circ\text{C}$, however, it is possible to release the tension stored in the foil during its manufacture so that it is tightened and the roll shrinks at the ends and becomes hard and stable. The air is thereby pressed out of the roll and at the same time good contact is obtained between dielectric and metal foil, so that no cavities are left in which ionisation might arise. Fig. 4 shows a roll before and after heat treatment.

During the heating process the capacitance increases, which necessitates the winding of a lower capacitance than that finally required.

A check measurement is made of the capacitor rolls when they have cooled to room temperature. A voltage test is first carried out, and rolls not possessing the required dielectric strength are rejected. Next the capacitance is checked by accurate bridge measurement. Unfortunately the demands of customers for narrow capacity tolerances have proved impossible to meet fully by controlling the capacitance of the rolls through capacitance measurements during winding. A special method of assortment has been developed by which capacitance tolerances of $\pm 0.5\%$ or better are attainable. The rolls are first sorted into capacitance groups with close tolerances. After that two groups are selected, the combined mean values of which give the desired capacitance, and a roll from one group is connected to a roll from the other group. In this way it is possible to produce capacitors down to an accuracy of about one-tenth per cent.

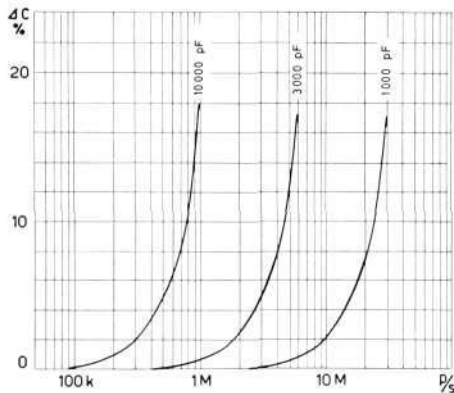


Fig. 5
Apparent capacitance as function of frequency for polystyrene capacitors, type PFD 1012

X 4973

Properties of Polystyrene Capacitors

The normal polystyrene capacitors can be used at temperatures up to $+70^\circ\text{C}$. Recently new kinds of polystyrene with higher temperature stability have been produced. This has been achieved by the introduction of cross-linking between the rod-shaped styrene molecules. The electrical properties of this modified material do not differ noticeably from those of the normal material. Capacitors which withstand ambient temperatures up to $+85^\circ\text{C}$ can be produced from the new materials.

Polystyrene is a non-polar material, and its capacitance is therefore independent of frequency. At high frequencies, however, an apparent rise in capacity is noticeable, due to resonance with the inductance in connecting wires and metal foils. In fig. 5 are shown curves of the capacitance as function of frequency for an unprotected polystyrene capacitor.

The capacitance stability of polystyrene capacitors on ageing is very good and is comparable to that of the best mica capacitors. As a test of stability the capacitors are subjected to an ageing test by passing them through a number of temperature cycles. The capacitance after a series of cycles

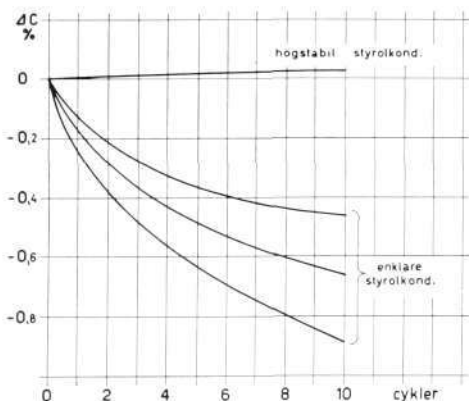


Fig. 6
Capacitance stability of polystyrene capacitors on ageing in temperature cycles $+20 \rightarrow +70 \rightarrow +20^\circ\text{C}$

X 4974

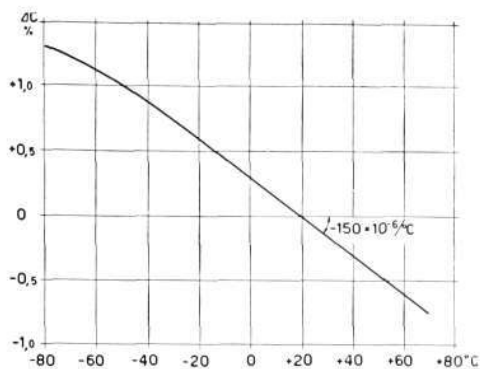


Fig. 7
Change in capacitance of polystyrene capacitors as function of temperature

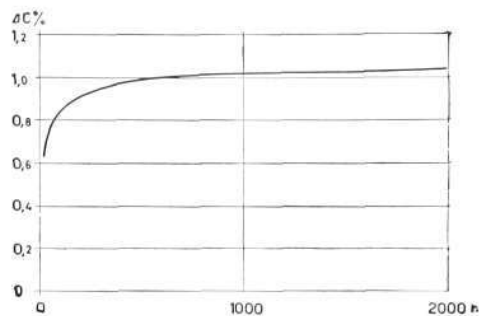


Fig. 8
Rise in capacitance of unprotected polystyrene capacitors as function of storage time at +40°C and 100% relative humidity

+20 → +70 → +20°C is shown in fig. 6. The same figure contains some curves illustrating the stability of some capacitors of other makes.

The change in capacitance of polystyrene capacitors with temperature is illustrated in fig. 7. The temperature coefficient is negative and practically constant, being equal to $150 \cdot 10^{-6}$ per °C over the whole range of working temperatures.

The capacitance is affected, though only slightly, by moisture absorption. Fig. 8 shows the rise in capacitance of an unprotected polystyrene capacitor after storing at +40°C and 100% relative humidity. On storage in a dry atmosphere they dry out fairly quickly, and therefore, when the demand for capacitance stability is not too high, capacitors can be used unprotected.

As already stated, the power factor in the polystyrene foil is about $1 \cdot 10^{-4}$. This low value can only be utilized over a large range of frequencies with capacitors possessing extended metal foils. In normally wound capacitors, i. e. when the connection to the metal foils is by tags inserted between the foils, an increase in the power factor takes place at higher frequencies due to the resistance in the metal foils. When only one tag is used per metal foil, the lowest power factor will be obtained if the tag is inserted at the centre of the foil. Figs 9 and 10 show the power factor as function of temperature and frequency respectively for a number of different capacitances.

The next property of polystyrene capacitors which makes them superior to earlier used types is their high insulation resistance. The insulation resistance is determined almost exclusively by the moisture absorbed by the material. Therefore, if polystyrene capacitors are required with exceptionally low leakage, it is essential that the capacitor rolls are dried with extreme care

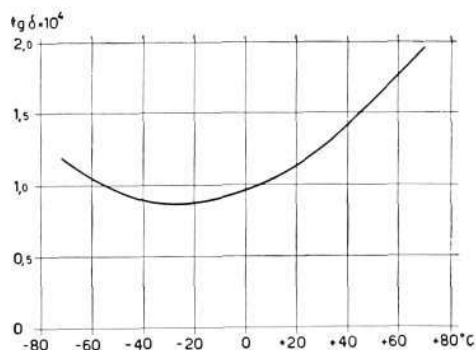


Fig. 9
Power factor of polystyrene capacitors with extended foils as function of temperature

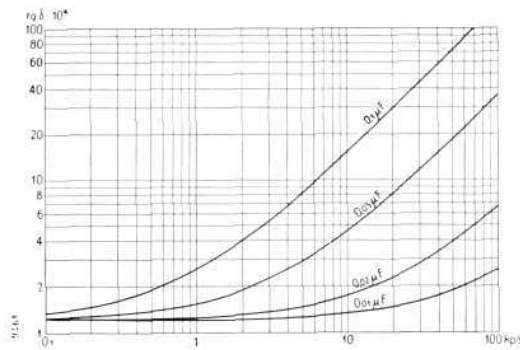


Fig. 10
Power factor of polystyrene capacitors with tags (normal winding) as function of frequency

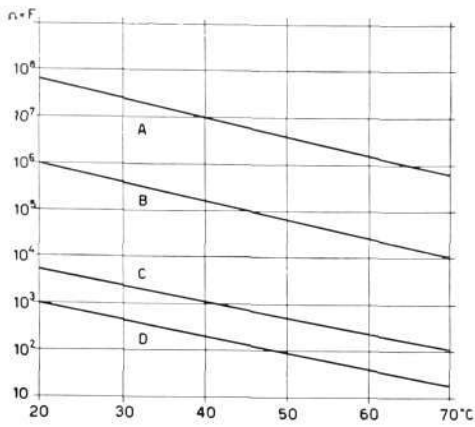


Fig. 11 X 4969

Insulation time constant of polystyrene capacitors as function of temperature

- A Maximum value for polystyrene capacitors
- B Normal value for polystyrene capacitors
- C Normal value for paper capacitors
- D Guaranteed value for paper capacitors

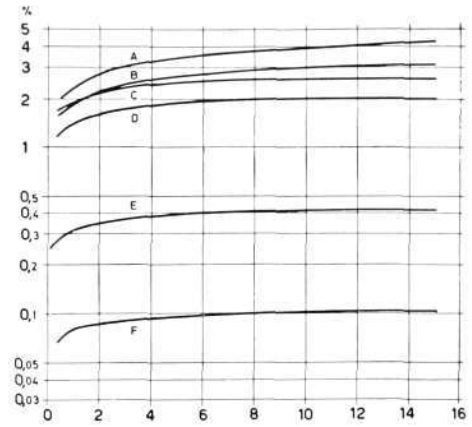


Fig. 12 X 4970

Retained charge in capacitors containing different dielectrics

- A Chlorinated wax impregnated paper
- B Vaseline impregnated paper
- C Cellulose acetate butyrate
- D Mica
- E Polyethylene terephthalate (Mylar)
- F Polystyrene

and that they are then enclosed in hermetically sealed cans. Especial care must also be devoted to the bushings, the surfaces of which must be protected to prevent the insulation resistance from falling, possibly even below that of the capacitor rolls. The manufacturer does not therefore guarantee high insulation resistance, but prefers to state that the insulation time constant (the product of insulation resistance and capacitance) exceeds 5,000 or 10,000 seconds at + 20° C. In the majority of cases, moreover, the customer's desire is not so much high insulation resistance as good capacitance stability and low power factor. It is, however, fully possible to produce polystyrene capacitors by factory methods with time constants up to 10⁶ seconds at + 20° C. In the case of well dried specimens, insulation time constants of even up to 10⁸ seconds may be measured. The latter time constant implies that a capacitor, which is charged up to 100 V and then left to self-decay, still retains a charge of 37 V after 3 years. Fig. 11 shows the insulation time constant of polystyrene capacitors as function of temperature compared with the insulation time constant of paper capacitors.

If a capacitor, after being charged, is short-circuited a moment and then left with open poles, it is found that part of the charge returns within a few seconds or minutes. Latterly there has been a certain demand for capacitors with an especially low residual charge of this kind. Polystyrene capacitors are particularly well adapted for such purposes, and fig. 12 shows the retained

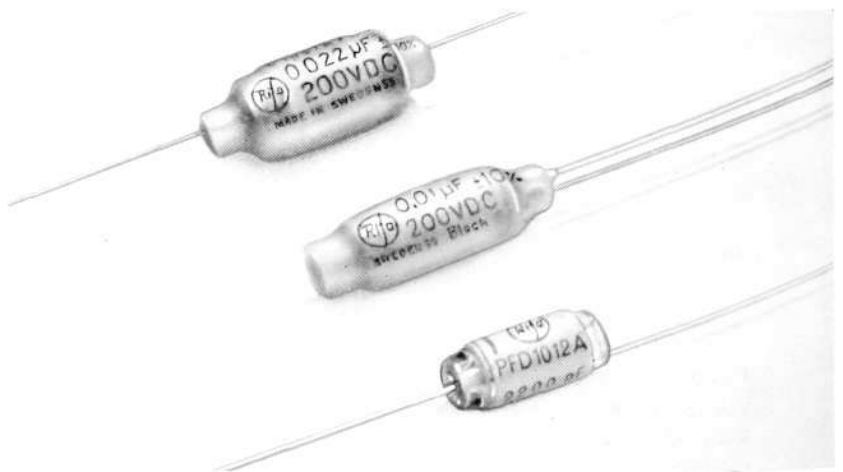


Fig. 13 X 6829
Various designs of polystyrene capacitors

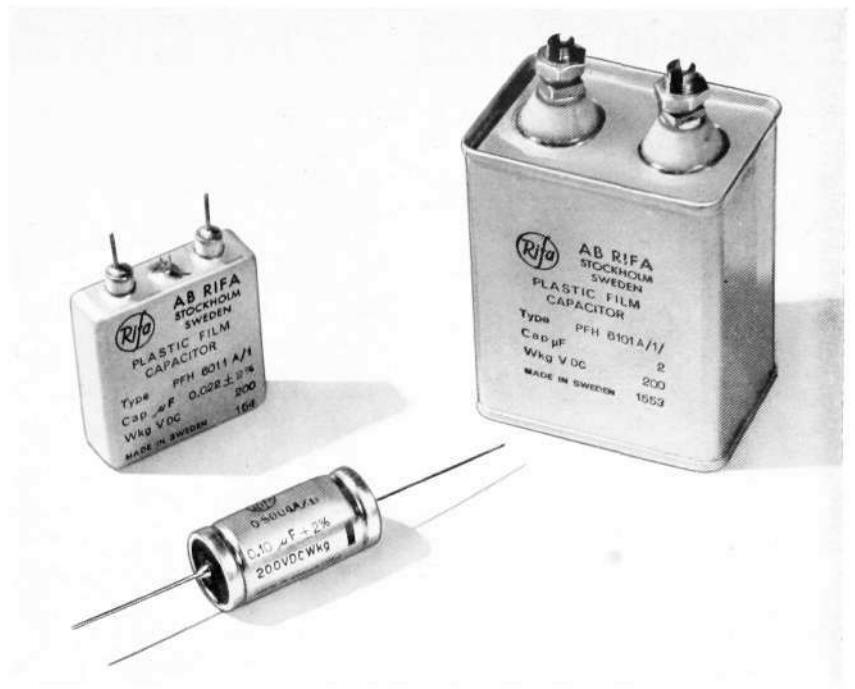


Fig. 14 X 6828
Various designs of polystyrene capacitors

charge of polystyrene capacitors compared with various other types. For purposes of measurement the capacitors were connected to a 100 V supply for 10 minutes, after which they were disconnected and short-circuited across a 2-ohm resistance for 20 milliseconds. The charge recovered was measured with a very high-ohm valve voltmeter. As is seen, the residual voltage in the case of polystyrene capacitors is only about one thousandth of the applied voltage, and five times as low as the best of the earlier types, the mica capacitors.

Applications and Designs

Polystyrene capacitors have hitherto been mainly used for electric filters in transmission systems in place of mica capacitors. Polystyrene capacitors are very much simpler to manufacture than mica capacitors, and their use involves a great saving in cost. The fact that the temperature coefficient of the capacitance of polystyrene capacitors is negative means that a certain compensation of the positive temperature coefficient in the filter inductances is obtainable.

With the advance of electronics the number of applications open to polystyrene capacitors has increased. Their excellent capacitance stability enables them to be used as capacitance standards in bridges, and their high insulation makes them suited to electronic computing circuits, timing meters, and indicators, for the measurement of small currents or charges, as filter capacitors in rectifiers for high voltages at low current outputs etc. Due to their low moisture absorption they have become popular as cheap and highly insulated tuning and coupling capacitors in radio sets, amplifiers, and oscillators.

Figs 13 and 14 show some different forms of design. The simplest unprotected type which is mounted suspended on its tags is seen at the bottom right of fig. 13. Behind it and to the left are seen some capacitors enclosed in a polyvinyl tube and dipped in a moisture-protecting wax with high melting point according to a process for which patent has been claimed. In the background of fig. 14 are two capacitors in soldered metal cases with ceramic bushings and, in front, an aluminium tube type that is seated with a rubber-bakelite laminate.

Balancing Machine for Objects Rotating at High Speeds

H TÖRNROS, L M ERICSSONS MÄTINSTRUMENT AB, STOCKHOLM

U.D.C. 621—755

L M Ericssons Mätinstrument AB has included a new type of balancing machine, YRB 30, in its production schedule, which is specially designed for balancing the rotors of reamotors. It differs from Ericsson's other types of balancing machines with respect to the transmission of the torque and ensures a high degree of precision when balancing rapidly rotating objects. The machine may also be used for rotors that do not require extremely accurate balancing, such as pump rotors, fans and rotors for electric motors

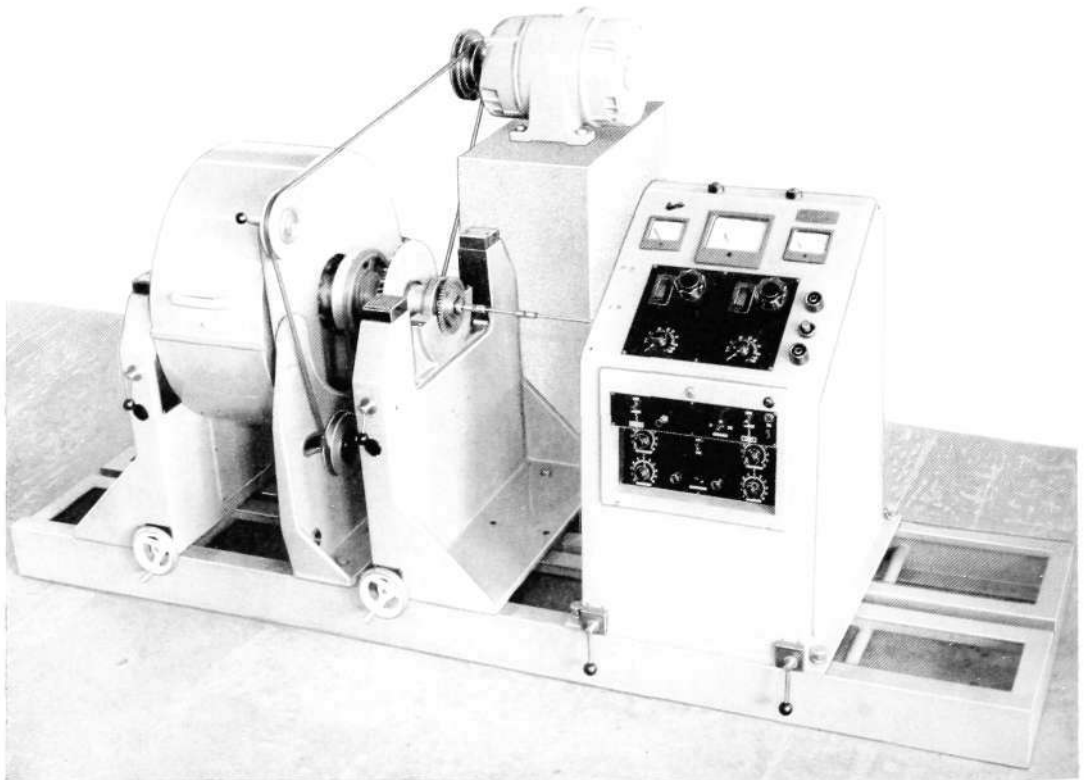
L M Ericsson has designed a balancing machine, type YRB 30, for balancing the rotors of reamotors, which differs in many respects from the balancing machines hitherto manufactured by this concern, fig. 1.

Objects rotating at high speeds require very accurate dynamic balancing. For example, one manufacturer of reamotors specifies that the residual unbalance in turbine and compressor rotors must not exceed 0.01 oz. inch. (7 gm), which in a rotor of this size corresponds to a displacement of the centre of gravity of approximately 0.00004" (1 μ). As the manufacturing tolerances for roller and ball bearings are of the same order of magnitude, this implies that the balancing accuracy represents the limit of what can be actually obtained under practical conditions.

Fig. 1

X 6776

Balancing machine, type YRB 30



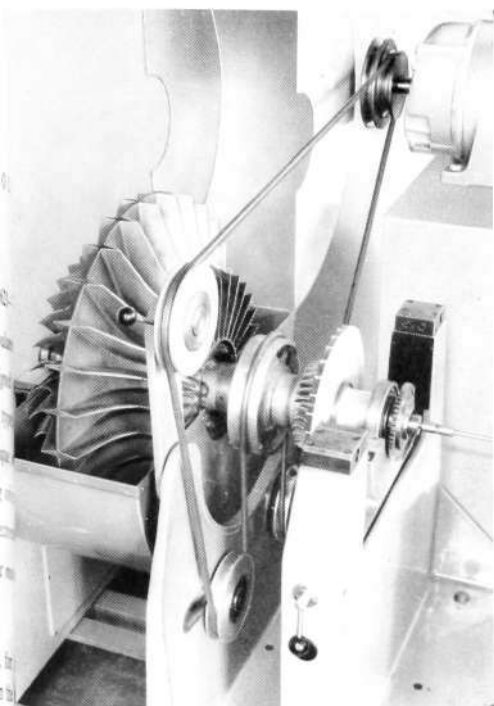


Fig. 2
Belt-tightening device

X 4925

In L M Ericsson's other types of balancing machines the torque is transmitted to one shaft-end of the object through a link coupling which is attached to a driving sleeve mounted on the shaft-end. This form of drive is unsuitable for the high degree of sensitivity necessary for cases of the kind mentioned above. In this instance it is difficult to produce the driving sleeve with the requisite concentricity to obviate disturbances from the coupling. In this machine, therefore, the torque is transmitted directly from the driving motor through a belt of plastic material to the shaft of the object as close to the centre of gravity as possible. When vibrations in a horizontal direction are measured by the machine, the belt must be led over the shaft vertically in order to eliminate disturbances in the horizontal plane. Furthermore, the belt must be mounted in such a way that it can be easily released when changing the object to be balanced. The belt-tightening device designed for this purpose is shown in detail in fig. 2.

The principle of measurement is the same as that adopted in L M Ericsson's other balancing machines. The rotor is suspended in two resilient bearings which can execute substantially undamped oscillations in the horizontal plane. Each bearing is connected to a vibration indicator which consists of a coil inserted in the air-gap of a permanent magnet. When an unbalanced object rotates in the bearings at a constant speed, the latter will vibrate, whereupon sine-wave alternating voltages proportional to the vibrations are set up in the vibration indicators. These voltages are amplified and applied, one at a time, to the one coil of an electrodynamic instrument. The other coil is fed at the same time with a reference voltage obtained from one of two synchronous generators—one for each balancing plane—mounted on a shaft in a stand which contains the measuring equipment. This shaft is driven from a sleeve mounted on the shaft-end of the object, via a link-coupling which can be constructed very light since the necessary torque is small. The disturbance due to the link coupling will thus be negligible.

The electrodynamic instrument will give a deflection under the influence of the vibration voltage and the reference voltage, which is dependent upon the product of these voltages and the cosine of the phase angle between them. The phase position of the reference voltage can be changed by turning the stator of the reference generator by means of a handwheel. If the phase position for the two voltages is the same, that is to say, the cosine of the phase angle between them = 1, the instrument will give a maximum deflection. By this means the angular position of the unbalance can be determined. Thus, the magnitude of the deflection is solely dependent upon the product of the two voltages, and since the reference voltage is directly proportional to the balancing speed of rotation which is always fixed for a given type of rotor, the instrument's maximum deflection represents a measure for the magnitude of the unbalance.

The angular position of the unbalance can be read off directly on a scale placed on the handwheel employed for turning the stator of the reference generator. After the machine has been stopped the object is turned by hand until the corresponding angular position can be read off on a scale placed at the ingoing shaft-end of the measuring equipment. The point to be machined will then be in the required position, vertically upwards for example. It is also possible to locate the position by means of an optical position-marking device. This consists of two lamps—one for each balancing plane—which light up through a commutator mounted on each generator when the point to be machined in the plane concerned is facing vertically upwards.

In addition to the above-mentioned electrodynamic instrument the instrument panel includes an instrument for reading the number of revolutions and an instrument on which the residual vibration voltages, after correction has been effected, can be read off for the respective planes. In this way it is possible to check the condition of the bearings which is of interest in cases where the rotor is fixed in the machine with the help of the ordinary ball-

or roller bearings. Furthermore, a change-over switch is provided for connecting up the measuring equipment to the left or right balancing plane, a change-over switch for measuring the "heavy" or "light" points, depending upon whether material is to be removed or added, handwheels for regulating the amount of amplification and adjusting the correction network, with the help of which one is rendered independent of the effect exercised by unbalance in the one balancing plane on the measurements in the other one. Pushbuttons are also mounted on the stand for operating the driving motor.

Mechanical Construction

The machine consists of a base on which the pedestal bearings, the belt-tightening device and the measuring panel are mounted. The base is intended to be cast into a concrete foundation and is constructed of welded and planed iron girders. The driving motor is installed on a separate concrete foundation and the belt-tightening device is located on the base immediately in front of the driving motor. On account of the driving system adopted, the position of the belt-tightening device is fixed. Thus, in order to enable the machine to be adapted to different types of rotors the pedestal bearings and measuring panel framework have been arranged to move along the base.

The pedestal bearings are constructed of cast iron and are fitted with bearing cradles suspended by leaf springs. Adjustable roller bearings or holders for fixing the object's own bearings can be mounted in the bearing cradles. In order to eliminate aerodynamic disturbances and limit the driving motor output required, the machine is provided with air casings for turbine and compressor rotors.

The framework for the measuring panel is constructed of welded sheet iron. The amplifier and operating device, the adjusting gear and change-over switches are mounted on a hinged shutter so that they are conveniently accessible for inspection. The vital parts of the measuring equipment can be readily changed, so that any servicing at the point of use can be restricted to the replacement of complete units, such as a complete amplifier or reference generator equipment.

Other Forms of Application

The machine can, of course, also be employed for rotors which do not require such extremely accurate balancing, such as pump rotors, fans and the rotors of electric motors. A necessary assumption is, however, that a smooth surface must be available for the driving belt or can be applied without difficulty. The machine is particularly suitable for use where objects of varying types have to be balanced. The sleeves required for driving the measuring equipment can be made in a very simple form and do not call for a specially high degree of concentricity so that their cost is insignificant compared with that of driving sleeves for driving the object through a link-coupling.

Technical Data

Rotor weight: 6—2,000 lbs. (3—1,000 kgs).

Max. rotor diameter: 40" (1,000 mm).

Max. distance between bearings: 80" (2,000 mm) (can be increased if necessary).

Balancing speed: 490—900 r.p.m.

Sensitivity: Vibrations with amplitudes of 0.00001" (0.2 μ) can be measured at slide bearings.

Total length: 120" (3,100 mm) with a distance between bearings of 80" (2,000 mm).

Max. width: 53" (1,350 mm) incl. motor foundation.

Ericsson
LM

NEWS from

All Quarters of the World

Water Level Indicator System for Flood Prevention in New Zealand

A water level indicator system was recently supplied by L M Ericsson for the Rangitikei River on the North Island of New Zealand. It is anticipated that this system will have a great effect in the prevention of the serious annual flooding of this river. The Rangitikei River drains the western slopes of the Ruahine Mountains in the southern part of the island. The spring flood is very heavy and the water level varies greatly at different seasons.

The transmitter of the water level indicator system, which is of L M Ericsson's normal design, is placed at Mangaweka Bridge. The photograph below was taken when the water level was 7 ft. In May this year the depth at the same point was 15 ft.

The transmitter impulses are received and recorded on the receiver equipment located in a telephone exchange about 3 kilometres from the bridge. On the sounding of a high



Rangitikei River where the road crosses Mangaweka Bridge. The transmitter equipment of the water level indicator system is located at this bridge. The photograph was taken in summer at low water.

water alarm signal, the telephone operator immediately informs the staff of the dam at Marton, a town some 50 kilometres down river. Measures are there taken to prevent flooding and the damage caused by it, particularly in the agricultural areas through which the Rangitikei flows in its lower stretches.

The telephone connection with Marton is a reminder of the automatic exchange L M Ericsson supplied to that town as long ago as 1931. The exchange is equipped with 500-line selectors for 990 extensions and is the most southerly of L M Ericsson's automatic exchanges. Marton lies on a latitude of 40°.

New Edition of «Table of the Erlang Loss Formula»

The first of a projected series of formulae tables for use in the designing of telephone plants, «Table of the Erlang Loss Formula», was published by Conny Palm in 1947. The table comprises congestion figures for different traffic values and numbers of switching devices according to Erlang's formula for busy-signal systems (Erlang's B formula). The table is computed for traffic values with the following intervals:

interval 0.05 within the range 0.05—	1.00
» 0.1	» » » 1.0 — 20.0
» 0.5	» » » 20.0— 30.0
» 1.0	» » » 30.0— 50.0
» 4.0	» » » 50.0—100.0

The table has proved its value to telephone administrations and companies. The first edition ran out some time ago. In the new edition the range has been extended to comprise traffic values up to 200 Erlang with a 5.0 Erlang interval for the added section. The calculations have been carried out on the Swedish electronic computer BESK.

The new edition, like the former one, is the product of cooperation between the Swedish Board of Telecommunications and Telefonaktiebolaget L M Ericsson, from either of which the table may be ordered.

C PALM: Table of the Erlang Loss Formula, 2:nd edition, Stockholm 1954.



Frederiksberg's New Town Hall Equipped by L M Ericsson

A new town hall was recently built in Frederiksberg, a suburb of Copenhagen with about 120,000 inhabitants, and some of its equipment was supplied by L M Ericsson, viz. a P.A.B.X. with 500-line selectors at present equipped for 400 extensions, 44 link circuits and 50 public lines; an electric clock installation to which the large clock in the tower of the town hall is connected; and finally a fire alarm system comprising 30 alarm sections. The latter includes both thermocontacts for automatic alarm and alarm press buttons.



The head of the Ericsson Company in Essen is Herr Gerhard Dillenberg.

Similar types of P.A.B.X. to that in the Frederiksberg Town Hall are installed in other parts of Denmark, serving at present about 2,900 extensions. A further plant will soon be operating in the Town Hall of Lyngby, with a capacity of 200 lines.

Ericsson Verkaufsgesellschaft m. b. H. to Essen

Ericsson Verkaufsgesellschaft m. b. H., the offices of which were previously in Frankfurt-am-Main, moved on May 1, 1954, to its new address, Daimlerstrasse 2, Essen-Bredeney. The head of the company is Herr Gerhard Dillenberg, while Herr Walter Schöneck is in charge of the technical service. Sales comprise telephone and telesignal material. The Essen office furthermore acts as L M Ericsson's purchasing agent in Germany.

Its situation in the heart of the Ruhr affords the firm excellent contact with the large industries of the area. Among the groups of material which are of most interest may be mentioned time control systems and *Centralograph*, for which an ample spare parts stock is held. Ericsson Verkaufsgesellschaft is thus in a position to render rapid and efficient service to all new West-German customers as well as to those who have had Ericsson plants operating since before 1939.

Grants for Research and Travel Scholarships

The Telefonaktiebolaget L M Ericsson Foundation for the Promotion of Electrotechnical Research has granted scholarships this year amounting to 21,000 kronor. Among the recipients is Folke Bolinder, Doctor of Technology who received 4,000 kronor for research studies in Mexico City at the laboratory of Dr. Manuel Cerrillo, one of the world's foremost experts in the theory of modern circuits.

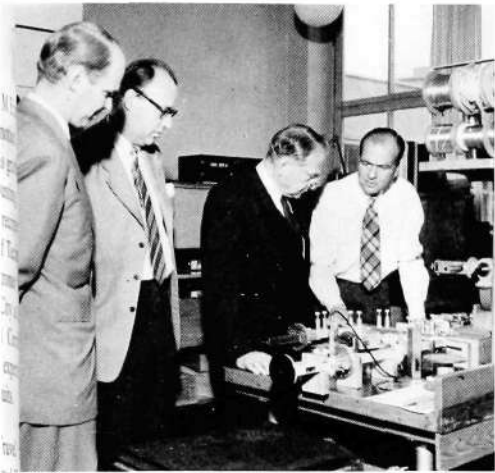
The Foundation for Travel and Study Scholarships has allotted 27,800 kronor to 18 employees at L M Ericsson companies and to 6 members of the Swedish Telecommunication Administration.



New Sections of French Catalogue

L M Ericsson's new export catalogue of telephone material is divided into sections, each comprising one group of materials. The English catalogue is already complete, as announced earlier, and the Spanish edition is expected to be ready very soon. The sections covering telephone instruments, private automatic exchanges and selective calling telephone systems have now been printed in French as well under Catalogue No. 685 to fulfil the requirements of catalogues in the French language for some of L M Ericsson's markets.

From the Visitors' Book



Dr. Vladimir H Zworykin, Vice President and Technical Consultant of the RCA Radio Corporation of America is seen in the photograph above between Dr. Christian Jacobæus (left) and Dr. C-G Aurell during a visit to one of the Transmission Dept. laboratories. At the far left is Mr. K V Fredriksson of Elektronikbolaget.

The members of the British Iron and Steel Institute held a congress in Stockholm in June. The photograph below shows a group studying the work in one of L M Ericsson's workshops.



LM Ericsson A/S, Copenhagen

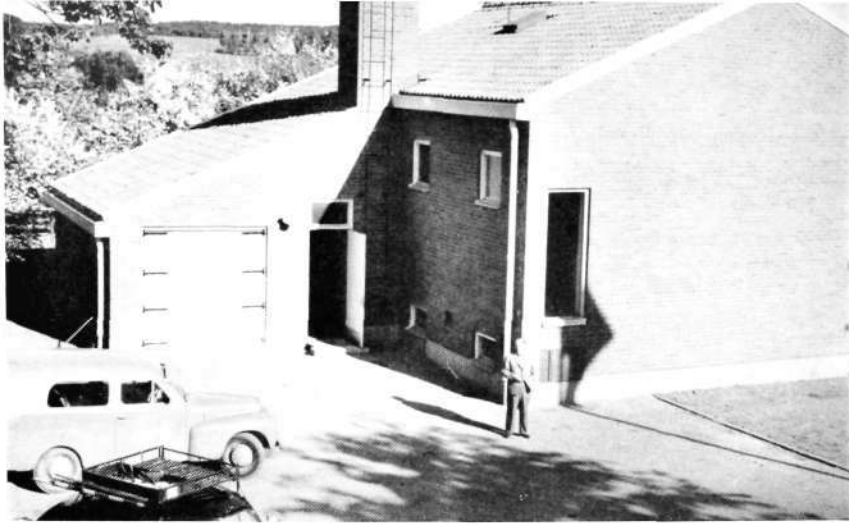
The Danish sales company, L M Ericsson A/S, has moved into premises of its own at Finsens Vej 78, Copenhagen F. In the same building are offices and workshops of the associated firm of Dansk Signal Industri A/S.



The above photograph shows the Mexican Minister to Sweden, Mme Amalia de Castillo Ledon, on a visit to Midsommarkransen. On her left is the President of L M Ericsson, Mr. Sven T Åberg, and on her right the head of the Mexican Telefonaktiebolaget Ericsson, Mr. Bernhard Wahlqvist.

Dr. Azikiwe, Prime Minister of Eastern Nigeria (right in photograph below), paid a visit to L M Ericsson at the end of June, accompanied by Dr. Ojukwu, a leader of industry. Before being shown over the factory, some of the main features were pointed out to them on the Show Room model by their guide, Captain Hagstedt.





The photograph (left) shows a corner of the Sjöbo telephone exchange.

Advance of Automatization in Southern Sweden

Among the automatic telephone exchanges in the south of Skåne being installed by L M Ericsson, the 900-line exchange at Sjöbo has now been delivered and was cut into service in May. All of the exchanges on order are being built to the Telecommunication Administration marker system with crossbar switches.

Sjöbo is a group centre with nine terminal exchanges. The Sjöbo group will in the first place have fully automatic traffic with Malmö and Lund. Of the four south-Skåne exchanges on order, totalling 7,900 lines, Ystad is the largest with 4,000 lines and is expected to be in service by March next year, by which time practically the whole of south Skåne will be fully automatized.

An automatic exchange has also been recently delivered to Nässjö. The Nässjö exchange was cut into service on July 4, and the material supplied by L M Ericsson comprises equipment for 4,000 lines and junction equipment for the 17 tandem and terminal exchanges within the group.



New Sales Office in Zürich

For the sale of L M Ericsson products in Switzerland a branch has been opened in Zürich at Stampfenbachstrasse 63. The manager of this office is Mr. Kurt Klöpfer (seen in the photography above), and his assistants on sales and technical service are Messrs. Weber and Hintermann. The main sales lines are time control equipment, intercom telephone systems and *Centralograph*. A well assorted stock of spare parts enables the Zürich organization to render prompt service to L M Ericsson's Swiss clientele.

Cable Laying by Jeep

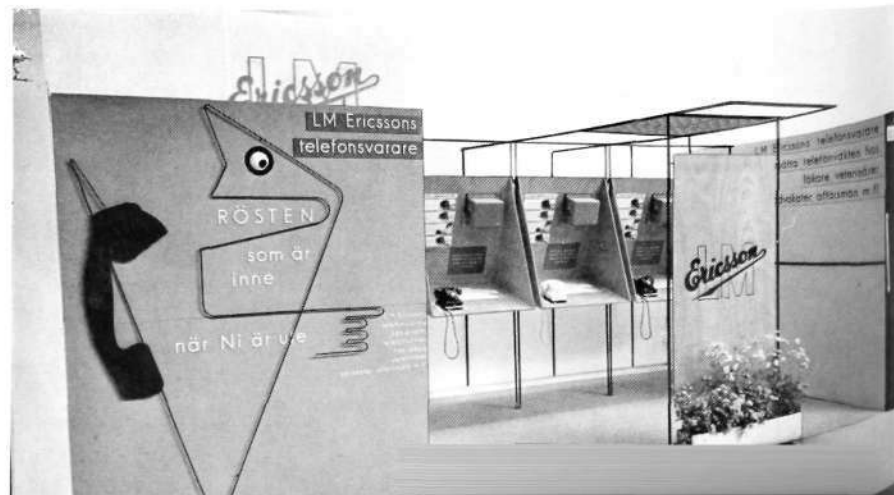
Among the exhibitors at the Spring Motor Car Show in Stockholm was L M Ericsson. A jeep-driven cable

laying outfit, developed by L M Ericsson in cooperation with the Telecommunication Administration, was shown mounted on a Willys-Overland jeep. The outfit consists mainly of winching gear for laying aerial and underground cable, armoured or in ducts. A compressor, electric generator or the like can also be driven from the power take off. A jeep equipped in this way can, of course, still be used as tractor and for other normal purposes.



The outfit can be carried on jeeps of different types. It has been widely employed on L M Ericsson's large network construction projects all over the world and has proved its worth as a cutter of labour costs.

L M Ericsson's stand at this year's Swedish Fair in Gothenburg. The public were given the opportunity of listening to recordings they had themselves made on L M Ericsson's telephone answerer — a chance that was eagerly seized upon by large numbers of visitors to the Fair.



U.D.C. 621.319.416.3

HARRIS, P O: *Plastic Film Capacitors*. Ericsson Rev. 31 (1954) No. 2 pp. 56—61.

AB Rifa has for several years been manufacturing capacitors of polystyrene—a plastic material obtainable in thin sheets. Due to their unusual properties these capacitors are now being used for a number of special purposes. In addition to describing these capacitors in the form in which they are manufactured by Rifa, the article gives examples of their use.

U.D.C. 621-755

TÖRNROS, H: *Balancing Machine for Objects Rotating at High Speed*. Ericsson Rev. 31 (1954) No. 2 pp. 62—64

LM Ericssons Mätinstrument AB has included a new type of balancing machine, YRB 30, in its production schedule, which is specially designed for balancing the rotors of reamotors. The machine, presented in this article, ensures a high degree of precision when balancing rapidly rotating objects. The machine may also be used for rotors that do not require extremely accurate balancing, such as pump rotors, fans and rotors for electric motors.

U.D.C. 621.315.211.4

HENCKEL, A: *Gas Control on Telephone Cables by Gas Flow Meters and Automatic Pressure Compensation*. Ericsson Rev. 31 (1954) No. 2 pp. 34—47.

In an article entitled »Gas Control on Telephone Cables» published in the Ericsson Review No. 4/1952 a new method was described by means of which, on the occurrence of a leak, gas is also fed into the cable automatically simultaneously with the gas control, whilst at the same time the drop of pressure in the gas is recorded. The following article describes this method in greater detail as well as the necessary apparatus and materials employed. The method itself and a part of the apparatus have been patented.

U.D.C. 621.395.26
621.395.655

ADENSTEDT, W: *New Type of Cordless C. B. Private Branch Exchanges*. Ericsson Rev. 31 (1954) No. 2 pp. 48—52.

A new line in the range of LM Ericsson's modern manual telephone switchboards has been brought out in the form of cordless C.B. private branch exchanges. These switchboards possess a number of advantageous features which make them simple to handle. The article deals principally with their construction and operation.

U.D.C. 621.385.1

EDSMAN, S & LAGERHOLM, G: *Review of SER Electron Tubes: Standard and Long Life Types*. Ericsson Rev. 31 (1954) No. 2 pp. 53—55.

This article presents a summary description of the range of standard and long life electron tubes at present being manufactured by AB Svenska Elektronrör.

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

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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.

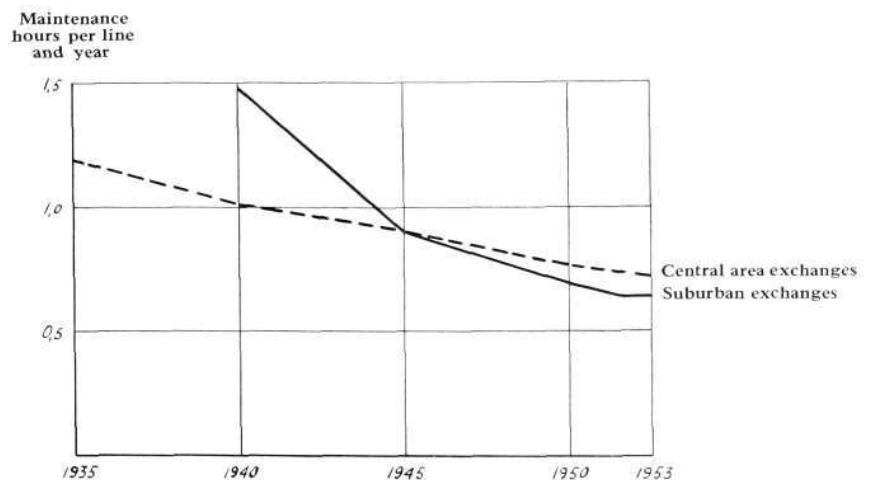


Fig. 1
X 6900
Number of maintenance hours per connected line and year for the Stockholm telephone exchanges during the period 1935—1953

Table 1

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

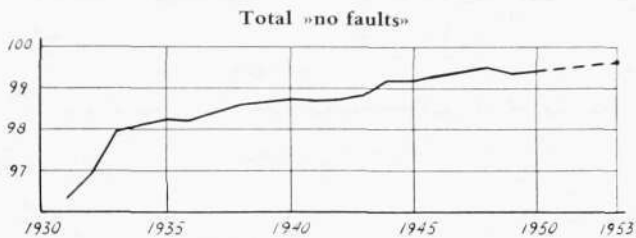
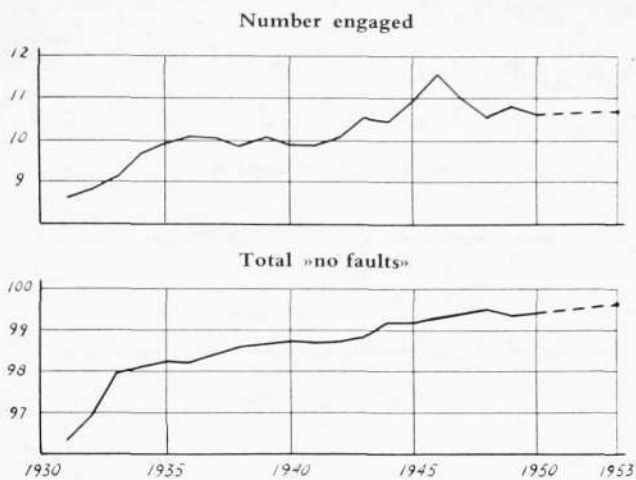
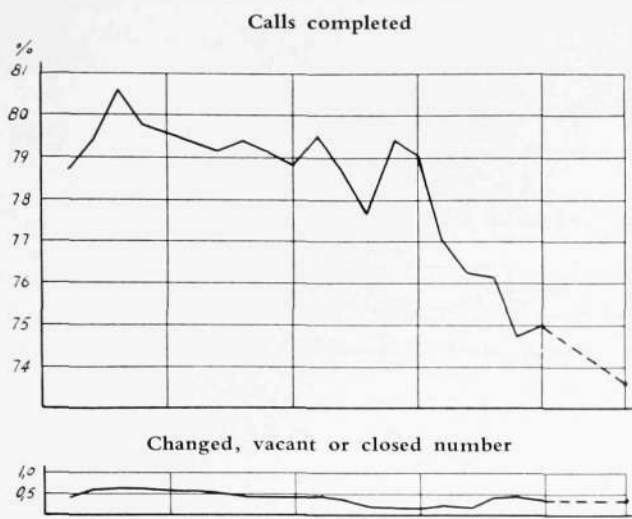


Fig. 2
 X 6901
 X 6902
 Percentage of «no faults» for Stockholm central area exchanges, divided in main groups according to table 2, during the period 1930—1953



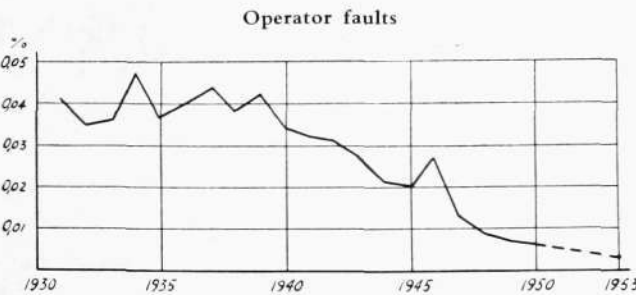
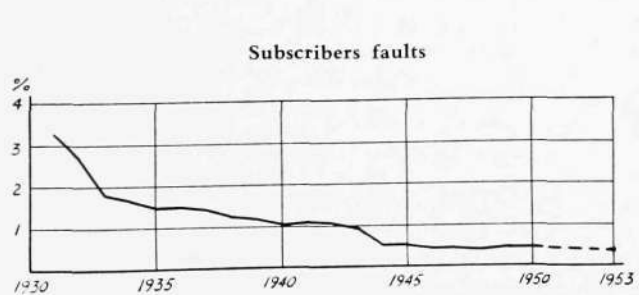
a greater extent than before. No doubt the free school lunches have caused the homes to be left empty at certain times of the day and with this the rate of "no reply" will naturally increase. The increased standard of living may also to a certain extent have contributed to the rising tendency of the 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



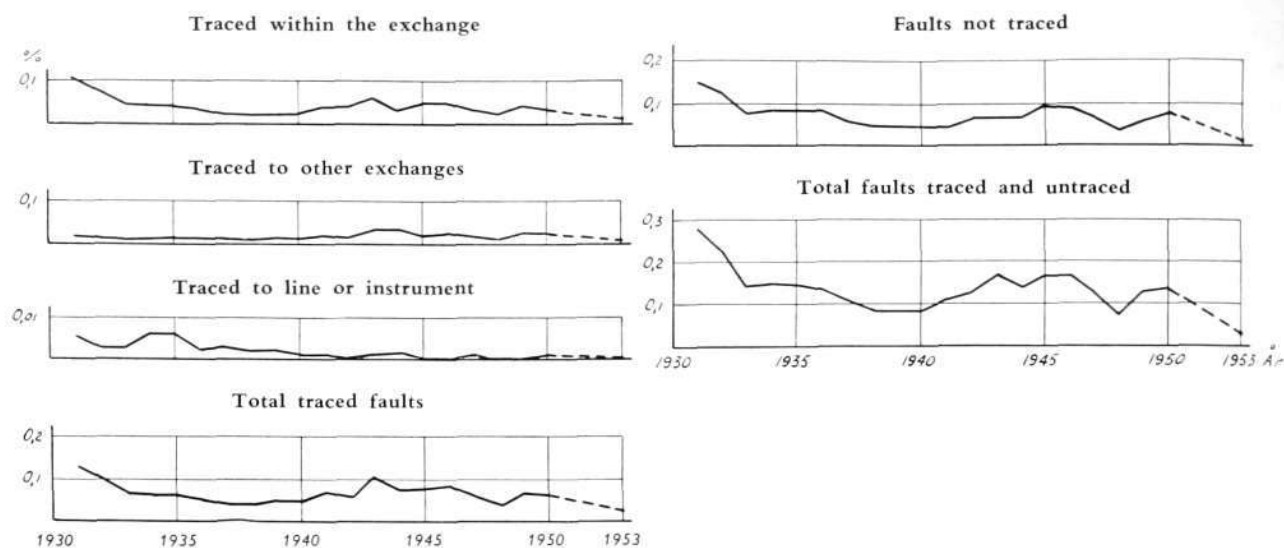


Fig. 4
Percentage of equipment faults or faults not traced

X 6904
X 6905

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 S IDENMARK, 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.

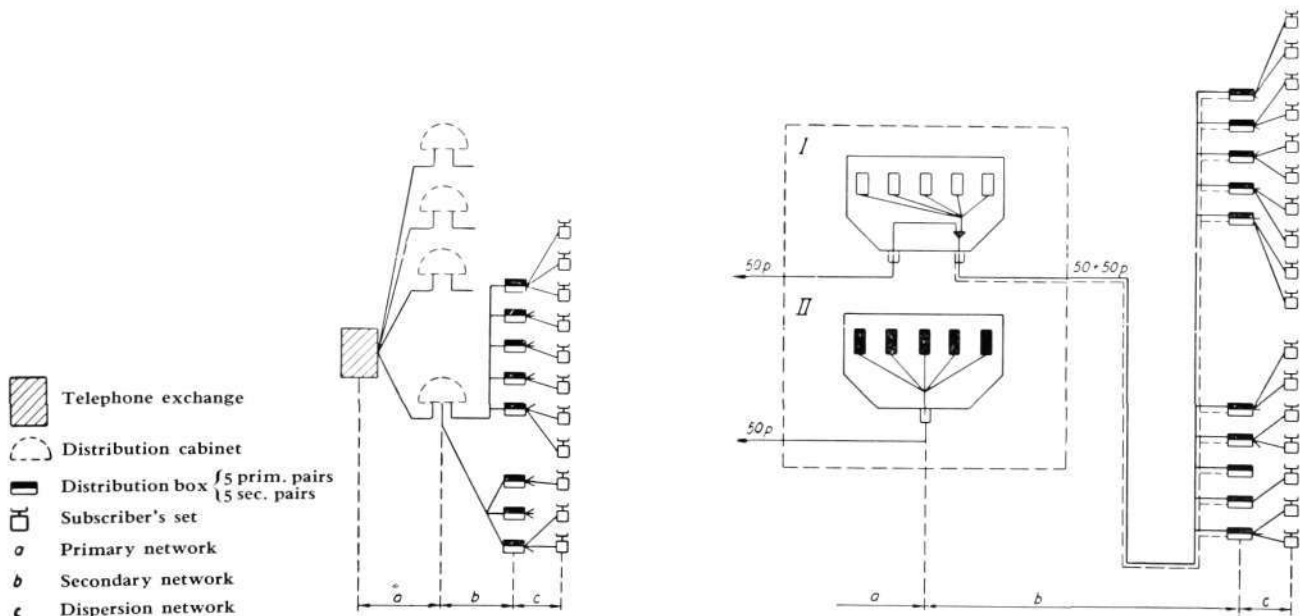
Fig. 1
X 9129
X 7669
Skeleton diagram for full through-connection

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

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.



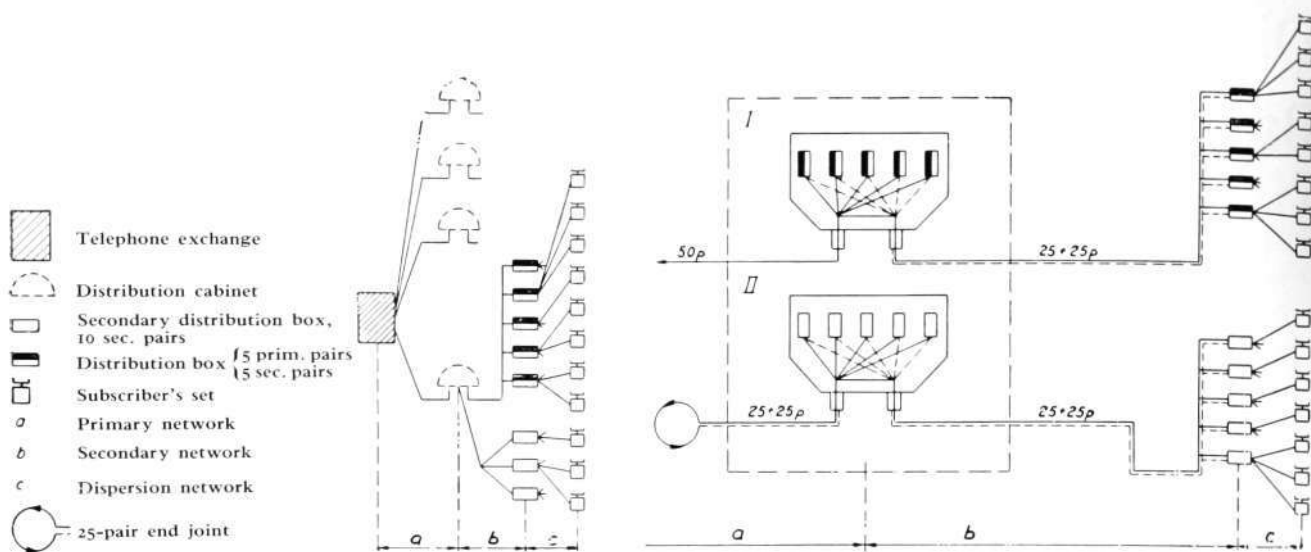


Fig. 2

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.

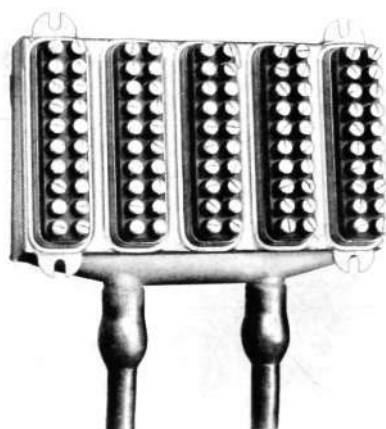


Fig. 3

X 4985

By-pass box with two cable entries

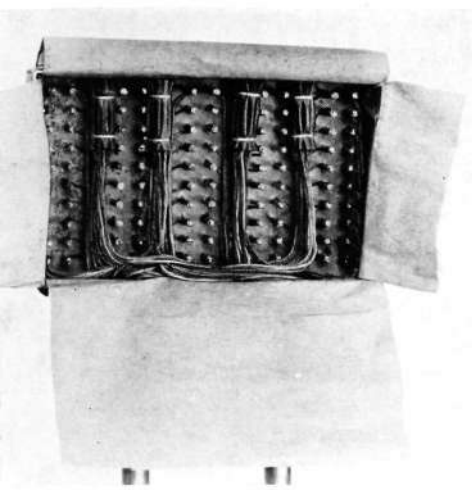


Fig. 4 X 4984
By-pass box with cable connected
rear view

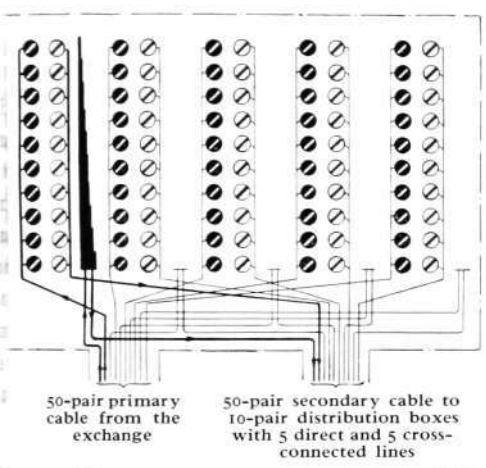


Fig. 5 X 4981
Connection of a by-pass box with two cable entries
front view

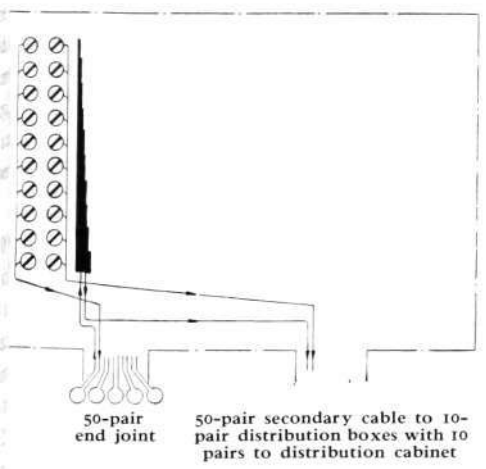


Fig. 6 X 4980
Connection of secondary cable box with two cable entries
front view

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-

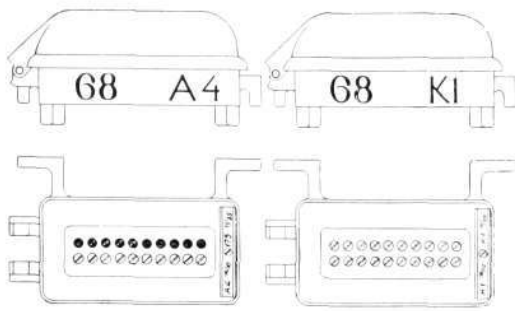


Fig. 7
Registration of distribution boxes X 4979

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 insulation 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 gradation 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.

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.

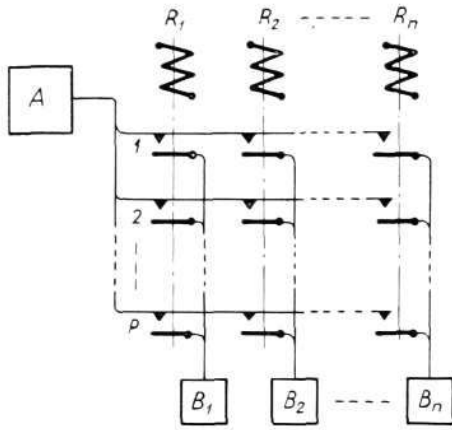


Fig. 1
Circuit diagram of multicoil relay
RAM 100
Example 1

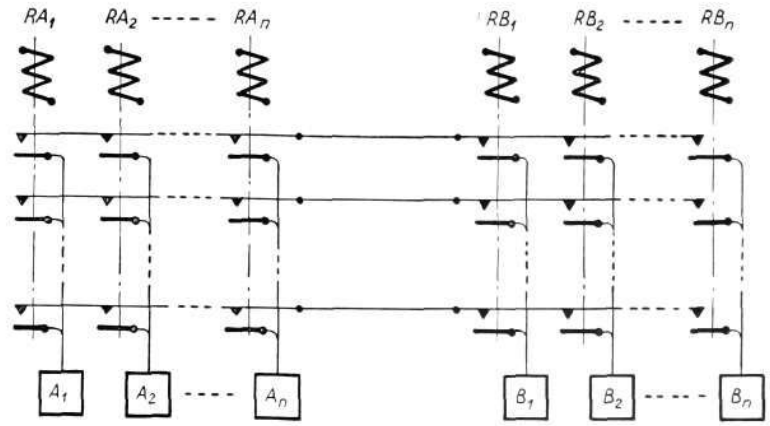


Fig. 2
Circuit diagram of multicoil relay
RAM 100
Example 2

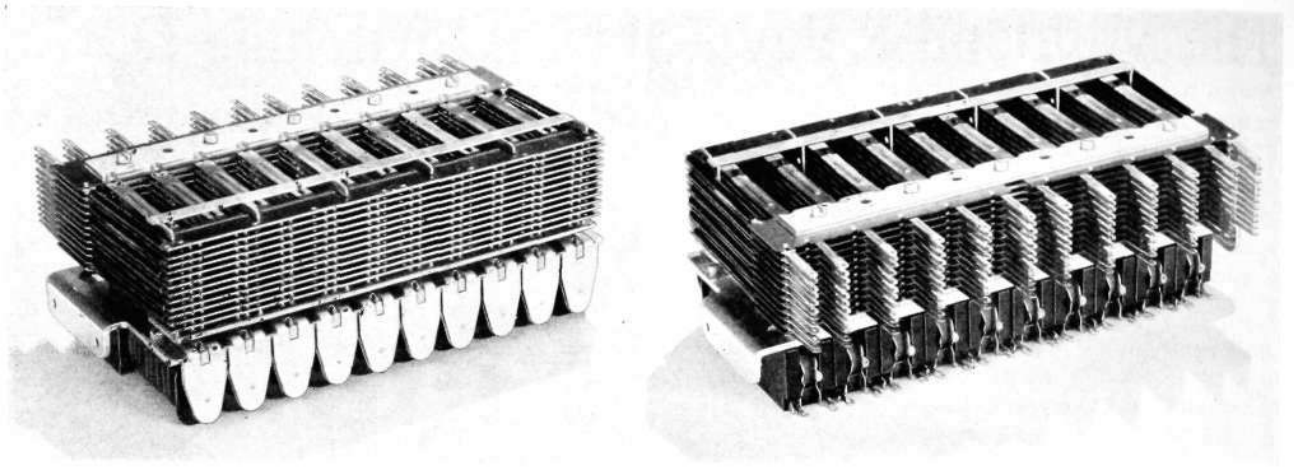


Fig. 3 X 7661
 Multicoil relay RAM 100
 Right: View from wiring side

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.

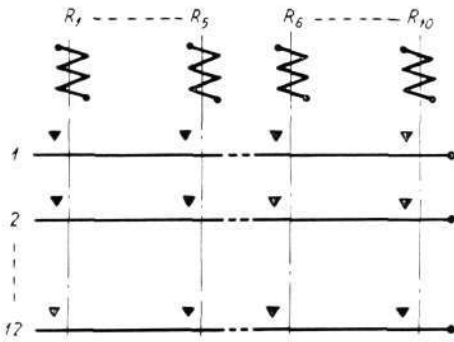


Fig. 4 X 4934
 Schematic diagram of multicoil relay

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.

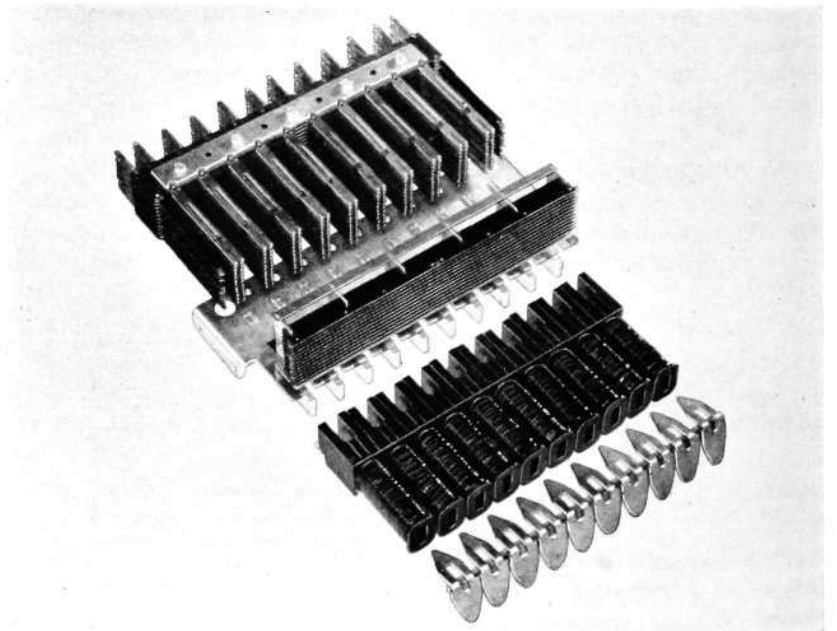
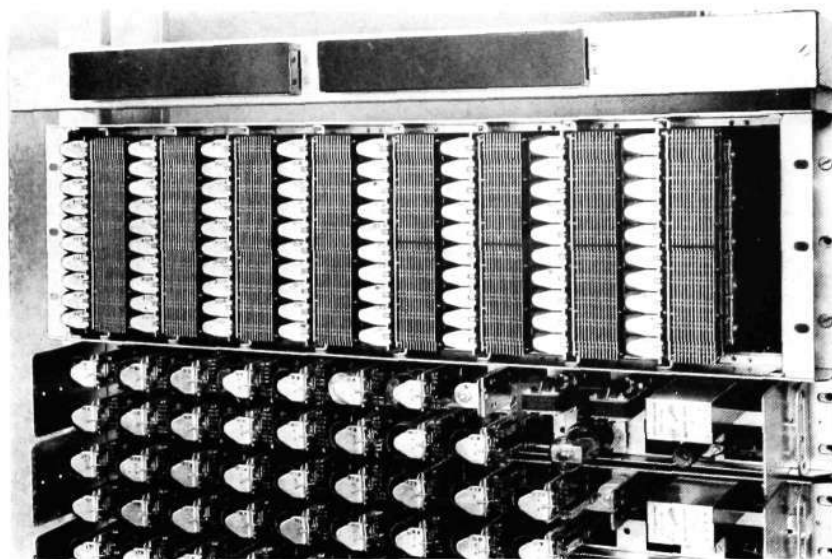


Fig. 5 X 6785
 Main components of multicoil relay
 From rear: bank, set of contact strips, frame carrying magnet cores, coils and armature

Fig. 6
Multicoil relays mounted in relay set

X 6786



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

F AHLBERG, TELEFONAKTIEBOLAGET L M ERICSSON, DIVISION ERGA, STOCKHOLM

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
The L M Ericsson parking meter
front view.

X 6912



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) and 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
The L M Ericsson parking meter
front view

X 4983

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 dismantled 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 dismantle 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

W WESSEL-HANSEN, GENERAL DIRECTORATE, DANISH STATE RAILWAYS, COPENHAGEN

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

Fig. 2
Schematic lay-out of Odense Station

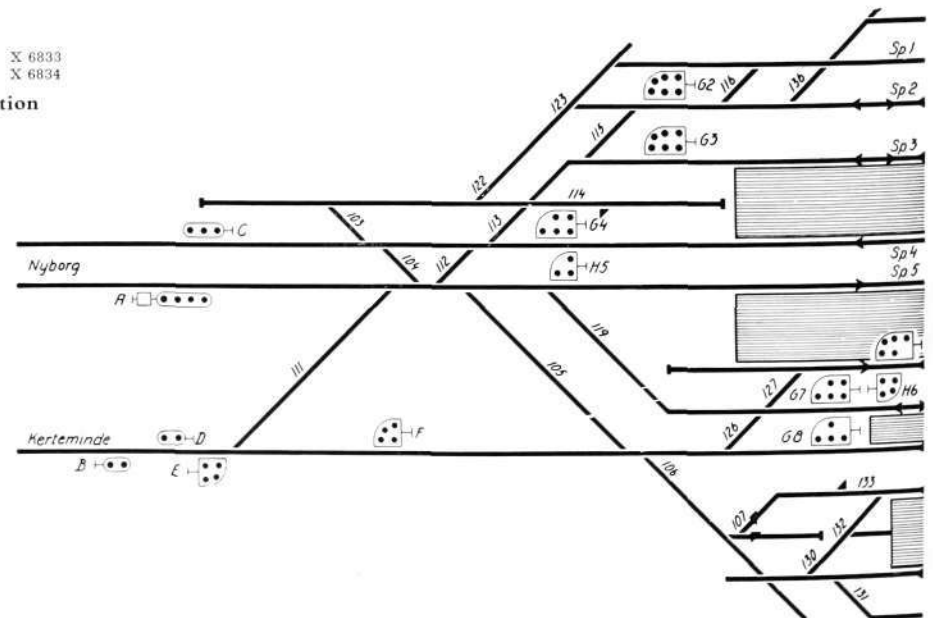
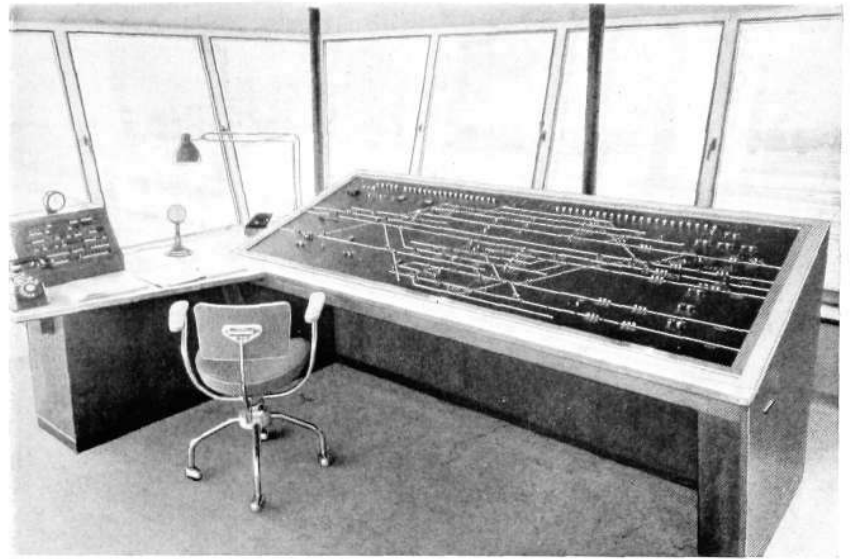


Fig. 3 X 6831

Control panel

On the left is seen the telephone switchboard and loudspeaker microphone



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.

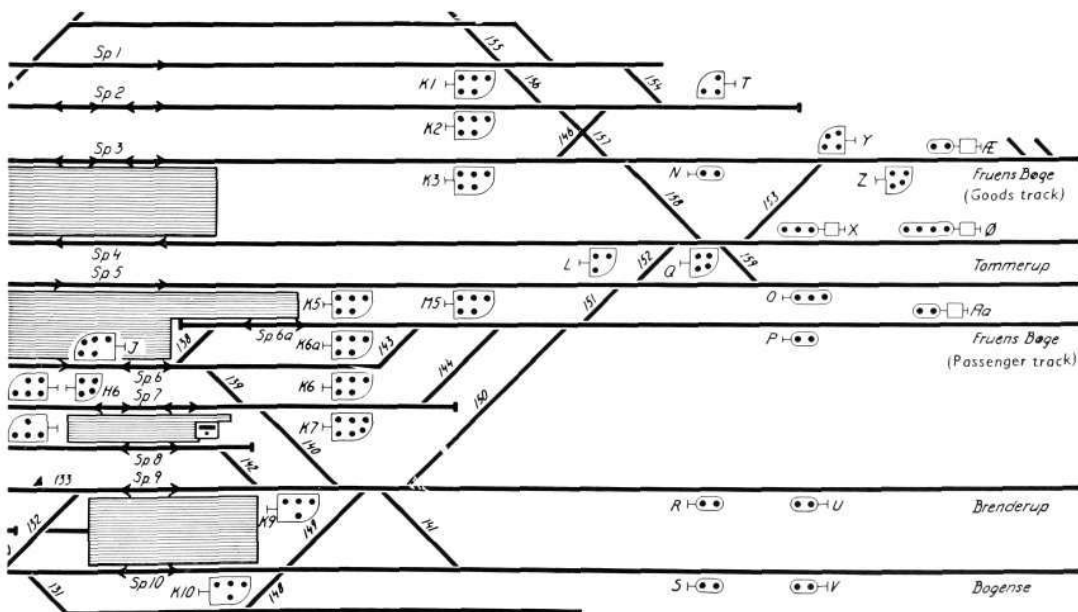
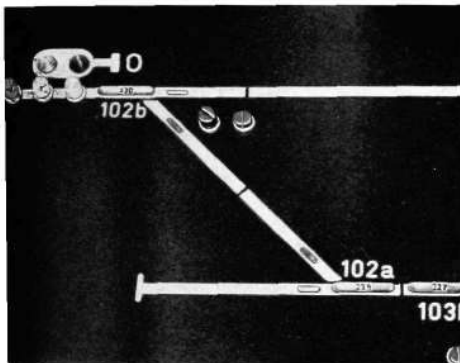
To provide for shunting movements and to facilitate the removal of snow from the points, some points have local switching arrangements. The change-over to local operation is done by turning a button (black with white stripe), which is placed beside the ordinary point push-button on the track diagram. 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

Fig. 4 X 4987

Section of control panel



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.

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.

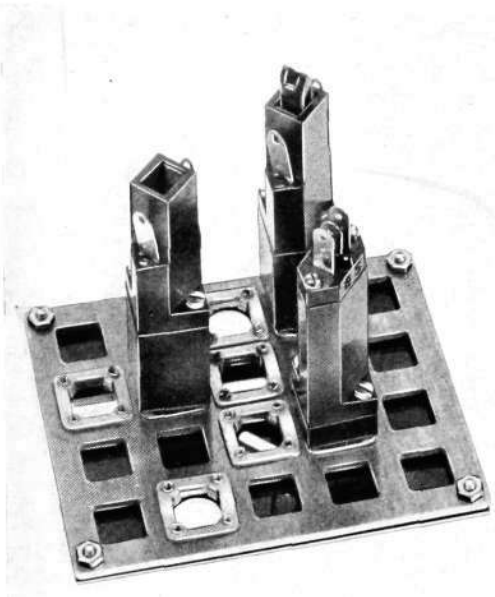


Fig. 5 X 4986
Press-buttons and indication lamps are mounted in identical fittings on a perforated aluminium plate forming the base of the control panel.

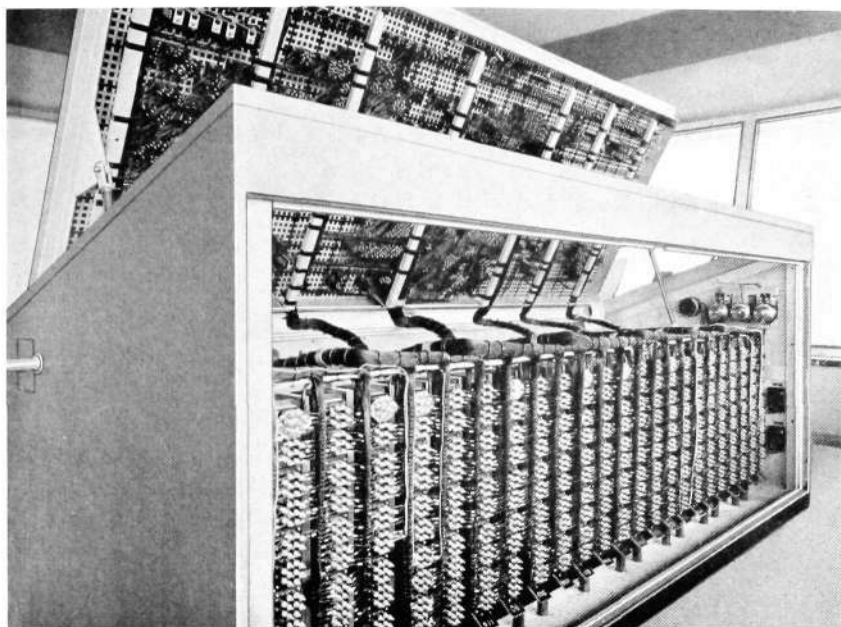


Fig. 6 X 6830

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.

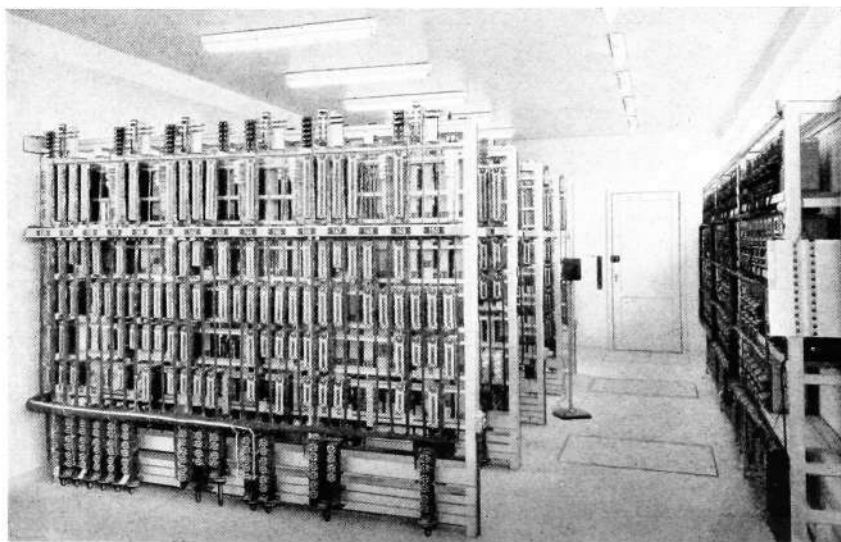


Fig. 7 X 6832

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 E D S M A N & G L A G E R H O L M, A B S V E N S K A E L E K T R O N R Ö R, S T O C K H O L M

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

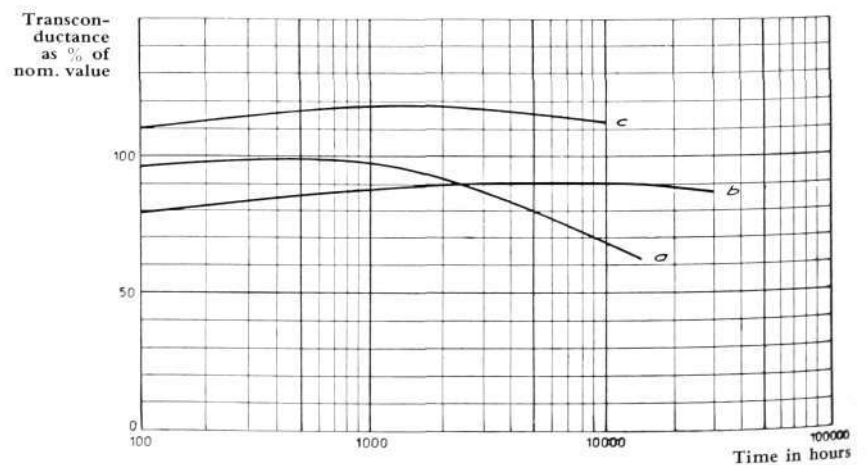


Fig. 1 X 6910
Life of 18J6 (6J6L)
a Cathode of INCO 220, mean of 10 tube systems
b Cathode of DH 499, mean of 10 tube systems
c Cathode of DH 499, grid redesigned for higher nominal transconductance, mean of 96 tube systems. (After 10 000 hours 100 % of the tubes are still within the functional limits.)

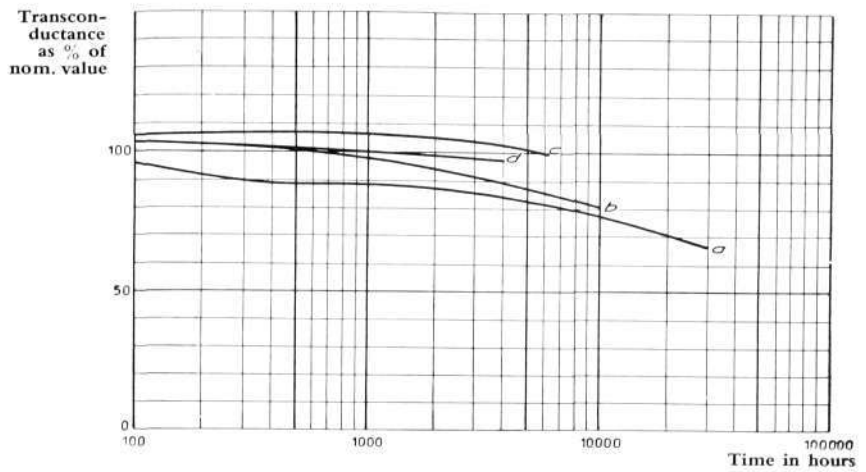


Fig. 2

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.

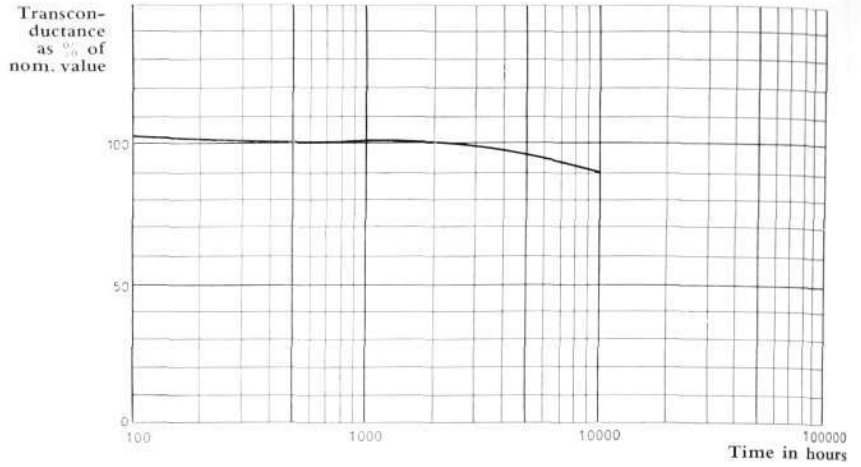
Since such good results were found with batch *b* in fig 1, S. E. R. decided to redesign their long life tubes. This passive nickel was now adopted as cathode material. But the time required for activation usually proved too long at the low cathode temperature employed. If large scale production of long 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 it 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.

Identical 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
Life of 404 A

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

X 6908



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.

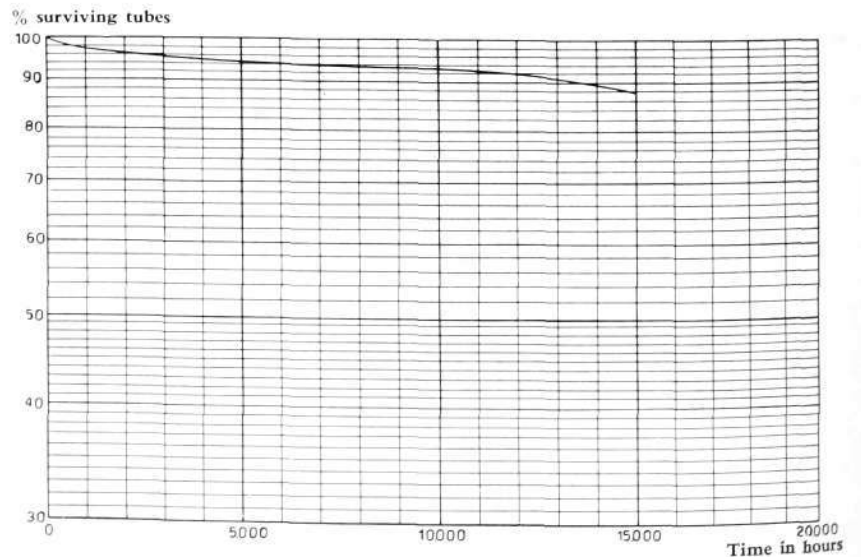
Fig 4 shows how the number of tubes diminishes as a result of the data falling outside the functional limits or of sudden faults developing of the kind outlined above. After a certain time this curve should tend to become a straight line, and the mean life is obtained by extrapolating the line to 37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

X 6907





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.

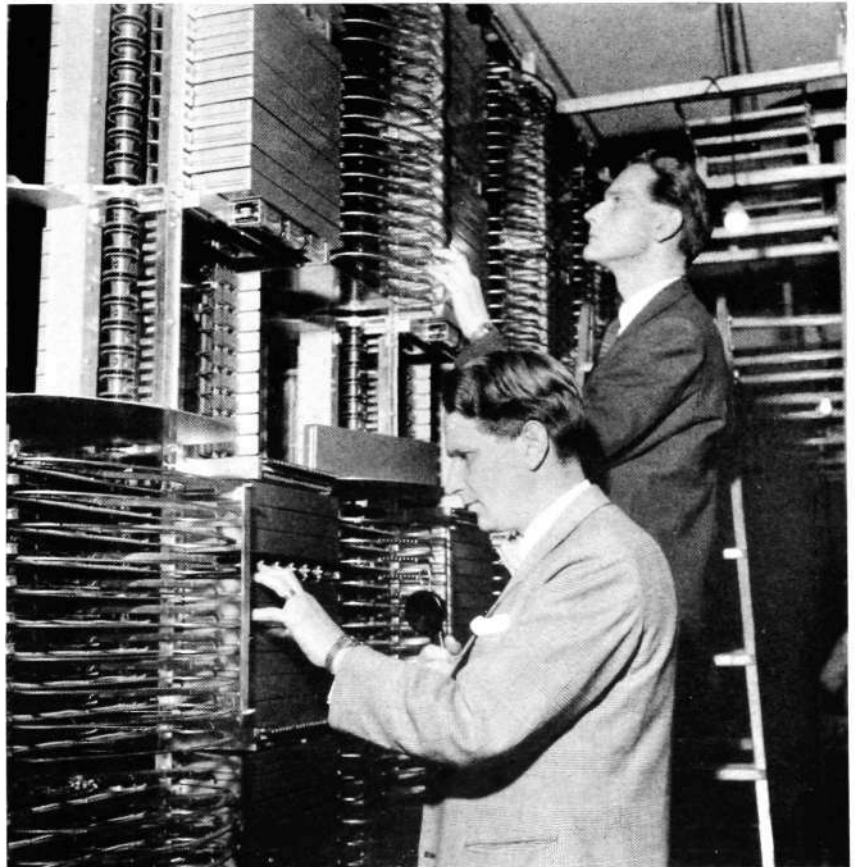
Another great benefit to subscribers is that automatization has made

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 tele-

phone 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 Mid-sommarkransen. 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 ex-

pected 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. 621.358.1: 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 1816 (6J6L), 403B (18AK5) and 404A.

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. 621.395.343.004.5

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.

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