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CONTENTS

On cover: L M Ericsson telephone instruments of 1878 and 1951 design

Maintenance of Automatic Telephone Exchanges with 500-line Selectors

C BERGLUND, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.343.004.5

The economic significance of maintenance work is frequently underestimated and should receive more attention than is usually given it where automatic systems are concerned. The following article contains a summary of the operating results obtained in the Stockholm automatic exchanges. Suitable maintenance methods for the system are described and general directions are given for the organization of a satisfactory maintenance service.

The Economic Significance of Maintenance Work

In consequence of the sharp rise in wages throughout the world the question of maintenance costs for automatic telephone exchanges has become increasingly important. Experts from a number of telephone undertakings with whom L M Ericsson has come into contact and members of the firm's own staff who have had opportunities of inspecting automatic telephone exchanges of different systems in various countries have been able to confirm that the composition of the maintenance staffs varies considerably. It has been observed that in many exchanges the maintenance staff for the actual automatic exchanges consisted of less than 5 men per 10,000 subscribers, whereas in other places the corresponding staff amounted in some cases to 40—50 persons. At the same time it was noted that generally speaking, the operating reliability was greater in exchanges having a relatively small maintenance staff. The following figures given by way of example will convey some idea of the great economic significance of the maintenance costs.

An exchange for 10,000 lines is assumed to have cost US $ 50 per line, purchase price, and is maintained by 6 persons receiving an average wage of 100 $ per month. The wages of the maintenance staff thus amount to 0.72 $ per line and year. A sum equivalent to 20 % is added to the wage costs for administration and extra charges, thereby increasing the amount to 0.864 $. Assuming that the exchange's length of life is 25 years and that the rate of interest is 5 %, the capitalised wage costs for the maintenance staff will be 12.70 $ per line. The total sum of the installation costs and staff costs will thus amount to $50 + 12.70 = 62.70$ $ per line.

Another exchange of the same size is assumed to require a staff of 30 persons for its maintenance. With the same average wage the staff costs will then be 5-times greater or 63.50 $ per line. If these very much heavier staff costs were due to the properties of the automatic systems, it would clearly be unremunerative to install this system with its more exacting maintenance demands, even if it were supplied free of charge.

Wages and labour conditions vary considerably in different countries, but it cannot be denied that far too little attention is, as a rule, devoted to maintenance costs and the choice of an automatic system is frequently decided on too narrow a view regarding the purchase price.

To enable a relatively correct economic comparison to be drawn between different automatic systems it is essential to include the maintenance costs in the calculations. It may prove difficult in many instances, however, to prepare an accurate estimate of the maintenance costs for various automatic systems.

The problem is a fairly simple one for telephone administrations which have already tested all the systems to be compared. At the same time due attention should be paid to the fact that the maintenance methods found most suitable for the system prevailing within a given telephone undertaking's area are often applied to other systems for which they may not be altogether satisfactory. In such instances a comparison will not be entirely just as regards the systems less frequently employed. In the case of a telephone undertaking which has had no actual operating experience with the automatic systems between which the choice lies, the comparison should be based on the studies and experience of other telephone administrations, and primarily those which can show accurate operating statistics.

Operating Results of the Swedish Telephone Board

(The particulars are taken from the statistics of the Swedish Telephone Board, see Ericsson Review No. 3/1937 and No. 1/1948.)

The Swedish State Telephone Board keeps clearly arranged statistics based on objective and reliable observations. In Sweden the view is held that, assuming a complete check is obtained on the actual calls made, the percentage of technical faults in automatic equipments should not exceed 0.5 %, but the statistics for the large automatic exchanges in Stockholm show that technical faults only averaged 0.169 % for the years 1931—1935 and 0.14 % for 1936. (These figures must not be confused with the statistics relating to the number of registered faults at the exchanges. For faults of this kind the mean figure was 0.025 %.)

The size of the staffs and nature of the work during 1936 may be seen from the following table:

Exchange	Opened year	Number of lines installed	Female staff			Male staff		
			Cleaner staff	Equipment cleaning		M.D.F. and test desk staff	Automatic exchange	
				staff	working hours pr year		staff	working hours pr year
Central exchange	1929	20 000	2	3	7 336	3	12	27 330
Södra Vasa	1932	30 000	1	3	6 419	3	9	21 846
Norra Vasa	1924	10 000	1	1	2 333	1 1/2	6 1/2	15 436
Söder	1931	40 000	2	3	5 905	3	9	21 692
Kungsholmen	1928	27 000	2	3	7 116	3	9	21 780
Östermalm	1933	25 000	2	3	6 910	3	9	21 732
Average	for	10 000	0.66	1.05	2 370	1.09	3.59	8 540

During 1936, the most important data from the operation of the Stockholm automatic exchanges were as follows:

The operating reliability was 0.14 % technical faults of the actual calls.

The maintenance staffs comprised 3.59 men + 1.05 women = 4.64 persons per 10,000 lines and year.

The working time for the maintenance staffs was 0.854 male + 0.237 female = 1.091 total working hours per line and year.

These particulars apply to the older exchanges in Stockholm. In the new automatic exchanges considerable improvements have been introduced, including the replacement of sequence switches by relay sets and the installation of crossbar switch registers and twin contacts, the result of which has been to increase the operating reliability and reduce the maintenance work. The reliability tests carried out in the new Stockholm exchange in 1946 did not disclose a single fault during the checking of 50,000 connections.

Permanent supervision is only adopted in the largest exchanges, but even the main exchanges with up to 15.000 subscribers are unattended at night. The sub-exchanges with up to 2.000 lines are normally unattended during the daytime also.

Conditions for Economic Operation

Similar operating results have been obtained in other Swedish exchanges and in exchanges working on the same system in a number of other countries. In order to achieve reliable and economic results of this kind the maintenance service must be well organized. One necessary step in this direction consists in keeping the exchange premises as clean and free from dust as possible. All precautions should be taken to prevent dust from the outside from penetrating into the building and the polishing of floors and dust removal should be carried out in such a way that the dust is not caused to eddy up. In dusty places a ventilation system employing dust filters should be installed, and in countries with a particularly high or low or very variable humidity a suitable air-conditioning plant will contribute towards keeping down the maintenance costs.

The actual maintenance service which comprises measures for preventing faults such as inspection and testing, fault location, fault-reporting, traffic supervision and operating control should be arranged in accordance with a fixed programme as far as feasible, and the exchange manager should take care that it is adhered to. The working programme should be arranged in such a way that the members of the staff can carry out their duties without undue haste. No more people should be employed than are necessary, and unauthorized persons should not be permitted to enter the exchange premises. An unnecessarily large staff not only increases the staff costs proportionately, but the greater the number of persons employed, the more difficult will the work of supervision become, and the larger the number of visitors to the exchange, the greater will be the amount of dust brought in and caused to circulate, thereby rendering the maintenance work more difficult.

Inspection

All connecting devices should be cleaned and lubricated at regular intervals. This work may in many cases be suitably undertaken by a female staff. Since all connecting devices are provided with plugs and jacks they can be conveniently removed from the rack for cleaning. Under normal working conditions the requirements will be met if inspection is carried out once within the following time intervals in order to ensure satisfactory operation:

500-line selector:	1 1/2 years
rack motors, external inspection:	1/2 year
» » , complete inspection:	3 years
rack shafts, etc.:	2 »
bearings:	4 »

The relay sets forming part of the 500-line selectors should be taken out at the same time as the selectors, and normally merely require to be dusted and subjected to a general inspection. Registers with crossbar switches of the type now employed, as a rule need very little more inspection than the relay sets. Generally speaking, adjustment of the selectors, relay sets and registers need not be undertaken but the adjustment should be checked by random tests in maintenance tools provided for the purpose.

Traffic Control Desk and Fault Location

The traffic control desk includes a strip containing test-jacks, press-buttons and lamps for each register. If a connection has not been established within a given time, the register's alarm lamp lights up. On connection to the register in question it is possible to verify which number has been called. The register may then be restored and the subscriber advised whereupon he can call the number again or it may be selected for him. This convenient means of assisting subscribers is particularly useful when a new exchange is placed in service and the subscribers have not become accustomed to operating their instruments correctly.

Although the traffic control desk need not be permanently manned at a later stage, it is very useful as a central point from which the progress of a connection can be conveniently followed. If it is discovered when making a connection to a register that a technical fault exists, the connection can be held, by pressing a button and the fault can be traced. During the time in which the traffic control desk is not under observation it can be reconnected in such a way that the register is released when an alarm is given, and a connection which has not been established is transferred to a special line.

On the occurrence of a fault in any of the connecting devices an alarm lamp lights up. The maintenance staff can then establish a connection through the test jack of the device in question and can ascertain whether the alarm is due to a subscriber holding the connection unnecessarily or whether a technical fault has occurred. In the latter case the fault must be traced.

Routine Testing

Certain telephone managements only resort to routine testing in exceptional cases and achieve a high standard of operation exclusively by tracing and remedying faults for which an alarm has been given or an indication sent out. Nevertheless, the most economic form of maintenance usually results when a suitable balance is observed between fault location and routine testing. It is important from an economic point of view, however, to be able to carry out routine tests at relatively long intervals and with simple equipment which does not require special supervision by a highly qualified staff. Routine testing is carried out nowadays with portable manual or automatic exchange testers.

The manual exchange tester is placed in front of the panel containing the devices to be tested and is connected to the latter's test jacks one after the other. Testing should be carried out during periods of light traffic. In the Swedish exchanges testing usually takes place between the hours of 7 and 9 o'clock in the morning.

The automatic exchange tester (see Ericsson Review No. 2/1945) calls the test number automatically, sends out impulses, listens and distinguishes between different tones, makes interurban disconnection and also stops and holds a faulty connection. It can also be employed without permanent supervision to detect faults during busy periods. At such periods the connecting devices is engaged from time to time by the ordinary traffic and the exchange tester therefore makes random tests. In this way many different combinations are obtained and faults are detected which are not disclosed by normal routine testing.

Under satisfactory working conditions the regular routine testing of *each switching connection once every second month* will be found sufficient to ensure reliable operation provided, of course, that faults are carefully traced and removed. If the tests disclose that some particular fault is due to unsatisfactory adjustment of the part in question, its readjustment must be carefully »limit-tested» at the separate maintenance tool. In certain automatic systems automatic routine testing devices have been introduced which are permanently mounted on the panels for the respective connecting devices. During the routine tests one device after another is subjected to a series of limit tests. With respect to what has been said above, particularly under the section »The Economic significance of maintenance work» it can be shown that the introduction of such devices can only be justified when it contributes towards a reduction of the maintenance staff. In this connection it is necessary to bear in mind the fact that technical faults may also occur in routine testing sets, just as in other exchange equipment. Unfortunately, faults arising in routine testing sets may result in much testing work being carried out uselessly. A point that militates still more directly against the conditions necessary for ensuring satisfactory maintenance economy, however, is found in the introduction of routine testing equipment that is of such a complicated character that a specially qualified staff is required merely to maintain it in good condition.

Generally speaking, it may be said that the conditions for obtaining economic maintenance consist in installing an automatic system which is so designed that the routine tests can be carried out at as long intervals as possible with testing equipment which is very easy to handle. No desire has been expressed by any of the telephone undertakings that have installed L M Ericsson's 500-line selector to introduce more complicated routine testing equipment. It is rightly pointed out that this would complicate the working of the exchange unnecessarily, that it would add to the maintenance costs and that no appreciable increase in operating reliability would result.

Operating Control

A well-arranged maintenance service should also include an operating control by means of which the quality of the service can be checked. On the basis of the latter it is possible to assess the adequacy of the maintenance work. As a rule such control is undertaken from the previously mentioned traffic control desk at which an observer can connect himself in on a limited number of calls, and then follow the progress of a call until connection is established. Any irregularity in the service is noted, and from the records thus obtained operating statistics are prepared concerning the number of faultless connections and those that are irregular in any respect due to some action on the part of the subscriber or to the technical equipment.

Operating control also includes observation of the traffic and the keeping of statistics on the traffic density so that measures can be taken in good time to prevent overloading and traffic blocks. This can be done by observing the number of connections engaged in different groups during the rush hours, and the work will be facilitated if the exchange is provided with traffic meters.

Qualifications of the Maintenance Staff

The greater part of the maintenance service is of a routine character. Since the equipment consists of precision mechanism, however, it must be handled cautiously and it is extremely important that the instructions for its upkeep should be carefully followed.

The most exacting work consists in fault location and the adjustment of connecting devices which may be necessary in certain instances. A fault tester should, of course, have rendered himself familiar with the functioning and should be able to follow the circuits on the diagrams. It is important that fault location should be carried out systematically and that no steps should be taken before the cause of the fault has been definitely confirmed. Useful assistance can be obtained in fault-location from accurate fault statistics which are entered up on a card index for the various connecting devices. With the help of these cards it is then possible to determine which part is functioning unreliably and make any necessary adjustments.

It is absolutely essential that no relays, selectors or registers should be re-adjusted before they have been subjected to limit tests and checked in maintenance tools suitable for the purpose, and such adjustments should only be made by persons competent to undertake this work and who follow the instructions. It is also extremely important that intimate contact should be maintained between the maintenance staff, primarily the responsible exchange manager, and the factory's representative in the country. If the maintenance staff are uncertain concerning the measures which should be taken to correct a fault, the faulty device should preferably be blocked and advice sought of the factory representative.

New Developments on LM Ericsson's Telephone System with 500-line Selectors

I THOMSON, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.343

A previous article which appeared in the Ericsson Review No. 4, 1949, described some of the new developments incorporated in L M Ericsson's system with 500-line selectors. Particulars of further changes made in this system are given below.

Introduction of Time-debiting for Telephone Calls

The methods employed for debiting telephone calls vary widely in different countries and telephone administrations, both with respect to urban and interurban calls. Certain telephone administrations debit local calls, by making a fixed charge proportional to the subscriber's income, after payment of which the subscriber is entitled to use his telephone for an unlimited number of local calls.

The method most commonly employed, however, consists in metering each completed call on a call meter corresponding to the subscriber's line. The subscriber is then required to pay a sum in accordance with the number of calls made.

In recent years a wish has been expressed in various quarters for a system in which subscribers are debited according to the length of time they use the lines and exchange equipment for telephone calls. With this system a subscriber who makes a call which lasts 18 minutes, for example, is required to pay the same amount as another subscriber making two calls of 9 minutes each or a third who speaks for 6 minutes during each of three calls.

L M Ericsson's new exchanges are designed to meet various requirements with respect to the debiting of telephone calls. If metering of the calls is not required the call meter can, of course, be omitted. When it is intended to employ single metering and reasons for changing over to multi-metering arise subsequently, this can be effected by a simple alteration of the connections in the cord circuit relay sets.

The method employed for multi-metering is known as random metering, which implies that the first metering impulse after the call has started falls within a time interval that may vary from the time zero to the time representing the interval between two meterings, depending upon the point of time in the metering interval at which the connection is established.

The metering interval is determined by the requirements of the respective telephone administrations and may vary according to the accuracy desired and the interval that elapses between two consecutive readings of the call meters. As a rule, two minutes is found suitable. If required, however, the interval may also be varied for different days and different times of the day. On Sundays and at night-time the load is usually small, and consequently a longer metering interval, *i. e.* a lower rate may be justified. According to this procedure two impulse clocks with different intervals are connected up alternately, either automatically or manually, one of which is in use for periods of normal traffic and the other during the time a lower rate is being applied.

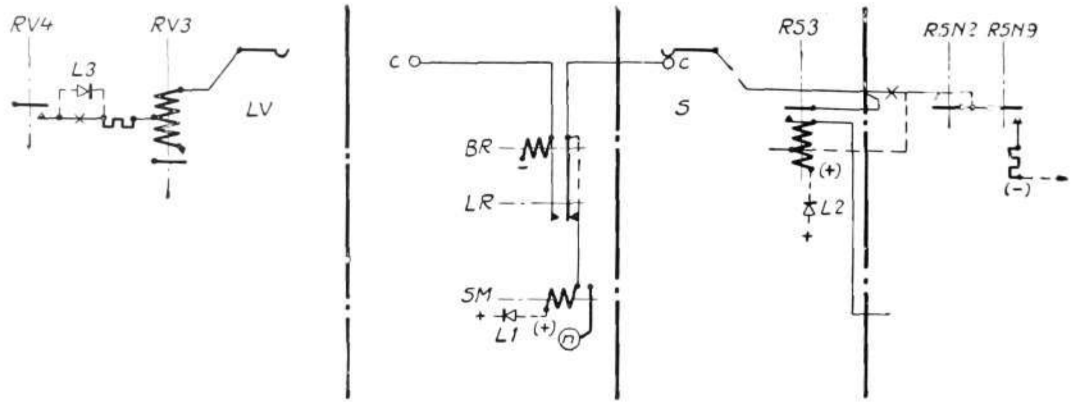


Fig. 1 X 7586

Circuit diagram showing the changes in the testing- and call meter circuits resulting from the introduction of multi-metering

LV	final-selector
RV3—4	final-selector relays
LR—BR	subscriber's line equipment
SM	subscriber's call meter
S	line-finder
RS3	line-finder relay
RSN2, 9	cord circuit relays
L1 - 3	rectifiers

Together with the development of multi-metering for new exchanges the problem has also been solved for old exchanges with three-wire finder multiple. The method is illustrated in Fig. 1.

In this case the metering impulse is produced by a current surge from a 36 V battery with plus polarity in relation to earth. During the time the impulse lasts the current flows from the + 36 V battery through the upper winding of relay *RS3* via the c-wire, through the meter *SM* and rectifier *L1* to earth. The meter is actuated. The rectifier *L2* blocks the current which would otherwise flow through *RS3*'s lower winding and set up a magnetic field of opposite direction to that formed by the normal holding current at which *RS3* would release. The rectifier *L1* blocks the current from the meter *SM*'s earth to the minus pole of the release relay *BR*. To avoid interference with the testing of a final selector which might respond to a line already engaged by an outgoing call over the c-wire of which a metering impulse is being transmitted, the rectifier *L3* is connected in the circuit. This rectifier also prevents the call meter from being shunted by *RV3*.

The chief item in the material required for carrying out an alteration of the kind described above consists of the rectifiers *L1* which are individual for each subscriber line, but since a new and cheap type is employed for this purpose the costs are relatively small. The power consumption for metering is low and a 36 V battery with a capacity of 16 Ah will suffice for 10,000 lines.

The variations in the methods employed for debiting local calls find their counterpart in the different systems for debiting long-distance telephone traffic. The method most commonly adopted is probably the recording system in which a demand for a call is made to the operator who then notes the time for the call, its duration, etc. With the constantly increasing mechanization of rural and toll traffic now in progress this system cannot be employed for obvious reasons. The choice then lies between the automatic printing of call tickets and multi-metering at the subscriber's call meter. The first method necessitates heavy costs and a complicated equipment, whereas the introduction of multi-metering does not entail appreciably higher costs than those normally applying for automatic exchange equipment.

L M Ericsson's new automatic exchanges are designed for the introduction of multi-metering of rural and toll calls. The principle followed is the same as that for the time-debiting of local calls but the length of the metering interval is dependent upon the distance over which the call is made amongst other factors. For its determination a tariff device is required.

As in the case of local calls, the time-debiting of rural and toll calls can also be introduced in older exchanges with 500-line selectors.

The principle adopted for transmitting the metering impulse from the cord circuit to the call meter is the same as that for the multi-metering of local calls. On the other hand, a general method for the transmission of the impulses from the tariff device to the cord circuit cannot be given as this will depend upon the construction of the exchange concerned. The problem must therefore be solved for each case individually.

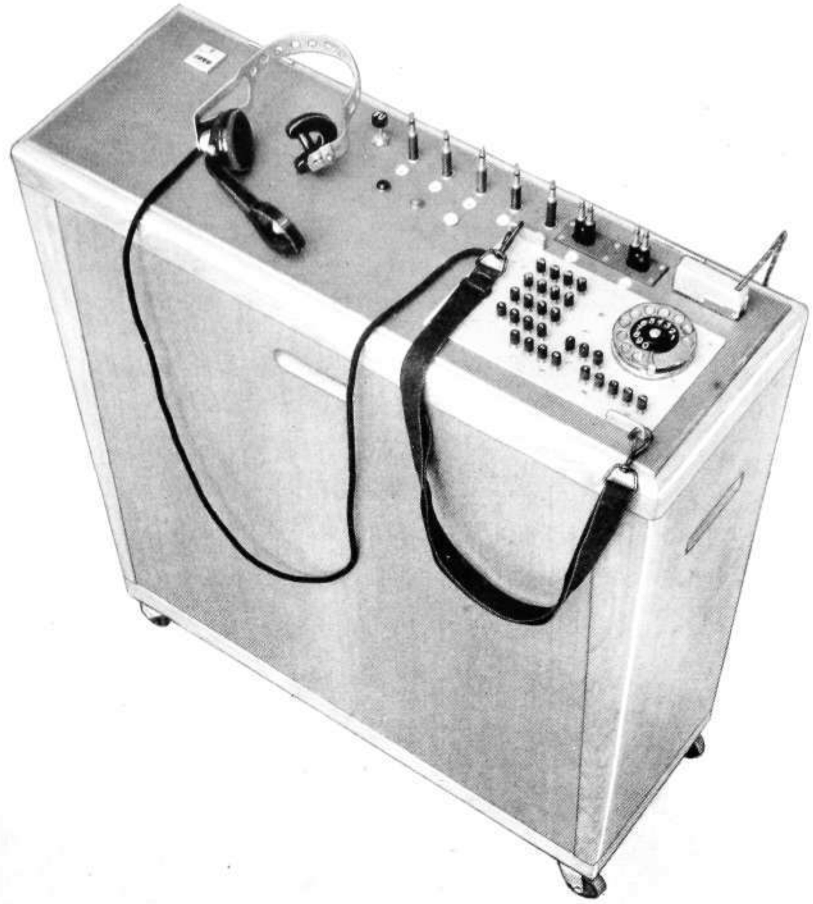


Fig. 2 X 6569

Exchange tester for the manual testing of switching devices

On the right, the control box is visible, lowered into the cover.

Testing Equipment

Apart from other factors, the efficient and economic maintenance of a telephone exchange calls for simple and practical testing equipment. The automatic tester described in the Ericsson Review No. 2, 1945, is of great assistance to the exchange staff in locating and remedying faults. This automatic tester controls a normal connection in an automatic exchange, that is to say, a circuit from one subscriber's line to another. By connecting up the tester during a period of heavy traffic in one 500-group after another, it will in all probability be possible to test all switching devices.

In order to test each switching device individually, an apparatus has been constructed for manual testing, see Fig. 2. This apparatus is designed to serve as an aid when testing switching connections in which a fault has been located or is suspected.

The apparatus consists of two parts. The first comprises a wooden framework mounted on wheels and containing the necessary relays, lamps, press-buttons and switchboard cords and plugs, the other part consisting of a control box which is connected by a flexible multi-core cable to the first part. The control box which is lowered into the cover of the framework when the tester is not in use, contains a dial, press-buttons and a head set for carrying out the tests.

When inspecting a final selector with its associated relay set, for example, the testing cord of the tester is plugged into the testing jack corresponding to the final selector. Another cord is connected to the testing jack for a free register which is used as an auxiliary device for testing the final selector. The number with which the final selector is to be tested is dialled on the dial at the control box. The starting impulses which are sent out from the register

1*

for the group selector are received by the tester and revertive impulses are transmitted for translation in the register. The operation of the final selector is then effected and the necessary tests such as answering on a free line, busy signal when the line is engaged, toll testing, etc., can be carried out.

The control box is fitted with a strap which can be hung around the neck of the person making the tests. The latter can then conveniently follow the functioning of the tested switching device whilst at the same time all the necessary control equipment is immediately in front of him, whether he is standing on the floor or on a ladder placed in front of a rack.

The testing devices in question are intended for routine testing under normal working conditions, that is to say, with a fairly constant voltage and shaft speed. For the periodic checking of switching devices where performance limits or the like have to be investigated a so-called test rack is used. A device of this kind may be said to represent an automatic exchange in miniature in which both the working voltage and shaft speed can be varied according to requirements. Series resistances, leakage resistances and parallel circuits can be linked up with all important circuits such as those for testing, current supply and forward and revertive impulsing. Test racks are available in many old exchanges but in the new type several changes have been introduced. For example, the relay set to be tested can be turned into different positions to enable the functioning of the relays to be observed in the most convenient manner. No separate rheostats are required as the necessary resistances and inductances are directly attached to a jack panel from which they can be connected to any desired circuit. Changing over from a normal working voltage to limit voltages is effected by means of a throw-over switch. The voltage required for this purpose is obtained from a small additional battery. Fig. 3 illustrates the appearance of a modern test rack.

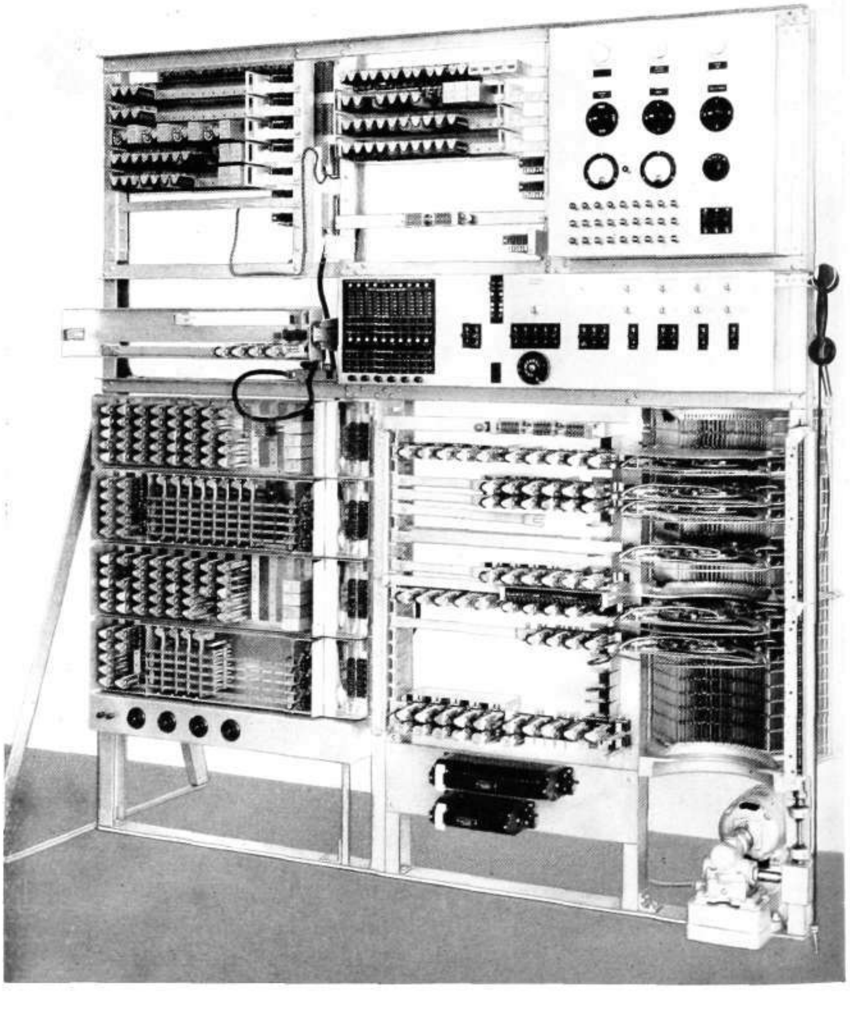


Fig. 3 X 6570

Test rack for checking the performance limits of switching devices

An Optimum Law for Telephone Networks

PROFESSOR TORBERN LAURENT, THE ROYAL INSTITUTE OF TECHNOLOGY, STOCKHOLM

U.D.C. 621.395.743.003.1

When connecting a telephone line between two subscribers or a subscriber and an interurban exchange within the same local network, the line attenuation must comply with certain stipulations in the CCIF standards. These requirements may be met satisfactorily in numerous different ways; for example, by the unequal distribution of the line attenuation in the subscriber's- and junction cables. In such a case it is necessary to find the method which will result in a minimum cost. The present paper offers a guide to this end, and a general optimum law of simple form is advanced for the dimensioning of the different conductors.

Fig. 1 is a schematic view of the connections between a telephone exchange C and a subscriber's apparatus B through the bunches 1, 2 .... n with an arbitrary number of conductors. These bunches may consist of cables or separate conductors. The bunch costs per unit of length K are clearly a function of the attenuation constant α. Where the symbol S indicates the length of the bunches, the total conductor costs will obviously be

$$\sum_{\nu=1}^{n} S_\nu K_\nu(\alpha_\nu) = \text{minimum} \qquad (1)$$

and the total line attenuation will be

$$\sum_{\nu=1}^{n} \alpha_\nu S_\nu = \text{a given constant} \qquad (2)$$

If α_μ and $\alpha_{\mu+1}$ are varied, α_μ being selected for the minimum cost, then according to eq. 1

$$S_\mu \frac{\delta K_\mu}{\delta \alpha_\mu} + S_{\mu+1} \frac{\delta K_{\mu+1}}{\delta \alpha_{\mu+1}} \frac{\delta \alpha_{\mu+1}}{\delta \alpha_\mu} = 0 \qquad (3)$$

According to eq. 2

$$S_\mu + S_{\mu+1} \frac{\delta \alpha_{\mu+1}}{\delta \alpha_\mu} = 0 \qquad (4)$$

which in combination with eq. 3 gives

$$\frac{\delta K_\mu}{\delta \alpha_\mu} = \frac{\delta K_{\mu+1}}{\delta \alpha_{\mu+1}} \qquad (5)$$

The result of eq. 5 thus indicates that the derivative of the bunch costs per unit of length with respect to the attenuation constant in the bunch in question should be the same for all bunches.

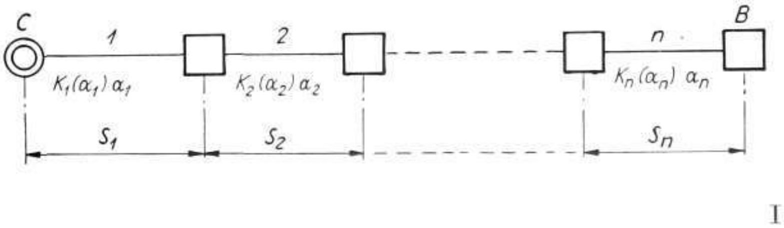


Fig. 1 X 6562

Schematic reproduction of the connection between a telephone exchange C and a subscriber's apparatus B

through the bunches 1, 2 . . . n with an arbitrary number of conductors

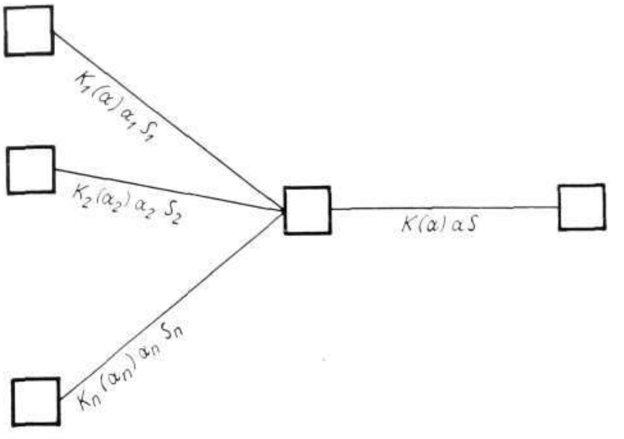


Fig. 2 X 6561

Spreading of a bunch into *n* bunches with an arbitrary number of conductors

Fig. 2 is a schematic view of the spreading of a bunch into n bunches with an arbitrary number of conductors. In this case the total conductor costs will obviously be

$$\sum_{\nu=1}^{n} S_\nu K_\nu(\alpha_\nu) + SK(\alpha) = \text{a minimum} \tag{6}$$

and the attenuation conditions will be

$$\left.\begin{array}{l} \alpha_1 S_1 + \alpha S = A_1 \\ \alpha_2 S_2 + \alpha S = A_2 \\ \text{— — — — —} \\ \alpha_n S_n + \alpha S = A_n \end{array}\right\} = \text{given constants} \tag{7}$$

If α is variable in relation to the minimum cost, then according to eq. 6

$$\sum_{\nu=1}^{n} S_\nu \frac{dK_\nu}{d\alpha_\nu} \cdot \frac{d\alpha_\nu}{d\alpha} + S\frac{dK}{d\alpha} = 0 \tag{8}$$

According to eq. 7

$$\left.\begin{array}{l} S_1 \dfrac{d\alpha_1}{d\alpha} + S = 0 \\ S_2 \dfrac{d\alpha_2}{d\alpha} + S = 0 \\ \text{— — — — —} \\ S_n \dfrac{d\alpha_n}{d\alpha} + S = 0 \end{array}\right\} \tag{9}$$

Which in combination with eq. 8 gives

$$\sum_{\nu=1}^{n} \frac{dK_\nu}{d\alpha_\nu} = \frac{dK}{d\alpha} \tag{10}$$

The result obtained in eq. 10 thus indicates that the sum of the derivatives of the bunch costs per unit of length, with regard to the respective attenuation constants should be the same on each side of a spreading point. Eq. 10 may be regarded as a generalisation of eq. 5.

The quantity $dK/d\alpha$ is clearly of fundamental importance for calculations of the kind in question, and the introduction of a term for this quantity is therefore justified. Hereafter, the term »cost characteristic» is employed for $dK/d\alpha$.

The cost characteristic for a bunch will depend upon the number of conductors in the bunch, the diameter of the conductors, pupinising if adopted, etc. Under the approximate assumptions that

$$\begin{cases} \alpha_o = \dfrac{p}{x} + u \text{ for non-pupinised conductor} \\ \alpha_p = \dfrac{t}{x^2} + v \text{ for pupinised conductor} \\ K = n(qx^2 + r) \\ n = \text{number of conductors in the bunch} \\ x = \text{the wire diameter} \\ \left.\begin{matrix} p,\ u,\ t,\ v \\ q \text{ and } r \end{matrix}\right\} = \text{constants} \end{cases} \tag{11}$$

then

$$\begin{cases} \dfrac{d\alpha_o}{dx} = -\dfrac{p}{x^2} \\ \dfrac{d\alpha_p}{dx} = -\dfrac{2t}{x^3} \\ \dfrac{dK}{dx} = 2nqx \end{cases} \tag{12}$$

whereby

$$\begin{cases} \dfrac{dK}{d\alpha_o} = -\dfrac{2nq}{p}x^3 \\ \dfrac{dK}{d\alpha_p} = -\dfrac{nq}{t}x^4 \end{cases} \tag{13}$$

The cost characteristic is thus sensibly dependent upon the wire diameter, particularly for pupinised conductors.

In the practical application of eq. 5 and 10 the cost characteristic should be calculated for different types of cables and separate conductors. Since only a limited number of wire diameters and pupinising types are available for selection, the optimum conductor system which fulfils the given attenuation conditions can be found by progressive trials. With a little practical experience the desired result can be achieved relatively quickly.

Eq. 5 and 10 may also be employed for examining the economic balance in completed telephone networks, by which means certain valuable information can be obtained with respect to subsequent developments.

Private Automatic Branch Exchange AMD 10201

E NILSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.24

The demand for small and reliable private branch exchanges is constantly increasing. Telefonaktiebolaget L M Ericsson has therefore taken up the manufacture of a series of small private branch exchanges consisting exclusively of relays and capacitors and intended for direct connection to the electric supply mains without batteries. The smallest of these exchanges which is now ready for delivery comprises 5 extensions, 1 exchange line and 1 link for local calls.

Constructional Principles and Range of Use

The new private branch exchange, Fig. 1, to which the type designation *AMD 10201* has been allotted, is primarily intended for small offices or firms but may also be suitably employed in private houses for both internal and external traffic. It may also be used as a sub-exchange in conjunction with a large private branch exchange, a point of considerable practical advantage since it affords convenient means of increasing the number of telephone stations in cases where the capacity of the large exchange is fully occupied. In its normal form the exchange is constructed for co-operating with an automatic main exchange, but by plugging in small auxiliary sets it can co-operate with a manual CB- or Magneto exchange. Auxiliary sets for co-operating with semi-automatic exchanges are also available. When connected as a sub-exchange to a large private branch exchange, auxiliary equipment is also required if it is desired to obtain inquiry and transfer facilities to the extensions connected to the main PABX. This possibility is only available during connection to the main exchange.

During communication with the main exchange, *AMD 10201* provides the same general facilities as a large automatic private branch exchanges of modern type. The extension apparatus consists of ordinary telephone instru-

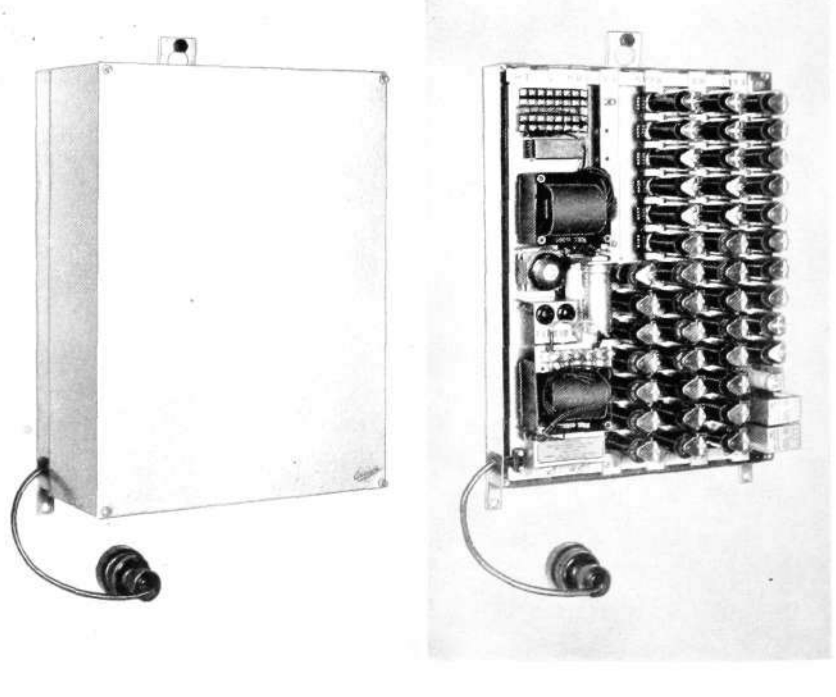


Fig. 1 X 6571

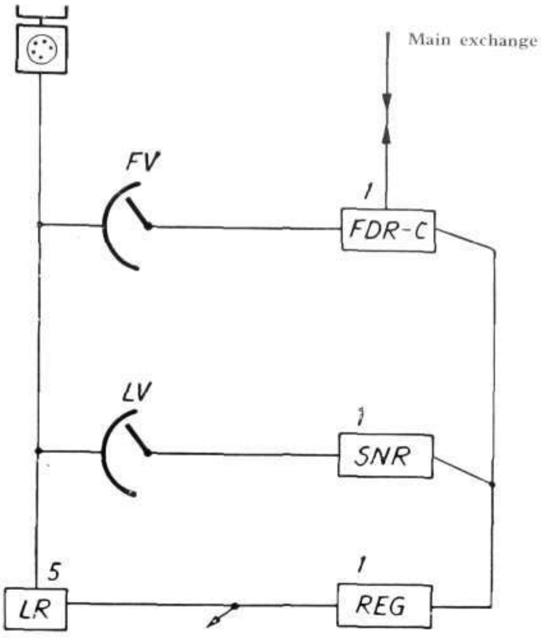
Private automatic branch exchange AMD 10201

for 5 extensions, 1 exchange line and 1 local link connection

Fig. 2 X 6563

Routing diagram for AMD 10201

FDR-C exchange line
FV connecting relays for FDR-C
LV connecting relays for SNR
LR line relays
REG register
SNR cord circuit



ments with dials. No special apparatus is required for transmitting incoming calls. Incoming calls are signalled in due order to the three extensions having the lowest numbers, until an answer is received. If one or two of these extensions are engaged, all signals will pass to the extension or extensions which happen to be free, whilst at the same time an audible signal in the existing connection indicates the incoming call. This calling system is accompanied by the advantage that the incoming call will in all probability always be answered without necessitating the continuous supervision of any particular telephone instrument. The two extensions having the highest numbers can be barred for traffic with the main exchange. Switching incoming connections from the main exchange is effected according to the same method as that for enquiry and transfer.

The constructional elements in the exchange consist solely of relays and capacitors. The current supply is obtained from a battery eliminator which normally gives a working voltage of 24 V. The relays are so dimensioned that voltage fluctuations between 20 and 30 V will not affect their operation. Moreover, since all contacts are of the twin type, reliable functioning is obtained under all conditions and at the same time very little or practically no maintenance work is required.

To ensure telephone connection with the main exchange even in the event of a breakdown in the current supply, the line branches to the central line are connected through the change-over contact of a supervisory current relay. On an interruption in the current supply this relay is restored and an extension is connected directly to the line equipment of the main exchange.

The battery eliminator for the exchange is designed for connection to alternating current mains. Where direct current mains are available a rotary converter with the necessary starting- and control gear must be installed.

The exchange constitutes a complete unit in itself and contains the battery eliminator, space being available for the auxiliary set. It is intended for wall mounting and has the following dimensions: 500 × 375 × 190 mm. The weight is 31 kgs.

Constructional Principle

The routing diagram, Fig. 2, shows the principle on which the exchange is constructed. Each extension has a line relay which is used for connection to the exchange register. The relays for connecting the extensions to the local link circuit and exchange line are denoted in Fig. 2 by selector symbols.

Direct connection of the register to the line relay implies that connection to the exchange line is independent of the local connecting link. Outgoing calls can therefore be made even when the latter is engaged, and thanks to this arrangement the initiation of the call can be effected with the dial. Thus, no extra earthing button is required on the telephone instrument for this purpose and connection to the exchange is carried out with two-wire conductors.

The digits for the extensions are *2—6* and the main exchange is called with the digit *1*. For systems in which the numbering on the dial begins with the digit *0* the extension digits will be *1—5* and the main exchange is called by the digit *0*.

To obviate unnecessary manipulation when making connections from extensions, circuits are drawn out from the cord circuit and central line to the connection panel and, if considered desirable, these may be connected to indicators (lamps or drop indicators) at each telephone instrument. As soon as either of these connecting devices are engaged, this fact will be indicated at every instrument.

Functioning

Local Connections

When an extension lifts the receiver the line relay establishes connection with the register — if the latter is disengaged. When a number of extensions make calls simultaneously, only one of these will be connected to the register. The dialling tone, *i. e.* continuous tone, indicates that the required number can be obtained with the dial. If the desired extension and link circuit are disengaged the calling extension will be connected to the link circuit immediately after dialling the number and the line relay will restore. Directly afterwards, the line relay for the called extension will operate and a ringing signal will be sent out from the register via this relay to the extension. At the same time the calling extension will hear ringing tone. The calling signal for local calls continues for about 1 second. After the ringing signal the called extension will also be connected to the link circuit and at the same time the register will be released.

The ringing signal is not repeated for local connections, but it can be produced by replacing the receiver and repeating the call a number of times or by alternately dialling one impulse and the required number on the dial.

If the required extension is engaged locally or if the cord circuit is engaged by another call, the calling extension will again hear the dialling tone after dialling the number. If the required extension is engaged by a call on the exchange line no signal will be obtained.

An extension at which the receiver is removed is first connected to the register, connection to the cord circuit taking place after 5 secs. which consequently also occurs when an extension waits for a corresponding period before dialling the number.

Traffic with the Main Exchange

Outgoing Calls

Outgoing calls are initiated by one dial impulse. After an outgoing call has been initiated, the register establishes connection with the exchange line. The desired subscriber's number is dialled after the dialling tone from the main exchange is heard.

On the conclusion of the call the extension is released when the receiver is replaced provided that the main exchange subscriber replaces his receiver at the same time. If the latter remains on the line, the extension will be released at the end of a few seconds whilst the exchange line will remain blocked until release has been effected at the main exchange. To obtain a control over the release, however, the line relay at the main exchange must be connected to the line branches with reversed polarity with respect to the current supply in the link circuit. If the exchange line is engaged, the calling extension will again hear the dialling tone.

Incoming Calls

An incoming ringing signal to the exchange line causes the latter to be connected to the register, and extension *2 (1)* is rung up if it is disengaged. The digit in brackets indicates the extension number with *o* as the first digit on the dial. If the first extension is engaged the call will be transmitted to one of the two following disengaged extensions.

If the three first extensions are disengaged, the first and second ringing signals from the main exchange will be repeated to the first extension. If no answer is received from the extension first called, the following signal is repeated to extension No. *3 (2)*. The fourth ringing signal is repeated to extension No. *4 (3)*. A fifth ringing signal is again repeated to extension No. *2 (1)* and so on.

The signals from the main exchange are sent out in the form of a short signal immediately followed by a long one. The caller will gather from this that the call is from the main exchange.

If one or two of the extensions which receive incoming calls are engaged, the second and the third are called or only the third, by all signals. Each time the signal is repeated the person speaking will hear a tone signal. If this is repeated it implies that the call is not being answered at the disengaged instrument. If the person speaking replaces his receiver, the instrument next in turn in the register will be called. When an incoming call is answered the register is released and communication is established. Control of release is accomplished in the same manner as for outgoing calls.

Enquiry and Transfer

Enquiry and transfer are effected by the same method as that employed for transmitting incoming calls. The enquiry call is originated by one dial impulse. If the register is free it is connected to the exchange line and the caller receives the dialling tone. The enquiry call is connected in the same way as a local call and thus engages the local link circuit. After the called extension has answered the call, the enquirer can change between the called extension and the exchange subscriber. If no answer is received, the link circuit is released when the enquirer dials one impulse. If the called extension replaces the receiver after the caller has established communication with the exchange subscriber, the enquiry connection is restored.

Transfer is effected when the enquirer replaces the receiver after the enquiry call has been answered. Transfer takes place irrespective of whether the enquirer is connected to the called extension or to the exchange subscriber. The cord circuit is released when transfer takes place.

Comparison with Large Private Automatic Branch Exchanges

Large private branch exchanges which are equipped with special apparatus for transmitting incoming calls and have one or more persons allotted exclusively for handling the incoming traffic, usually have a number of other means available for making connections, such as: waiting connections, parking of incoming calls, priority connections, series calls, etc. These conveniences can scarcely be applied to a 5-line private branch exchange and furthermore, the cost of introducing them would be so high in relation to the cost of the exchange in general that their adoption has not been considered remunerative or even necessary.

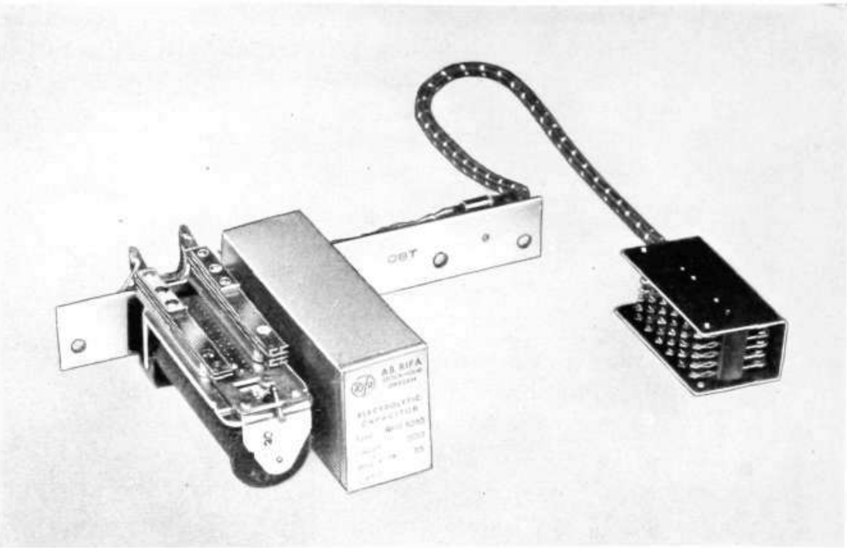


Fig. 3 X 6564

Auxiliary set for co-operation with a CB-main exchange

In place of a waiting connection, the person required is requested to ring up. This method is the only one that can come into question when only one exchange line is available.

Co-operation with a Manual Main Exchange

When AMD 10201 is co-operating with a manual main exchange with none repeated calling signal certain supplementary equipment is required. For this reason a number of circuits are connected to a jack mounted in the frame.

Co-operation with a CB-main Exchange

For co-operation with a CB-main exchange without repeated ringing signal an auxiliary set is installed comprising a relay and an electrolytic capacitor which are connected to the jack by a plug. Fig. 3. With this supplementary equipment an incoming signal transmits a call to extension No. *2 (1)*. If the call is not answered within 10 secs. a ringing signal is transmitted to extension No. *3 (2)* and after a further 10 secs extension No. *4 (3)* is called.

If the call is not answered on extension No. *4 (3)* disconnection will take place 10 secs after the last calling signal. If one of the extensions is engaged the calling signals will be received on the extension or extensions that are free.

Co-operation with a Semi-automatic Exchange

For co-operation with a semi-automatic exchange which requires special calling arrangements with earth potential on both line branches, an auxiliary equipment is employed consisting of three relays and an electrolytic capacitor, Fig. 4. A ringing signal from the semi-automatic exchange sends signals to three extensions successively.

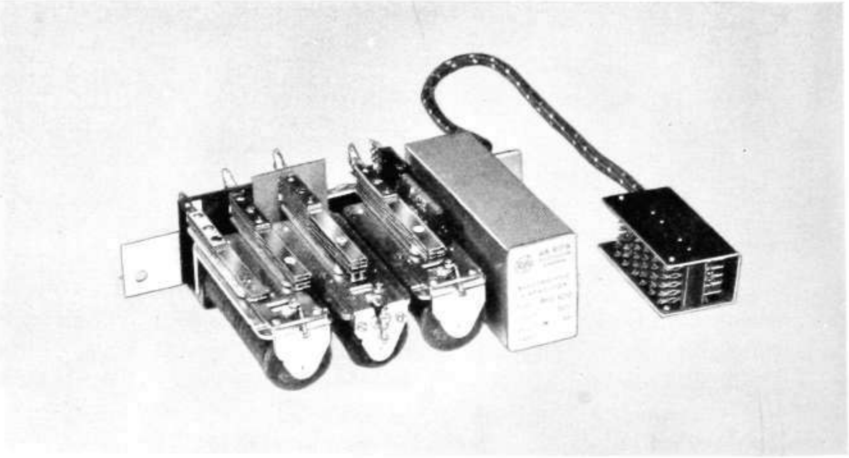


Fig. 4 X 6565

Auxiliary set for co-operation with a semi-automatic exchange

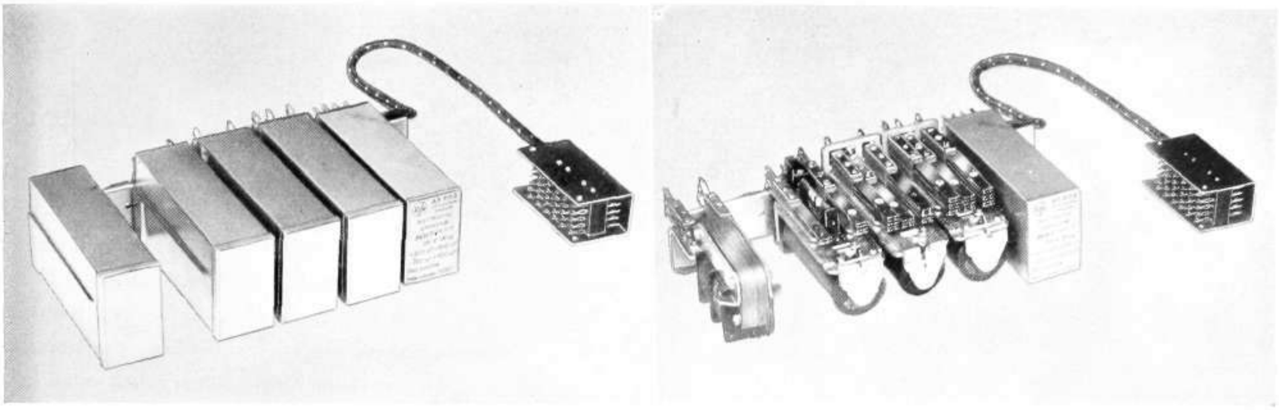


Fig. 5 X 7567

Auxiliary set for co-operation with a *magneto* main exchange

Left: with covers in position

Co-operation with a Magneto Main Exchange

For co-operation with a magneto main exchange an auxiliary set consisting of three relays and an electrolytic capacitor is employed. Incoming calls with a ringing signal transmit signals to three extensions in due order. Outgoing call signals are produced automatically by a short alternating current signal to the main exchange. When the receiver is replaced a short ring-off signal is sent out. This final signal is also transmitted after an incoming call. After the ring-off signal the exchange line is blocked for outgoing calls for about 10 secs by the end of which time disconnection should have taken place at the main exchange.

A special auxiliary set for co-operating with magneto main exchanges which requires an unearthed ring-off signal, also includes a transformer for this purpose, Fig. 5.

On an interruption in the supply, the line branches from the main exchange are connected directly to a magneto telephone. If one of the automatic extension instruments is provided with a local microphone feed and hand inductor, the latter can be used during the interruption in the current supply.

Power Supply

For the power supply a battery eliminator is employed which also generates the necessary tone- and ringing signals. Tappings are provided for connection to alternating current mains for 110, 127, 150 and 220 V, 40—60 cycles. In addition, the secondary side of the transformer can be regulated up or down 20 %. On delivery, the eliminator is connected for a 220 V supply voltage. The normal working voltage is 24 V but the exchange permits a fluctuation between 20 and 30 V. At the minimum voltage the line resistance for the extensions may be 500 ohms.

The power consumption is very low and remains in the vicinity of 5W (13 VA) when the exchange is idle; at the maximum load it reaches 36 W (41 VA).

When connected to direct current mains, the exchange when idle is directly connected to a potential divider which supplies a calling voltage of 24 V. As soon as a call is made a starting relay for a rotary converter is closed, and when this machine is generating alternating current the potential divider is disconnected from the exchange which is then fed from its own mains set. The converter continues to run as long as the speech connection is maintained. The converter, the starting relays and an excess voltage relay form a special unit. The excess voltage relay constitutes a protective device when the exchange is idle and is directly connected to the potential divider.

If the voltage to the exchange exceeds 50 V the excess voltage relay drops out and the mains voltage is completely cut off from the exchange. Reconnection of the mains after a cut-out of this kind can only be carried out manually.

Absence Indicators

A TRÄGÅRDH, TELEFONAKTIEBOLAGET L M ERICSSON, TELESIGNAL WORKS, STOCKHOLM

U.D.C. 654.915.2

In commercial undertakings it is important and helpful for ensuring good service that customers should be able to establish telephone connection quickly with the employee they are seeking. A similar need exists in public offices and hospitals for convenient telephonic communication with officials or doctors. The operator is not in a position to offer such service without some technical aid since it is impossible to keep account of the persons actually on the premises at the time enquiries are being made for them.

As a supplement to staff-locating installations of the ordinary type, L M Ericsson have now designed apparatus in the form of absence indicators with the help of which the operator can immediately ascertain whether officials frequently sought for have left the building, when they may be expected to return and the reason for their absence,

The installation for absence indicators comprises one or more switch panels and table contacts and an indicator in the form of a clock with indicating lamps.

Construction

The switch panel, Fig. 1, which is located in the entrance hall through which the officials must pass when arriving at or leaving their offices, consists of 5 switches mounted on a front panel of elm with a cellulose finish. One switch is required for each person and one switch panel is therefore sufficient for 5 people. When the indicator is to be used by more than 5 persons, additional panels can be placed one over the other or beside each other and the capacity of the installation is then increased by 5 for each new panel employed. The switch has a pointer, which points towards a ring with a scale. Every hour between 9-o'clock and 5-o'clock is marked on this ring with half-hour intervals; 9-o'clock is indicated by »In» and the remaining hours by figures. Furthermore, the notations »*Out*», »*B*» and »*S*» are employed. Under each switch is a designation frame strip where paper strips with the name of the person concerned can be inserted.

The switches are connected to a terminal block mounted by claw fastenings in an inset box belonging to the panel. This box is made of wood and is intended for recessing in the wall. When connecting the panel the terminal block can be drawn forward and is then completely accessible. After making the connections the block is pushed back into the bottom of the box.

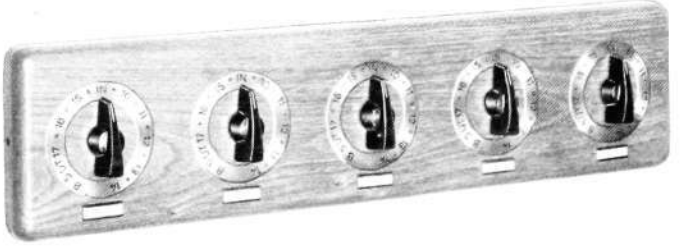


Fig. 1 X 6566
Marking panel type KEM 5501
for five persons

Fig. 2

X 6568

Table contact type KEM 1201 for reading the indications

The table contact, Fig. 2, is to be placed in a position conveniently accessible to the operator since it represents her means for reading the indications given by the respective officials. It is constructed of plastic material and contains ten press-buttons. Each press-button corresponds to one switch, so that one table contact suffices for ten persons or two switch panels. In extensive installations two or more table contacts are placed beside each other or a special equipment may be employed consisting of a suitable number of 10-press button strips mounted in a wooden case. If desired, the press-button strips may also be mounted on the operator's exchange board.

On front of the table contact is a space where the names of the persons concerned may be printed. The table contact is provided with 2 metres of flexible cable and a wall terminal box for surface mounting.

As may be seen from Fig. 3, *the indicator* is constructed in the form of a secondary clock which is mounted close to the operator. Lamps and lenses are fitted in the clock dial for each half-hour from 9-o'clock to 5-o'clock. The time mark for 9-o'clock is fitted with a green lens whilst the remaining hour marks between 9-o'clock and 5-o'clock have red lenses. A yellow lens is provided for each half-hour. Three lenses are fitted at the bottom of the clock dial and are provided with the notations »*B*», »*S*» and »*Out*», corresponding to the text for the switches on the panel.

When an electric clock installation is available the secondary clock is connected to the master clock of this installation in the usual manner and then shows the time whilst being used simultaneously as an absence indicator. In cases where there is no electric clock installation, however, a similar secondary clock is employed as an indicator, but it is not fitted with hands and impulse motor.

Functioning

When a person entitled to use the indicator enters the premises he sets his switch at the position »In», thus indicating that he is in the building. If he goes out during the course of the day, when passing the board he sets the switch at the hour at which he expects to return, or if he is not coming back on the same day, he sets the switch at »*Out*». Holidays may be suitably indicated by setting the switch at the position »*S*» and in case of sickness or other reason for absence, at the position »*B*». If a person is absent on account of sickness his switch may be set by the hall-porter, for example, or some other suitable person.

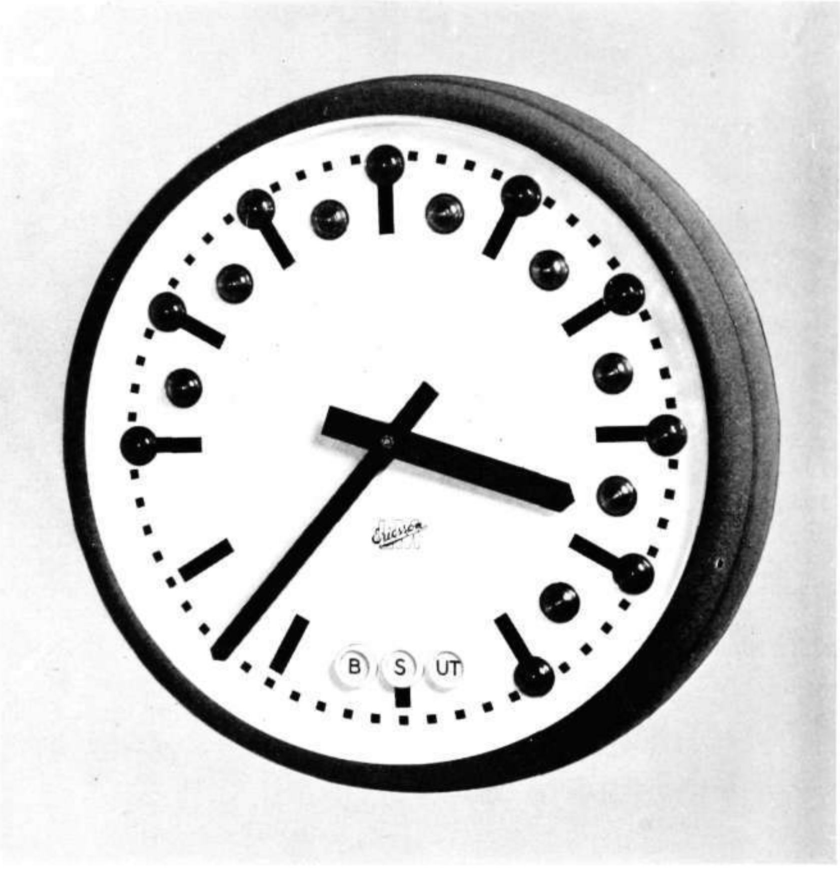


Fig. 3 X 6567
Absence indicating clock KAC 11x01

When the operator wishes to locate a person entitled to use the indicator she presses the latter's button on the table contact and reads the indication on the indicator. If the person sought registers the indication »*In*» the green lamp on the hour mark for 9-o'clock will light up and it is consequently known that he is on the premises, whereupon he can be found by means of a staff-locating installation when he is not in his room. On the other hand, if he has gone out, a red or yellow lamp will light up at the time on the clock at which he expects to return. If he has set his switch at any of the positions »Out», »B» or »S» one of the three corresponding lamps at the bottom of the clock dial will light up and indicate that he has gone for the day, is absent or on holiday. The indicator lamp will only remain alight as long as the operator presses the button on the table contact.

The installations are usually operated at 24 V alternating or direct current and the current consumption is 0.05 A. Thus, the apparatus can either be connected to A.C. mains through a transformer or to a battery.

Vehicle-actuated, Progressive Road Traffic Signals in Västerås

S EKWALL, L M ERICSSONS SIGNALAKTIEBOLAG, STOCKHOLM

U.D.C. 656.057.73

L M Ericssons Signalaktiebolag has recently delivered four vehicle-actuated progressive road traffic signals to be installed at street intersections in Stora Gatan in Västerås. The installations are the first of their kind in Sweden, inasmuch as all the control apparatus for the four street intersections is inter-connected to permit progressive signalling in the main street. A detailed description of the planning, construction and functioning of the installations is given below.

Planning

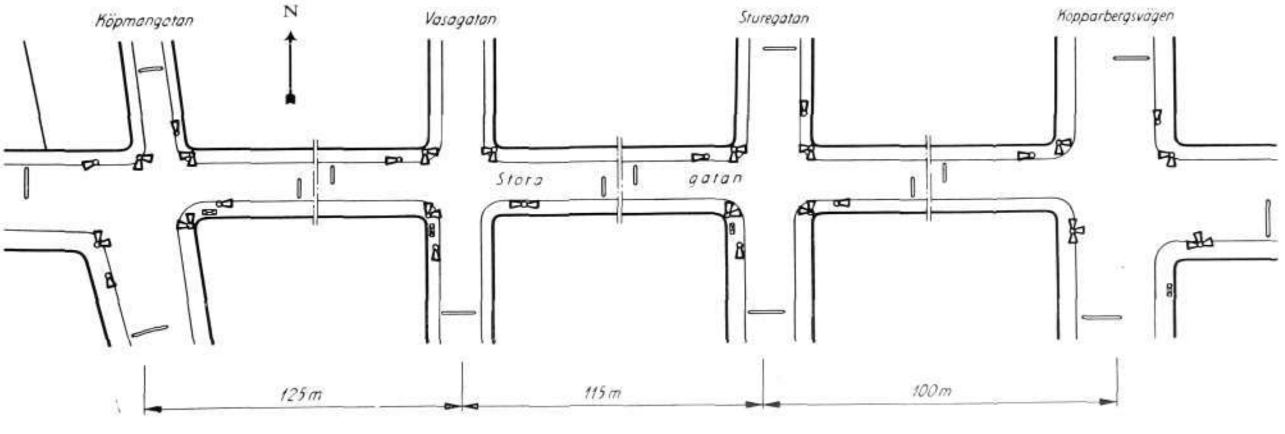
The installations have been designed with a view to ensuring the highest possible degree of traffic safety at the intersections of Stora Gatan (main street) with Köpmangatan, Vasagatan, Sturegatan and Kopparbergsvägen respectively, and by no means least for obtaining an increased traffic capacity in Stora Gatan. This street possesses the distinctive character of a main thoroughfare, whereas the traffic in the intersecting streets is of a more local nature. During certain times of the day a number of traffic peaks are reached, due to the journeys of workers to and from the industries located in the vicinity of these streets. At such times the traffic has a clearly marked flow in one direction or the other through the different streets.

Stora Gatan must in all circumstances absorb a through traffic which is very considerable in relation to that in the intersecting streets. It was therefore found desirable to introduce a signalling system by means of which a stream of traffic flowing along Stora Gatan may be allowed to pass unchecked at a certain speed subsequent street intersections regulated by signals. Thus the signal must change to green for Stora Gatan in good time at the respective intersections so the stream of traffic is not held up, but can pass on freely. The choice therefore fell upon vehicle-actuated progressive street signals which must be regarded as the most suitable system in the present instance. By means of this system the traffic capacity of Stora Gatan can be increased whilst at the same time the signals at each street intersection have a certain degree of independence which is not too restricted. This arrangement also enables the demand to be met for satisfactory traffic circulation in the intersecting streets.

Fig. 1 X 7583

Site plan

- light signal
- control apparatus
- detector



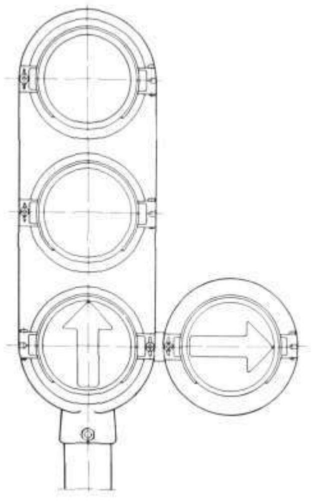


Fig. 2 X 4713
Traffic signal
with side lantern

Construction

Fig. 1 shows a site plan which includes all four of the street intersections. From this plan the position of the light signals, vehicle detectors and control apparatus may be seen, and also the distance between the street intersections. The number of light signals and their location are dependent upon the permissible traffic routes in the respective streets. Thus, no signals are provided in Vasagatan for travelling in a southward direction as this street is restricted to northward bound one-way traffic on the north side of Stora Gatan.

In consequence of the fact that Köpmangatan is restricted to south-bound one-way traffic on the north side of Stora Gatan, all the signals at this intersection which indicate south, east and west respectively are equipped with two green lights, one of which is at the side of the other. The green lights in these signals are provided with arrows whereby the permissible direction of travel in the street intersection is already indicated on entering the latter. Fig. 2 illustrates a signal with a vertical green arrow on the main signal and a horizontal arrow on the side lantern, indicating that vehicles may proceed straight ahead or to the right.

All control apparatus at street intersections are mounted on house walls. Fig. 3 shows the control apparatus at Kopparbergsvägen.

The construction of the light signals, vehicle-detectors and control apparatus is similar in principle to that described in the Ericsson Review, No. 3, 1950.

Functioning

The four installations are constructed with control apparatus for two vehicle phases. There is no separate phase for pedestrians, but in the event of special signals being found necessary for pedestrians, the equipment for this purpose can be added to the installations at a later date without difficulty.

For progressive signalling all the control apparatus is connected to a common time distributor included in the control apparatus at Köpmangatan which is the master apparatus (key point) for the system. Each of the other three control apparatus is connected to the master apparatus by a twin-lead. (An unlimited number of secondary control apparatus may be connected to the master apparatus. The connections from the master apparatus to the secondary apparatus are made in telephone- or power cables.)

The time distributor sends out current impulses to all of the control apparatus at such intervals that the signal in the respective intersections will change to green with respect to Stora Gatan as the vehicle, or vehicles, which has caused the change of signal at the preceding intersection passes along Stora Gatan. A current impulse from the time distributor will not cause a change of signal to Stora Gatan if a vehicle has not been registered by the vehicle detectors in Stora Gatan at the respective street intersections.

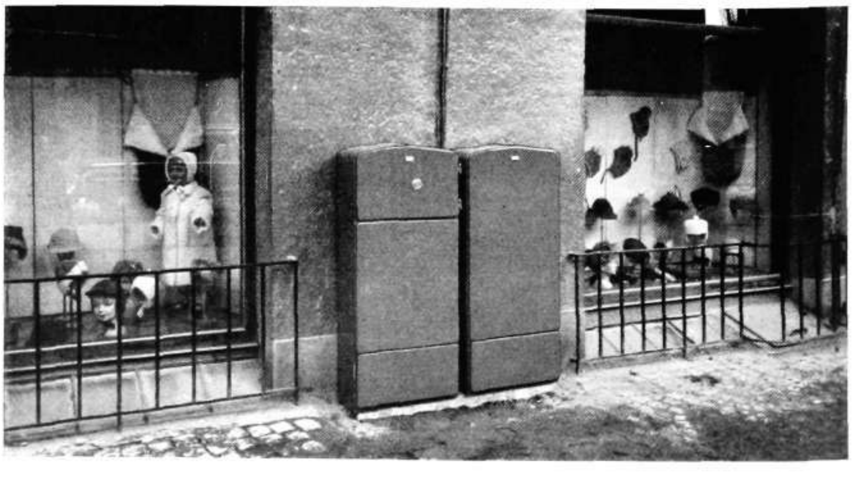


Fig. 3 X 6574
Control apparatus at Kopparbergsvägen
exterior

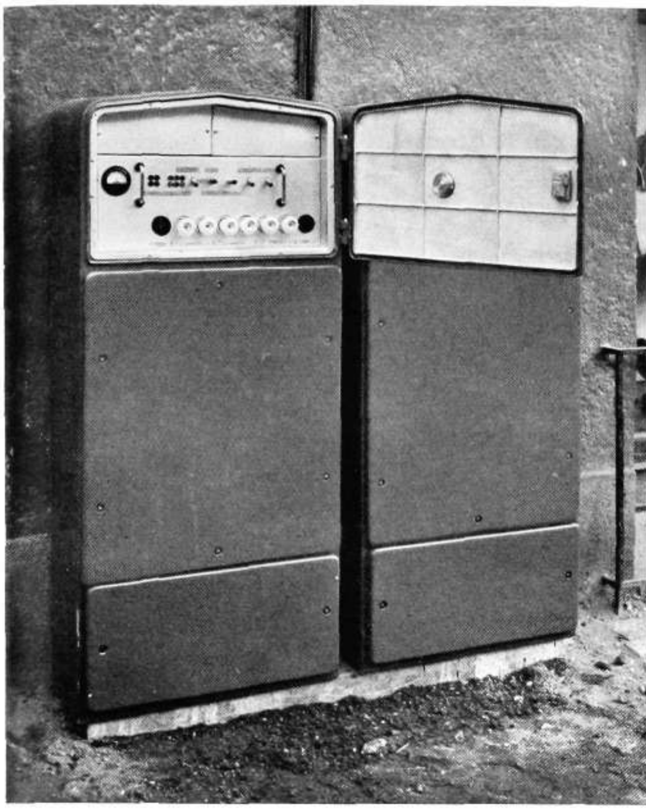
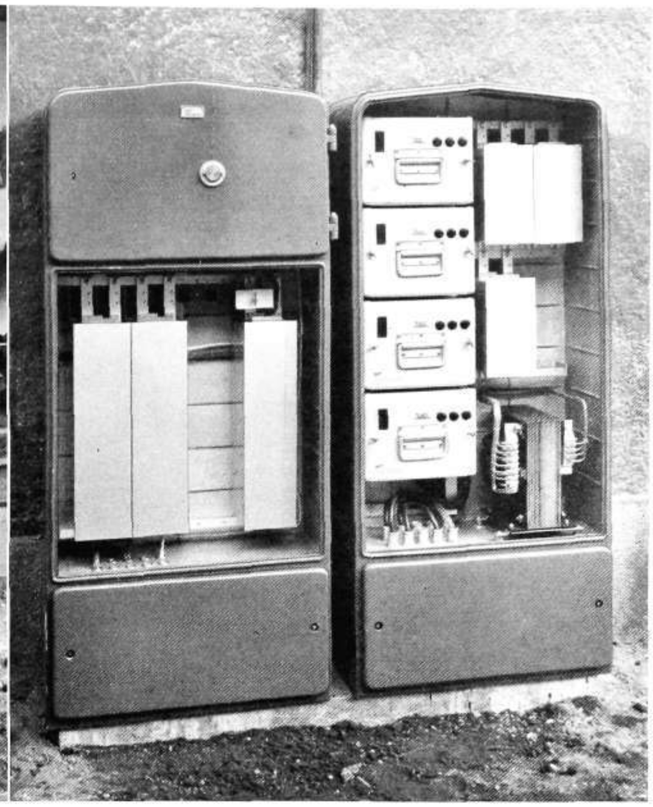



Fig. 4 X 7584

Control apparatus

showing the controlling gear

Fig. 5

Control apparatus

left: with the relays for changing signals, and right: showing the amplifier, etc.

After a current impulse for Stora Gatan has been registered by the control apparatus a prevent period sets in during which no change from green in Stora Gatan to green in one of the intersecting streets can take place. In this way a change to an intersecting street is prevented from occurring at such a point of time that the signals have been unable to change back to Stora Gatan before the period for a right-of-way sets in for this street.

When the prevent period has expired, the privileged period for right-of-way begins in Stora Gatan. This implies that the green light in this street is guaranteed for the first vehicle in a stream of traffic that registers on the vehicle detectors at the respective street intersections. The privileged period terminates after the first vehicle impulse received during the time the signals are showing a green light in Stora Gatan. If the following traffic flow is so dense that the incoming vehicle impulses do not exceed the time for the maximum time spacing of the vehicles which applies for each control apparatus in order to retain the green light, this light will remain unchanged. As soon as the privileged period sets in for the intersecting streets and vehicles have been registered in the latter, the signals will change to these streets. If, on the contrary, no vehicles have been registered in the intersections the green light will remain unchanged in Stora Gatan. Every installation will thus operate to a large extent as an independent vehicleactuated installation after the privileged period for Stora Gatan has terminated and until it has begun for the street intersections and vice versa.

What has been said above in connection with Stora Gatan also applies in principle to the street intersections, with the difference, however, that the prevent period may be omitted for these streets.

If it is desired to disconnect one or other of the installations this can be done without difficulty. In such an event the progressive arrangement can be retained or the installations may be allowed to operate similarly to entirely

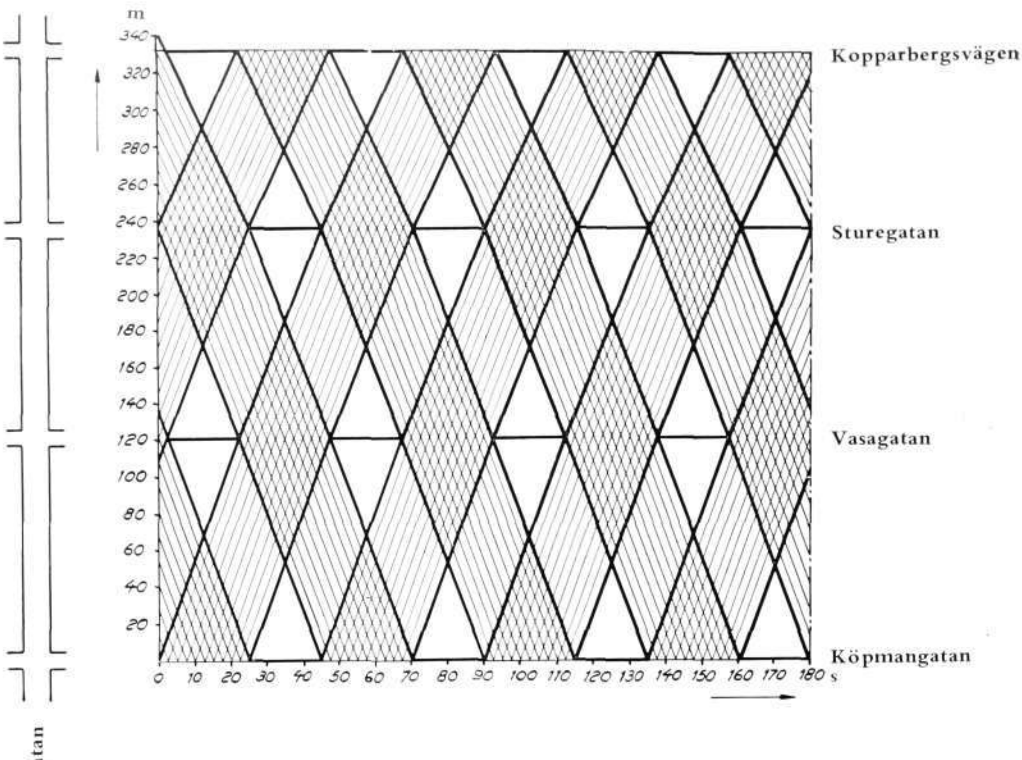


Fig. 6
Traffic diagram

X 6486

separate street intersections which are independent of one another. In the latter case the maximum periods for green light are determined locally by the respective control apparatus.

Fig. 6 shows a traffic diagram with progressive signalling in both traffic directions along Stora Gatan. With a maximum time of 25 secs for the green light the average speed of travel along Stora Gatan will be 17 km/hr. Changing over for other speeds of travel in this Street at different times of day is carried out automatically by a time switch mounted in the control apparatus at Köpmangatan.

The installation is also constructed in such a way that the green light either returns to Stora Gatan without any vehicle being registered there, or it remains in the street from which traffic has last passed. Switching between these two systems of working is done in the control apparatus.

The Speaking Clock Makes its Debut in Egypt

A Speaking Clock system — the first of its kind in the Middle East — has been installed in Egypt. The Egyptian lady announcer, Mrs. Tomander Tawfik, whose voice is used in the system, recently visited Stockholm to make the time records. The illustration shows her in the company of Mr. G. Lindblom, who supervised the erection of the installation in Cairo.

Since the Arabic numerals are of some length, it will sometimes take as much as 7 seconds to announce the time. With allowance for the pips denoting the exact time, 8 to 9 seconds are actually required for a complete time communication.

Sievert's Dust- and Watertight Fitting ALAV for Fluorescent Tubes

E. JENSEN, SIEVERTS KABELVERK, SUNDBYBERG

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In the earlier type of Sieverts Kabelverk's fluorescent tube fitting the reactors were located inside the protective glass tube of the fitting. In the new fitting which Sievert's are now placing on the market it has been possible to mount the reactors at one end thus ensuring their more effective cooling. A number of other improvements have also been incorporated in the fitting.

For some years past Sievert's have been manufacturing a dust- and watertight fitting for fluorescent tubes in which the lamps and other equipment are enclosed in a thick glas tube. The ends of the tube are closed by two rings with corresponding covers. The rings are drawn up tight against the end surfaces of the glass tube by means of four thin wires consisting of a special steel which pass along inside the tube from one ring to the other. The reason for constructing the fitting with a cover at each end was due to the fact that the lamps were formerly provided with clamping sockets. The reactors were placed inside the glass tube to provide satisfactory protection against the action of the surrounding air.

The location of the reactors inside the tube is not entirely an ideal arrangement, however, in view of the fact that the air is heated up by the lamps. Since the lamps now used have pin sockets it is no longer necessary to open the tube at more than one end when changing the lamps, and Sievert's have therefore taken advantage of this fact and have fitted the reactors at the other end. In a new type of fitting recently placed on the market, see Fig. 1, one end has been designed in the form of a box in which the reactors are cast in insulating compound. To ensure satisfactory cooling, the box is constructed with cooling fins. The outer end of the box takes the form of a connection box of the same size as Sievert's ATU-connection box. The terminal plate and box cover are standard ATU parts. The reactor box is fixed in the same way as the former type of end ring, that is to say, by means of four stay-wires.

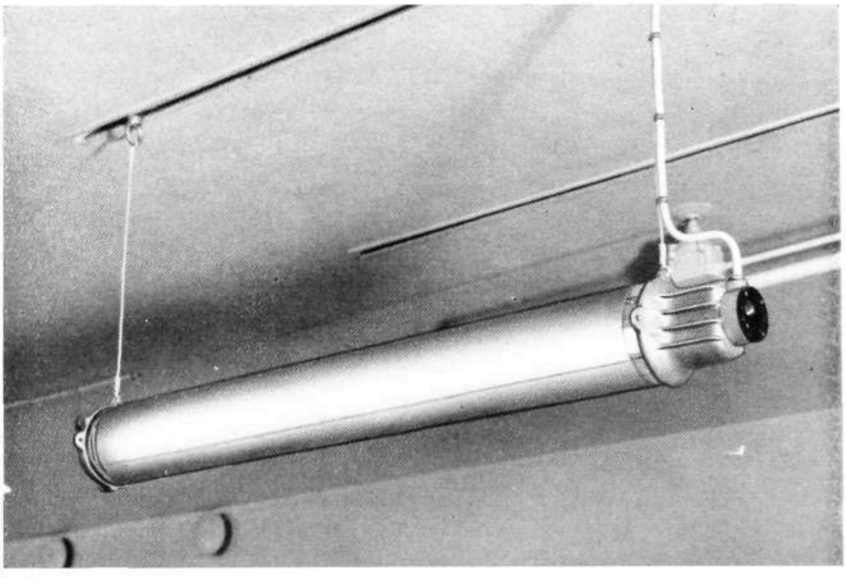

Fig. 1 X 6572

Sievert's fluorescent tube fitting ALAV

To the right the box with the reactors cast in insulating compund and with the outer end of the box in the form of a connection box.

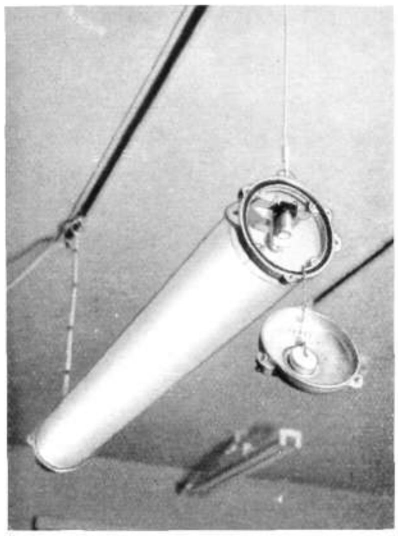

Fig. 2 X 4715

The tube fitting with the cover unscrewed in order to show the starter

Fig. 3 X 4714

Fixture for mounting the fitting on a wall or a ceiling

To prevent glare from the lamps, the fluorescent tubes are frosted inside. As the frosted glass renders it difficult to see whether both lamps are alight, however, a few centimetres of clear glass have been left at each end.

The starter, see Fig. 2, is immediately accessible inside the cover. Guide rings are attached to two of the stay-wires to facilitate the insertion of a lamp. A guiding yoke is also placed close to the inner lampholder. The cover is fixed by a chain to one of the stays which therefore holds it when it is unscrewed for the purpose of changing the lamp.

A drying box is mounted in the cover and is held in position by a wire loop. On moving the latter the box can be withdrawn for replacement. The purpose of the drying box is to absorb the moisture present in the fitting and which in accordance with »the law relating to cold walls» might be deposited on the inside of the glass tube at the bottom after the lamps have lit up and have had time to warm the upper part of the tube. In order to render the drying box effective, the drying medium must be well-dried after it has been placed in the box. This should be followed immediately by the application of a coating of paraffin to the box cover. The paraffin must, of course, be removed before the end cover is screwed home after the lamp has been inserted. When changing the lamp a new drying box should be taken. Drying boxes which have been used can be made fit for further service by heating them up. If it is possible after changing a lamp to allow the fitting to remain alight for a short time with the cover removed until the air inside the fitting has been warmed up, no moisture will be deposited and the drying box may then be dispensed with.

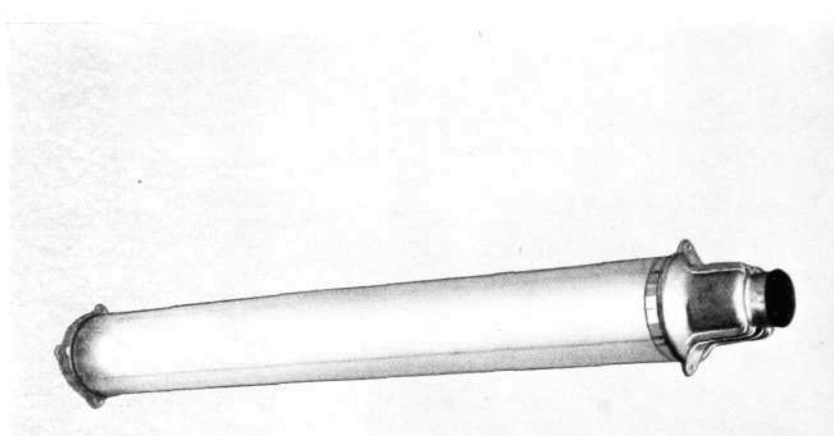

Fig. 4 X 6573

The fitting mounted on a wall

Since it is extremely important that a fitting of this type should be perfectly tight under practical conditions of use, particular care has been devoted to the designing of the packing and the choice of material for the same. As a last step in the manufacture, each fitting is subjected to a pressure test.

Owing to the fact that the reactors have relatively low losses and are well-cooled, the fittings can be run continuously on the starting current, that is to say, on closed circuit with failure of the lamp to ignite, without a temperature rise occurring which would be dangerous for the reactor. This also applies when the mains voltage rises 10 % above the normal voltage.

The fittings are designed for one and two lamps. In the latter case the connection box has a three-pole terminal plate and one end of each lamp circuit is connected to its own terminal whilst the other ends of the circuits are connected together to the third terminal. In this way it is possible to connect the fittings between one phase and neutral (or between two phases at 3×220 V) or between two phases and neutral (or between three phases at 3×220 V) according to requirements. They can also be connected for two separate circuits.

To permit the changing of a lamp when a number of fittings are installed in a row close to one another, the fittings are suspended on two wires. When a lamp has to be changed the fitting is moved slightly to one side so that the lamp can be withdrawn without obstruction from the adjoining fitting. The two supporting wires consist of standard 2.5 mm^2 PVC-insulated wire.

To enable a fitting to be mounted directly on a ceiling or a wall when necessary, a special fixture is provided, see Fig. 3. Where fittings with two lamps are employed it is customary to arrange them side by side; only in exceptional cases are they placed one above the other. To allow any desired arrangement to be selected, however, the fittings are provided with three lugs for the attachment of supporting wires or wall fixtures. When a fitting is to be mounted on a wall, sufficient space must be available for changing the lamp.

A Long Ladder for a High Tower

One of Stockholm's longest fire-ladders was tested recently in the course of fire extinguishing exercises which took place at L M Ericsson's factories at Midsommarkransen, Stockholm. The ladder which is 105 feet high was placed against the L M Ericsson radio tower and the firemen entered this fine building through the windows. The radio tower is 237 feet high.

L M Ericsson Exchanges 1950

During 1950 the following exchanges on the L M Ericsson automatic telephone system with 500-line selectors have been put into service:

town	exchange		number of lines
Argentine			
Buenos Aires	PABX		500
Nogoya			500
Salta		(extension)	1000
Santa Fé	Centro	(extension)	500
Santa Fé	Maipú	(extension)	500
Santa Fé	Noroeste	(extension)	500
Bolivia			
Cochabamba		(extension)	1000
La Paz		(extension)	1000
Sucre			500
Brazil			
Belo Horizonte			6000
São Paulo	PABX		460
Colombia			
Armenia		(extension)	1000
Bogotá	Chapinero	(extension)	1000
Bogotá	Las Cruses		4000
Bogotá	Ricaurte		2500
Ibagué		(extension)	400
Manizales	PABX		140
Medellín	America		3000
Medellín	Centro	(extension)	2000
Denmark			
Köpenhamn	3 PABX		640
Dutch West Indies			
Curaçao	Mahaai	(extension)	500
Ecuador			
Mariscal Sucre			1100
Finland			
Björneborg			3500
Iceland			
Akureyri			1000
Hafnarfjördur		(extension)	660
India			
Rajapalayam	PABX		90
Italy			
Abano Terme			200
Asti		(extension)	500
Bergamo		(extension)	1000
Bologna	PABX		200
Brescia		(extension)	1000
Capri			500
Cremona		(extension)	500

town	exchange		number of lines
Enna			500
Genova	PABX	(extension)	40
Lecce		(extension)	500
Mantova		(extension)	500
Napoli	Posillipo	(extension)	500
Napoli	PABX	(extension)	60
Ovada			160
Padova		(extension)	2000
Palermo	PABX		500
Pompei	PABX		200
Ragusa			500
Sorrento			500
Spinetta Marengo			200
Taranto		(extension)	1000
Treviso		(extension)	500
Venezia	Centrale	(extension)	2500
Venezia	Mestre	(extension)	500
Vercelli		(extension)	500
Verona		(extension)	1500
Vicenza		(extension)	500
Mexico			
México D. F.	Chapultepec	(extension)	500
México D. F.	Coyoacán	(extension)	500
México D. F.	Roma	(extension)	1000
México D. F.	Tacuba	(extension)	500
México D. F.	Victoria	(extension)	3000
México D. F.	PABX		480
Morocco			
Tanger		(extension)	1000
Netherlands			
Rotterdam	Schiedam	(extension)	1500
Rotterdam	10 PABX		2140
Norway			
Eidanger	PABX	(extension)	40
Halden		(extension)	1700
Harstad			2000
Oslo	4 PABX	(extension)	300
Stavanger		(extension)	2000
Panama			
Panama City	Panama II		4000
Panama City	Panama III		3000
Poland			
Katowice	10 PABX		1970
Warszawa	PABX		400
Sweden			
Borås		(extension)	1000
Eskilstuna		(extension)	2000
Falköping			3500
Gävle			14500
Göteborg	Kålltorp		9000
Göteborg	Masthugget	(extension)	5000
Göteborg	Partille		1000
Göteborg	Vasa	(extension)	2500
Göteborg	2 PABX		240
Göteborg	3 PABX	(extension)	220
Hagfors			1000

town	exchange		number of lines
Karlskoga		(extension)	1000
Kiruna			2500
Kristinehamn		(extension)	1000
Norrköping		(extension)	2000
Stockholm	Aspudden	(extension)	3000
Stockholm	Enskede	(extension)	3000
Stockholm	Kungsholmen	(extension)	1000
Stockholm	Råsunda	(extension)	2500
Stockholm	Tullinge		1000
Stockholm	Älta		1000
Stockholm	7 PABX		2270
Stockholm	12 PABX	(extension)	580
Västervik			3500
Västerås		(extension)	1000
Örebro		(extension)	3000
Various places	13 PABX		1960
Various places	18 PABX	(extension)	1340
Turkey			
Ankara	Yenişehir	(extension)	4000
Istanbul	Şişli	(extension)	3000
Izmir	Buca		100
Izmir	Bornova		100
Karabük	PABX		200
Ödemis			500
Venezuela			
Rubio			150
San Cristobal			1000
		Total	157740

During 1950 the following exchanges and switchboards with 100-, 25- and 12-line selectors have been delivered. Extension to existing plants are not included in the figures.

	number	number of lines
Exchanges with 100-line selectors	18	5300
Switchboards with 100-line selectors, system AHD	96	8970
Switchboards with 25- and 12-line selectors, system OL	531	12798
Total	645	27068

U.D.C. 621.395.343.004.5

BERGLUND, C: *Maintenance of Automatic Telephone Exchanges with 500-line Selectors.* Ericsson Rev. *28* (1951) No 1 pp. 2—6.

The economic significance of maintenance work is frequently underestimated and should receive more than the usual attention where automatic systems are concerned. The following article contains a summary of the operating results achieved in Stockholm's automatic exchanges. Suitable maintenance methods for the system are described and general directions are given for the organization of a satisfactory maintenance service.

U.D.C. 621.395.343

THOMSON, I: *New Developments on L M Ericsson's Telephone System with 500-line Selectors.* Ericsson Rev. *28* (1951) No. 1 pp. 7—10.

The article describes certain changes incorporated in the L M Ericsson telephone system with 500-line selectors. Various methods for debiting calls are mentioned and new devices for testing switching connections are described.

U.D.C. 621.395.743.003.1

LAURENT, T: *An Optimum Law for Telephone Networks.* Ericsson Rev. *28* (1951) No. 1 pp. 11—13.

When connecting a telephone line between two subscribers or a subscriber and an interurban exchange within the same local network the line attenuation must comply with certain stipulations in the CCIF standards, which requirements may be met satisfactorily in different ways. The present paper offers guidance for finding the method which will result in the minimum costs.

U.D.C. 621.395.24

NILSSON, E: *Private Automatic Branch Exchange AMD 10201.* Ericsson Rev. *28* (1951) No. 1 pp. 14—19.

To meet the demand for small private branch exchanges L M Ericsson has taken up the manufacture of a series of such exchanges consisting exclusively of relays and capacitors and intended for direct connection to the electric supply mains without batteries. The smallest of these exchanges comprises 5 extensions, 1 exchange line and 1 link for local calls. The article describes the construction, range of use and functioning of the new private branch exchange. A comparison is also made with large private automatic branch exchanges and various possibilities for connection and power supply are described.

U.D.C 654.915.2

TRÄGÅRDH, A: *Absence Indicators.* Ericsson Rev. *28* (1951) No. pp. 20—22.

As a supplement to staff locating installations of the ordinary type used in offices, L M Ericsson has designed apparatus for indicating absence. With the help of this apparatus the telephone operator can ascertain whether persons frequently sought for are not on the premises, when they are expected to return and the reason for their absence. The article contains a short description of the construction and functioning of the apparatus.

U.D.C. 683.854:621.324.43

JENSEN, E: *Sievert's Dust- and Watertight Fitting ALAV for Fluorescent Tubes.* Ericsson Rev. *28* (1951) No. pp. 27—29.

In the new type of fluorescent tube fitting which Sieverts Kabelverk have placed on the market the reactors are located at one end, thus ensuring their more effective cooling. This and another of other improvements are described in the article.

U.D.C. 656.057.73

EKWALL, S: *Vehicle-actuated, Progressive Road Traffic Signals in Västerås.* Ericsson Rev. *28* (1951) No. pp. 23—26.

L M Ericssons Signalaktiebolag has recently supplied four vehicle-actuated road traffic signalling installations to Västerås. The control apparatus for the four street intersections are connected together for progressive signalling in the main street, which is novel arrangement in Sweden. The article describes the planning, construction and functioning of the installation.

The Ericsson Gr—

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New Domestic Telephone with an Ivory-white Finish

K W NILSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.22:621.395.721

A new series of domestic telephones, both of the wall- and table instrument type, has been placed on the market by Telefonaktiebolaget L M Ericsson during the year 1951. In the new domestic telephones the more exacting demands of the present day have been met both with respect to choice of colour and form as well as robust construction and reliability in operation. Furthermore, the instruments are easy to install and connect, and either surface wiring or conduit wiring may be employed.

The following article describes the construction, installation and schematic arrangement of these new domestic telephones, and gives a few examples of the most customary types of installations.

The domestic telephones placed on the market by Telefonaktiebolaget L M Ericsson in 1936 and 1941, found great favour with the general public owing to their low price and wide range of use, which contributed towards the rapid establishment of communication in the home or in working premises, thereby rationalizing the work and rendering it more efficient.

The domestic telephones were designed for wall mounting and were constructed in two forms; both with and without calling buttons. The former type was primarily intended for installations comprising a maximum of three instruments, such as are required for communication between a shop, store and office in a business for example, whereas the latter type was more suitable for installations in large offices, cinemas, hospitals, laboratories, warehouses, workshops and similar premises.

The more exacting requirements of the present day, both with regard to colour and form, have been accompanied by a constantly increasing demand for domestic telephones of some colour other than black however. It was unfortunately impossible for L M Ericsson to meet this demand at an earlier date owing to the lack of satisfactory materials. Phenolic material could not be obtained in permanent light colours and other moulding compounds that might have been employed for the purpose possessed inadequate strength and further exhibited a tendency to crack easily.

On the conclusion of the second world war an entirely satisfactory material for moulding telephone parts in colours became available to L M Ericsson, namely, *melamine with a cellulose filler,* a substance which possesses excellent strength and a hard surface resistant to corrosion.

From the year 1951, therefore, Telefonaktiebolaget L M Ericsson has taken up the manufacture of a new series of domestic telephones with casings and handsets of melamine in a permanent ivory-white colour, which are also fitted with beige instrument cords. The new series includes both wall- and table instruments which have been designed in an elegant and aesthetically attractive form. In addition, the instruments have very small dimensions and can be very easily mounted and installed.

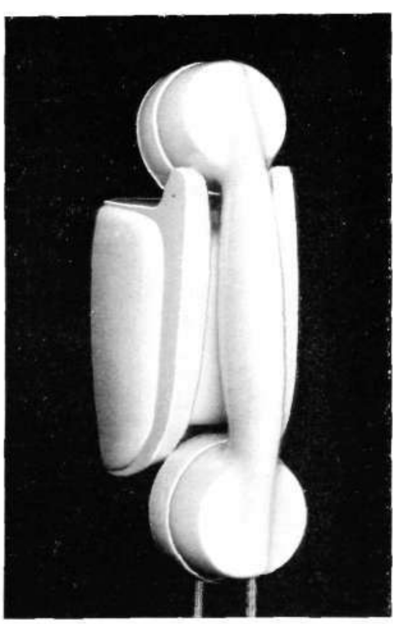

Fig. 1 X 4719
Wall instrument DEP 4002

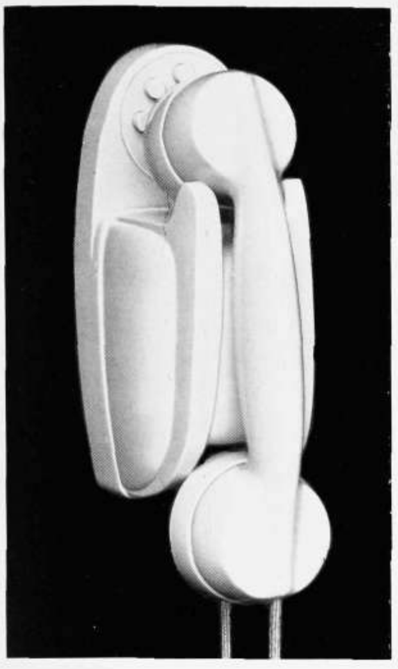

Fig. 2 X 4720

Wall instrument DEP 3202

The types of instruments described here are also available in black colour. The material in the casing and handset then consists of phenolic material.

Wall Instruments

The new domestic telephone for wall mounting is manufactured in two types, both of which are arranged for direct calls, namely:

DEP 4002, Fig. 1, which is intended for installations comprising 2—3 instruments, where calls are initiated by depressing the instrument's plunger to the bottom position, and

DEP 3202, Fig. 2, which consists of the above instrument fitted with a press-button set *RMP 1022*. The press-button set is equipped with 8 calling buttons for individual calls up to a maximum of 8 instruments.

Construction

The wall instrument represents an entirely new design, the experience gained in previous years having been utilized in its construction. LM Ericsson's main object has been to produce an instrument at a low price which nevertheless fulfils the same requirements of quality as those made af a telephone instrument in an automatic system.

The handset is exactly similar to that included in L M Ericsson's table instrument for an automatic telephone system. It is provided with interchangeable transmitter- and receiver insets of the latest type.

The casing can be entirely removed from the enclosed mechanism, which facilitates the work of installation considerably. Owing to the shape of the casing the handset has a very stable position when it is hung up, and the gravity mechanism is operated in a vertical direction, thus ensuring maximum reliability for the disconnection of the battery current.

The enclosed mechanism, see Fig. 3, is built up as an overhung unit. Even when the baseplate is handled relatively carelessly during installation, the adjustment of the sensitive parts of the mechanism is not affected.

The contact spring set and *the switch slide* are of the same construction and operate in a manner similar to the corresponding parts in L M Ericsson's new telephone instrument for the automatic system.

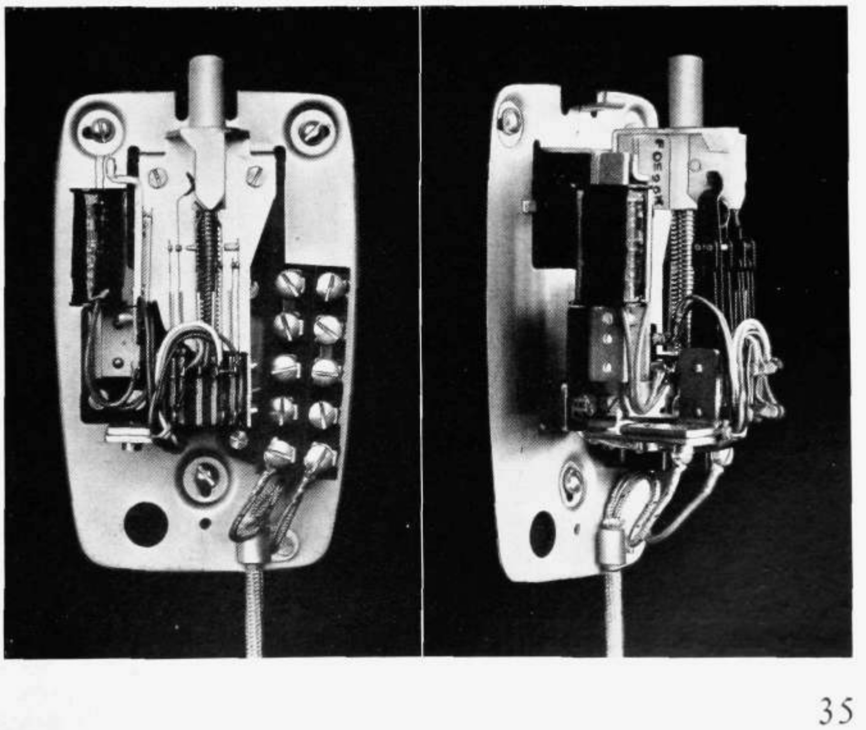

Fig. 3 X 6580

Internal mechanism

for the wall instrument. In the lefthand view, from the left, the buzzer, the contact spring set and terminal block may be seen.

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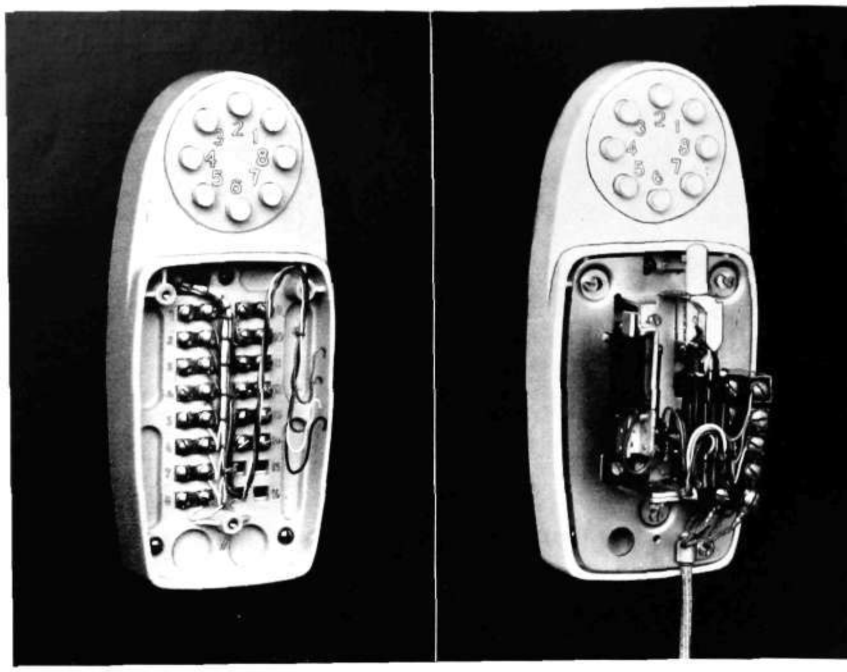


Fig. 4 X 6581

Press-button set RMP 1022

with 8 numbered calling buttons. On the right, with the mechanism screwed to the baseplate.

The terminal block is constructed of phenolic material and is provided with 10 terminal screws and 3 connecting strips. With the help of these connecting strips the instrument can be employed in installations for 2-, 3- and 4-wire systems or as a secondary instrument in installations with 8 calling buttons.

The buzzer is of a new design and is constructed as a separate unit. It is fitted with an adjustable air-gap and gives powerful signals even over long lines.

The press-button set RMP 1022, see Fig. 4, has been designed with a view to giving the domestic telephone an attractive appearance. It is provided with 8 numbered calling buttons and has 14 terminals for the connection of the instrument.

Schematic Construction

The schematic construction is similar in principle to that adopted for the earlier types of domestic telephones, see Figs 5, 6 and 7.

The installation shown in the diagram in Fig. 5 is only intended for calls between two instruments. The conductors employed are 2-wire cables having a diameter of 0.7 mm. The source of current consists of a 4.5 V battery at each instrument and is suitable for distances up to 400 metres, or with a 6 V battery, up to 500 metres.

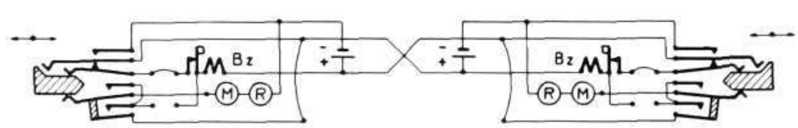


Fig. 5 X 6575

Two instruments with separate batteries and 2-wire connections

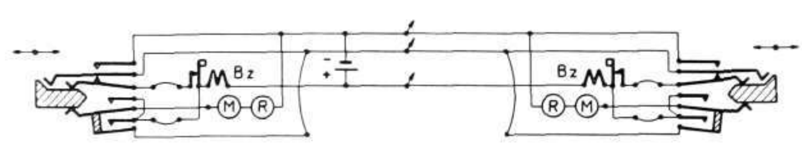


Fig. 6 X 6576

Two instruments with a common battery and 3-wire connections

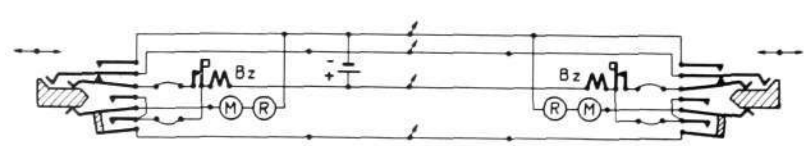


Fig. 7 X 6577

Two instruments with a common battery and 4-wire connections

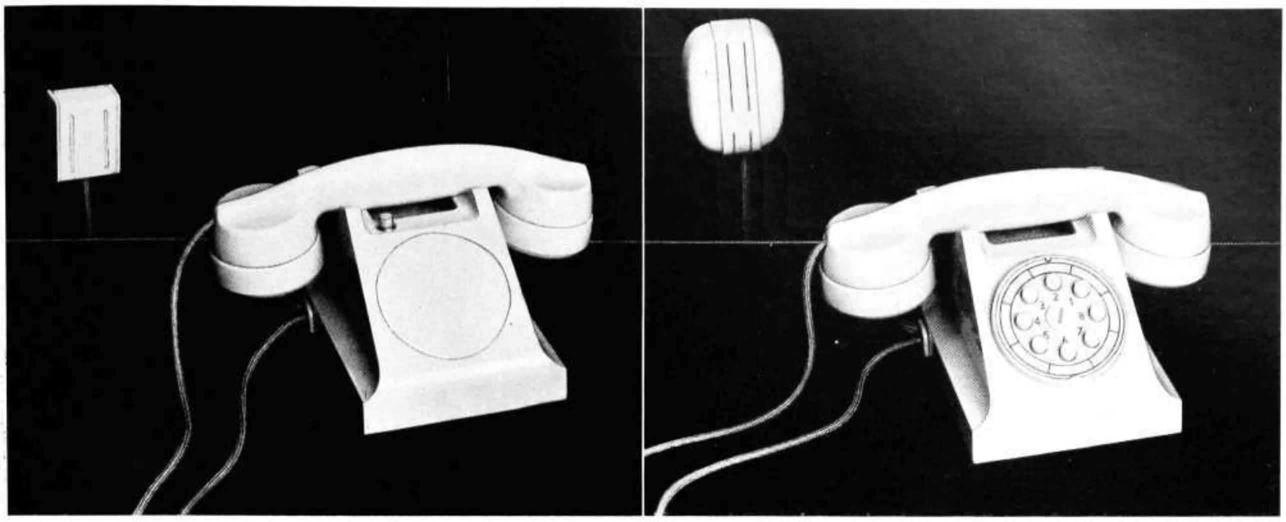


Fig. 8 X 7591

Table instrument for a domestic telephone

left: DEK 9202 with one calling button, right: DEK 9004 with 8 calling buttons

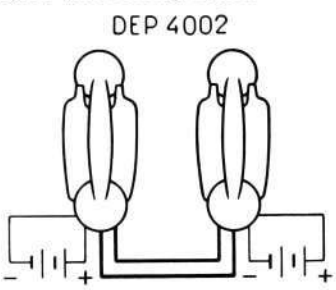


Fig. 9

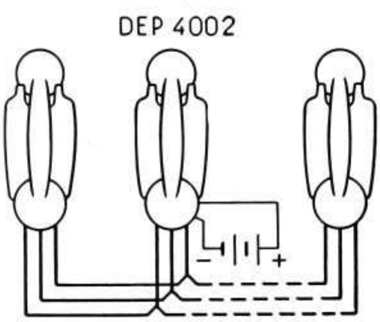


Fig. 10

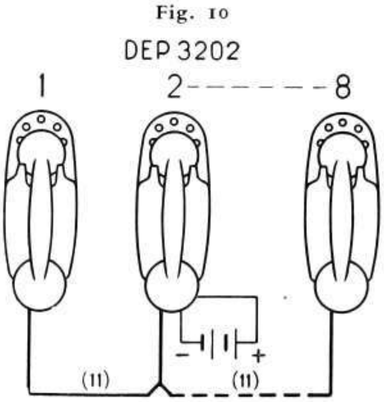


Fig. 11

An installation according to the diagrams in Figs 6 or 7 is intended for two or more instruments which are connected in parallel and are called by code signals. For the conductors, 3-wire or 4-wire cables having a diameter of 0.7 mm are employed. The source of current is a 4.5 V battery which is suitable for distances up to 300 metres.

It is not necessary to employ 4-wire connections as shown in Fig. 7, but this diagram has been included in order to illustrate how the fourth wire is to be connected. The reason why this form of connection was recommended for L M Ericsson's earlier type of domestic telephones is that 3-wire cable was not previously available on the market. At the present day, however, 3-wire cable can be obtained from L M Ericsson's Cable Works at Älvsjö. This cable has the type designation *EKUA* and has a conductor diameter of 0.7 mm. It is of the same construction as the 2-wire cable *EKUA* (with a 0.7 mm conductor diameter) which has been used in recent years for indoor telephone and tele-signal installations.

The cable is insulated with polyvinylchloride (PVC) and is supplied with an ivory-white finish.

Table Instruments

In addition to the wall pattern instruments described above, L M Ericsson also manufactures entirely new types of table instruments, *DEK 9202* and *9204*, see Fig. 8 on the left, and a modernized form of the old table instruments with 8 calling buttons, *DEK 9004*, Fig. 8 on the right.

DEK 9202 is fitted with a 4-wire instrument cord and can only be employed for small domestic telephone installations comprising two or three instruments.

DEK 9204 has a 5-wire instrument cord and is employed as a substation to the main instrument with 8 calling buttons.

The foregoing instruments are fitted with casings of a small type and have a buzzer for incoming calls.

The table instrument *DEK 9004* with calling buttons, in distinction to the earlier type, has a wall terminal with a casing of plastic material. The instrument has a cover of the small type and is provided with a direct current bell for incoming signals.

Fig. 9 X 4716

Domestic telephone installation comprising two wall instruments DEP 4002

The connection between the instruments is 2-wire and separate batteries are required.

Fig. 10 X 4717

Domestic telephone installation comprising three wall instruments DEP 4002

The connection between the instruments is 3-wire and a common battery is employed.

Fig. 11 X 4718

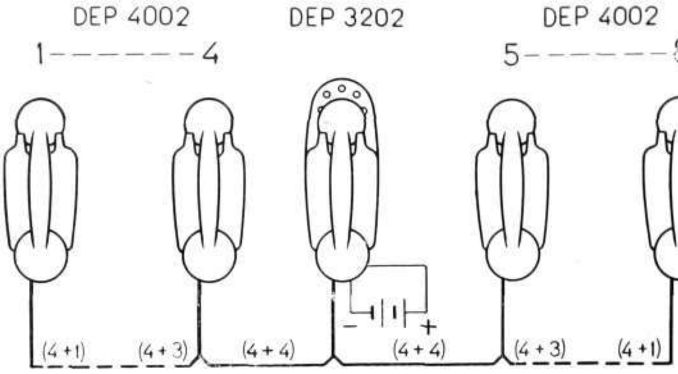
Domestic telephone installation comprising eight wall instruments DEP 3202

Each instrument is provided with 8 calling buttons for individual calls. Common battery.

Fig. 12 X 6579

Domestic telephone installation comprising one main instrument DEP 3202 and up to eight substations DEP 4002

This type of installation may be employed as a manager's telephone installation. A domestic telephone instrument with a set of buttons is located in the manager's room, and he can then call the substations individually. Calls to the manager cannot be made from the substations however.



Installation

The new domestic telephones can be installed by the customer himself without difficulty. Detailed instructions for connection accompany each instrument.

The wall instruments are supplied with ample directions for opening walls for the insertion of bushings. It is thus possible to connect up the cables either to surface wiring or conduit wiring. In the case of the instruments with 8 calling buttons the cable is connected in the same way for both the table and wall instruments.

An additional bell can be connected either to table or wall instrument if required. In such a case care must be taken to ensure that the bell has the same resistance and voltage sensitivity — 40 ohms and 3 V respectively — as the instrument's buzzer.

In view of the fact that PVC-insulated cable is now employed for surface wiring it has become possible to improve the appearance of a domestic telephone installation considerably. Apart from the 2- and 3-wire conductors mentioned above, 8- and 12-wire cables are now available on the market — likewise with an ivory-white finish. These cables which are designated *EKKX 8 × 0.5 mm* and *EKKX 12 × 0.5 mm* respectively, are particularly suitable for installations comprising instruments with calling buttons.

For fixing *EKUA* cables the use of white-enamelled steel nails *NSV 1001* or *NSV 1003*, 12 and 19 mm long respectively, is recommended. For fixing cable of the type *EKKX* cable cramps *NSV 2026* will be found suitable, whilst for nailing it to concrete walls cable clamps *NSV 2523* may be used.

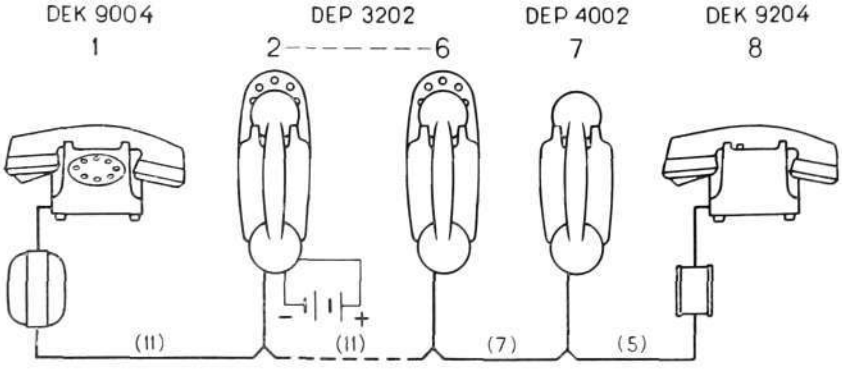
Different Types of Installations

A large number of different types of installations can be obtained with the new domestic telephones, thanks to the possibility of combining the various forms of instruments with one another. Figs 9—13 illustrate some of the possible combinations thus available. In none of the combinations is secrecy in calling possible however.

Fig. 13 X 6578

Domestic telephone installation comprising a table instrument DEK 9004 and a number of instruments DEP 3202 and one substation DEP 4002 (connected to instrument No. 1) and a substation DEK 9204 (connected to instrument No. 6).

The main instruments can call all other instruments in the installation. On the other hand, a substation can only be called from its own main instrument.



Telefonaktiebolaget LM Ericsson's 75-Year Jubilee

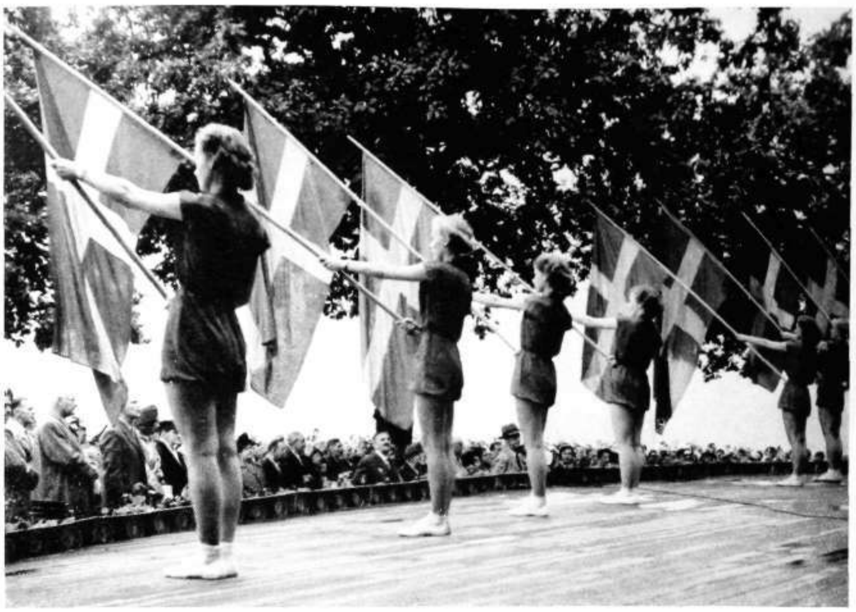
In the year 1876 Lars Magnus Ericsson opened the mechanical workshop which was the origin of the world-wide L M Ericsson concern. The 75-year jubilee was celebrated on the last Saturday and Sunday in August. In connection with the Jubilee, the Directors of L M Ericsson decided to set aside a sum of 1 million crowns for the benefit of the staff in recognition of the services of the company's employees during the past 75 years. More than 500 com-

On LM-Day at Skansen greetings were received from LM-companies in all parts of the world. At the same time LM-girls paraded with the flags of the respective countries. In the top picture Uruguay's flag is being carried across the stage.

This solderer, Gustaf Ekman, has worked for LM Ericsson for 41 years without being late once. In the picture below left, the Managing Director Helge Ericson, is presenting him with a commemoration plaquette amid the applause of his fellow workmen.

The three brothers, Ludvig, Waldemar and Robert Ljungkvist, have a combined length of service of 165 years. They are seen in the lower picture right, admiring 70-year old Ludvig's commemoration plaquette.

Nearly 10,000 people were present at Solliden in Skansen when the 5th LM-Day was inaugurated by Managing Director Helge Ericson. This ceremony concluded with an attractive flag parade (picture, right).



"This is a double jubilee for me" exclaimed machinist Karl Fredrik Larsson, on receiving his commemoration plaquette. He has now reached the age of 75, and was thus born in the year that Lars Magnus Ericsson started his career (picture below.)

memoration plaquettes were distributed to the workers and employees engaged in the various undertakings of the company. In addition, bonuses amounting to a total sum of 250,000 crowns were presented to all workers who had been employed for 25 years in the company's Swedish undertakings.

The Sunday jubilee programme held at Skansen, in Stockholm, was combined with the fifth »LM-Day», a traditional annual rendezvous at which the company's employees and their families have an opportunity to meet one another, and this year it assumed the character of the 75-year jubilee in many respects. In the course of the opening ceremony Telefonaktiebolaget's Managing Director, Mr. Helge Ericson, announced the grant of 1 million crowns to be used for the benefit of the staff.

From this sum, 450,000 crowns has been assigned to the fund inaugurated in 1946 for the commemoration of the 100-year anniversary of Lars Magnus Ericsson's birth. This fund, now amounting to 700,000 crowns yields interest which will be used for travel stipendiums and educational grants. Applications for some of these stipendiums may now also be submitted by the staff of the Telegraph Board. A further 100,000 crowns has been assigned to the LME fund for the promotion of electronic research within the range of the company's activities. The capital of this fund will, therefore, now amount to 350,000 crowns. A sum of 200,000 crowns has been allotted to a sick relief fund for the company's workmen. After agreement had been reached between the board of directors and the various workshop clubs, the workers relief funds were com-

In the jubilee exhibition at Skansen, homage was rendered to the company's founder, Lars Magnus Ericsson. In the picture (right) a part of the exhibition's historical section is visible, showing the development of telephone instruments through the years.

The oldest LM-worker, foreman Johannes Lelki — who will shortly reach his century — was present at the opening of the Skansen exhibition. In the above picture he is seen, examining a telephone dating from 1895, together with his son, pensioned foreman Bernhard Lelki, and Director Hans Thorelli.

bined with this fund. The chief purpose of these funds is to make contributions to workers who are in need of financial assistance during long periods of illness.

As one feature of the 75-year celebrations, the company had arranged an exhibition during the summer months in the Exhibition Hall at the main entrance to Skansen. This exhibition not only illustrated the progress of the company but also the advances made in telecommunication engineering during the past years. In this exhibition, which was widely patronized, the public was able to follow the development of the concern, from the first workshop in Drottninggatan, Stockholm, up to the great international organization of the present day. The first telephones made in the 1870s to the modern instruments of our times were on view in the historical section, which also traced the development of the handset and the dial. L M Ericsson's various automatic telephone systems were demonstrated on test panels and at other stands the visitors themselves were able to examine various novelties amongst the company's widespread range of products.

The above pictures show interiors from the large hall. More than 25,000 persons are employed at the present time by the various companies of the concern, the distribution of which is indicated on the map visible in the upper picture together with illustrations of the different plants. In Sweden the concern employs 13,000 persons, 5,000 of whom are engaged at the main works in Midsommarkransen, Stockholm. The picture below illustrates the company's social activities. The miniature installation of vehicle-controlled street traffic signals was an appreciated feature of the exhibition visited by about 175,000 persons.

Radio Links for Power Stations

L PERSSON, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U. D. C. 621.396.65

Permanent radio connections using ultrashort waves, known as radio links or radio chains, are now employed in many places instead of telephone wires. Generally speaking, these radio connections transmit a number of telephone conversations simultaneously and form a part of the public telephone network. A demand exists in power station operation for another form of permanent radio connection arranged for carrying on a single conversation only, but combined with a number of low frequency tone channels for remote control. The Svenska Radioaktiebolaget has developed a radio link of this kind, known as SUF-30, which is specially designed for permanent radio connections between power stations.

In the distribution of power the provision of means for rapid tele-communication between different operating points is of vital importance, both under normal working conditions and during interruptions in the service. In addition to ordinary wired telephony, carrier frequency communication over power lines has been in use for a long time, and in a number of countries including Sweden these carrier frequency systems are connected through automatic telephone exchanges to form a network covering the entire country. The Svenska Radioaktiebolaget's radio link *SUF-30* can be connected in such a network in the same manner as a carrier frequency system. In many instances, however, it is found more suitable to connect the radio link to a local telephone exchange or to allow a number of radio links to form a telephone network of their own. *SUF-30* has been designed in such a way that it can be adapted to different requirements in this respect.

The natural range of use for radio links covers distances from a few kilometres up to the range that can be obtained by a link without an intermediate relay station, that is to say, about 50 km. For distances requiring one or more relay stations a carrier frequency system is usually found cheaper, although there are exceptions to this rule. Generally speaking, for very short distances a telephone cable is cheaper apart from special instances where ground conditions offer difficulties.

Remote measurement and remote control are carried out through the radio link *SUF-30* by the transmission of tone pulses. Six channels are available for transmission in each direction.

Selection of Frequency and Service Range

For radio communication of this kind frequencies above 30 Mc/s are adopted. A common feature for these frequencies is found in the fact that only ground waves can be employed for communication, since space waves are not normally deflected to the earth's surface. The range for such radio connections is short and for frequencies above 300 Mc/s optical vision is necessary, whereas for lower frequencies, radio communication can usually be established somewhat beyond the range of optical vision. Since it is generally desirable to locate the radio equipment in the immediate vicinity of the operating positions with the result that direct optical vision cannot be obtained in many cases, it is preferable to use a relatively low radio frequency. On the other hand, the lowest frequencies within the range are sporadically hampered by space wave interference from distant transmitters, and consequently the most suitable frequency ranges are found to be 70—87.5 and 156—174 Mc/s. The 156—174 Mc/s band represents the normal range for *SUF-30*. When the frequency is selected within this band, communication up to 50 km can be

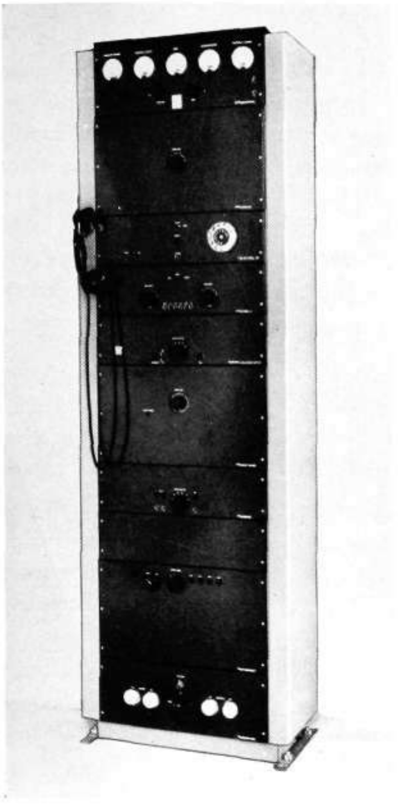


Fig. 1 X 4721
Radio link SUF-30

obtained over normally undulating country, and in extreme cases up to 100 km. Generally speaking, it is not found expedient to extend the range forcibly and operate with very low field strengths. In such a case communication may be adversely affected from time to time or interrupted, either on account of the abnormal atmospheric cut-off conditions close to the earth's surface or owing to local disturbances from electrical apparatus or the like. When the system is planned in such a way that good signal strength is obtained, it will not be influenced by phenomena of this kind.

In order to ensure satisfactory radio communication the aerials should be placed high up and in a position free from interference. The costs for aerial masts rise rapidly in proportion to their height, and for this reason masts exceeding 40 m are seldom used in practice. Normally, directional aerials of the Yagi type with a directivity of 7 to 8 dB are employed. To prevent the properties of the aerials from being affected by snow or a coating of ice, the aerials are equipped with heating elements for deicing.

The operating costs rise rapidly with an increase in transmitter output, and consequently relatively low outputs are usually selected for radio links. *SUF-30* has a transmitter output of 20 W.

Operating Reliability

Good operating reliability is an essential condition for a radio link employed in power station operation. Apart from allowing a satisfactory margin for signal strength, good operating reliability calls for the use of amply dimensioned material of high quality and for careful maintenance.

In particular, the electron valves should be run below their normal working data in order to ensure the longest possible life for them. In addition, the equipment should be designed in such a way that any faults arising can be quickly repaired. It should be possible to measure currents, voltages and tone levels at different points in the installation in order to localize faults quickly and all components should be conveniently accessible for replacement.

Maintenance must not be restricted to the removal of faults. A routine inspection of the material should be carried out at regular intervals to enable valves, that are run down to be replaced before communications is detrimentally affected.

When a radio link *SUF-30* is used and regular inspections are undertaken, the number of annual interruptions in service due to faulty apparatus is very small.

Principal Data

A terminal equipment consists essentially of a frequency-modulated radio transmitter and receiver in the 160 Mc/s band, which transmits a low-frequency band, 300—7,500 cycles.

The frequencies between 300 and 3,000 cycles are adopted for the telephony channel. The latter can be connected to different types of telephone exchanges by means of a line equipment the construction of which is adapted to the prevailing requirements.

The frequencies above 3,000 cycles are employed for the transmission of pulses for remote control. These tone pulse channels are designed on the frequency shift principle. A maximum of six duplex channels can be transmitted. In addition, the radio link may be provided with a duplex tone channel for selective protection.

The installation also includes an aerial equipment and a filter for preventing the transmitter output from interfering with the reception.

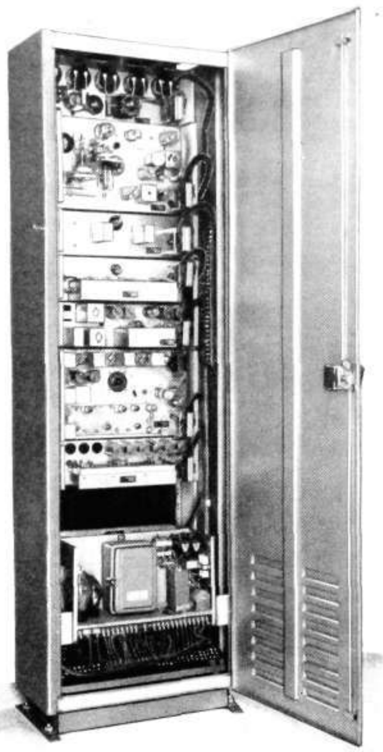


Fig. 2 X 4722
Radio link SUF-30
viewed from the back

Mechanical Construction

The equipment is divided into the following units: radio transmitter, radio receiver, line unit *A*, line unit *B*, selective protection unit, tone transmitter, tone receiver, power supply and measurement panel. These units are vertically rack-mounted in a sheet-metal cabinet. The undersides of the chassis face the front and are protected by detachable cover-plates. All valves are mounted on the upper sides of the chassis, and are therefore accessible through the back-door. On removal of the cover-plates, all components in the frame can be easily reached. The cover-plates are lacquered dark-blue, the remainder of the cabinet having a light-grey finish.

The Radio Transmitter

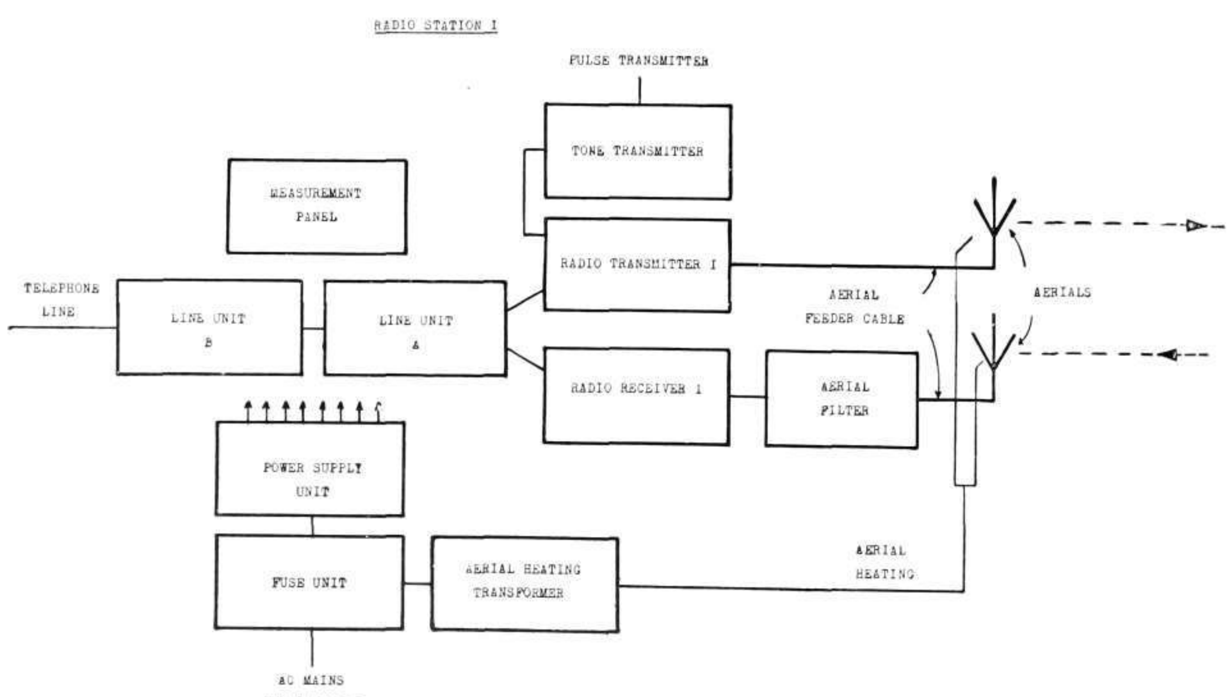
Frequency-modulated transmitters can operate on two different principles, either with direct frequency modulation or with phase modulation.

In direct frequency modulation the frequency is modulated by an oscillator with the help of a reactance valve or in some other manner, and thus receives the frequency-modulated voltage directly. Since the oscillator's mean frequency must remain constant, the oscillator is equipped with an automatic frequency controlling device.

In phase modulation, which is adopted in *SUF-30*, a crystal oscillator is used, thus enabling an accurate mean frequency to be obtained. With reactance valves the phase angle is modulated up to a maximum of $\pm$ ½ radian. The crystal oscillator works at a low frequency in *SUF-30*, namely 2.2—2.4 Mc/s, and the frequency is progressively increased 72 times in frequency multipliers. In this way the required frequency of about 160 Mc/s is obtained and at the same time a maximum phase modulation of $\pm$ 36 radians. Phase modulation of this kind may be shown to be equivalent to frequency modulation. If full equivalence is required, the phase modulator must be provided with an audio-frequency network which attenuates the high audio-frequencies so that the amplitude of the audio-frequency voltage applied to the phase modulator will be inversely proportional to the frequency.

In a phase-modulated transmitter it is extremely important that undesirable multiples of the oscillator's frequency should be suppressed. The transmitter's stages are therefore connected to one another through inductively coupled bandpass circuits with low losses.

Fig. 3 X 7600
Block diagram for radio link SUF-30



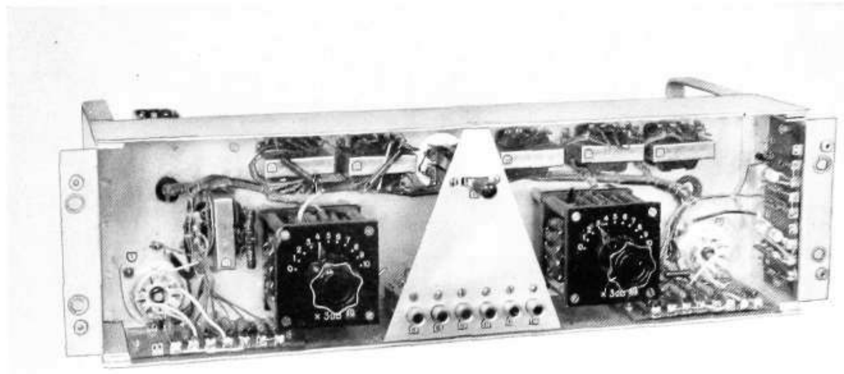


Fig. 4
Line unit A

X 6583

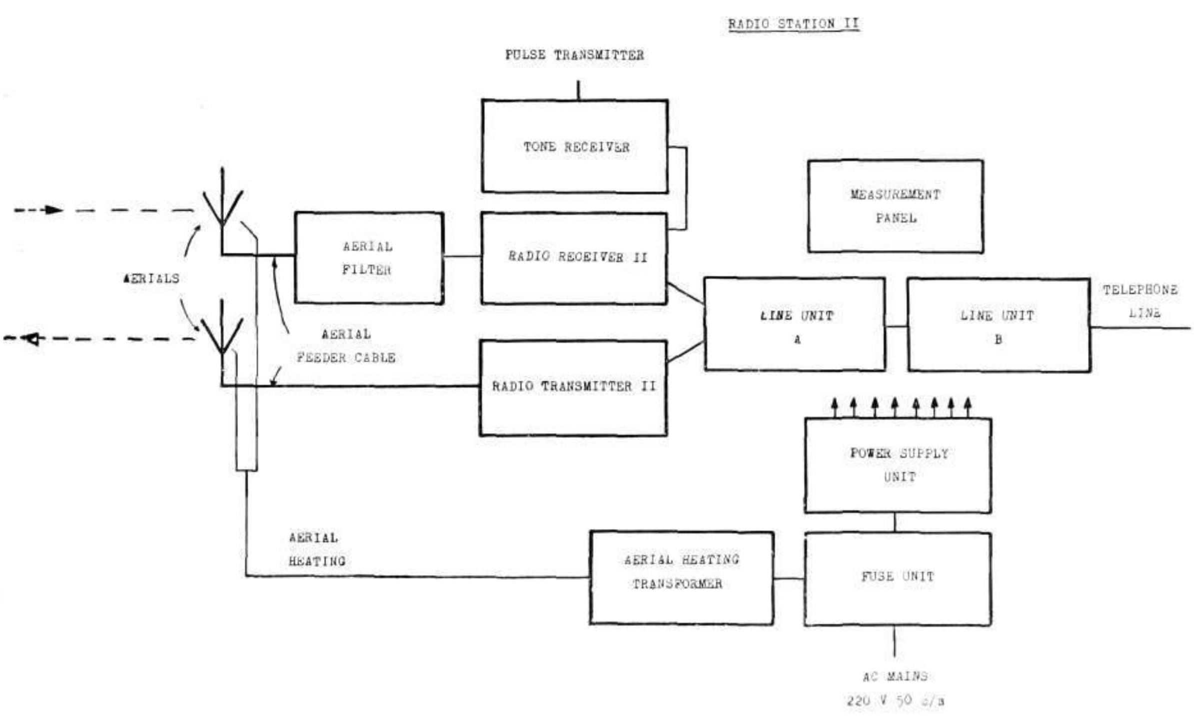
The Radio Receiver

The radio receiver is a superheterodyne set with double frequency conversion. The received signals are amplified in two high-frequency amplifier stages and then converted in a mixing valve to the first intermediate frequency, 11.8 Mc/s. The oscillator frequency which is higher than the signal frequency is obtained from a crystal oscillator with a frequency of 28—30 Mc/s. The crystal works on its third mechanical harmonic. The oscillator frequency is first multiplied three times and then twice, in two amplifier stages. The intermediate frequency, 11.8 Mc/s is amplified in an intermediate frequency stage and then mixed with the frequency from another oscillator having the frequency 8.4 Mc/s to produce the second intermediate frequency of 3.4 Mc/s. The second oscillator which is not crystal-controlled is influenced by a reactance valve controlled by the discriminator. In this way fine tuning is obtained automatically. The second intermediate frequency is amplified in three stages, the two last of which work as limiters.

Demodulation of the intermediate frequency takes place in a discriminator, whereupon the low-frequency voltage is amplified in two amplifier stages.

Line Units

Two line units are employed in the radio link. One of these, line unit *A*, Fig. 4, contains the elements which are independent of the nature of the telephone



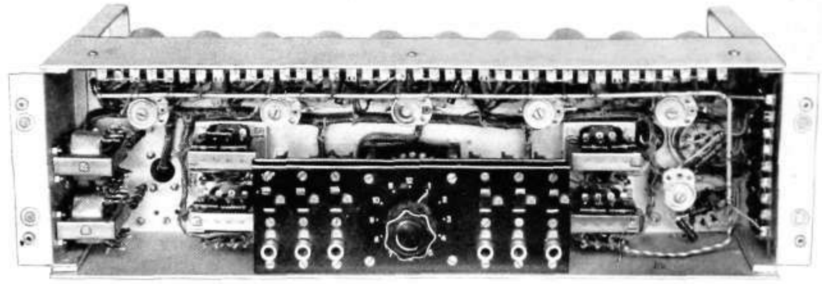


Fig. 5 X 6584
Tone transmitter for 6 tone channels

network, while the second, line unit *B*, adapts the radio connection to the telephone network and is therefore available in various forms.

Line unit *A* contains a voltage divider, attenuator for the transmission and reception levels and the filter which separates the speech channel from the tone channels. It also includes a tone transmitter and a tone receiver for 1 000 cycles for the transmission of call signals and finger dial pulses. The line unit *A* is designed in such a way that the two-wire connection usually employed can be divided up into a four-wire connection, which may be found advantageous in certain cases.

Line unit *B* is constructed in two main forms, *B 1* for connection to a local battery network and *B 3* for connection to a carrier frequency exchange, that is to say, the type of exchange which connects up the Swedish power undertaking's network to the carrier frequency system on the power lines. Line unit *B* is equipped with a handset so that when carrying out inspections, direct connection which is independent of the telephone network can be established over the radio link.

Tone Channel Equipment

The tone transmitter unit, Fig. 5, can be provided with tone oscillators for a maximum of 6 tone channels. Two valves are required for each channel, an oscillator valve and a reactance valve. The reactance valve is blocked by a negative voltage when the pulse contact is off, but receives a normal grid bias voltage when the contact closes. The frequency of the oscillator is then shifted 200 cycles. The tone transmitter unit has no relays. A tone is operated by earthing one conductor.

The tone receivers are divided into two units, each of which has three tone channels. A tone receiver consists of a band pass filter, a limiter valve, a discriminator and a relay valve in the anode circuit of which a polarized relay is placed. When the received tone frequency changes between its two values, the relay valve is blocked and opened, thus causing the polarized relay to alternate between its positions.

The tone channels utilize the frequencies 3700/3900, 4100/4300, 4500/4700, 4900/5100, 5300/5500 and 5700/5900 c/s.

The tone channels are employed for remote measurements, remote control and remote indication. The radio link may, however, also be included in a power line's selective protection. In such a case it is equipped with a special rapid response channel in both directions which operates with the frequencies 6500/7500 c/s. The operating time for this tone channel is approximately 5 milliseconds. The design of the tone channel equipment for selective protection is the same in principle as that for the normal tone channels, but the tone transmitter and receiver are combined in one unit. The tone receiver is provided with a fault indicating relay which disconnects the radio selective protection if the radio link develops a fault and thus causes the tone frequency to cease.

The Power Supply Unit

The power supply unit is connected to the AC mains. This unit delivers the following voltages: 6.3 V AC for valve heaters, 24 V negative DC for relay operation and grid bias voltage, 150 V for the anode voltage of all valves with the exception of the transmitter's power stage, and 300 V for the transmitter's power stage. Selenium rectifiers are used for the 24 V voltage and mercury rectifier tubes for the other voltages. The power supply unit is equipped with an auto-transformer with a manual voltage regulator so that adjustment can be made for the correct primary voltage. The installation functions with normal mains voltage fluctuations but when carrying out inspections it is advisable to adjust the set for the exact primary voltage by means of the regulator switch so that check measurements carried out in the installation from time to time can be compared.

The Measurement Panel

To enable the routine checking of the installation to be undertaken by an unskilled staff also and thus preclude the occurrence of faults as far as possible, extensive arrangements are provided for carrying out measurements.

The measurement panel is equipped with instruments for checking the primary voltage, the radio transmitter and receiver, and an instrument which is common to the other units. By means of change-over switches on the respective units these instruments can be connected up to a large number of different measuring points. A valve voltmeter is provided for measuring the tone frequency voltages, which can be connected by a cord plug to various points in the installation.

With the help of these instruments it is possible to examine all the valves and measure all voltages of interest. The number of measurements is certainly considerable, but if a definite normal plan is adopted, the work can be carried out quickly. A routine check of this kind may suitably be undertaken once or twice each month.

Technical Data

Frequency range: 156—174 Mc/s

Transmitter: frequency tolerance ± 0.005 %
power 20 W
frequency deviation for speech channel max. 10 kc/s
» » for tone channel 2—5 kc/s
» » for tone channel, for selective protection appr. 5 kc/s

Receiver: sensitivity 1 μV at 20 dB noise reduction

Transmitted tone frequency band: 300—7.500 c/s

AC mains: voltage 220 V, 50 c/s
power consumption 350 W

Valves:

Radio transmitter	3 EF 50, 4 6V6GT, 1 807, 2 829 B, 1 6AL5
Radio receiver	8 EF 50, 1 6V6GT, 6 6AK5, 1 7A6, 1 2050
Line unit A	2 6J6
Line unit B	1 6J6
Tone transmitter	2—12 EF 50 } depending upon the number of tone channels
Tone receiver A	3—7 EF 50 } depending upon the number of tone channels
Tone receiver B	2—6 EF 50 } depending upon the number of tone channels
Tone unit for selective protection	4 EF 50, 1 6V6GT
Power supply unit	2 816 2 866 A
Measurement panel	1 EF 50

Dimensions: width 600 mm
height 1910 mm
depth 320 mm

New Wires for Subscribers' Lines

N SIDENMARK, N ERIKSSON & G WILLSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.315.3

Subscribers' lines in an urban telephone network were originally built of uninsulated bronze wire lines, known as open wire lines, insofar as the external part of the installation is concerned. Subsequently, the self-supporting lead covered cable *EDBS* was employed on a large scale, and now it is in turn replaced by a self-supporting rubber insulated and neoprene jacketed wire *EVVS*, or by a self-supporting wire with polythene insulation *ELXS*. With regard to the indoor installation for subscribers' lines, the lead covered single pair cable *EDBA* formerly employed has now been replaced almost entirely by the PVC insulated wire *EKUA*.

The present article describes the general properties of the new types of wires and the methods of installing them.

General Properties

The table on page 52 contains a general summary of technical data relating to the new types of wires. Apart from the particulars given in the table, the most important properties of the insulating materials employed for the different types of wires are briefly described here.

I. PVC and Polythene Insulated Wires

PVC as this term is used here, means plasticized polyvinyl chloride, i.e., a compound of polyvinyl chloride resin, plasticizer and certain other ingredients. The properties of PVC can be varied within relatively wide limits, primarily by changing the nature and quantity of the plasticizer. The particulars that follow refer to the PVC quality employed in L M Ericsson Cable Works in the manufacture of the PVC wires here in question.

Polythene, as well as PVC, is a thermoplastic material. It is chiefly characterized by its excellent dielectric properties, and for this reason it is employed first and foremost for high frequency cables. This thermoplastic substance is also referred to in the literature as polyethylene, and often the brand name Alkathene is used.

Mechanical Properties

PVC has a smooth, relatively hard surface and its tensile strength, elasticity, resistance to abrasion, tearing strength and resistance to damage by cutting are very high. The mechanical properties of polythene are not quite as good as those of PVC. Its elasticity, resistance to abrasion and damage by cutting in particular are somewhat lower. On the other hand, its resistance to indentation by blunt objects is at least equal that of PVC.

Aging Resistance

The PVC compounds now used for the insulation of wires are practically unaffected by aging even in tropical climates, this result having been obtained by the suitable selection of the plasticizing and stabilizing agents. Uncoloured or lightly coloured compounds that have been exposed for a long period to the ultraviolet radiation of sunlight may, however, exhibit a tendency to surface cracking. Effective protection against this is obtained with an admixture of carbon black.

When used indoors polythene is practically not affected by aging, even at high temperatures. Outdoors unpigmented polythene is affected by the ultraviolet rays of the sunlight to a greater extent than PVC, and exhibits a tendency to cracking after a longer or shorter time. Effective protection is also obtained for polythene by the inclusion of an adequate quantity of carbon black of suitable quality. Thus, a weather-resistant polythene compound for use outdoors can only be produced in *black* colour, but this black quality has an excellent aging resistance.

Resistance to Chemicals, Solvents, Oils, etc.

PVC is highly resistant to acids, alkalies, most oils and engine fuels as well as a large number of solvents.

Many solvents and hot oils dissolve the plasticizing agent, however, whereupon the PVC-material becomes harder without losing its good electrical properties.

Polythene possesses a still higher resistance to chemicals of all kinds and at room temperature it is insoluble in all solvents. Various substances are absorbed in such large amounts, however, that the dielectric properties deteriorate appreciably.

Inflammability

When a PVC insulated wire is ignited at one point, the fire does not spread along the conductor, which is the case, however, with a polythene insulated wire, unless some outer covering is provided which gives adequate protection in this respect.

Behaviour at Low Temperatures

At room temperature and above PVC is very flexible, but it stiffens with falling temperature and under conditions of severe cold the PVC insulation cracks when a PVC insulated wire is subjected to sharp bending or impact. The Swedish Standards issued by SEMKO (The Swedish Society of Testing Electrical Materials) prescribe that a PVC wire, at a temperature of —25° C, shall withstand winding round a mandrel the diameter of which is five times the overall diameter of the insulated wire without causing the insulation to crack. The PVC wires referred to in this article and manufactured in L M Ericsson Cable Works can withstand such a test at — 35° C.

Polythene also stiffens with falling temperature, although not as rapidly as PVC. Polythene wires can pass the binding test referred to above when this is made with a mandrel diameter equal to twice the external diameter of the wire and at —40° C (the lowest testing temperature normally applied). Repeated cooling has no effect on the properties at room temperature of either PVC or polythene insulation, and the original properties are regained on returning to higher temperatures.

Behaviour at High Temperatures

Owing to the thermoplastic nature of PVC insulation, PVC wires should not be employed in installations in which the temperature exceeds 70° C unless the PVC insulation is protected by an outer covering capable of resisting the higher temperature.

In installations with a working temperature above 70° C the wiring must be done with special care and the wires installed in such a manner that they are not subjected to constant high pressure and in particular, are not stretched over sharp edges or the like. If the PVC insulated wire is laid free in the air or without any appreciable pressure against other objects, the PVC insulation is capable of withstanding temperatures above 100° C for short periods.

Polythene melts at about 110° C and is consequently fluid above this temperature, although it is very viscous. A normal working temperature of 70° C is permissible if the same precautions are observed as with PVC wires, and heating for a short time up to 90°—100° C will cause no damage provided that the insulation is not simultaneously subjected to any pressure.

Electrical Properties

The following table gives the electrical data at different temperatures for standard insulating compounds of PVC and polythene and for the types of wires referred to in the present article.

Insulation:	PVC				Black Polythene
Temperature °C	15°	25°	50°	70°	15°—70°
Insulation resistance, megohms · km	1000	400	30	3	>10,000
Dielectric constant at 1 kc/s	5.2	5.8	7.7	8.2	2.7—2.6
Dissipation factor at 1 kc/s tg δ	0.13	0.13	0.10	0.06	0.0005—0.001
Dielectric strength, kV/mm 50 c/s, 1 minute test	30	30	30	30	25

As may be seen, the insulation resistance of PVC insulation varies widely with the *temperature,* whereas the other PVC properties are less sensitive to temperature. The data for polythene insulation are practically constant throughout the given temperature range.

The PVC values also vary with the *frequency:* at 25° C and 1 Mc/s the dielectric constant is 3.3 and the dissipation factor 0.10 for the compound the data of which are given at 1 kc/s in the table above. The electrical properties of polythene are independent of the frequency up to 100 Mc/s.

The electrical properties of PVC wires decrease only slightly after *immersion in water* for a long time. For polythene wires immersion in water is not accompanied by any measurable changes in the electrical data.

Summary

The comparison above between PVC and polythene insulated wires shows that the *black* polythene quality used for the self-supporting drop wire ELXS in comparison with PVC has the following properties:

1. superior dielectric properties practically independent of temperature and frequency, (the dielectric strength, however, is a little lower then for PVC),
2. superior properties at low temperatures,
3. higher resistance against chemicals,
4. the same good aging resistance,
5. the same resistance against mechanical strains normal for these types of self-supporting drop wire.
6. Furthermore, it can be mentioned that the density of polythene is 0.92 and that of PVC 1.33, i.e., polythene is lighter than PVC.

II. Neoprene-covered Wires

The synthetic rubber neoprene (also known as chloroprene) is employed in particular as a covering for wires used outdoors. It consists of the neoprene polymer, a carbon black of suitable quality and certain other additions so balanced that a compound with suitable properties is obtained.

Resistance to Weather and Aging

Neoprene is almost completely weather resistant and is not affected by rain, sunlight or atmospheric ozone. The resistance to aging is excellent, being appreciably superior to that of natural rubber. Wire coverings of neoprene have been able to pass a 10-year practical test under severe tropical conditions with excellent results, whereas corresponding outer coverings of natural rubber have failed after a much shorter period.

Behaviour at High and Low Temperatures

Neoprene can also withstand relatively high temperatures, 100° C for a considerable time and up to 150° C for shorter periods. The flexibility is retained at low temperatures down to —40° C and lower.

Mechanical Properties

The neoprene compound employed for the outer covering of the wires types *EVVS* and *EVVK* referred to in the table on page 52 has a high resistance to tearing and abrasion and therefore gives excellent protection against mechanical stresses. This is obviously of the greatest importance for the self-supporting type EVVS which must be capable of withstanding abrasion against tree branches and the like, in addition to the stresses to which it is subjected in the suspension clamps.

Inflammability

Contrary to natural rubber, neoprene is practically noninflammable and therefore a neoprene covering considerably improves the flame resistance of the wire.

Resistance to Oils, etc.

Neoprene differs from natural rubber in as much as it has a high resistance to oils and the like, an important factor for types of wire that come into direct contact with such substances.

Installation

For the construction of subscribers' lines with the new types of wires here in question a main distinction may be drawn between five different methods of installation which are illustrated diagrammatically in Fig. 1. A subscriber's line is reckoned from the cable terminal box terminating the secondary cable at the distribution point up to the subscriber's station. The line will either consist of indoor wires only or both indoor and outdoor wires. To this must be added the cross-connection in the cable cabinets and distribution boxes of the external plant. The manner in which different methods of installation are carried out is briefly described below for each particular case.

I. Indoor: PVC wire

In business and residential buildings with many apartments the secondary cables are now laid indoors in staircases, corridors or the like wherever possible and are terminated in distribution boxes which are also located indoors. In such cases, therefore, the subscriber's line consists exclusively of indoor wires with surface or flush wiring.

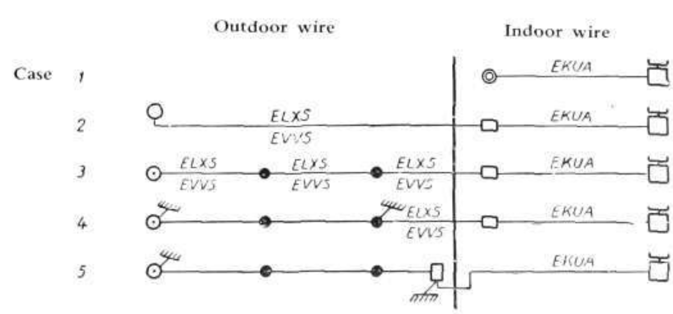


Fig. 1 X 6585 X 9118

Various methods for installing subscribers' lines

Case 1 Indoor: PVC wire

Case 2 Outdoor: polythene or neoprene wire along walls
Indoor: PVC wire

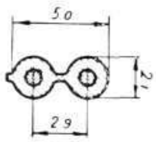
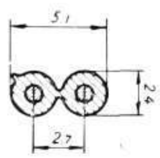
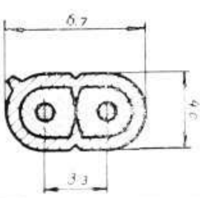
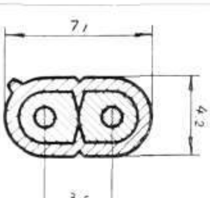
Case 3 Outdoor: self-supporting polythene or neoprene drop wire
Indoor: PVC wire

Case 4 Outdoor: open wire line and self-supporting polythene or neoprene drop wire
Indoor: PVC wire

Case 5 Outdoor: open wire line
Indoor: PVC wire

- Indoor wall distribution box
- Outdoor wall distribution box
- Pole
- Distribution pole with cable terminal box
- Distribution pole with protector terminal box
- Pole with subscriber's protector
- Sectional connecting block NEN 5211
- Telephone instrument
- Outdoor subscriber's protector

Technical Data for the Wires

Cross-section	Name	Type designation	Conductor diam. (mm)	Net weight per 1000 m of wire (kg)	Total tensile strength per conductor (kg)	Construction		Electrical data per 1000 m at 20° C: Conductor resistance of a single conductor (ohms)	Insulation resistance after 24 h in water (megohms)	Mean mutual capacitance at open suspension (microfarad)	Mean attenuation at 800 c/s at open suspension (neper)
	PVC insulated parallel wire	EKUA	0.7	16	9	Solid copper conductor	Two parallel conductors insulated with PVC of 0.7 mm thickness in one operation. A thin PVC middle between the insulated conductors makes it easy to separate the wire into two insulated conductors without damaging the insulation. A ridge is moulded longitudinally in the insulation of one conductor for identification. Colour: ivory	46	100	0.04	0.11
	Self-supporting polythene insulated parallel drop wire	ELXS	0.8	17	20	Solid hard-drawn copper conductor	Two parallel conductors insulated with polythene of 0.8 mm thickness in one operation. A thin polythene middle between the insulated conductors makes it easy to separate the wire into two insulated conductors without damaging the insulation. A ridge is moulded longitudinally it the insulation of one conductor for indentification. Colour: black	36	10,000	0.03	0.07
	Self-supporting rubber insulated neoprene jacketed parallel drop wire	EVVS	0.8	44	35	Solid tinned bronze conductor	Each conductor insulated with vulcanized rubber of 0.8 mm thickness. Two insulated conductors laid parallel are covered with a black neoprene jacket of 0.8 mm thickness firmly vulcanized to the rubber insulation. By cutting through at traces on the flat sides of the wire it can be separated easily into two insulated conductors. A moulded ridge at one side of the jacket is applied for conductor identification. Colour: black	65	250	0.07	0.15
		EVVS	1.0	53	50			42	250	0.12	0.16
	PVC insulated connecting or jumper wire	EK	0.7	6.7	9	Solid tinned annealed copper conductor	The conductor insulated with PVC of 0.6 mm thickness Colour: black	46	100	—	—
	Rubber insulated neoprene jacketed connecting or jumper wire	EVVX	0.7	12	9	Solid tinned annealed copper conductor	The conductor insulated with vulcanized rubber of 0.5 mm thickness and covered with a black neoprene jacket firmly vulcanized to the rubber insulation. Colour: black	46	250	—	—

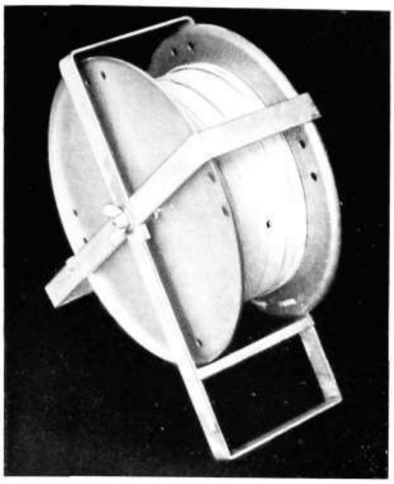


Fig. 2 X 4729

Wire drum LVE 1011

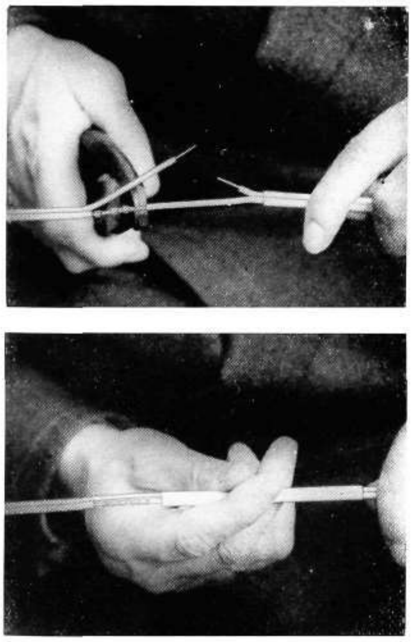


Fig. 3 X 6587

Splicing PVC wire with a joint sleeve NTA 1401

Above: the joint sleeve is pressed together with jointing pliers LSD 3411; below: the PVC tubing is pushed back over the joint.

Surface Wiring

The lead covered, single pair cable *EDBA* 2 × 0.7 mm was previously used for this purpose. At the present day this type has been replaced by the PVC insulated wire *EKUA* 2 × 0.7 mm. Compared with the EDBA cable, the PVC wire is lighter and far more flexible and easier to install.

In Ericsson Review No. 3, 1948, the general properties of the PVC wires and the most suitable methods for installing them have already been described. For completeness, however, a summary description of the methods of installation is included here.

Attaching

For surface wiring of EKUA wire either enamelled nails or special clamps and steel nails are used.

The enamelled nails are available in two sizes, *NSV 1901*, 1/2" × 1.4 mm, and *NSV 1903*, 3/4" × 1.5 mm of which the latter is intended for use on walls constructed of very loose material. The installation is effected by driving the nail through the PVC strip which holds the two insulated conductors together. The nail must first be pushed through the PVC strip by hand before nailing to the wall etc. In corners the wire must be twisted a half-turn.

The most reliable manner of attaching the PVC wire, however, is to use clamps and this method is recommended to be used in damp premises or moist climates. The clamp designation is *NSV 3705*. This clamp is so constructed that it completely encloses the wire and is also provided with two flanges which prevent the nails being driven in too hard. Before fitting, the clamp is open so that it can be put on the wire, after which it can be easily pressed together by hand before nailing. Nailing is done with steel nails which are available in three sizes, *NSV 1401—NSV 1404*. The clamp may also be used for twisted PVC wires.

As mentioned earlier in this article, owing to the thermoplastic properties of the PVC insulation precautions must be taken when installing PVC wires. The wires must not be installed in such a way that they are exposed to excessively high temperature (as, for example, in the immediate vicinity of hot water pipes, heating elements, etc.) or subjected to constant high pressure (as when stretched over sharp edges). Where necessary, in passing through holes in walls for example, a PVC joint sleeve, *NDE 1163*, may be slipped over the PVC wire as a protection.

Finally, when installing EKUA (as the conductors are laid up parallel) care must be taken where a number of wires are wired close to each other on longer stretches than 20 m, each wire must be twisted half a turn (the *a*- and *b*-branches of the wire change places) in order to eliminate the risk of disturbing cross-talk when telephoning.

The EKUA wire is delivered in coils of 200 m. Every installation gang should be supplied with a drum *LVE 1011* specially designed for the purpose, on which the coil can be conveniently fitted. The drum is constructed with slightly tapered wooden barrel, Fig. 2, and has two handles which also serve as supports when the drum is placed on the floor. When unreeling the wire the drum can be adequately braked by tightening a wing nut on the axle.

Splicing

The EKUA wire is spliced as shown in Fig. 3. The insulation is stripped away and the conductors are twisted together. Over the two splices a PVC tubing is then pushed, the cross section of which fits the PVC wire. The PVC sleeves can either be supplied in cut lengths of 100 mm, joint sleeve *NDE 1113*, suitable for the joint or in coils of 20 m, which the operators themselves cut to the necessary lengths.

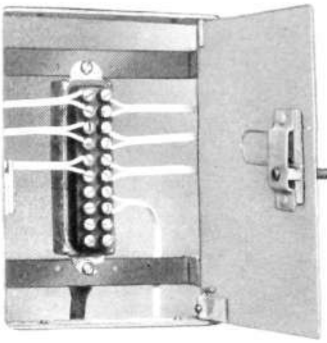


Fig. 4 X 4730

Connection of PVC wires (EKUA) to a flush-mounted distribution box

Instead of twisting the conductors they may be spliced with copper splicing sleeves *NTA 1401*. The splicing sleeve is pressed together with jointing pliers *LSD 3411*, as shown in Fig. 3.

Connection to a Cable Terminal Box and Cross-connection in a Cable Cabinet

Connection of the PVC wire to a cable terminal box, which in this case is *NCD 8003*, is carried out without any special leading-in bushing.

For cross-connection in a cable cabinet PVC insulated jumper wire *EK* 1 × 0.7 mm is employed.

Flush Wiring

When installing telephone lines (both secondary cables and subscribers' lines) indoors, the general tendency at the present day, however, is to place the conductors in a special conduit system which is flush-mounted in the flooring and walls. In a large building a conduit system of this kind consists of a number of vertical risers (wall slots or conduit tubes) through which the incoming secondary cables are drawn to the distribution boxes which are flush-mounted in the walls on the different floors.

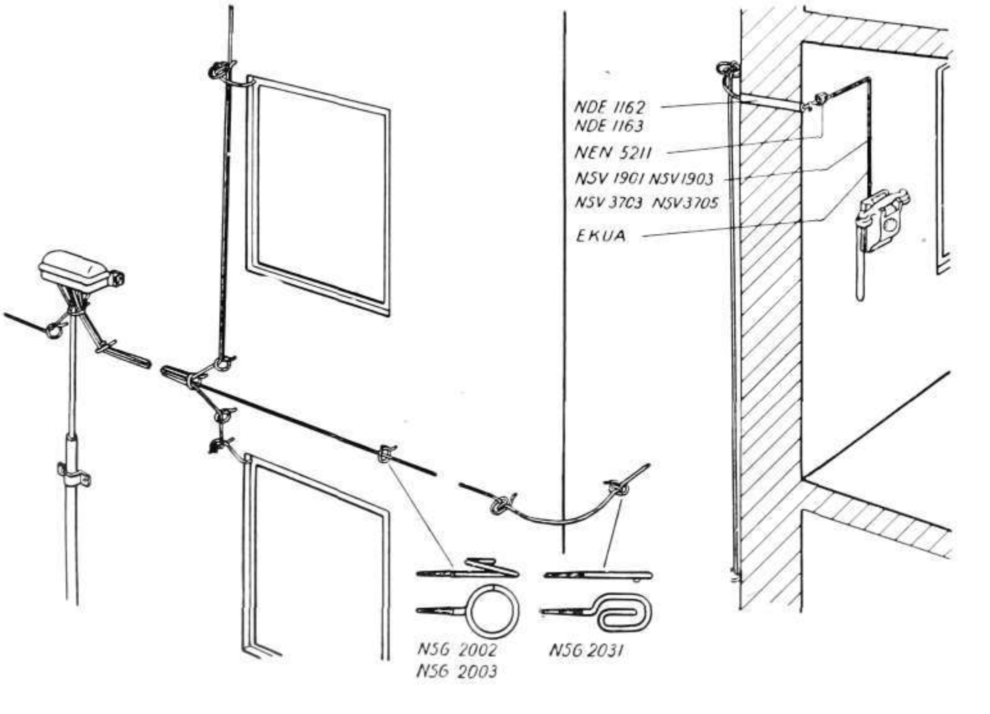
From the distribution boxes the subscribers' lines are then drawn to the instrument locations, either in the form of surface wiring or wiring in flush-mounted 1/2" conduits which usually consist of iron tubing coated on the inside with a layer of asphalted paper. In Sweden lead coated insulating tubing is employed. For subscriber's line drawn in conduit, lead sheathed single pair cable EDBA was previously used. This cable is now replaced by the PVC wire EKUA. PVC wires in general are particularly suitable for drawing in conduit as the PVC insulation has a smooth and hard surface, and its tensile strength and resistance to abrasion, tearing and damage by cutting are very high. The wires are drawn in the tubing in the usual manner and connection to the distribution boxes is also done as usual, see Fig. 4.

II. Outdoor: Polythene or Neoprene Wire along Walls Indoor: PVC wire

Outdoor wiring on walls is chiefly adopted in quarters where the houses, each containing a few flats, are built adjoining one another. The secondary cables then terminate in outdoor wall distribution boxes. In this case the subscribers'

Fig. 5 X 7592

The bridle ring system



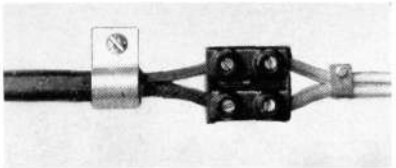


Fig. 6 X 4724

Indoor connection of outdoor wire EVVS to indoor wire EKUA on a sectional connecting block NEN 5211

lines consist of indoor and outdoor wires. In buildings of this kind with a small number of flats surface wiring to the indoor wires is most common and thus the particulars given under section I apply to the indoor installation.

Two different forms of installation are employed for the outdoor wiring which in turn are dependent upon the manner in which the secondary cables have been laid.

The Bridle Ring System

In this case the secondary cables are fastened to the walls by means of clamps.

Lead covered single pair cables EDBA were formerly employed for the subscribers' lines and were fastened to the outdoor walls in the same way as the secondary cables. This form of installation proved expensive in many instances however. In place of it either *ELXS 2* × *0.8* mm, a self-supporting polythene insulated parallel wire with hard drawn copper conductors, or *EVVS 2* × *0.8* mm, a self-supporting rubber insulated and neoprene jacketed parallel wire with bronze conductors, are used nowadays. With these wires a form of installation can be employed which is cheaper than attaching with clamps.

Installation is carried out as shown in Fig. 5. Bridle rings *NSG 2002* or *NSG 2003* are mounted along the façade of the building, preferably at a distance of 3 m from the ground and 3 m apart. For vertical runs this distance may be doubled. Bridle rings *NSG 2002* can take up to 10 neoprene wires *EVVS* and therefore this size generally meets the requirements. For a larger number of wires *NSG 2003*, which provides space for more than 20 neoprene wires, is employed.

At points where a slight locking is required a new patented type of clamping bridle ring with a locking device *NSG 2031* is mounted, see Fig. 5. This is necessary, for instance, at the leading-in holes for indoor wires and at the corners of a house.

The wires are laid in the rings without special straining. In order to prevent cross-talk, the wires must be given a certain twist so that the two conductors of the wire change places in relation to the other lines over the same distance. This twisting can be effected most conveniently by turning the wire continuously in the same direction, that is to say, with the same hand, while it is being drawn from the coil. At corners and leading-in holes in walls friction tape may be wound round the wire to protect it against abrasion.

Inside the house the outdoor wires are connected to the indoor wires on a sectional connecting block *NEN 5211* as shown in Fig. 6. The connecting block is placed as close as possible to the leading-in point for the outdoor wires. Between the leading-in point and the connecting block polythene wires ELXS are fastened by means of clamps *NSV 3705* and steel nails *NSV 1401—NSV 1404* in the same way as EKUA. For the same purpose cable staples *NSV 2007* are used for neoprene wire EVVS.

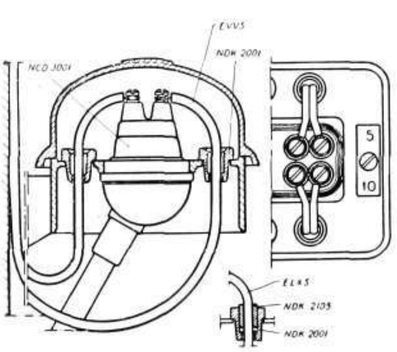


Fig. 7 X 4725

Connection of ELXS or EVVS to an outdoor distribution box

The connecting of outdoor wires to wall distribution boxes is carried out as illustrated in Fig. 7. Where the outdoor wire consists of the polythene insulated type ELXS, the latter is led through a rubber cushion *NDK 2105*. On the other hand, this bushing is not used for connecting neoprene wire EVVS. Cross-connection in the cable cabinet is done in the usual manner with PVC insulated wire EK 1 × 0.7 mm.

The jointing of ELXS or EVVS should be avoided as far as possible outdoors, as no entirely reliable method for such splicing is available at present. The lengths of wire which are too short for use should therefore be collected for splicing in the stores.

Where it is essential to make a joint outdoors, however, a method is described here which appears to be quite satisfactory from a laboratory point of view, although little experience has been gained with it hitherto in practice. This method is illustrated diagrammatically in Fig. 8. As may be seen, the wires are

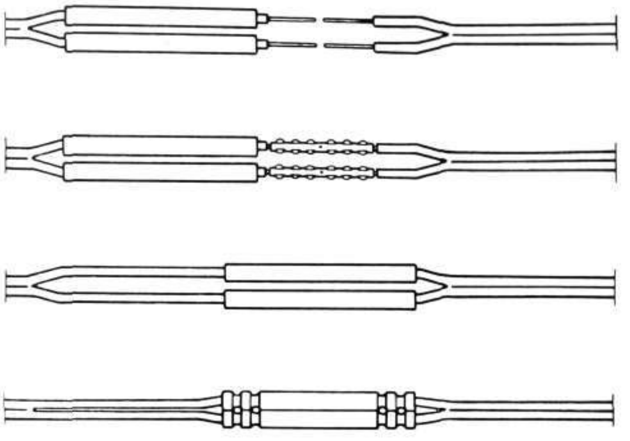


Fig. 8 X 6589

Jointing polythene wire ELXS and neoprene wire EVVS with splicing copper sleeves, PVC outer tubes and protective copper sleeves

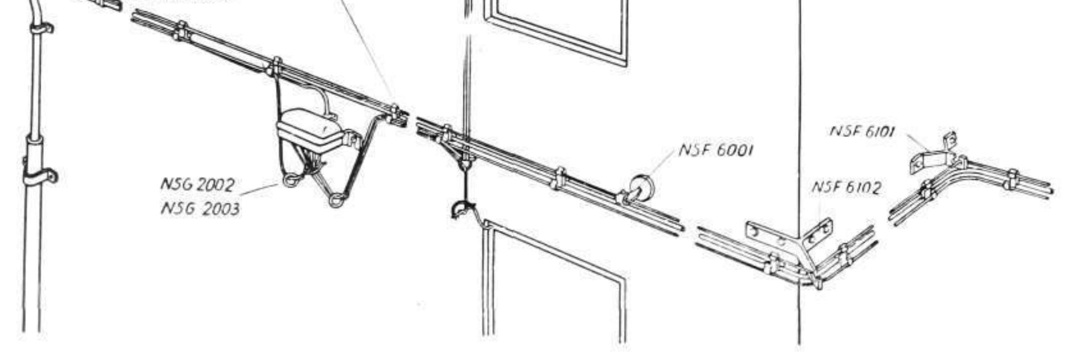
first spliced together with splicing sleeves of copper which are pressed together with jointing pliers *LSD 3411* in the usual manner. A PVC tubing and over this a protective copper sleeve are then pushed over each joint. The protective sleeves, like the splicing sleeves, consist of a thin copper tube but are in comparison to the joint sleeves fitted inside with a layer of insulating material. The PVC tubings and the protective sleeves extend beyond the conductor insulation slightly on both sides of the joints. The protective sleeves are pressed together at both ends with special jointing pliers, whereupon the conductor insulation and the PVC tubing inside the protective sleeve are pressed together to form a completely tight seal at each end of the protective sleeve. Owing to the internal layer of insulation and the PVC tubing, the conductors are thus completely insulated from the outer protective sleeves. Thus, it is not necessary to stagger the joints on the two conductors and they can be located side by side, which is an advantage inasmuch as the total length of the joints will be shorter and the wire can therefore be separated in two parts over a relatively short length. In addition to obtaining a completely tight and reliable joint in this way, the advantage is also gained that the conductor insulation is held together on both sides of the joint so that it cannot shrink in either direction. If further practical jointing tests also yield entirely satisfactory results, the firm will place these protective sleeves on the market shortly. Patents have been applied for both on the method of jointing and on the protective sleeve.

The Suspension Wire System

In this method of installation the secondary cables are laid outdoors along the façade of the building with the help of open cable suspenders *NSH 1202* of stainless steel tape under a galvanized suspension steel wire *NRA 3001*, Fig. 9.

Fig. 9 X 7593

The suspension wire system



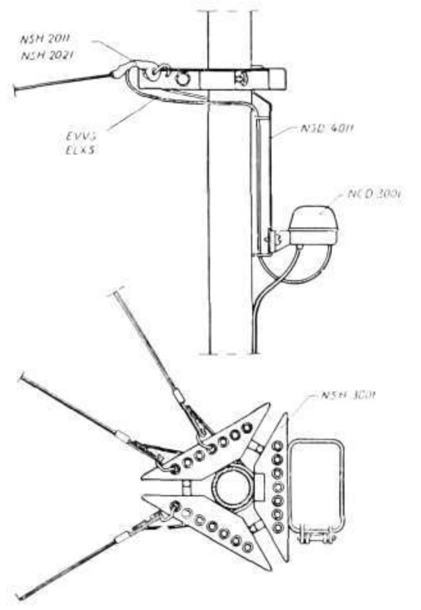


Fig. 10 X 4726

Pole distribution bracket type NSH 30 with cable terminal box type NCD 30 and outgoing self-supporting drop wires ELXS or EVVS

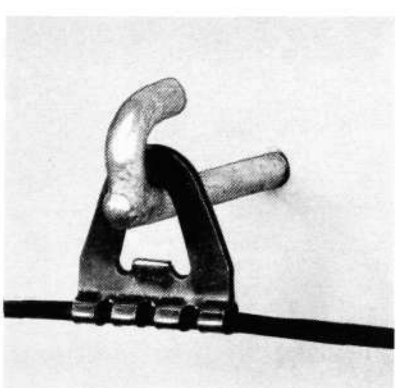


Fig. 11 X 4731

Drop wire clip NSH 1301 suspended by a drive hook NSV 7301

The cable suspenders NSH 1202 differ from ordinary overhead cable suspenders chiefly in the fact that they form two open rings or channels into which the wires cannot only be drawn but also laid. They are particularly suitable, therefore, for supporting small bunches of cables or wires for surface wiring on walls. The suspension wire *NRA 3001* is strained and supported at suitable points on the wall by galvanized steel brackets and hooks, see Fig. 9. The suspension wire is located at a distance of 7.5 cm from the wall. The suspenders are so constructed that they are rigidly attached to the suspension wire, where the cable can slide in them. The secondary cables are always laid in the channel of these suspenders, which lies nearest to the wall.

Lead covered single pair cable EDBA was also used previously for the subscribers' lines for this kind of installation; it has now been replaced by polythene wire ELXS 2 × 0.8 mm or neoprene wire EVVS 2 × 0.8 mm. In this case, on the spans over which the suspension wire is stretched, the wires ELXS and EVVS are laid beside the secondary cable in the open double cable suspenders NSH 1202, but in the outer channel.

The suspension wire may extend both in a horizontal and vertical direction. On spans over which the subscribers' lines are to be drawn but not the secondary cables, no suspension wire is installed but the subscribers' lines are then installed with the help of bridle rings in the same manner as that described under the bridle ring system. Bridle rings are also used at the leading-in points for indoor wires.

The same particulars apply to splicing, connection to indoor conductors and connection to wall distribution boxes as those prescribed for the bridle ring system.

III. Outdoor: Self-supporting Polythene or Neoprene Drop Wire
Indoor: PVC wire

This method of installation is adopted in villa districts particularly, where open wire or self-supporting lead covered cables EDBS were previously employed for the subscribers' lines.

In this case the secondary cables terminate in distribution boxes normally arranged for 10 pairs, which are usually located on poles. The cable terminal boxes used are the types *NCD 3001* or *NCD 3201* for example. Since the subscribers' lines are insulated over their whole length from the spreading points to the subscribers' instrument, and the risk of atmospheric excess voltages as well as of contact with lighting cables in this case is considered as minimal the distribution boxes are not provided with fuses.

The spreading points are arranged with the help of a pole distribution bracket *NSH 3001—NSH 3004* as shown in Fig. 10. The cable terminal boxes *NCD 3001* and *NCD 3201* are installed under the distribution bracket on a bracket *NSD 4011* which is clamped between one steel angle of the distribution bracket and the pole. The secondary cable is connected to the distribution box in the usual manner. The self-supporting subscribers' lines are suspended by means of a clamp *NSH 2021* for polythene wire ELXS and *NSH 2011* for neoprene wire EVVS, se Fig. 10. These clamps which are of an entirely new and patented design differ from the clamps previously employed for the self-supporting lead covered cable EDBS in the fact that the wire is led twice over the same resting surface thereby locking itself. With this arrangement the locking of the wire end coming from the span is more effective and the advantage is also gained that the drop end of the wire is more effectively locked than was the case with the earlier clamp. From the clamps the subscribers' lines are led down behind the bracket *NSD 4011* to the sealing thim-

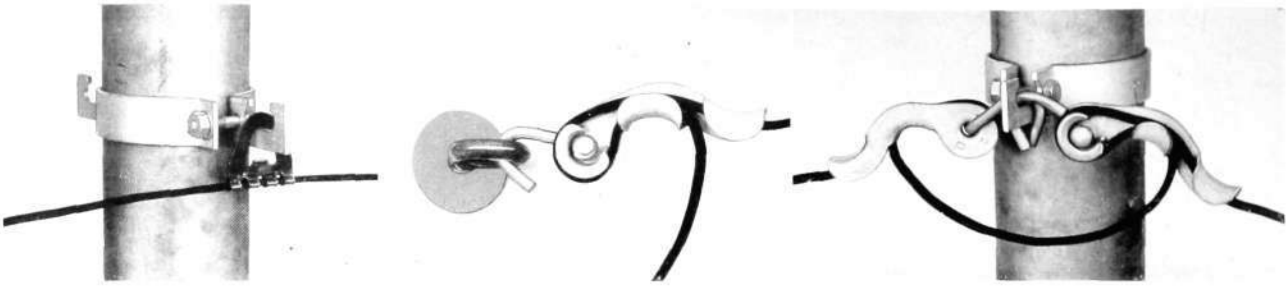


Fig. 12 X 7594

Different methods of suspension

Left: drop wire clip NSH 1301 on drop wire support NSG 3001. Centre: clamp NSH 2011 in eye bolt NSV 7001. Right: NSH 2011 on drop wire support NSG 3001.

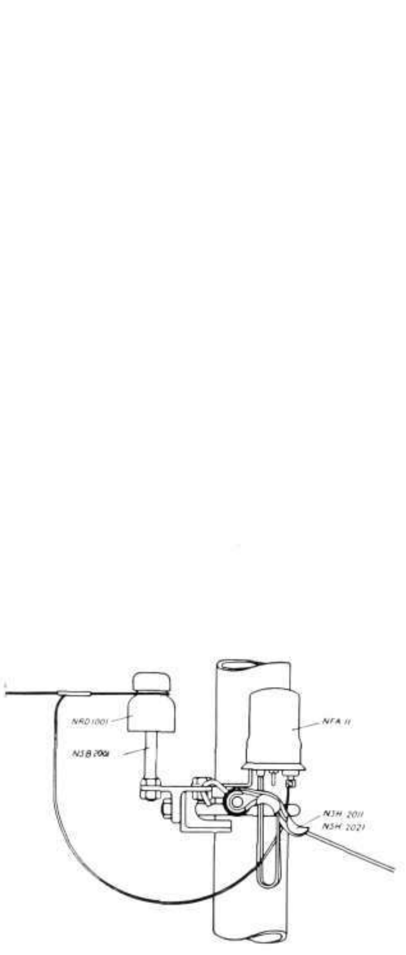


Fig. 13 X 4727

Connection of open wire to self-supporting drop wires ELXS or EVVS at an outdoor subscriber's protector NFA 11

bles of the cable terminal box. For polythene wire a rubber cushion *NDK 2105* is placed in the sealing thimble, whereas neoprene wire EVVS is connected directly, see Fig. 7.

The self-supporting subscribers' lines are then either led via a number of poles, or directly, to the fixing point on the wall of the building at which the leading-in hole for the indoor conductors is located. The self-supporting drop wires are attached to the poles in the manner illustrated in Figs 11 and 12. On straight runs or slight bends drop wire clips *NSH 1301* are employed for this purpose, and are suitable both for polythene wire ELXS and neoprene wire EVVS. The clips are pressed together round the drop wires by means of ordinary drawing pliers. The drop wire clips *NSH 1301* are suspended on wooden poles by drive hooks *NSV 7301* and *NSV 7302*, Fig. 11, and on steel tubular poles by drop wire supports *NSG 3001—NSG 3004*, Fig. 12, left. For sharper bends a locking must be provided in both directions of the wire. For this purpose the clamp *NSH 2021* is used for polythene wire ELXS and *NSH 2011* for neoprene wire EVVS, Fig. 12, right. On wooden poles the clamps are fixed in eye bolts *NSV 7000*, Fig. 12, centre, and on steel tubular poles by drop wire supports *NSG 3001—NSG 3004*, Fig. 12, right.

For attaching the clamps *NSH 2021* or *NSH 2011* to chimneys, a chimney bracket *NSH 4501* is used which is fixed in the usual manner by means of two eye bolts *NSV 7101*, three corner guards *NSC 4001* and a 3—4 mm galvanized iron wire. At the fixing point on the wall of the building at which the leading-in hole to the indoor conductor is to be located the wires are fixed in an analogous manner by a clamp *NSH 2021* or *NSH 2011* which is suspended in an eye bolt *NSV 7001*, see Fig. 12, centre. The wires are drawn through the wall and connected to the indoor wire EKUA on a sectional connecting block *NEN 5211* as described earlier under section II, Fig. 6.

With regard to the suspension of the wires the following minimum values may be adopted for the sag. The figures correspond to the net weight of the wire without any additional load and a suspension force equal to one quarter of the tensile strength of the wire, which generally allows an adequate margin of safety for wind and ice loading.

Minimum Sag

	50 m span	70 m span
Polythene wire ELXS 2 × 0.8 mm hard drawn copper	0.5	1.0 m
Neoprene wire EVVS 2 × 0.8 mm bronze	0.8 m	—
Neoprene wire EVVS 2 × 1.0 mm bronze	0.6 m	1.2 m

IV. Outdoor: Open Wire Line and Self-supporting Polythene or Neoprene Drop wire

Indoor: PVC wire

In villa districts in which the buildings are widely scattered and the subscribers' lines are consequently of some length, uninsulated open wire lines are

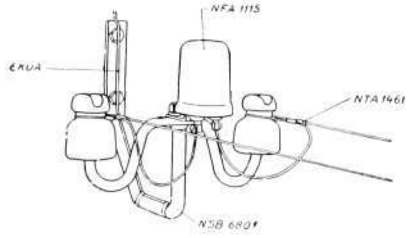


Fig. 14 X 4732

Connection of open wire to PVC wire EKUA

still employed. The drop wire from the last pole to the leading-in point on the wall usually consists of self-supporting insulated wire however. The method of installation is as follows.

The secondary cables terminate in distribution boxes for 10 or 20 pairs, fitted with fuses in different combinations. Protector terminal boxes *NCF 1101* or *NCF 1102* are usually employed, and are provided with carbon arresters and tubular fuses.

The distribution points are arranged in the usual manner. The open wire subscribers' lines are then drawn from the distribution points. In cases where the last span has to consist of self-supporting insulated wire as a protection against contact with trees or for other reasons, the change-over from the open wire is carried out as shown in Fig. 13. On the cross-arm, which is generally *NSH 3101—NSH 3102* on the last pole, a subscriber's protector *NFA 11—NFA 13* is mounted to which the open wire is connected. The self-supporting insulated wire is usually suspended with clamps *NSH 2021* in the case of polythene wire ELXS and with *NSH 2011* for neoprene wire EVVS, and is then connected to the subscriber's protector, the polythene wire being provided with a rubber cushion *NDK 2105* whilst the neoprene wire is connected direct. The self-supporting insulated wire is then drawn through the leading-in hole in the wall of the building to the indoor wire in the manner described under section III.

V. Outdoor: Open Wire Line
Indoor: PVC wire

As an alternative to the preceding arrangement, the subscriber's line is sometimes installed with uninsulated open wire up to the leading-in hole for the indoor wires.

In this case the connection between the uninsulated open wire and the PVC insulated wire EKUA is carried out outdoors in a subscriber's protector *NFA 11—NFA 13* which in turn is mounted on a two-position wall bracket *NSB 6801*, see Fig. 14. In the leading-in hole through the wall of the building the PVC wire EKUA is then protected by a PVC joint sleeve *NDE 1103*. If it is necessary to fasten the PVC wire EKUA outdoors, this is done with clamps *NSV 3705* and nails *NSV 1401—NSV 1404*. The PVC wire EKUA is connected to the subscriber's protector with a rubber cushion *NDK 2105*.

Phase-Sequence Indicator

S E LINDBERG, L M ERICSSONS MÄTINSTRUMENT AB, STOCKHOLM

U.D.C. 621.317.373

When connecting electricity meters and motors in an electrical three-phase system it is necessary to know the phase sequence. L M Ericssons Mätinstrument AB manufactures an instrument, VAV 10, by means of which the phase sequence can be determined.

Fig. 1 X 4723

The instrument can easily be attached to a breast pocket or the like

The new Ermi instrument, Fig. 1, is so small — length including connecting plug 74 mm, diameter 43 mm — that it can be carried in a coat pocket, and it weighs barely 4 ozs. The instrument is designed for voltages from 110 V up to 380 V and for frequencies from 15 cycles to 60 cycles per sec, but it can also be employed for 500 V during short periods.

When making measurements with a voltage below 300 V, the phase-sequence indicator may be connected in circuit continuously without causing its windings to reach a higher temperature than 50° C. At 380 V and 500 V this excess temperature is reached in 15 mins and 5 mins respectively. Generally speaking, a measurement can be made in a few seconds, and consequently noticeable temperature rises very seldom occur.

The construction of the phase-sequence indicator is based on the fact that a rotary field is produced with a three-phase alternating current. If a rotor with closed windings is placed in this field, it is set in rotation. In the phase-sequence indicator the rotor consists of an aluminium disc fixed to a spindle mounted between two pivot bearings. When the instrument is connected to a three-phase voltage with the correct phase sequence, the disc is set in clockwise rotation in the same direction as that indicated by an arrow marked *R-S-T*, on the front of the casing. When the phase sequence is incorrect the disc rotates in the opposite direction. The disc is provided with a mark, the direction of rotation of which can be observed through a window in the casing.

If any of the voltages in the three-phase system is zero, the disc remains stationary. Thus, no risk of faulty indication exists on this account.

The casing consists of oxidised aluminium which gives the instrument an attractive finish and a wear-resisting surface, Fig. 2. The casing is also provided with a hook by means of which the instrument may be attached to a breast pocket or the like, thus leaving both hands of the observer free to carry out measurements.

The phase-sequence indicator is connected in circuit by means of three single-pole plugs marked *R*, *S* and *T*. The measuring cord is 0.8 m in length, and is connected to the instrument by means of an ordinary plug and socket. The measuring cord and the instrument can therefore be carried separately and connected up quickly when measurements have to be made.

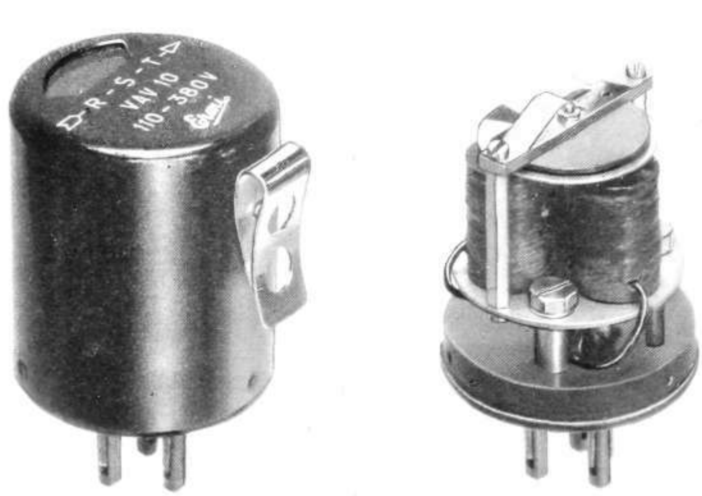


Fig. 2 X 6582

Phase-sequence indicator

on the right with the casing removed

U.D.C. 621.395.22:621.395.721

NILSSON, K W: *New Domestic Telephone with an Ivory-white Finish.* Ericsson Rev. *28* (1951) No. 2 pp. 34—38.

Description of a new series of domestic telephones placed on the market by Telefonaktiebolaget L M Ericsson during the year 1951. The construction, installation and schematic arrangement of these new domestic telephones are dealt with and a few examples of the most customary types of installations are given.

U.D.C. 621.396.65

PERSSON, L: *Radio Links for Power Stations.* Ericsson Rev. *28* (1951) No. 2 pp. 42—47.

Svenska Radioaktiebolaget has developed a radio link SUF-30 for permanent radio connections using ultrashort waves, which is specially designed for power station operation, with only one conversation possibility but combined with a number of low frequency tone channels for remote control. Description of the construction, range of use and technical data of the radio link.

U.D.C. 621.315.3

SIDENMARK, N, ERIKSSON, N & WILLSON, G: *New Wires for Subscribers' Lines.* Ericsson Rev. *28* (1951) No. 2 pp. 48—59

Subscribers' lines in an urban telephone network were originally built of uninsulated bronze wire, known as open wire lines, insofar as the external part of the installation is concerned. Subsequently, the self-supporting lead covered cable EDBS was employed on a large scale, and now it is in turn replaced by a self-supporting rubber insulated and neoprene jacketed wire EVVS, or by a self-supporting wire with polythene insulation ELXS. Description of the general properties of the new types of wires and the methods of installing them.

U.D.C. 621.317.373

LINDBERG, S E: *Phase-Sequence Indicator.* Ericsson Rev. *28* (1951) No. 2 p. 60.

L M Ericssons Mätinstrument AB manufactures an instrument with the type designation VAV 10 by means of which the phase sequence can be determined. Short description of the construction and functioning of the phase-sequence indicator.

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ASSOCIATED AND CO-OPERATING ENTERPRISES

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Danmark

L M Ericsson A/S *København V*, Trommesalen 5, tel: C 3438, tgm: ericsson-københavn

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

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Great Britain

Swedish Ericsson Company Ltd. *London, W. C. 1*, 329 High Holborn, tel: Holborn 1092, tgm: teleric-london

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

Italia

Setemer, Soc. per Az. *Milano*, Via dei Giardini 7, tel: 6 22 41, tgm: setemer-milano

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Sverige

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Corp. Sudamericana de Teléfonos y Telégrafos S. A. *Buenos Aires*, Belgrano 894, tel: TA 33; Avenida 2071, tgm: ericsson-buenosaires

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

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AUSTRALIA & OCEANIA

Australia

L M Ericsson Telephone Co. Pty. Ltd. *South Melbourne* (Victoria), 126 Grant Street, tel: MXY 220, tgm: ericmel-melbourne

AGENCIES

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

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ERICSSON Review

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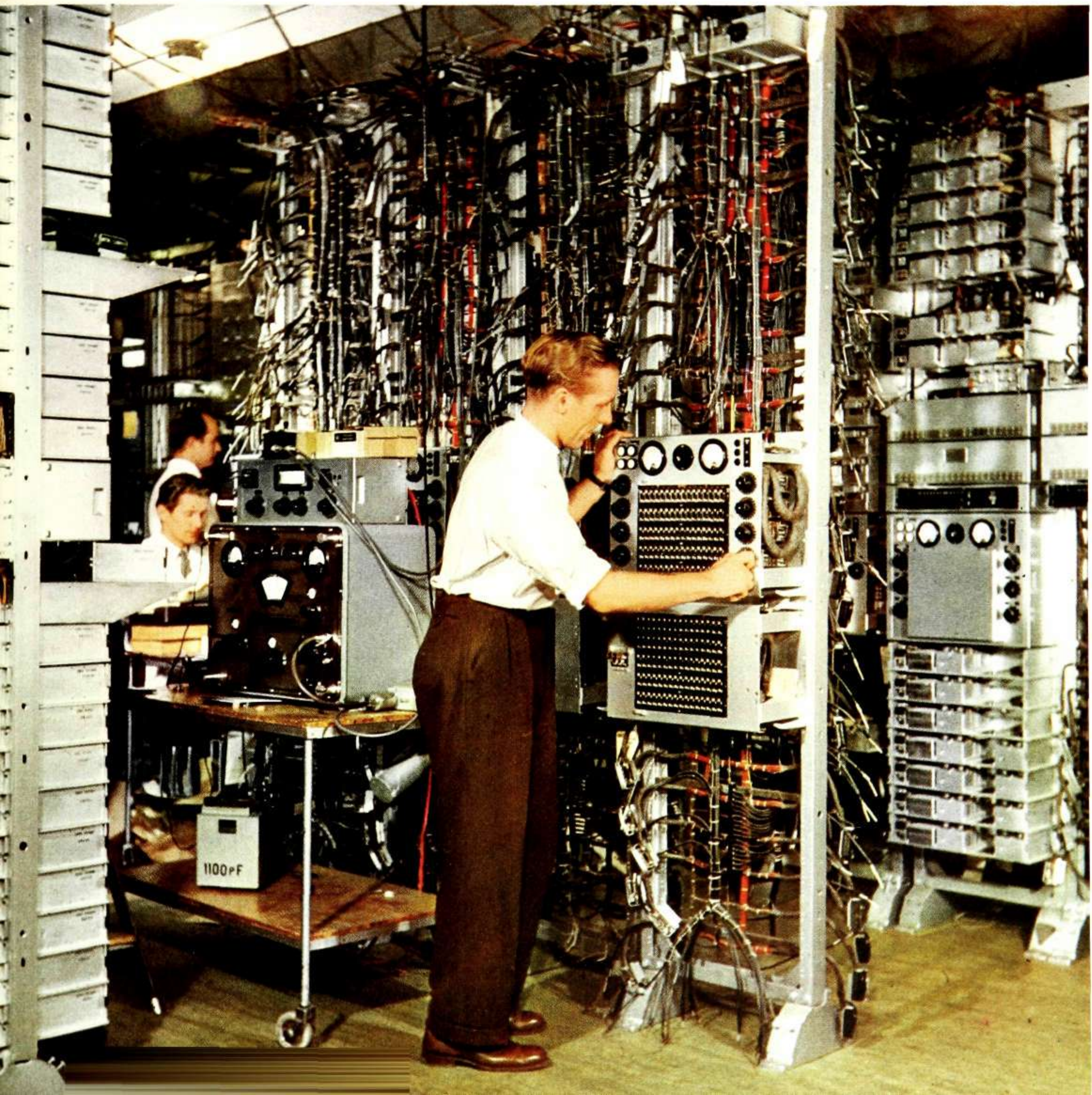

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CONTENTS

On cover: Interior of one of L M Ericsson's test-rooms for carrier frequency equipment.

VHF Radio Multichannel Carrier Telephone Circuits in Colombia

L C SIMPSON, RADIO CORPORATION OF AMERICA, H J B NEVITT & E J ERIKSEN, TELEFONAKTIEBOLAGET L M ERICSSON

U.D.C. 621.395.44:621.396.2.029.6

Multichannel telephone and programme facilities using normal FM broadcasting equipment and cable carrier terminals have been established by means of single hop frequency-modulated radio links operating in the 70—88 Mc/s range over the approximately 250 km distance separating the two cities Bogotá and Medellín in Colombia. The following article describes the main features of these facilities.

General

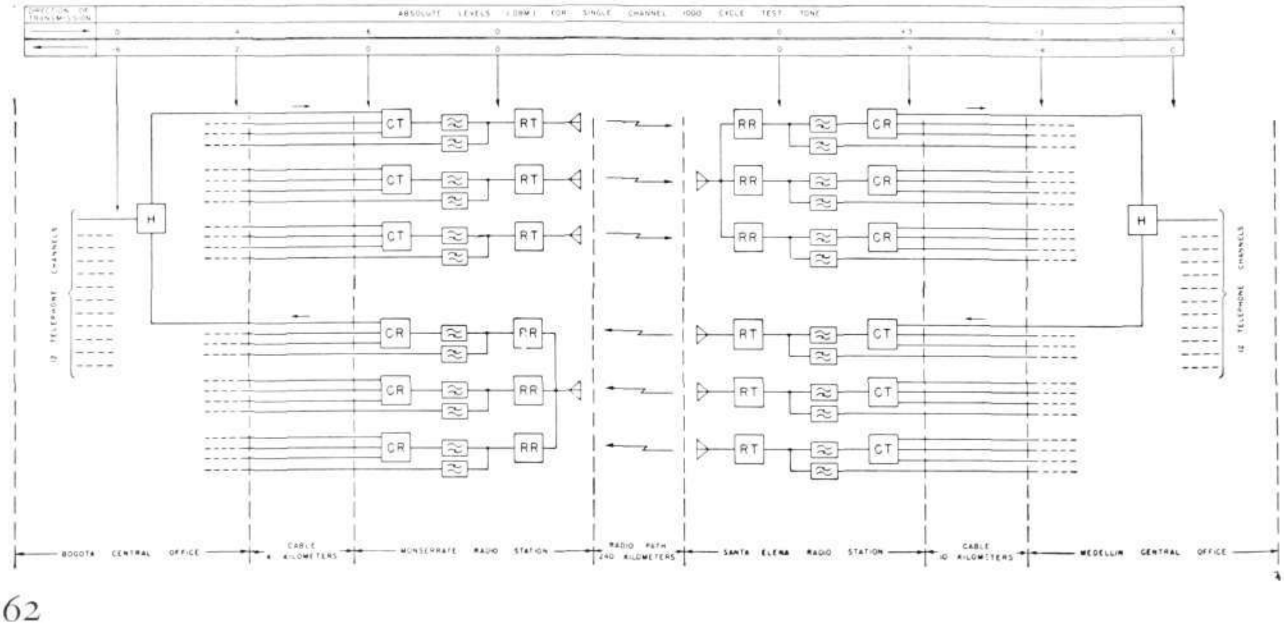
In February 1950 Telefonaktiebolaget L M Ericsson turned over to the Colombian Government, for commercial operation, three frequency-modulated VHF radio links installed, through collaboration with Radio Corporation of America, in Bogotá and Medellín, Colombia. These links provide a total of eleven telephone circuits and one two-way programme channel between these two cities.

The main features and operating levels of this system are shown in the block schematic diagram, Fig. 1. The intelligence band utilized on each radio link is 18 kc/s subdivided into three 200—3400 c/s carrier telephone channels, with the low pass arranged either to provide a similar telephone channel or a 30—5700 c/s programme channel. All circuits are extended by loaded cable from the carrier terminals, located in the radio stations on Monserrate and Santa Elena, to Central Offices in Bogotá and Medellín, respectively, where they can be terminated either on a 2 or 4-wire basis, as required by the toll switching plan.

Fig. 1 X 7595 X 9119

Block schematic diagram of the Bogotá—Medellín multichannel system

- RT radio transmitter
- RR radio receiver
- CT carrier transmitter
- CR carrier receiver
- ≈ high pass filter
- ≈ low pass filter
- H hybrid unit



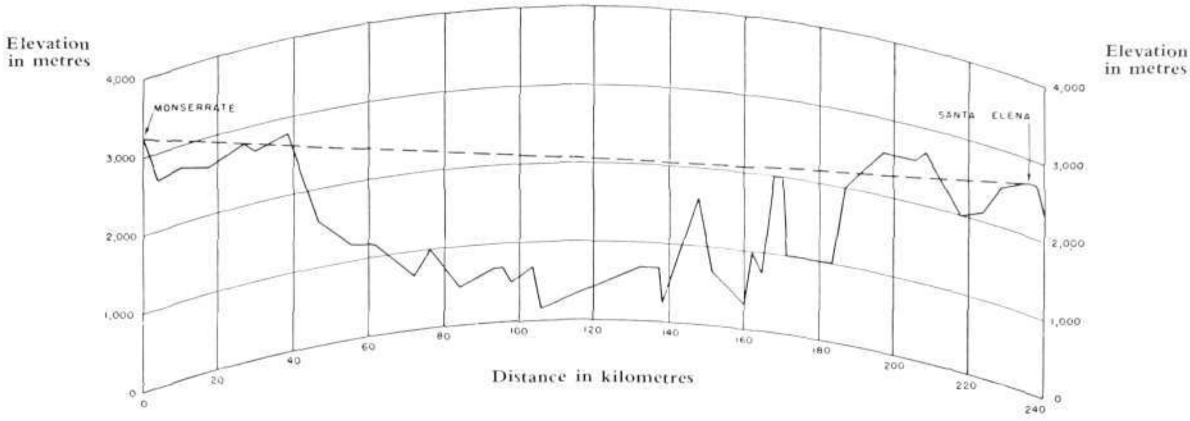


Fig. 2 X 7596
Profile Monserrate—Santa Elena
based on 1.33 × earth's radius

Radio Propagation

The extremely rugged terrain in this region of Colombia naturally suggested the 70—88 Mc/s VHF band as least likely to be affected by intermediate barriers or by extreme fading due to tropospheric variations, while being free of the occasional interference bursts experienced on lower VHF frequencies.

Fig. 2 shows the Monserrate—Santa Elena profile, as obtained from the best available maps of the region. Initial estimates of field strength were based upon this profile and well known methods of calculation[1] and empirical data[2]. While these estimates indicated that field strengths adequate to meet CCIF telephone circuit noise requirements for open wire lines might be expected with 250 W transmitter power and 1.4 N gain directional antennas it was, nevertheless, deemed necessary to make field trials to select final station sites and to see if extreme fading might not occur over this rather long path. Normal RCA 20 W mobile FM terminals operating in the 150 Mc/s band with simple dipole antennas were used at both ends in all tests.

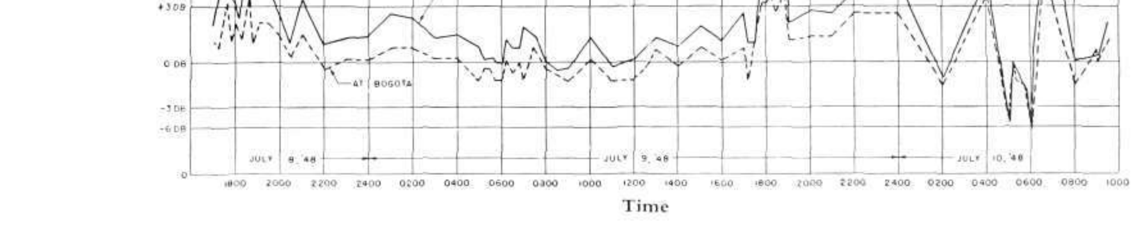
With one terminal located on Monserrate, the most conveniently accessible high point in Bogotá, it was found that a number of sites existed along the Santa Elena range near Medellin where good signals were obtainable. The final location chosen for the Medellin station was situated on a mountain side sloping gently toward Bogotá.

Typical relative field strengths, as indicated by the first limiter grid current on a calibrated FM receiver, may be seen in Fig. 3. The brief field tests demonstrated that we could be reasonably sure of less outage time, due to deep fades, than would normally be experienced with open wire lines in the same territory.

Fig. 3 X 7597
Relative field strengths as indicated by a 150 Mc/s test circuit at Monserrate and Santa Elena July 8—10, 1948

[1] "Radio Propagation at Frequencies Above 30 Megacycles", by Kenneth Bullington, Proceedings of the IRE, October 1947.

[2] "A Multichannel VHF Radio Communication System" by J. B. Knox and C. H. Brereton, RCA Review, June 1946.



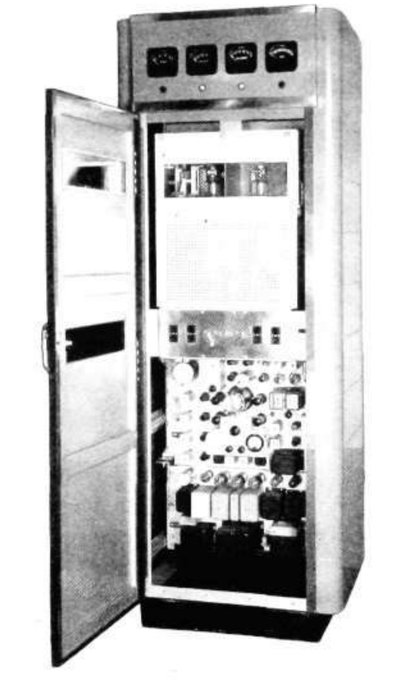


Fig. 4
FM transmitter
RCA model

X 4737

Radio Equipment

Transmitter

Three RCA Model *BTF-250 A, 250 W* FM transmitters are used at each terminal. This transmitter was designed primarily for continuous duty FM broadcast service, and its rated characteristics for this service are as follows:

Power output	250 W
Carrier frequency stability	± 1 000 c/s
Modulation capability	± 100 kc/s
Audio frequency response, 30—15000 c/s	± 0.1 N
RMS distortion at 75 kc/s swing	< 1 %
FM noise level below 75 kc/s swing	7.5 N
Power supply requirement	1200 W, 208/230 V, 50/60 c/s

The actual transmitting frequencies employed are given below.

Monserrate (Bogotá)	Santa Elena (Medellin)
85.9 Mc/s	77.4 Mc/s
86.9 »	78.4 »
87.9 »	79.4 »

The required intelligence band for each radio link extends from 30 to 18000 c/s, which is somewhat beyond the normal usage for this transmitter. However, no modifications or equalization were necessary to meet the requirement, and the combined response of each transmitter and receiver varies only 0.1 N between 30 and 18000 c/s.

Pre-emphasis of the higher audio frequencies at the transmitter and de-emphasis at the receiver, which is normally employed in FM Broadcast Service, was not used in the Bogotá-Medellin system.

The *BTF-250 A* transmitter, Fig. 4, occupies one 84 inch cabinet rack, with components mounted on removable vertical panels. The ease of assembly and the general ruggedness of the equipment makes it ideally suitable for installation and operation at relay station sites, which are often relatively inaccessible. More complete descriptions may be found elsewhere[3, 4].

Frequency modulation is effected by a circuit which permits direct modulation of the oscillator frequency, and at the same time provides crystal control of the center or carrier frequency. This »Direct FM» circuit combines the advantages of simplicity and relatively small number of tubes with the frequency stability of crystal control.

A self-excited master oscillator, working at approximately 5 Mc/s and employing a 6V6 tube, is frequency modulated by push-pull 6V6 reactance tubes. Carrier frequency control is effected by a variable trimmer capacitor directly coupled to a two phase motor which is caused to operate automatically when a submultiple of the oscillator frequency differs from a submultiple of the frequency of a crystal controlled reference oscillator. Comparison of the modulated oscillator and crystal oscillator frequencies is done at approximately 21 kc/s.

The direction of rotation depends upon whether the frequency derived from the modulated oscillator is above or below the frequency derived from the crystal oscillator, which causes the motor to seek the position corresponding to the correct frequency.

Motor torque is not affected by frequency modulation of the master oscillator within the range of modulation frequencies employed. It is well known that

[3] "New FM Transmitters" by R. J. Newman, Broadcast News, January 1946.
[4] "A New Exciter Unit for Frequency Modulated Transmitters" by N. J. Oman, RCA Review, March 1946.

the power in the carrier of a frequency modulated wave becomes zero for certain values of modulation index, all the power then being in the sidebands. In the present case, when the transmitted carrier frequency of approximately 80 Mc/s swings 75 kc/s, the 21 kc/s comparison frequency swings only about 20 c/s. The modulation index at the comparison frequency is therefore less than one for modulation frequencies down to 20 c/s, and for this condition the loss in motor torque is insignificant.

Following the 5 Mc/s modulated oscillator, the frequency multiplier and amplifier stages, as used in the transmitters of the Bogotá-Medellín system are:

1 6V6	frequency doubler
1 2E26	» »
1 2E26	» »
1 4-125A	» »
2 4-125A	output power amplifier

The transmitter output is delivered to a concentric transmission line, to which is coupled a monitor unit that will automatically cause the transmitter to be shut down in case of accidental irregularities or discontinuity in the antenna or transmission line.

Receiver

Three RCA model *CRR 3X* fixed frequency crystal controlled receivers are used at each station. This receiver was designed primarily for broadcast studio transmitter links, and was found to be readily applicable to the requirements of the Bogotá-Medellín system. The combined frequency response of the CRR3X receiver and the BTF-250A transmitter has been given on page 64. The combined RMS distortion does not exceed 2 %. The maximum available receiver output, into a 600 ohm line, is + 2.0 N for 75 kc/s frequency deviation.

Each receiver occupies 8-3/4 inches of panel space in the receiver cabinet, Fig. 5. The three receivers are mounted in a single cabinet rack, together with a volume indicator panel, a jack panel, and a heterodyne frequency meter used for transmitter adjustments and monitoring. The input of all three receivers are coupled to a single 52 ohm concentric transmission line by means of quarter wave matching sections.

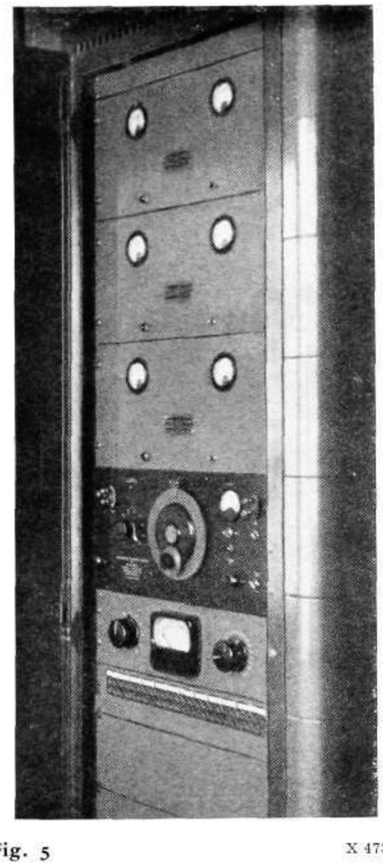


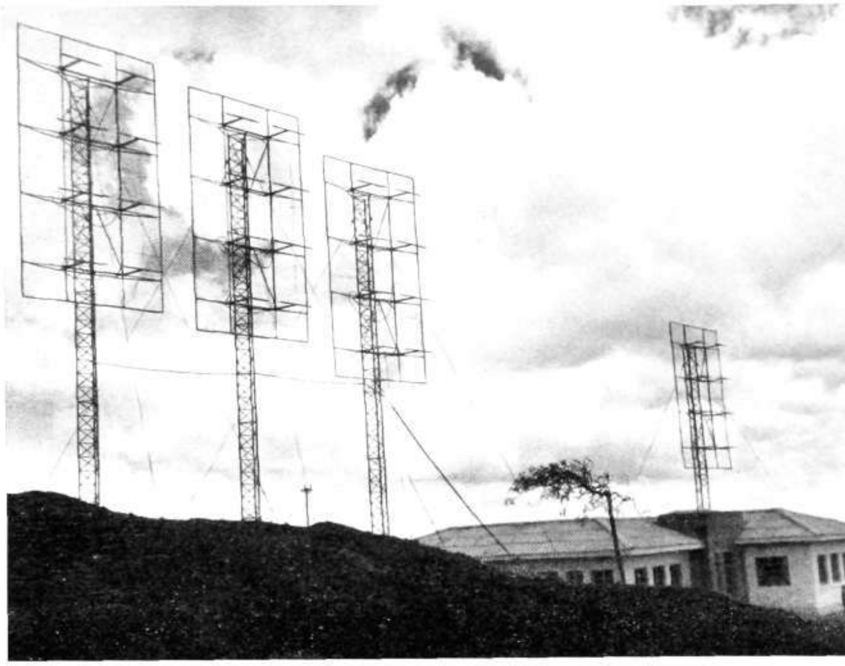
Fig. 5 X 4738
FM receiver cabinet
RCA model

All transmitter audio input and receiver audio output lines, as well as the inter-bay lines to the carrier equipment, are brought to the jack panel in the receiver cabinet. By means of attenuator pads the transmitter and receiver audio levels at the jacks are adjusted to + 1.2 N for 75 kc/s frequency deviation with a single 1000 c/s test tone. All circuits are normalled through, so that no patch cord connections are necessary for normal operation. However, cross patching may be used for loop tests or under abnormal conditions. The volume indicator may be switched to any transmitter input or receiver output line for level measurements.

Antennas

Four directive antennas are used at each station, one for each of the three transmitters plus a common antenna for the three receivers. Fig. 6 shows the antenna arrangement at Santa Elena. Each antenna consists of an array of 8 co-phased dipoles mounted in front of a reflecting wire screen. The measured gain in comparison with a single dipole has been determined to be approximately 1.4 N, and the horizontal beam width between the half power points was found to be 30 degrees.

The antennas are supported on triangular guyed steel masts, 40 feet high at the Santa Elena station and 30 to 50 feet high at Monserrate. Local conditions at both sites are such that effective antenna height is mainly determined by the terrain rather than by mast height.



X 6611

Fig. 6
Antennas at Santa Elena

The connections between the antennas and the radio equipment are made with *RG-17/U* solid dielectric coaxial cable having 52 ohms characteristic impedance and an attenuation of approximately 0.09 N/100 feet. The cable runs average about 75 feet in length, and messenger wires are used for support where necessary.

It may be mentioned that both station sites are located high in the mountains, the altitude being 10500 feet at Monserrate and 8500 feet at Santa Elena. Although both stations are often surrounded by clouds and subjected to high humidity and precipitation for a large portion of the time no difficulty has been experienced with the equipment because of these conditions.

Carrier Telephone Terminals

Frequency Allocation

The three 3-channel cable carrier telephone systems provided for the Bogotá-Medellin service are quite similar. Each system utilizes an intelligence band of 30-18000 c/s. As shown in Fig. 7, three modulated channels are included in the range 6—18 kc/s. Each telephone channel has a band width of 3200 c/s between the limits 200—3400 c/s and each satisfies CCIF's latest recommendations. The lower frequencies 30—6000 c/s are employed for either a single program or telephone channel as discussed later.

Oscillator Equipment

For the three modulated channels the carrier frequencies 10,14 and 18 kc/s are used, as is shown in Fig. 7. LM Ericsson have here developed a new carrier system which is of a more simple performance than the one previously used. Each terminal has its own carrier frequency generator controlled by a special 6000 c/s crystal oscillator. Special crystals with low temperature coefficient variety (2×10^{-6} c/s/degree C) mounted in a vacuum tube with standard miniature base assure oscillator stability sufficiently great so that thermostatic control of the oscillator and synchronization of opposite terminals are not required.

The 6 kc/s master-oscillator locks in the third harmonic of a 2 kc/s electron-coupled oscillator hereby dividing the 6 kc/s down to 2 kc/s with the same degree of stability as the master oscillator itself. After power amplification

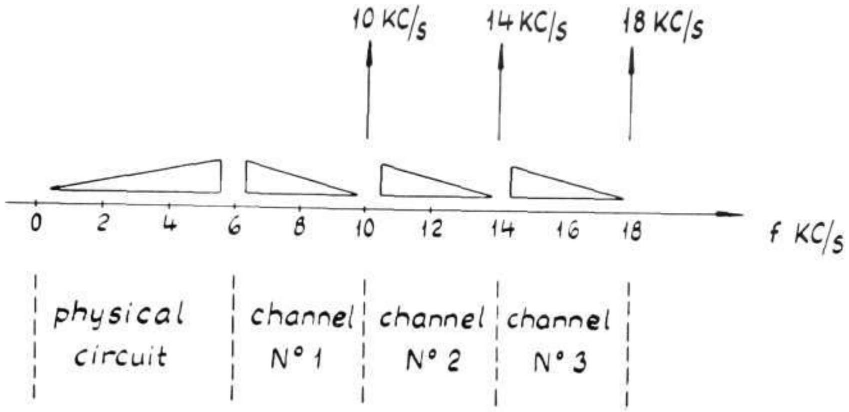


Fig. 7 X 6595
Carrier frequency allocation

the 2 kc/s voltage is applied to a saturable core reactor and a spectrum of odd multiples of this frequency is produced. Through proper dimensioning of the iron core the saturation point can be varied so as to give the desired harmonics, in this case the fifth, seventh and ninth. The power loss occurring with this method of harmonic production is sufficiently low so that no amplifiers are needed for individual carrier frequencies of the same system. In order to eliminate inter-channel cross-talk, however, these harmonics are passed through narrow band filters.

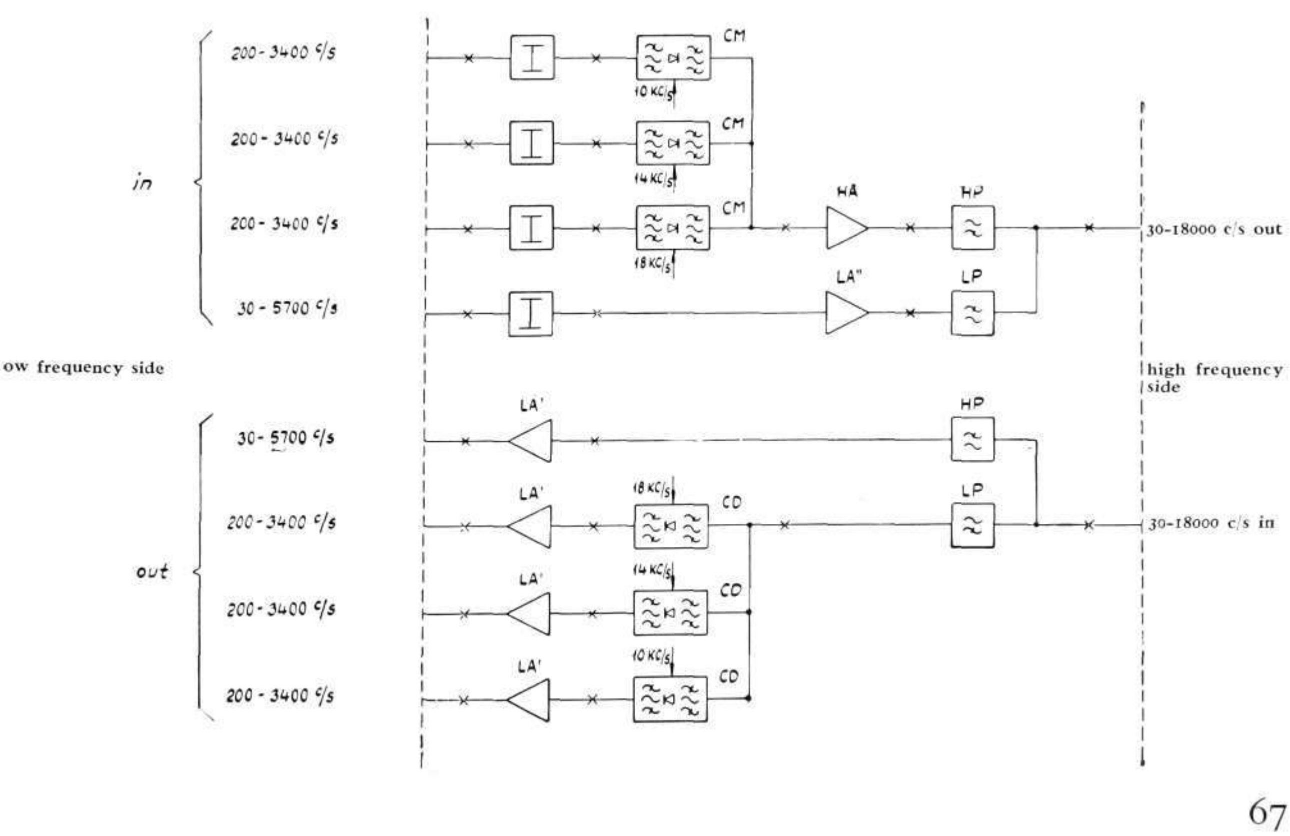
The three elements just described, crystal oscillator, frequency divider and power amplifier are built together into a single plug-in unit with similar reserve equipment mounted beside it on the same panel. In case of failure, the faulty unit can then be quickly and easily replaced by the reserve equipment. Fault indication is by means of a relay arrangement which indicates whether the amplified 2000 c/s is present.

Channel Equipment

The transmitting side

A simplified block schematic of the terminal equipment is shown in Fig. 8. As appears from this schematic, the signal enters through the line transformer terminating the cable and proceeds directly into a variable attenuator. Within

Fig. 8 X 7598
Block diagram of carrier equipment
- LA′ low frequency amplifier incl. signalling equipment
- LA″ low frequency amplifier without signalling equipment
- HA high frequency amplifier
- CM channel modulator
- CD channel demodulator
- HP high pass filter
- LP low pass filter



certain limits this enables maintaining a prescribed input level to the modulator independent of the signal level. This attenuator consists of two elements: a potentiometer with 10 steps of 0.1 N each and a solder strap element, adjustable in steps 0.2, 0.4 and 0.8 N or any combination thereof. By this means absolute levels from + 0.4 to — 2.0 N may be accepted by the terminals without auxiliary equipment. To obtain optimum transmission quality it is, of course, important that correct signal levels be applied to the modulator. If levels are too high undesired harmonics cause impairment whereas thermal noise predominates if levels are too low. The most suitable operating level is a compromise which neither promotes the one type of disturbance or the other.

Upon modulation both upper and lower side-bands are formed. Of these only the lower side-band is used and this is separated out by means of a band-pass filter after the modulator. This band-pass filter has high attenuation for the undesired side-band and blocks the carrier frequency. Since the modulator is balanced, the carrier frequency is also considerably attenuated in the modulator bridge. In order that this balance should not deteriorate, with aging of the dry disk elements, the rectifier bridge is provided with a small potentiometer where carrier leak may be balanced out from time to time. Thus only insignificant carrier leaks occur in the intelligence band, as is most desirable to reduce intermodulation and the possibility of intelligible cross-talk.

Mechanical construction of modulator and filter elements is very compact. Band filters for carrier channels 1, 2 and 3, together with their compensation filters, are mounted on a single panel requiring two mounting-plate spaces. Each filter is potted in its own solder-sealed container with terminals protruding through porcelain insulators. The modulator dry disk elements and potentiometers are each located above their associated filter containers. Both modulator bridge and parallelling resistors are of plug-in type so that they may be easily replaced.

From the above it can be seen, how the three modulated channels are formed. Since the three modulated channels, in the frequency range 6—18 kc/s, are of very low level after modulation, they are amplified by a flat amplifier covering just these frequencies and provided with negative feed-back so as to be practically independent of filament and plate voltage fluctuations. Since failure of this amplifier could prevent operation of three telephone channels, the terminal is provided with a reserve amplifier which can be connected into the circuit immediately the need arises.

The line filter consisting of high and low pass sections transmits the three modulated channels through the high pass while the remainder of the band goes through the low pass or physical channel, so called as it passes through the carrier terminal without being modulated. Since filter technique permits transmissions of the lowest frequencies, the actual low frequency limit of the physical channel is determined by its channel amplifier which transmits down to 30 c/s and is suitable for high grade radio programme service.

One of the three-channel systems, which form part of the complete carrier telephone terminal equipment used in the Bogotá-Medellín link, is equipped with a program channel covering 30-5700 c/s. In order to transmit frequencies up to 5700 c/s for this service strict requirements must be placed on the line filter design since the gap between the high and low pass filter sections is only 500 c/s. This requirement implies a large and relatively expensive filter. For this reason, only one programme channel was initially equipped, the other two low pass circuits being supplied with simple line filters permitting transmission of frequencies up to 3400 c/s. Should additional programme facilities be desired these telephone filters can always be replaced by programme filters.

After passing through the line filters all four channels proceed over a short inter-bay cable to the FM radio transmitter. The above describes the method of transmission from low frequency to high frequency on the sending side.

The receiving side

Reception is quite analogous. Four channels are received from the radio link, then separated by the line filter so that the modulated channels pass through the band filter before demodulation, while the physical channel proceeds directly to a low frequency amplifier before reaching the main cable. The demodulated channels also go through similar low frequency amplifiers.

The low frequency amplifiers are of new design requiring two 1-3/4 inch mounting plate spaces each. In the same panel are included the variable attenuator for adjustment of the incoming signal level as well as the signalling equipment and associated relays for 20 c/s ringing.

The 20 c/s signal is transmitted in the following manner: on the sending end a dry disk rectifier bridge shunted across the incoming cable pair rectifies the ringing signal. This rectified current actuates a relay which in turn sends out 500 c/s. Since 500 c/s lies within the transmitted voice band, 200—3400 c/s, it proceeds unhindered through the telephone channel. Speech level is too low to actuate the signal relay on the sending end. On the receiving end, the 500 c/s selected by the signalling equipment, built into the low frequency amplifier, actuates a relay which sends out the 20 c/s ringing signal. While it is true that speech also contains considerable 500 c/s, which could result in false operation of the signalling relay, the signalling circuits are so arranged that they will not operate if other frequencies than 500 c/s are present, as is normally the case in voice transmission.

The amplifier itself is a two stage negative feed-back type with 4.4 N maximum gain for highest output level of + 1.0 N. The double triode, 6J6, is used for all functions in the amplifier, resulting in considerable economy in the number of tubes, with corresponding reduction of power consumption.

The low-frequency amplifier panels also include 2 to 4-wire terminating sets which are not utilized in the Bogotá-Medellin system since, in this application, the carrier terminals are connected 4-wire from the Monserrate and Santa Elena radio stations to their respective Central Offices in Bogotá and Medellin. This arrangement was chosen to simplify future expansion of the long distance network and enable 4-wire switching of all important inter-city telephone trunks at the Central Offices.

Power Supply

The entire carrier telephone equipment for three 3-channel systems is mounted on a single double-sided bay. Power for the three systems is delivered from a common power supply, which converts the 50—60 c/s line voltage to the required plate, filament and relay voltages. The power equipment may be connected to alternating current networks in the range 110 to 240 V and has a total consumption of about 200 W. The power is fed from a distribution panel to each equipment which has its own protection and alarm arrangements. Here also various plate current measurements of the system vacuum tubes can be made so as to facilitate rapid maintenance.

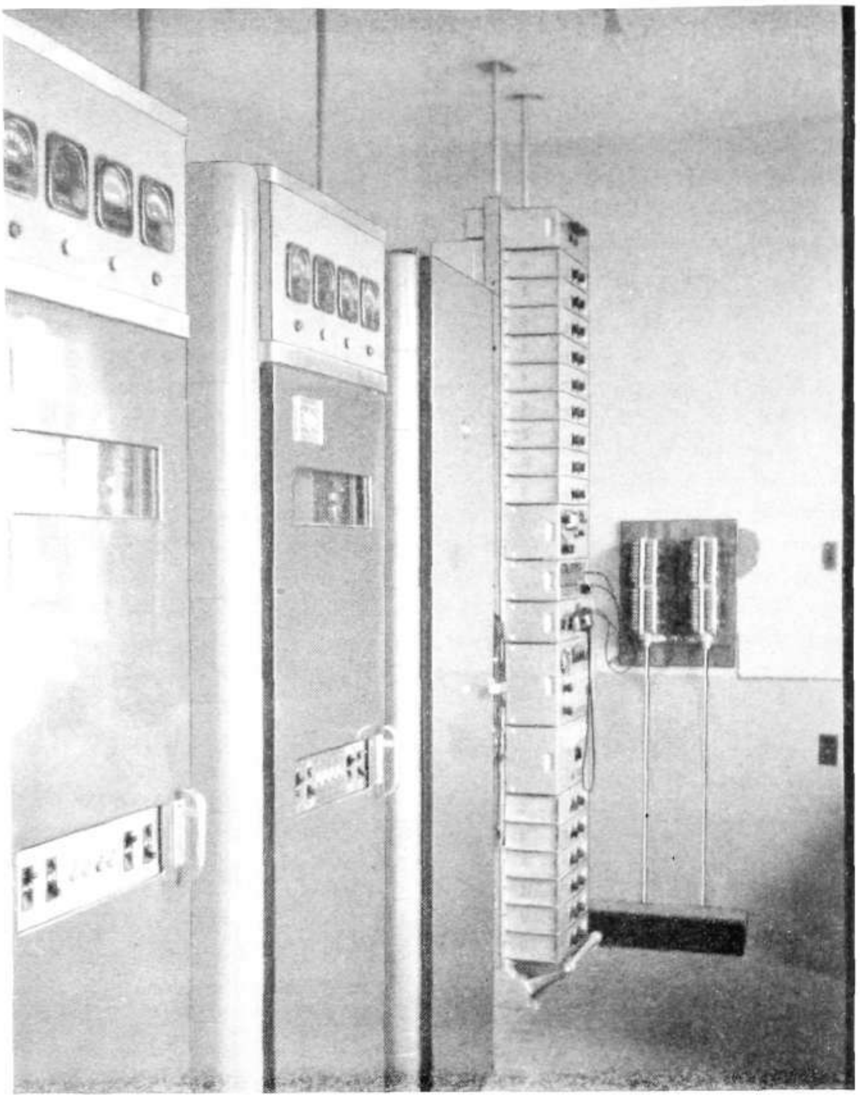


Fig. 9 X 6612

Partial view of the equipment at Monserrate

From the left: two FM transmitters, cabinet with three FM receivers and carrier frequency bay for the three 3-channel systems.

Station Build-up

All radio and carrier telephone terminal equipment at each station is located in a single building. At the Monserrate station the 5 cabinets or bays which contain the 3 transmitters, the receivers, and the carrier equipment are installed adjacent to one another. Fig. 9 shows a partial view of the equipment room at this station. At the Santa Elena station the transmitters are located in one room and the remaining equipment is located in an adjacent room of the same building. Power and audio wiring is installed in conduit placed in floor trenches, to suit local conditions.

Power for the stations is normally obtained from commercial power lines, through automatic induction voltage regulators. RCA gasoline power plants, equipped with 265 gallon underground fuel tanks are provided for emergency use at each station. These plants, rated 5 kW at 10500 feet altitude, automatically start and take the load in case of failure of commercial power.

System Performance

Actual commercial operation of the telephone system from February of 1950 has fully borne out our expectations regarding noise and cross-talk performance as well as reliability and freedom from maintenance troubles, compared to good European and North American standards for open-wire line carrier telephone systems. While all radio circuits operate in the same frequency band, they do not fade simultaneously, but have separate fading patterns. It has also often been demonstrated during these and other tests that the fading patterns at slightly separated sites vary considerably, so that space-diversity reception could have been used to advantage if fading had proven excessive. Until now, however, no special steps have been taken to eliminate occasional deep fades down to noise level, which have occurred under certain rare combinations of meteorological conditions for periods up to half a minute at a rate of once about every two or three days. Much more frequent and prolonged outages are commonly experienced with open-wire lines in the same region.

Typical signal/noise ratios measured at Medellin with FLAT and CCIF (FIA) weighting networks, on a Type 2 B Noise Measuring Set, are shown in Table 1. Relative field strengths of the FM carrier on the three VHF circuits are indicated by the first limiter grid current in each VHF receiver. The noise measurements are partly done direct on the receiving side of the radio link (bandwidth 18 kc/s) partly in the telephone channels, measured on the 4-wire side. At all the measurements the corresponding transmitting side of the opposite terminal is terminated in 600 ohms. The noise measurements indicated in the table are with reference to a 1000 c/s test tone, at points of zero relative reference level. Maximum instantaneous field strength variations, indicated linearly by the limiter current readings, which range from 0.1 to 11.0 mA, with an average of 2.0 to 4.0 mA for normal reception, give signal/noise ratios of approximately 7.5 N in each telephone channel, as shown in Table 1. Some impairment of signal/noise, in the order of 1.0—1.5 N, has been occasionally experienced at the Bogotá terminal, mostly on one of the radio circuits, during periods of low average signal strength, due to low level impulse noise emanating from an undetermined source in the city. This is being traced and will ultimately be reduced if not entirely eliminated. In the early stages of operation there was also occasional interference from harmonics of local broadcast and HF frequency-shift telegraph stations which have now been mostly suppressed.

Table 1

Signal-to-noise ratios measured at points of zero reference level at Medellín.

Radio link No.	Relative signal strength (Limiter mA)	Noise weighting	Signal/noise ratio — N				
			HF-channel 30—18000 c/s	Low pass telephone channel	Carrier telephone channel 1	Carrier telephone channel 2	Carrier telephone channel 3
1	0.7	flat	6.8				
		CCIF[1] 1946		7.9	6.9	6.4	6.3
2	3.0	flat	7.6				
		CCIF[1] 1946		7.7	8.1	7.7	7.0
3	1.5	flat	6.9				
		CCIF[1] 1946		7.5	7.5	7.1	7.0

[1] The noise weighting is that of CCIF 1946 recommended. On the Western Electric's 2 B Noise Measuring Set here used by the measurements the same weighting is indicated as FIA.

Near end cross-talk is so low that it is not measurable on the 2 B Noise Measuring Set. With the low distortion radio link, however, operating at the levels specified, some 0.3 N decrease in the signal/noise ratio with CCIF weighting may be expected in the disturbed channel, when all three other channels of the same link are modulated with voice at zero VU absolute level, measured at zero reference level points. Results of tests made with three 1000 c/s test tones at the same reference points with the same absolute levels, show impairment of the signal/noise ratio of about 1.0 N, which increases rapidly as the 1000 c/s test levels are increased beyond the specified operating points shown in Fig. 1. With proper initial line-up of the system transmission levels, however, this condition does not arise in actual operation with any combination of voice-frequency telegraph, telephone or programme service. The cross-talk is moreover unintelligible and apparently originates from second harmonics produced by non-linearity of the radio link which was not specifically designed for multichannel telephony.

Conclusions

1. Operating experience has amply demonstrated the feasibility of establishing economical multichannel long distance telephone service with 70—88 Mc/s VHF radio links over mountainous terrain in Colombia, without intermediate repeaters, for distances as great as 250 km.

2. By using available high-grade FM broadcasting equipment and cable carrier telephone terminals, it is possible to attain standards of performance and reliability equal or superior to open-wire line carrier telephone networks operated in mountainous terrain. These VHF plus carrier facilities may be used for radio programme, telephone, or voice frequency telegraph application without providing special auxiliary equipment.

3. Once the system is lined-up and is operated continuously, it is capable of long periods of trouble-free service. While initial installation has been planned for technical operator supervision, experience shows that many of the less important installations of this type could be operated unattended, if suitable alternate routing were available.

4. Overall system maintenance costs for direct VHF inter-urban facilities are considerably less than for open-wire lines, which are, however, more suitable for providing communication at intermediate points. Colombia appears to be particularly suited for application of VHF equipment due to its largely mountainous terrain and the existence of widely separated but important cities, which in most cases are easily accessible only to air transport.

While it is difficult to mention all those to whom we are indebted for assistance in this project, particular mention should be made of the former President and Minister of Communications of the Colombian Republic, who by his imagination and initiative in foreseeing the possibility of using high grade VHF radio circuits has contributed greatly to solving the problem of long distance telephone communication in Colombia.

To Dr C. M. Tellez, Director of the Empresa Nacional de Telecomunicaciones, and his staff engineers Gustavo Camacho and Hernando Bernal as well as to Dr Ruiz Cuevas and Dr Gustavo Piquero, who were technical representatives of the Colombian Government in the critical stages of the project, our thanks for their close collaboration are warmly extended.

In the RCA International engineering group, Mr G. G. Gerlach took charge of the field propagation tests as well as planning the basic radio system. He was assisted in Colombia by engineers George Watson, Ivar Hilfing and Arne Stein, who handled much of the engineering work. We would also like to express our appreciation to the many others not mentioned here both in the RCA and the Ericsson organizations, who so whole-heartedly gave their time and skill to make the system a success.

Thermotechnical Instrumentation for the Furnaces in Tube Rolling Mills

T WENDT, SANDVIKENS JERNVERKS AB, SANDVIKEN

U.D.C. 536.2
621.317.39:621.365

A number of heating furnaces have been installed in Sandvikens Jernverk's new tube rolling mills, for which a thermotechnical instrument equipment was required for controlling the heating process and the final temperature of the billets, and at the same time enabling an economy of fuel to be achieved. The instruments for this plant which were designed and installed by L M Ericssons Mätinstrument AB (Ermi), are found to meet all the demands made of them. A brief description of this installation is given in the present article.

It is only within quite recent times that ironworks have devoted an increasing interest to thermotechnical instrumentation in connection with their numerous different types of furnaces. All electric furnaces were equipped with instruments for controlling the temperature and kWh-consumption at an early stage however. For gas-fired furnaces, on the other hand, instruments were seldom used, with the exception of an occasional draught gauge. The fuel, which was coal or wood, was relatively cheap and furthermore, it was difficult to measure the gas flow when using unpurified producer gas. On the transition to oil-fired furnaces which took place after the last war, the question of instrument equipments became of immediate interest to the majority of ironworks. This was due to the fact that it was easier to measure the quantity of fuel supplied

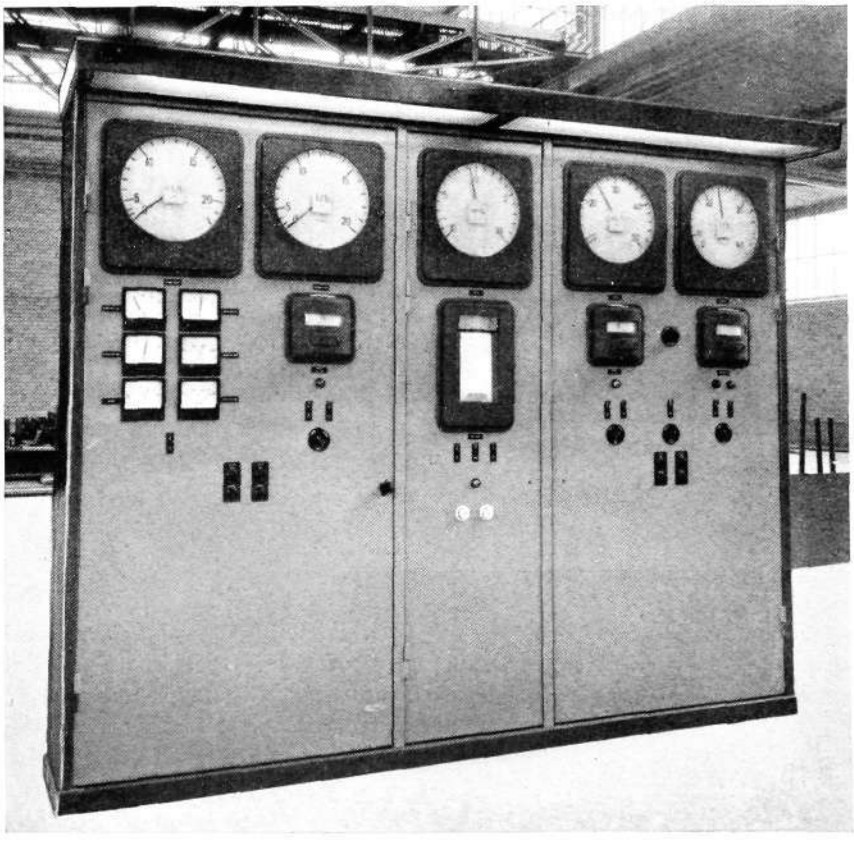


Fig. 1 X 6635
Instrumentation for a piercing mill furnace

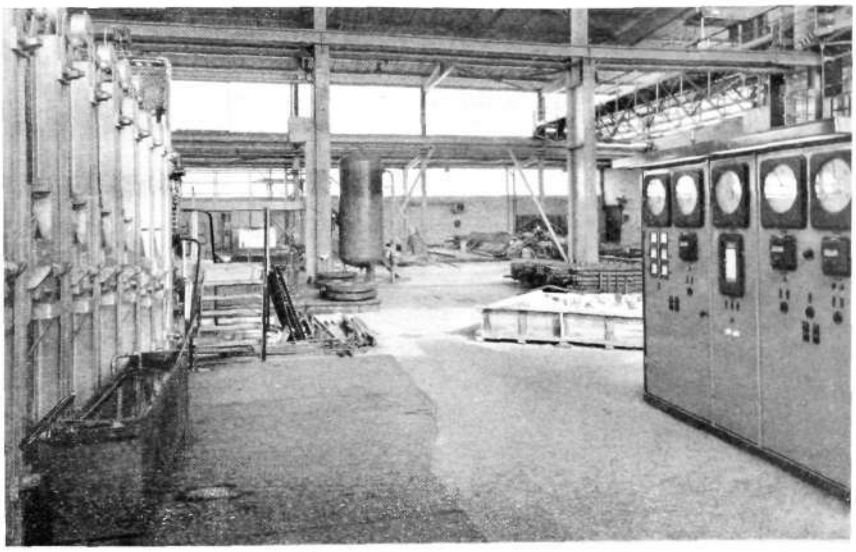


Fig. 2 X 6636

Position of the instrument board in relation to the furnace

to the furnace accurately and in addition, the prices for fuel have rendered it essential to handle this commodity more economically than was formerly necessary.

When we had reached the decision at Sandviken to build a number of heating furnaces for our new tube rolling mills the question naturally arose as to the form the thermotechnical instrumentation should take in order to meet our needs. Our foremost requirement consists in ensuring that the heating process in the furnaces is carried out correctly and that a correct final temperature is obtained for the billets. Moreover, it should not be necessary to employ more fuel than is essential for the type of furnace concerned.

Fuel-oil is used exclusively as the fuel for these furnaces as long as a supply is available. The burners for the oil have been incorporated in the burner for producer gas, so that it would be easy to change over from oil to gas firing in the event of difficulties arising suddenly in connection with the importation of oil. An air blast is used for the atomizing air. The quantity required is about 10 % of the theoretical quantity needed for combustion. The air of combustion is heated by the exhaust gases from the furnace and is fed to the burners in the same way as gas when the latter is used as the fuel in place of oil.

Up to the present, two furnaces have been placed in commission in the tube rolling mills — a billet furnace for the piercing mill and a billet furnace for the tube rolling mill.

In the billet furnace for the piercing mill, which is the smaller of the two furnaces but requires a greater amount of heat than that for the tube rolling mill, the burners have been divided into two groups. Burners have been inserted both at the end and on one of the longitudinal sides. The furnace is of the type known as a push heating furnace which implies that the billets to be heated are fed in at one end and drawn out at the other. The exhaust gases from the end and side burners pass over the billets and are then led directly to the recuperator where the blast air is preheated, after which they pass on to the chimney. The instrumentation for the furnace is shown in Fig. 1.

Construction

As may be seen, the instrument board is divided into three panels. The doors on which the instruments are mounted open outwards, thus enabling inspection of the connections and supervision to be carried out conveniently. The air flow meter and the oil meter for the side burners are mounted on the lefthand panel. The quantities are measured by means of throttle flanges inserted in the respective pipe lines. The meters are of the tubular ring type. A regulator built on the chopper-bar principle controls the oil/air ratio, so that when more oil is fed to the burners the regulator responds accordingly and increases the quantity of air until the oil/air ratio for which the regulator is set has been restored. The valves for adjusting the air and oil flow are motor-operated. The regulator can be disconnected and the motor-driven valves controlled by hand if desired. This form of control is resorted to particulary when firing up and damping down the furnace and on making alterations in the service which necessitate a rapid change in the prevailing conditions.

On the same panel of the instrument board certain indicating instruments have been mounted which show the temperature of the exhaust gas before entering and on leaving the recuperator, the air temperature on leaving the recuperator and the air pressure on entering and leaving the recuperator as well as the oil pressure in front of the regulating valve.

The central and smaller panel has a ring balance for the pressure in the furnace chamber and a six-colour recording apparatus for recording the course of certain temperature processes.

The righthand panel carries the instruments for the end burners. The air flow meter, the oil flow meter and the regulator for the oil/air ratio are mounted here. To enable a uniform and correct temperature to be maintained in the billets leaving the furnace, a pyrometer protected by a ceramic tube has been mounted in the furnace roof a few metres in front of the burners. The pyrometer projects approximately 50 mm down into the furnace chamber under the roof. It is obvious that the temperature of the billet is not indicated by this pyrometer, but it records variations in the furnace temperature and the oil valve is adjusted by the regulator so that a larger or smaller quantity of oil is supplied to the burners. The regulator is constructed with a delayed action, and it takes about half-an-hour for the oil valve to move from the fully closed position to the fully open position. Provision is, of course, also made for the manual operation of the valves by the press-buttons.

Fig. 3 X 6637

Instrumentation for a tube mill furnace

This panel likewise contains the regulator for the furnace pressure. It is located between the two large regulators and is visible in the illustration as a small black knob. On setting this knob in a suitable position, the pressure in the furnace can be adjusted so that it is as close to zero as possible without causing hot gases to be blown out through the doors. The regulator works directly on the damper for the gas passing out of the furnace, and it closes and opens this damper according to requirements. To avoid the necessity for the rapid adjustment of the furnace pressure which may give rise to oscillations when new billets are placed in the furnace and the end door is open, the regulator is controlled electrically by a pressure switch mounted on the end door. When the door is open the circuit is interrupted and the regulator is disconnected.

Fig. 2. shows the position of the instrument board in relation to the furnace. The attendants who operate the furnace stand on the platform in front of it. They thus have a clear view of the instruments and can quickly make any corrections in the oil and air supply which may be necessitated by a sudden change in the working conditions.

The instrumentation for the tube mill billet furnace has been designed largely on the same lines as that for the piercing mill furnace. As the furnace is only equipped with end burners, fewer instruments are required and they have been mounted on two panels as shown in Fig. 3. The quadratic indicating instruments have been mounted in a horizontal row below the flow meters. Regulation of the furnace pressure was not considered necessary in this case, but provision has been made for installing a regulator subsequently.

Although the instrument equipments described here only include the minimum number of instruments required to operate the furnaces correctly, they nevertheless represent a necessary supplement to the latter. Obviously, a more extensive instrument installation may be found desirable in certain cases with a simple measuring device for determining the billet temperature in the furnace if possible.

The reason for requesting Ermi to carry out this installation was based on the fact that this firm possessed all the necessary qualifications for undertaking the work successfully although this was the first occasion on which instruments for heating furnaces had been supplied.

25 Year Anniversary at San Sebastián

On June 13th 1951 the automatic telephone exchange at San Sebastián built by L M Ericsson completed its 25th year in operation. This anniversary was commemorated by a celebration arranged by the municipal authorities in the town.

The celebrations were opened with a memorial church service.

The commemoration was attended not only by telephone and council staff but by delegates from the state of Guipúzoca and the national government represented by the local commanders for the army and navy. After the service the guests were conducted to the telephone exchange which was demonstrated by the telephone manager, Sr José Maria Sirera and his immediate assistants. The exchange covers at present 10500 lines but L M Ericsson has recently received a contract for an extension of the installation covering a further 5000 lines.

The illustration shows Sr Sirera demonstrating the exchange for interested dignitaries.

New LB Plug Switchboard ABG 15

U.D.C. 621.395.65

The plug switchboard has proved itself to be the perfect answer for small telephone plants, both of a private and public nature, where the traffic intensity is not extensive. Thanks to its simple and sturdy connecting devices — plugs — this type of switchboard is much easier to maintain and service than the cord variety. Bearing these important factors in mind, Telefonaktiebolaget L M Ericsson engineers have now produced a new series of LB plug switchboards, to be known as type ABG 15. Owing to their modified calling and clearing devices and external design, these switchboards constitute an up-to-date "edition" of L M Ericsson's earlier plug models, type ABG 12—14. The new series, which will be dealt with in this article, supplements the manual LB switchboards described in the Ericsson Review Nos 3/1946 and 4/1947.

The new plug switchboards *ABG* 15 can be used to great adventage as rural switchboards in less developed networks, the calling indicators being so sensitive that long dural lines as well as normal subscribers' lines can be connected. The switchboards also make excellent private branch exchanges in networks where the local battery system is still retained. Finally, they can be incorporated as purely local switchboards, particulary in plants where the LB system must be used owing to the fact that the sections are widely separated, and therefore require long lines which would be less suitable for the CB system.

The advantages gained with a plug switchboard are:

Good speech transmission — there are no cords which might cause a deterioration in performance owing to some defect.

Low maintenance costs — investigations, repairs or replacements of cords are not required.

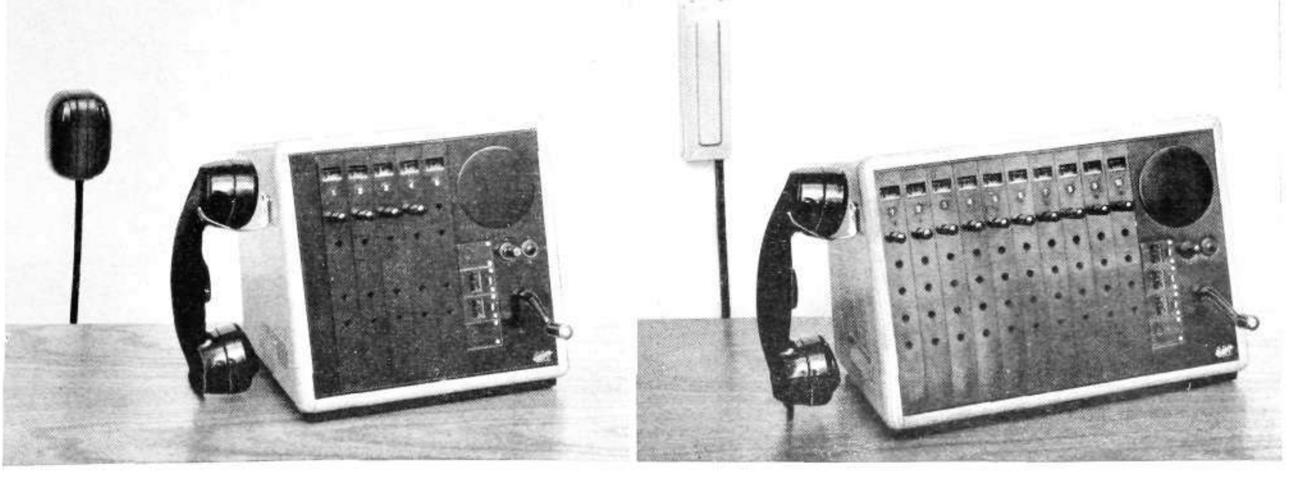
Several or all lines can be called at the same time. This is of vital importance when orders or alarms must be given.

Telephone conferences can be arranged by connecting up the lines of the parties concerned to the same connecting row.

Fig. 1 X 7601

Plug switchboards ABG 1505 (left) and ABG 1510

for 5 lines and 2 call facilities, and 10 lines and 3 call facilities, respectively



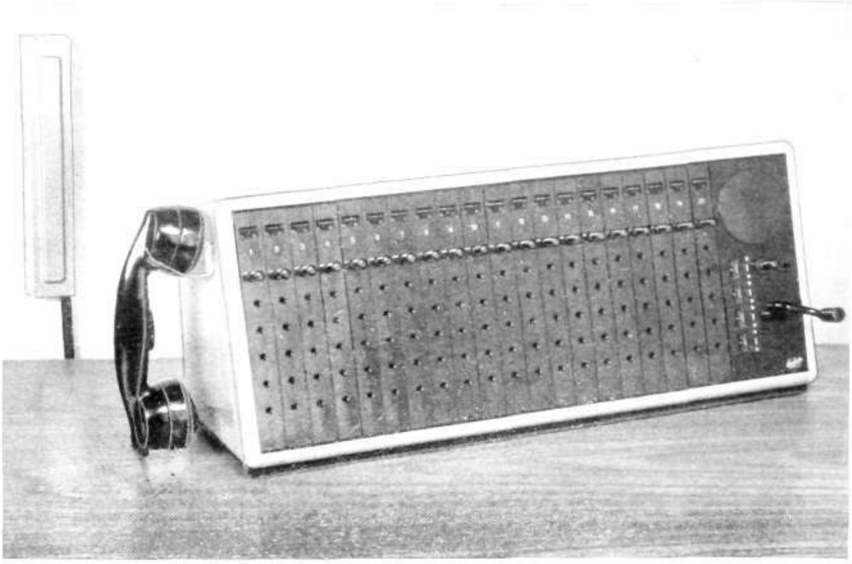


Fig. 2 X 6621

Plug switchboard ABG 1520

for 20 lines and 4 call facilities

Execution

The new LB plug switchboards are normally supplied in the following sizes:

ABG 1505 for 5 lines and 2 call facilities
ABG 1510 for 10 lines and 3 call facilities
ABG 1520 for 20 lines and 4 call facilities

In addition to the above mentioned call facilities, every switchboard has one call facility to its own speech and ringing equipment.

If required, the switchboards can be provided with equipment for exchange lines to manual or automatic CB systems. In this case, one or more line units for LB lines are replaced by the corresponding number of units for exchange lines and a dial is added. The following sizes are available:

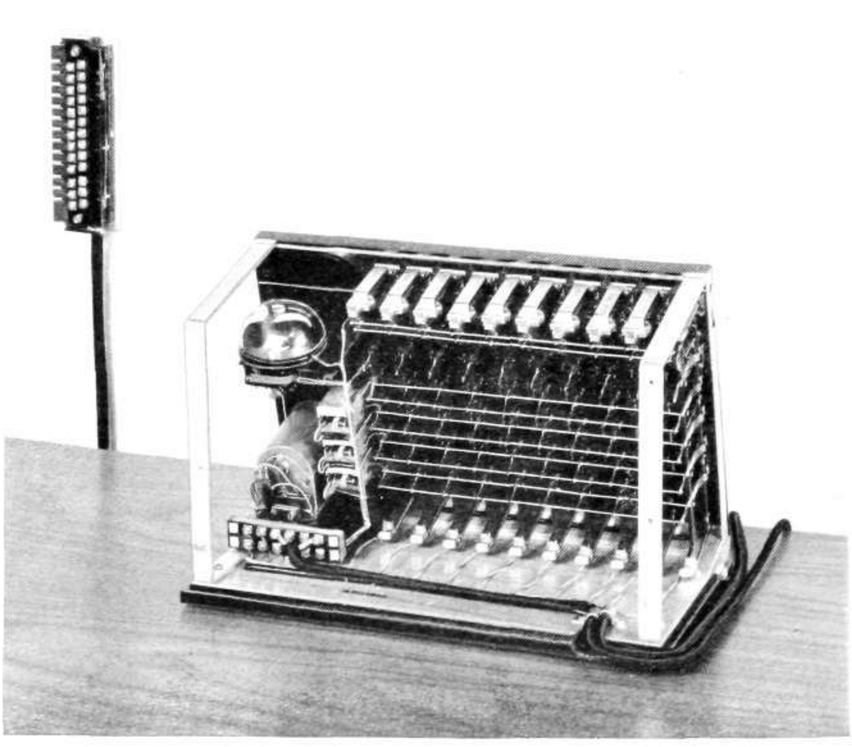


Fig. 3 X 6620

Plug switchboard ABG 1510

seen from the rear with cover removed. On the left side is the terminal block, hand generator and bell (from the bottom up).

ABG 1550 for 1 exchange line and 4 LB lines
ABG 1560 for 2 exchange lines and 8 LB lines
ABG 1570 for 3 exchange lines and 17 LB lines

Figs 1 and 2 show the three plug switchboards. Considerable trouble has been taken to render the external appearance as modern as possible. The black, inclined front and soft, flowing lines give the switchboard a finish which fully harmonizes with other items of current office equipment.

By making use of similar construction elements, it has been possible to provide standardized erection of the three sizes. A simple iron frame is fixed to an oaken base-plate, the line units and the position set being mounted on the former. A cover of light polished oak with rounded corners and edges completes the switchboard. The cover is fixed to the base-plate by two screws only. This ensures easy removal when the switchboard has to be inspected or overhauled, see Fig. 3.

The three models are all designed to be placed on a table and are therefore equipped with a wall-mounted junction-box, to which all outgoing lines are connected by means of a flexible cable. This and the cord of the handset are connected to the back part of the switchboard.

The handset, which is of LM Ericsson's latest design, is hung up on the left side of the switchboard where it is easily accessible. The hand generator for transmitting the ringing signal current is placed so that the crank protrudes through the front panel. This arrangement makes operating very easy, particularly in connection with the largest switchboard, ABG 1520.

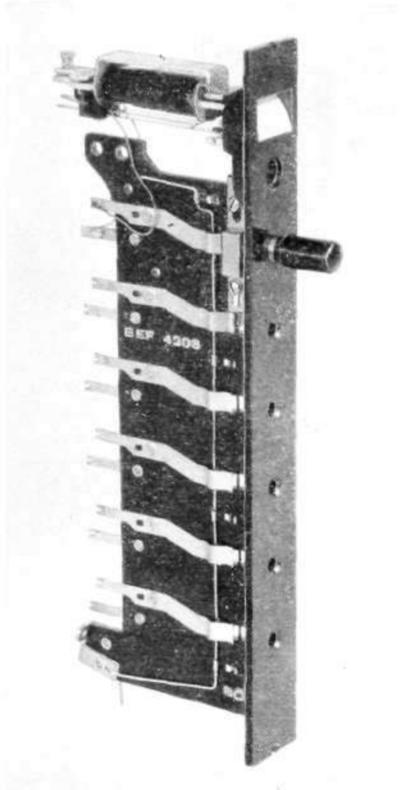


Fig. 4 X 4741

Line unit BEF 42

At the top is the calling drop indicator and under this the idle jack, the answering jack and the inter-connecting jacks. On the side of the strip one of the two longitudinal wires is seen. The incoming line is connected to these.

Components

As has already been mentioned, the switchboards are composed of line units with calling indicator and jacks, and position set with clearing indicators and common equipment.

Line Unit

The principal element in the new plug switchboard is the line unit, Fig. 4. It consists of a strip of phenolic resin fitted with a drop indicator and a number of jacks.

The calling drop indicator is of the latest »built-in» type and has the same shutter as the indicator in the new LM Ericsson cord switchboards. All the usual adjustment facilities are included and an alarm contact is fitted. On an incoming call, the shutter is released and then mechanically restored when the plug is inserted in the jack, Fig. 5. The winding of the drop indicator, which is normally connected to the neighbouring jack, has about 7,000 turns.

The jacks are mounted on the T-shaped part of the strip. Each jack consists of two contact springs, the *a* and the *b* springs, riveted one on each side of the strip just in front of the jack hole, but with relatively different displacement. Along the whole length of the jack strip runs a pair of contact wires, one on each side of the strip, which cross all the jacks. When a plug is inserted in a jack, contact is made between the contact springs and the wires. Both longitudinal contact wires are fixed at the bottom to a pair of terminals, to which the incoming line is connected.

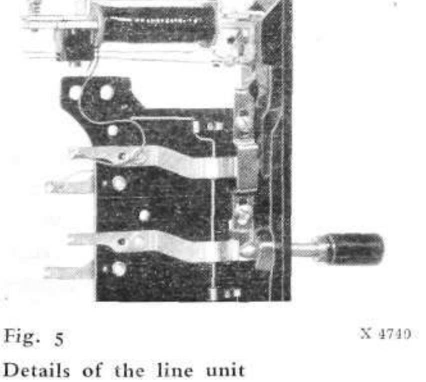


Fig. 5 X 4740

Details of the line unit

The shutter of the calling indicator is restored mechanically when the plug is inserted in the answering jack.

The jacks have the following functions: The jack nearest the indicator is connected to this indicator and is called the *idle jack* because the plug is placed there when the line is unoccupied. The next jack is the *answering jack*, to which the switchboard's speech and ringing equipment is connected. The other jacks, from two to four in number according to requirements, are *inter-connecting jacks* for the establishment of speech connections between the lines.

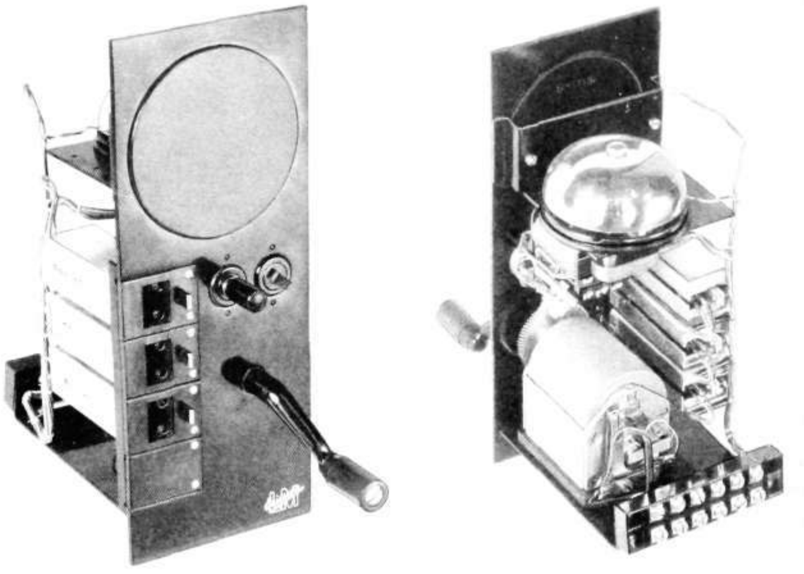


Fig. 6 X 6619

Position set BEK 12

(right) seen from the rear. In the left-hand picture the clearing indicators, extra plug for listening-in, key and generator crank are seen. In the right-hand picture (bottom to top) are: terminal block, hand generator, clearing indicators and bell.

Position Set

All parts common to a switchboard, such as the induction coil, hand generator and bell with a key, are contained in the position set, Fig. 6. The clearing indicators for the connecting rows are also accommodated here.

The clearing drop indicator, Fig. 7, is basically of the same design as the calling indicator, but is equipped with an iron mantle to prevent crosstalk between neighbouring indicators. In addition, it is fitted with a restoring mechanism consisting of a little metal tongue which sticks out at the front. A fallen indicator is restored by the tongue being pressed in. The clearing indicator is more sensitive than the calling indicator, and has a winding of about 9,000 turns.

Connecting Procedure

The connecting diagram for the ABG 15 is shown in Fig. 8. The lines are connected at *L 1*—*L n*.

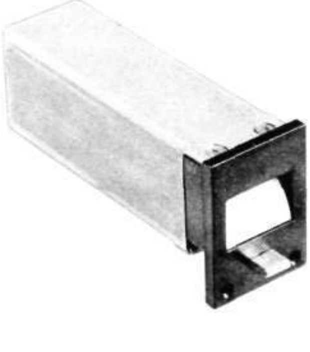


Fig. 7 X 4742

Clearing indicator RNA 16

The switching procedure when setting up a speech connection is as follows: When a call comes in on one of the lines, the calling indicator *C 1* for the line in question drops. If the key *XB* is thrown over, a signal is also obtained on the bell *B*. The call can be answered by the operator in the handset *M*—*R* when the plug of the calling line has been moved from the idle jack *A* to the answering jack *T*. By doing this, the line is disconnected from the calling indicator and connected instead to the operator's set. When the operator has obtained information regarding the desired connection, the calling line is transferred to an idle link circuit by moving the plug from the answering jack *T* to one of the connecting jacks *K 1*—*K n*. The line desired is then connected to the operator's handset by transferring the plug for the line in question from *A* to *T*, whereupon this line is called up by means of the hand generator *HG*. When an answer has been obtained, the called-up line is then transferred by means of the plug to the link circuit to which the calling line has been connected. The connection is now complete.

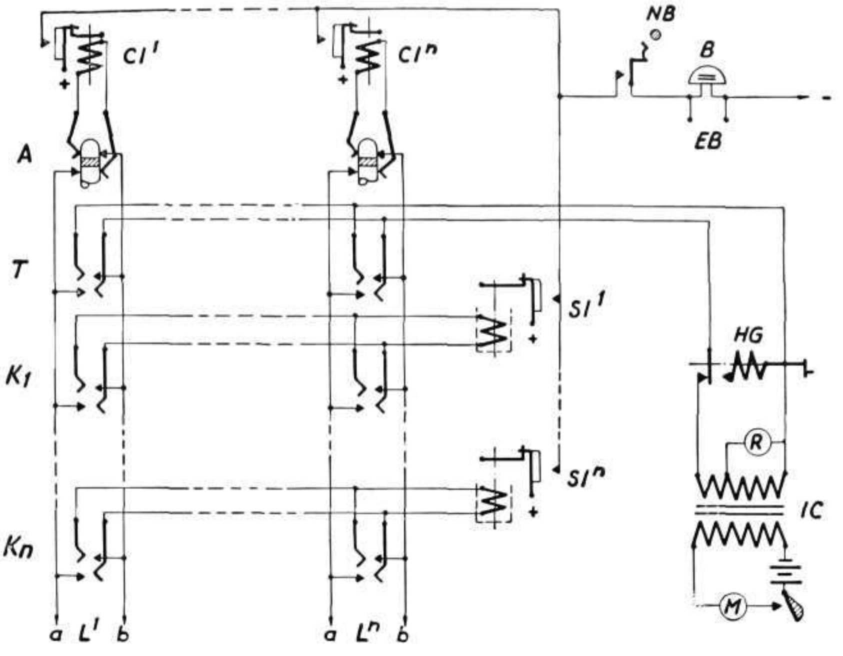


Fig. 8 X 6618

Connecting diagram for ABG 15

- A idle jack
- B bell
- CI calling indicator
- EB extra bell
- HG hand generator
- IC induction coil
- K inter-connecting jack
- L lines
- M transmitter
- NB key
- R receiver
- SI clearing indicator
- T answering jack

When one of the parties gives clearing signal with the hand generator, the clearing indicator falls for the connecting row in question. By inserting the listening plug into the answering jack of one of the parties, the operator can check whether or not the call really has terminated. If it has, the plugs are to be moved back from the interconnecting jacks to the idle jacks and the clearing indicator restored.

Dimensions and Weight

The dimensions and weight of the plug switchboards are shown in the table below. The width indicated does not include the handset hook, which protrudes by about 50 mm.

	height mm	depth mm	width mm	weight kg
ABG 1505	257	205	268	6.3
ABG 1510	257	205	368	8.2
ABG 1520	257	205	618	11.7
ABG 1550	257	205	268	7.5
ABG 1560	257	205	368	9.8
ABG 1570	257	205	618	13.8

Accessories

The only accessory required for the plug switchboards is a 3 V dry battery for the alarm circuit and microphone feed. Batteries should be placed in a special box outside the switchboard. Batteries and battery boxes are not supplied with the switchboards and must be ordered separately.

New Type of Interlocking Plant for the Swedish State Railways

MR T LUNDBERG, BOARD OF MANAGEMENT OF THE SWEDISH STATE RAILWAYS, STOCKHOLM

U.D.C. 656.257(485)

In February this year a new interlocking plant was put into operation at Stehag by the Swedish State Railways. Stehag is a station north of Eslöv on the line Stockholm—Malmö. Automatic line blocking has previously been arranged on the section Hässleholm—Malmö and the station now serves as a blocking section on this line.

The station is normally passed by some 40 through trains daily in addition to 20 stopping local trains and two local goods trains shunting at the station.

The equipment has been supplied by the LM Ericsson Signal Company whereas the planning and lay-out has been prepared by the Board of Management of the State Railways assisted by the Signal Company.

Electrical control plants operated by levers or handles are nowadays being superseded by relay systems controlled by press buttons or keys, enabling the introduction of certain automatic functions. This tendency is also apparent with regard to the interlocking machines. By incorporating the control keys for the points, track routes, signals &c on a schematic illuminated track diagram a very clear picture is obtained of the relationship between the control switches and the track lay-out.

The switches are of non-locking push button or lever type. The circuits are arranged for impulse operation.

In the interlocking machine for Stehag, Fig. 1, tracks and points are represented by oblong apertures illuminated with white light when the track is free from trains and with red light when the track is occupied. The signals are indicated in proceed position and stop position with a green and a red lamp respectively.

Fig. 2 shows the interlocking machine mounted on the signalman's working desk.

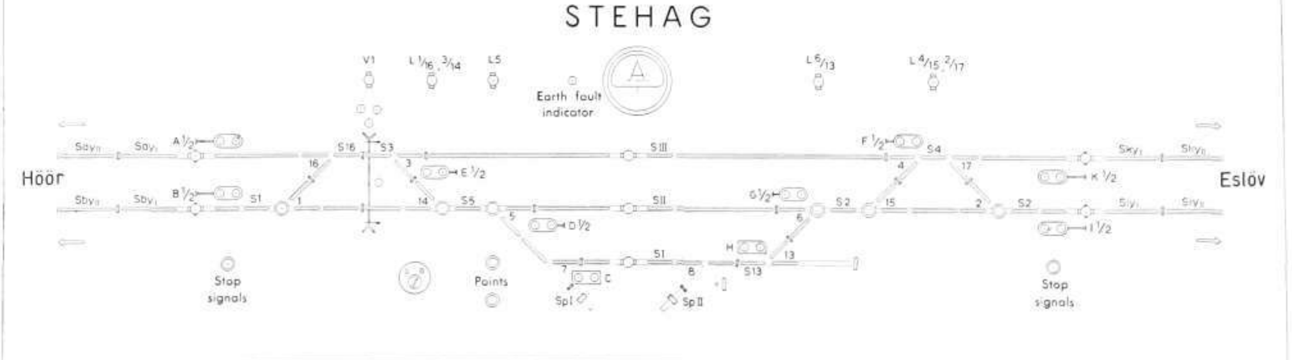


Fig. 1 X 7611

The track diagram

containing all control equipment and visual indications

X 6605

Fig. 2
The interlocking machine
mounted on the signalman's desk

Operation

Three buttons are used when operating a point: one selecting button placed in the track at the point together with plus and minus buttons common for all points and mounted at the bottom of the illuminated track diagram. When a point is to be operated the corresponding selecting button is pressed at the same time as a plus or a minus button. If the positive and the negative buttons are operated simultaneously when a selecting button is pressed, the movement of the point machine is halted. This facility must be available in winter time when packed snow may lodge between the point tongues and the running rails.

When a train route is to be set up, all appertaining points are operated to correct positions. Two keys are then operated one at the beginning and one at the end of the route. The train route established is indicated by a series of illuminated apertures showing white light, an illuminated ribbon. The keys mentioned above are mounted in the tracks on the diagram and may be operated both ways in line with the track. When setting up a train route the keys are operated in the direction of the train movement.

Point Operation

In an interlocking plant the equipment governing the operation and locking of the points is a very important factor. In a lever locking machine the point control, route locking and signal operation largely takes place over contacts on the levers, which are interlocked in the operated positions. In a relay system, these functions are carried out by the relays which are substituting the levers.

As mentioned above point operation is initiated by means of an impulse both in case of remote control from a signal box and in case of local push buttons at the point. A brief description will be given below of the point operation, see Fig. 3, showing the point in plus position.

On operation of the push buttons relay *Hj 1—* is operated by *V—* contacts breaking the SS-indication.

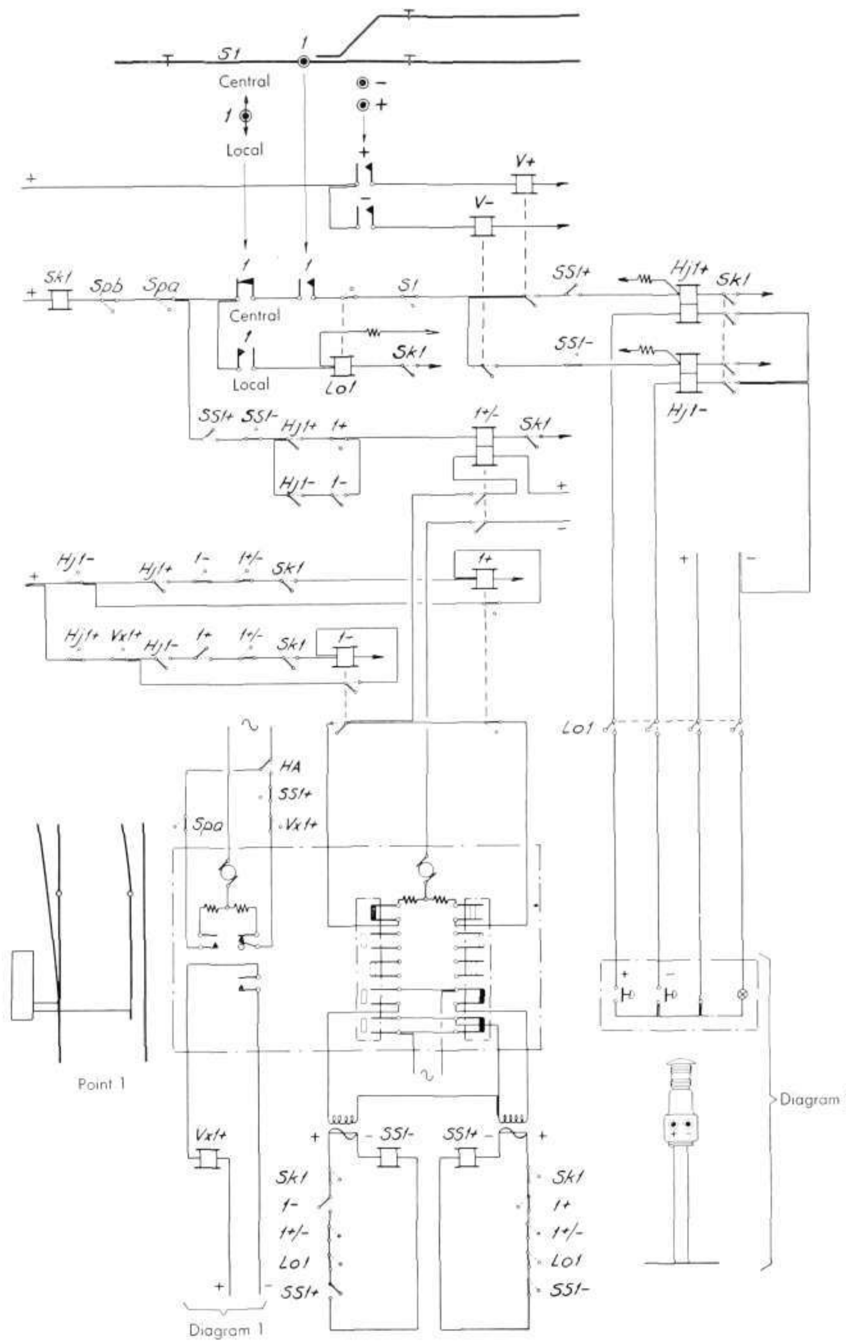


Fig. 3 X 6654

Circuit diagrams for a point

containing push buttons, control relays, point machine, point lock and local lever

Circuit 1: Operation and control of the point

2: Local operation

The impulse from the *Hj 1—* relay is stored in the relay *1—* which determines the direction of the point movement. Relay *1—* connects the motor relay 1 +/— closing the operating current for the motor.

The motor relay *1 +/—* contains a holding coil, which on the operation of the relay is connected in series with the motor. The relay will consequently remain operated until the motor circuit is opened by the end position contact in the point machine. When the point machine has stopped and relay *1 +/—* has released, the circuit to *SS 1—* is closed. The SS-relay consequently provides a continuous supervision of the point taking up a proper position.

Local point operation facility is obtained by the operation of a key. Relay *Lo1* is operated connecting current for relays *Hj 1--* to local lever on the

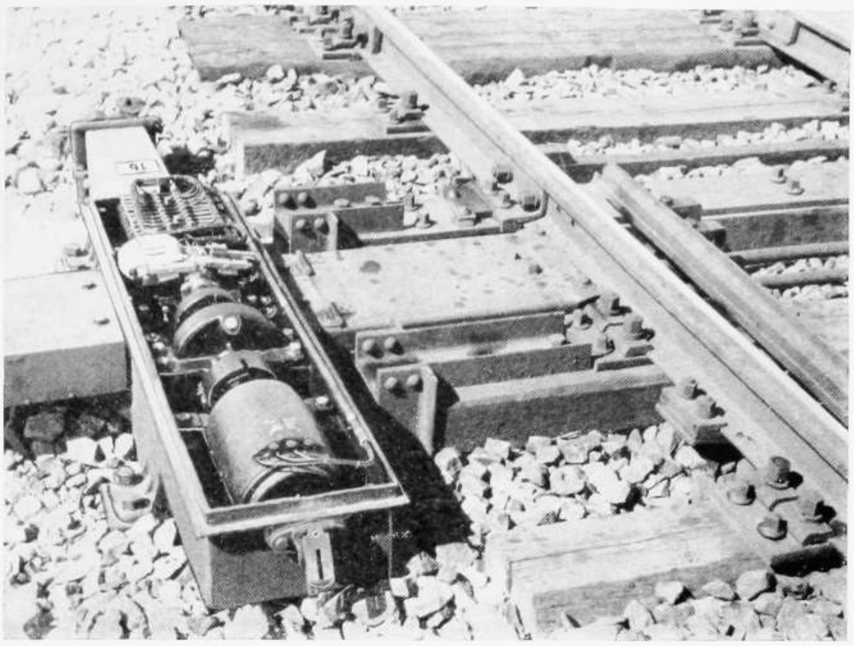


Fig. 4 X 6606

Point machine

provided with point lock. The point lock motor is visible at the far end of the equipment.

sidings. For this purpose relays *Hj 1--* are equipped with an additional coil. When local point operation is permissible a lamp is lighted above the local lever. This control has two push buttons from which initiating impulses may be transmitted for the operation of the point.

Point Locking

Owing to the increased train speeds it has been considered necessary to provide additional locking of the tongues for the points in the main tracks. This takes place by means of a motor driven point lock shown in Fig. 3, circuit 1, which is operated, when the signal is changed to proceed. This arrangement makes the point non-reversible for traffic coming in from an off-track as opposed to ordinary points.

Fig. 5 X 6607

Local lever

at the point. The lever contains a lower part with push buttons and on top a lantern fitting with drum lens. A yellow light in the lantern indicates that local point operation is permissible.

Fig. 6 X 6608
The home signals
are identical for the two tracks

Signalling

For home signals colour light signals are used as shown in Fig. 6. Distant signals are shown in Fig. 7.

As will follow from these illustrations the signals are identical in the same traffic direction for both tracks. The bottom light on the distant signals is a side track signal showing yellow continuous light with green flashing light in the distant signal when the train route is side tracked.

Main track exit signalling takes place by means of colour light signals. Shunting and traffic from side tracks are controlled by dwarf signals, see Fig. 8.

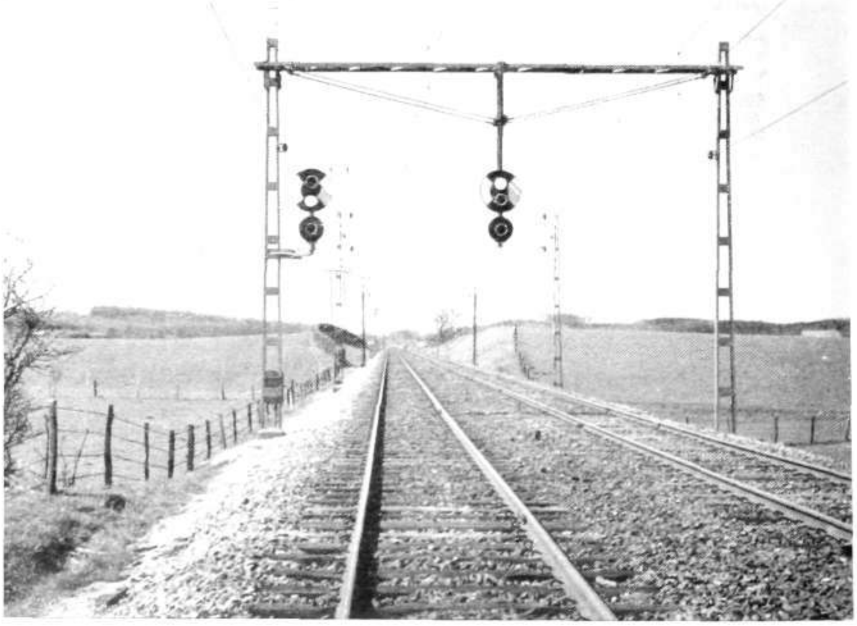


Fig. 7 X 6609
Electrical distant signals with side track light

Fig. 8 X 6610

Colour light signals

for exit from the two tracks. A dwarf signal is used for the side track with six apertures of which the two bottom lights are green.

Signal Operation

Fig. 10, circuit 1, shows a section of the track system including among other signals home signal *A*. The procedure for the operation is as follows.

If the points are in their correct positions for the track route (SS-conditions), relay *HA* operates, when signal keys a^1/a^2 and *IIIh* are pressed in the traffic direction. As the signal keys are non-locking the operated relay is held over own contact.

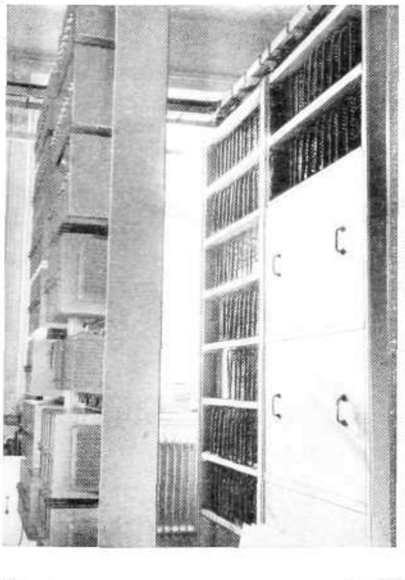


Fig. 9 X 4752

The plug-in relays

are arranged in four frames. The connections are carried out on the fixed terminal blocks. The relays can, therefore, be replaced very quickly.

Relay *HA* with track relays *S*-- and relay *Vx* for point locking set up a circuit to signal relay $A\,^1/_2$ in Fig. 10, circuit 4, which relay in its turn operates signal *A* to proceed, circuit 5.

Relays *Sp*-- are introduced for the exclusion of hostile traffic routes. In the example shown in Fig. 10 circuit 3, *Spa* is released on the operation of relay *HA* and blocks in this position the operation of hostile signals. This blocking will not be cancelled until *Spa* reoperates when the train is entering track circuit *SIII* and *SII* respectively and has left track circuit *S 3* entirely.

Relay *Sta*, Fig. 10 circuit 7, is arranged to prepare the release of the traffic route taking place on the operation of *Spa*.

Relay *TA* controls the traffic route indication on the illuminated track diagram. The circuit for this relay is shown in Fig. 10, circuit 6.

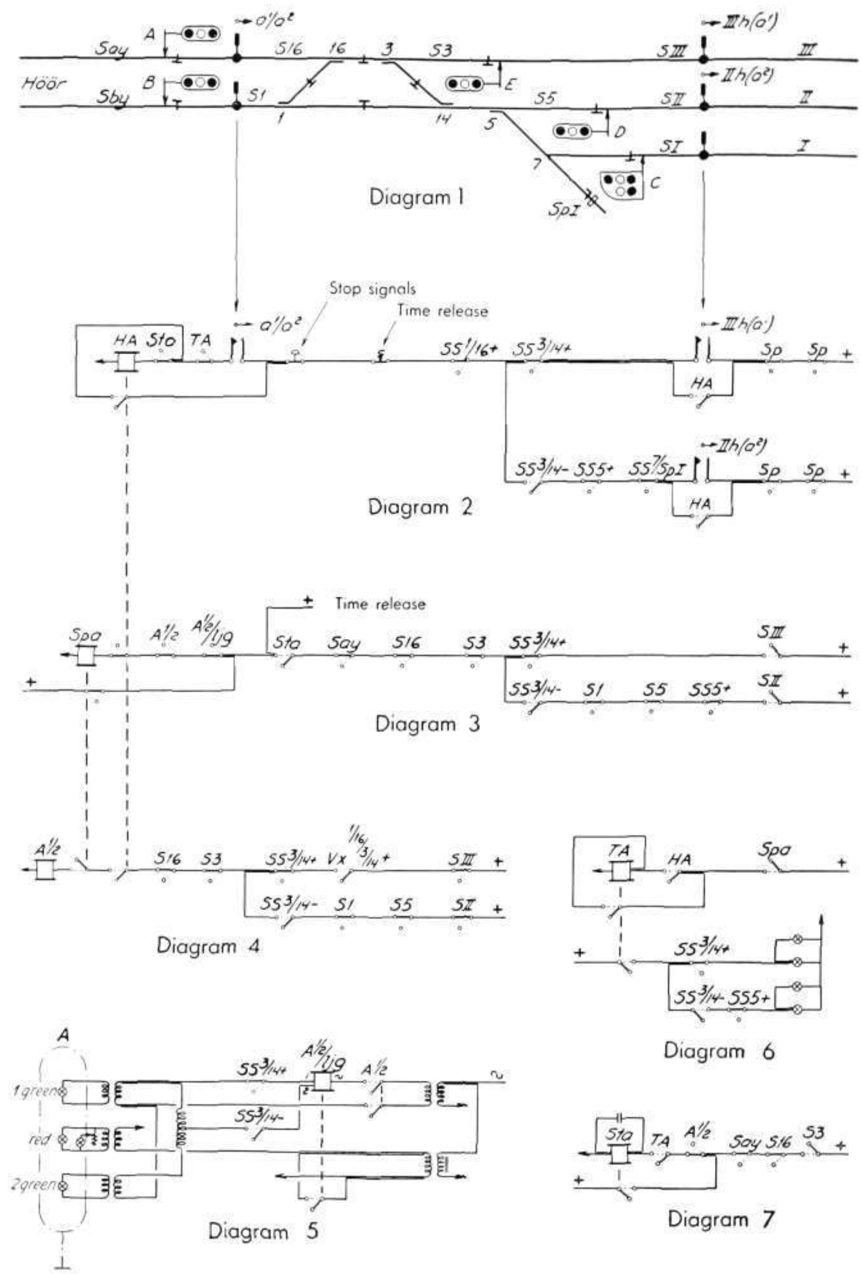


Fig. 10 X 6655

Circuit diagrams for signal operation

Circuit 1: Section of track diagram with traffic route keys
» 2: H-relay circuit controlled by traffic route keys
» 3: Blocking relay circuit
» 4: Signal relay circuit
» 5: Light signal circuit
» 6: Relay and indication lamps for traffic route
» 7: Relay circuit for release

Track Circuits

The track system is controlled by means of track circuits. The track relays consist of 2-phase motor relays operating on 75 c/s A.C.

The necessary power supply is obtained by the conversion of 50 cycles A.C. by means of the Signal Company frequency converter, which is built up without moving parts.

The relays used in the system are plug-in relays of the new type supplied by the Signal Company and which were described in Ericsson Review No. 4, 1950.

New Ericsson Receivers

C FREDIN, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.396.62

The present article describes three of Svenska Radioaktiebolagets new designs, model 1519 and 1518 radiogramophones and a large table model, 1514.

Ericsson model 1519

The classical form of the secretarial bureau has served as design for the *Ericsson model 1519* illustrated in Fig. 1. This beautiful radiogramophone is characterized by its distinct, and refined lines and the first-class materials employed in its construction. The ingenious arrangement of the loudspeaker opening has made it possible to retain the character of the apparatus as a piece of domestic furniture. The loudspeaker is located in the lefthand section of the bureau, and three shutters, presenting the appearance of drawers, are arranged in front of it, see Fig. 3. To open these shutters it is only necessary to pull the key. At the same time the switch is actuated and the switching-on of the set is indicated by the discrete illumination of the loudspeaker screen. On the right, a capacious compartment is provided for gramophone records, record albums, etc.

In its lowered position, the lid of the bureau forms an excellent writing desk or a table suitable for record sorting.

Model 1519 is manufactured with a highly polished special mahogany, a polished or a matt silk mackoré finish.

Needless to say, the model 1519 is equipped with a first-class receiver. It is also provided with all those special features looked for in a high-grade set, such as a push-pull output stage, bandspread on short-wave, a tuning indicator, etc. A detailed account of the receiver's electrical functions, however, apart from a few minor changes, would entail a repetition of the description published previously in the Ericsson Review.

Fig. 1 X 7608

Ericsson model 1519

right: with the lid in its lowered position and with record changer and receiver visible

Fig. 2 X 6647

The lid forms an excellent writing desk or a table suitable for record sorting

Fig. 3 X 4767

The shutters

are opened when the key is pulled

Fig. 4 X 4768

Combination-loudspeaker

for Ericsson model 1519

Specification

Type designations:

for AC, type *1519 AC*

for AC/DC, type *1519 AC/DC*

Receiver: 7-valves, 11 valve-functions, 6 tuned circuits, 7 tuning ranges on long wave, medium wave and bandspread on 19, 25, 31 41 and 49 m. Push-pull output stage.

Loudspeaker: HK 1130/HPA 1010.

The loudspeaker represents one of Svenska Radioaktiebolaget's latest designs. It is a combination type, that is to say, it consists of two loudspeakers, a large one for reproducing the bass and middle register and a smaller one for the high notes. Fig. 4 shows the combination-loudspeaker, in which the smaller speaker HPA 1010 is mounted coaxially within the larger one HK 1130, thus eliminating the risk of phase distortion which may arise when two loudspeakers are mounted side by side.

The *record changer* which is of the most up-to-date type can be set for speeds of 78, 45 and 33 1/3 r. p. m. It changes 25 and 30 cm records intermixed. The light movement and pressure of the pick-up on the record are of greatest importance to the long life of both the sapphire and the records. The pressure amounts to 8 g. only.

The alternating current receiver's pick-up is of the piezo-electric type and is provided with a sapphire which is ground in such a way that it is suitable for all records. The AC—DC receiver's pick-up has two interchangeable sapphires, one for ordinary and one for long-playing records.

Ericsson model 1518

Another excellent and attractive radiogramophone included in this season's Ericssons series is *model 1518*, Fig. 5. It is of somewhat simpler design than the bureau model. The record changer and accompanying record compartment are arranged on the lefthand side of the apparatus. The radio receiver is mounted on the right at the top, and is protected by a hinged panel. Below it in front of the loudspeaker the same arrangement is employed as in model 1519.

Model 1518 is manufactured with a highly polished or matt mahogany finish.

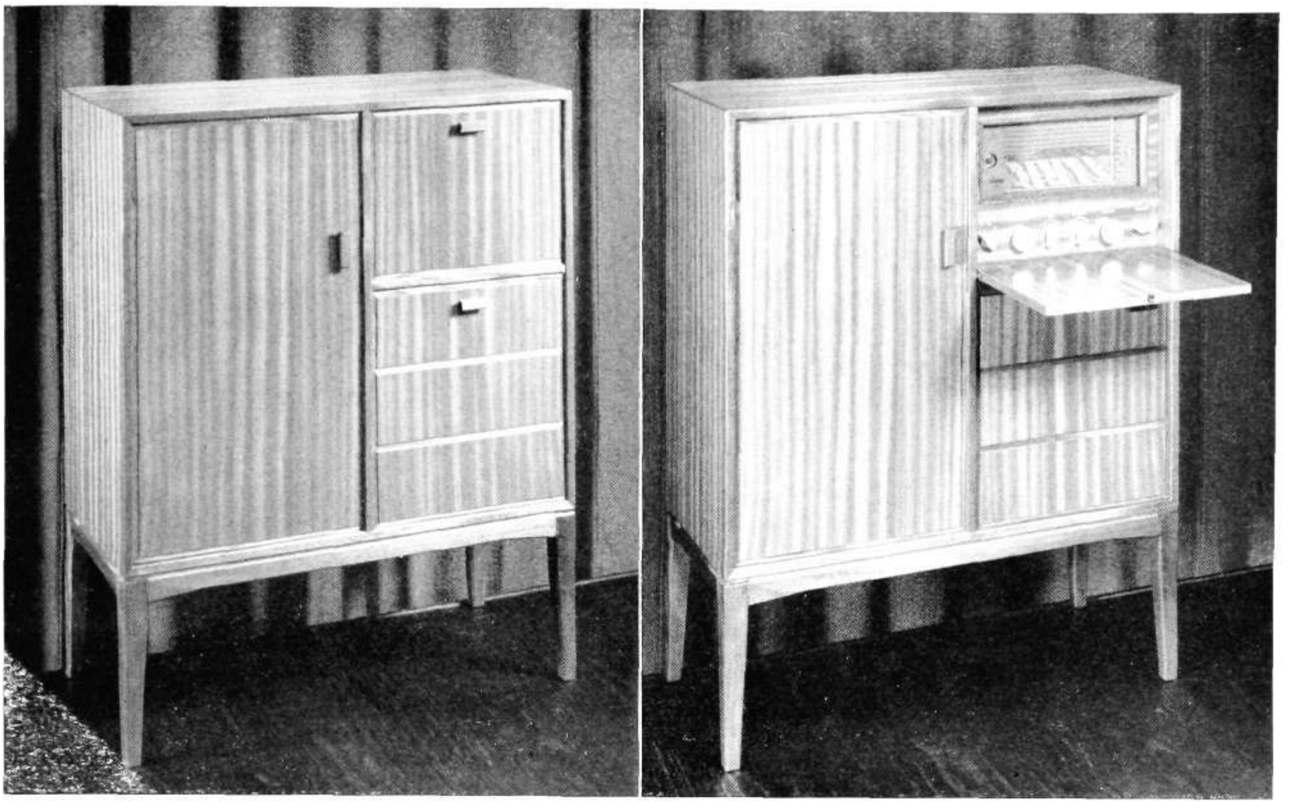


Fig. 5 X 7607

Ericsson model 1518

Type designations:

for AC *1518 AC*
for AC/DC *1518 AC/DC*

Ericsson model 1514

Table models are often designed with the scale located at the top, the loudspeaker in the centre and the control knobs at the bottom. This is no chance arrangement. The position of the scale and controls is practical and is generally appreciated. In this arrangement the loudspeaker is also placed correctly from an acoustic point of view.

Fig. 6 X 6648

Ericsson model 1514

The controls are from the left: on-off switch (on the left side), volume knob, bass and treble knob, combined tuning knob and bandswitch.

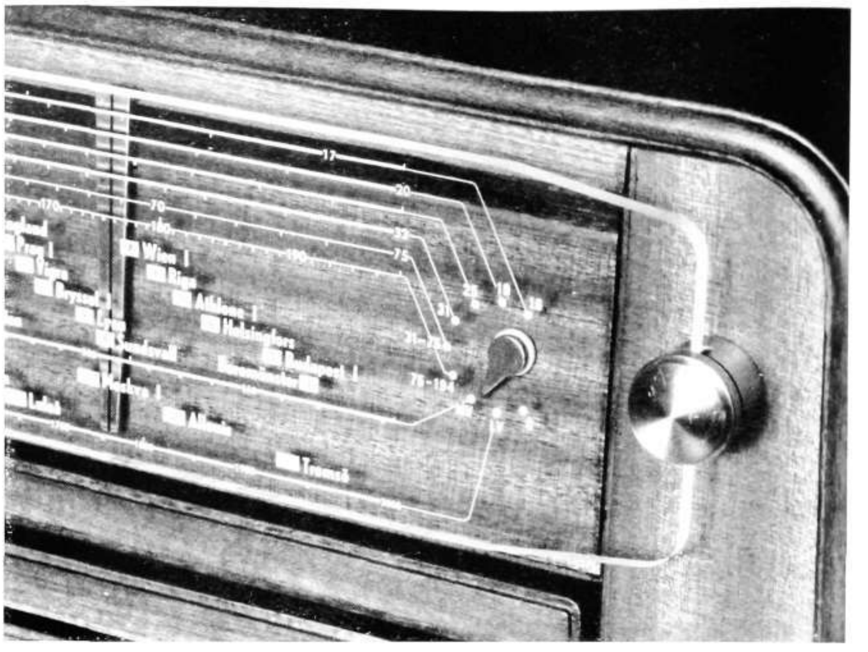


Fig. 7 X 6649

The scale of the Ericsson model 1514 is supported by two holders, which also serve as supports for the scale lamps

The external design in accordance with this principle may be seen in *model 1514* illustrated in Fig. 6. The handsome appearance of the receiver has been obtained by the careful selection of the materials and the skilful design and location of the different parts. The simple lines of the case form a discrete background to the attractive and effective scale and the decorative controls. The loudspeaker opening is concealed by a number of horizontal strips. The scale is so arranged that it can easily be removed from the front, which is an advantage if at some future date it should become necessary to revise the frequency distribution among the stations. The scale is made of acrylate plastic which is strong and possesses good light-conducting properties. The scale is illuminated from its two holders which also serve as supports for the scale lamps.

Ericsson model 1514 is a first-class long-distance receiver with high selectivity. It also has an unusually large reception range extending from 13 to 2 000 m, with the exception of a narrow band between 580 and 690 m. The signal-to-noise ratio is extremely good, particularly on long and medium wave.

Model 1514 is manufactured with a mahogny matt, natural-coloured finish or a highly polished finish in a somewhat darker tone.

Specification

Type designations:

Type 1514 AC and type 1514 AC/DC

Receiver: with 6 valves, 8 valve functions, with 6 tuned circuits. Tuning ranges, long- and medium wave, also 75—194 and 32—75 m, bandspread on 16, 19, 25 and 31 m.

Loudspeaker: *HPA 921* with a 300 cm² active diaphragm surface.

U.D.C. 621.395.44:621.396.2.029.6

SIMPSON, L C, NEVITT, H J B & ERIKSEN, E J: *VHF Radio Multichannel Carrier Telephone Circuits in Colombia.*
Ericsson Rev. *28* (1951) No. 3 pp. 62—72.

Multichannel telephone and programme facilities using normal FM broadcasting equipment and cable carrier terminal have been established by means of single hop frequency-modulated radio links operating in the 70—88 Mc/s range over the approximately 250 km distance separating the two cities Bogotá and Medellín in Colombia. The article describes the main features of these facilities.

U.D.C. 536.2
621.317.39:621.365

WENDT, T: *Thermotechnical Instrumentation for the Furnaces in Tube Rolling Mills.* Ericsson Rev. *28* (1951) No. 3 pp. 73—76.

A number of heating furnaces have been installed in Sandvikens Jernverk's new tube rolling mills, for which a thermotechnical instrument equipment was required for controlling the heating process and the final temperature of the billets, and at the same time enabling an economy of fuel to be achieved. Brief description of the installation.

U.D.C. 621.395.65

New LB Plug Switchboard ABG 15. Ericsson Rev. *28* (1951) No. 3 pp. 77—81.

Telefonaktiebolaget L M Ericsson have produced a new series of LB plug switchboards, to be known as type ABG 15, these switchboards constituting an up-to-date "edition" of L M Ericsson's earlier plug models ABG 12—14. In the article the advantages gained with a plug switchboard are pointed out and an account is given of the execution, construction and connecting procedure of the new plug switchboards.

U.D.C. 621.396.62

FREDIN, C: *New Ericsson Receivers.* Ericsson Rev. *28* (1951) No. 3 pp. 89—92.

Brief description of three new designs of Ericsson receivers: the radiogramophones Ericsson 1518 and 1519 and a big table model, Ericsson 1514.

U.D.C. 656.257(485)

LUNDBERG, T: *New Type of Interlocking Plant for the Swedish State Railways.* Ericsson Rev. *28* (1951) No. 3 pp. 82—88.

In February 1951 a new interlocking plant was put into operation at Stehag by the Swedish State Railways. Automatic line blocking has previously been arranged on the section Hässleholm—Malmö and the station now serves as a blocking section on this line. In the article the new plant is presented the equipment of which has been supplied by the L M Ericsson Signal Company whereas the planning and lay-out has been prepared by the Board of Management of the State Railways assisted by the Signal Company.

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L M Ericsson A/S *København V*, Trommesalen 5, tel: C 3438, tgm: ericsson-københavn

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Deutschland

Ericsson Verkaufsgesellschaft m. b. H. *Kronberg im Taunus*, Parkstrasse 1, tel: Kronberg 450, tgm: ericsson-kronbergtaunus

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ASEA Electric (N Z) Ltd. *Wellington C. 1*, Huddart Parker Building, tel: 42086, tgm: aseaburd-wellington

ERICSSON Review

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CONTENTS

On cover: Interior of a workshop in the factory at Midsommarkransen, Stockholm, where connection and soldering of cables in crossbar registers is carried out.

The L M Ericsson By-path System with Crossbar Switches — Fundamental Principles

C BERGLUND, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U. D. C. 621.395.344

The main features of the system under discussion are the by-path principle, link connection and the crossbar switch. This article surveys the meaning of these ideas, their application and their effect on the operating characteristics of the system.

Like most automatic telephone systems, the L M Ericsson by-path system with crossbar switches is built up in selector stages, the number of which is suited to the capacity of the telephone network.

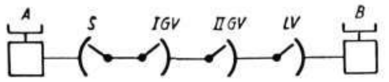


Fig. 1 X 4746
Decadic system

Among the systems for large exchanges there is one which in its grouping closely corresponds to the directly driven step-by-step system and is preferably used to connect to such a system. This system is built up of line finder *S*, a suitable number of group selectors *GV* and final selectors *LV*, as shown in Fig. 1. Each selector stage is provided with an impulse receiving device which sets the selectors in accordance with the dial impulses.

Another arrangement is the register controlled system, Fig. 2. The selectors in this system are arranged in stages in the same basic way as in the decadic system. Between the line finders *S* and the first group selectors *IGV*, however, registers *Reg* are connected. These receive the digits from the calling stations and then control the setting of the group and final selectors.

In small exchanges the numerical selection is sometimes made in a single selector stage.

In these respects the by-path system with crossbar switches differs little from the conventional systems. The main difference between them lies in the build-up of the individual selector stages. The main features of the by-path system with crossbar switches are *the by-path principle, the link connection* and *the crossbar switch.*

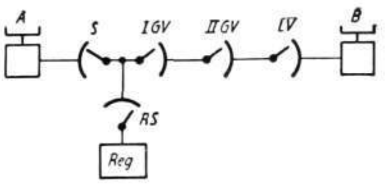


Fig. 2 X 4747
Register system

By-path Principle

The large number of selectors which remain connected during the whole conversation and the control devices associated with each of them should be as simple as possible. Since the time occupied in setting the individual selector is very short compared with the time during which it is occupied by calls, it is economical to free the selectors as much as possible from individual setting equipment and to provide a reduced number of control devices which can be connected temporarily to the selectors during the setting period.

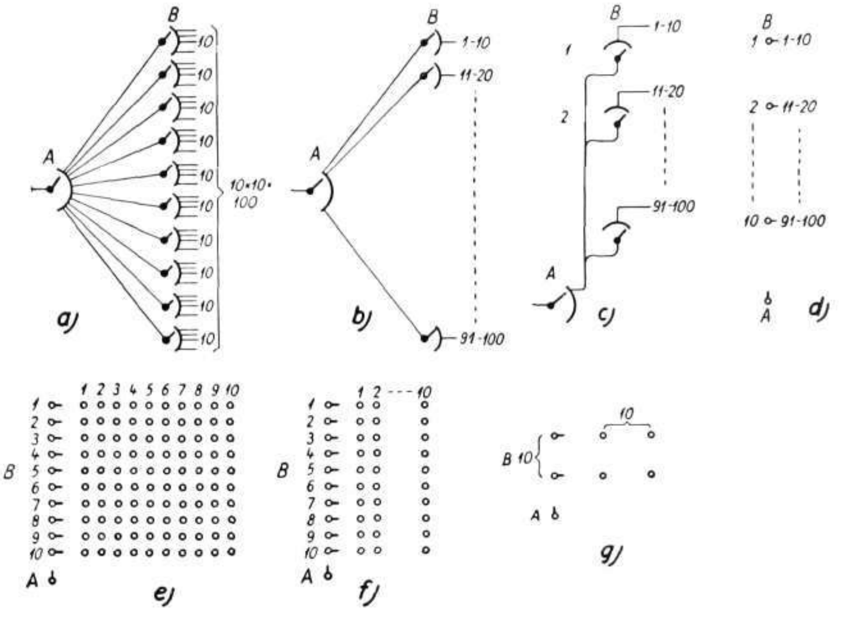


Fig. 3 X 6628

1-selector assembly for 100 lines made up of 11 10-line selectors

Figs 3a—c are drawn with old symbols, 3b and 3c with simplifications. Figs 3d—g are drawn with new symbols. Note the resemblance between 3c and 3d. Fig. 3e shows the complete grouping diagram, and Figs 3f and 3g the normal simplifications.

Systems built up in this way are called *common control systems* or *by-path systems*. The first name is used normally for systems in which the common device in each connection controls only one selector, while the latter name is used when the common device at each connection is associated with several selectors and sets them all. In the L M Ericsson system the control device sets two or more selectors. The system must therefore be called a by-path system, although it is in fact similar to a common control system since the selectors which are set by the control device normally form part on only a single selector stage.

The holding time for the common device, consisting of the selecting bars and the bar magnets of the crossbar switch and of the by-path control device, is very short, so that only a very small number of control devices is needed. They have, therefore, no important effect on the cost of the system and may be designed using particularly reliable elements and may be provided with all desirable safety precautions. Since the selectors in the speech circuits are freed from all complicated mechanism which is liable to damage, these can be particularly reliable. The great possibilities which the by-path system offers in providing high reliability and low maintenance cost have been utilized in the L M Ericsson crossbar system in a different and better way than in other systems using common control devices, which include mechanical selectors and stepping mechanisms in both speech paths and common equipment.

Link Connection

The capacity of the selectors in the L M Ericsson by-path system with crossbar switches is only 10 and 20 lines. To provide good utilization of the connecting devices and trunks it is necessary, however, to be able to search over a larger number of lines in the selector stages. Units having larger capacity are therefore built up with 10- and 20-line selectors. The most natural way is to connect the selectors in tandem. If, as in Fig. 3a, we connect to each position of a 10-line selector *A* a 10-line selector *B*, the selector *A* can connect to 100 lines, and a unit with a finder capacity of 100 lines has been produced.

The possibilities of altering the selector grouping are very wide in a link system, and the conventional symbols are not suitable for giving a clear picture of the groupings which are produced. L M Ericsson have therefore introduced a simplified circuit form which greatly simplifies the study of link connections. Those who wish to be familiar with link connection systems should therefore endeavour to understand and use these simple and practical symbols.

The new symbols are based upon the symbol, ○, used in switching technique for a line or a device. When the device is a selector it is indicated by a line, ○-, which points towards the lines or devices connected to the selector multiple. The table below shows the symbolism for some elementary cases:

1 selector with 10 lines connected to the multiple	a) ○-	○○○○○○○○○○
	b) simplified ○-	○ ○ (10)
5 selectors with 10 lines connected to the multiple	a) ○-○-○-○-○-	○○○○○○○○○○
	b) simplified ○-○- (5)	○ ○ (10)
	c) alternative form ○-○- ○- ○-○-	○ ○ (5)

Fig. 3 shows the connection described above in both the old and new symbols.

If a larger number of *A*-selectors, say 10, is to be connected to reach the same 100 lines, it can be arranged with the outlets from the selector groups interconnected as shown in Fig. 4.

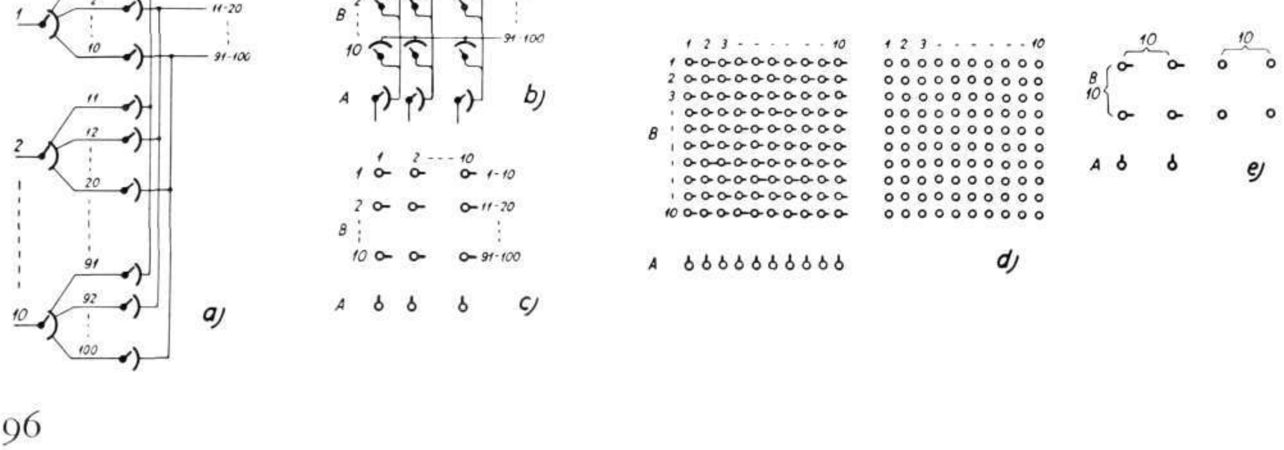
The number of 10-line selectors required for this circuit is $10 \times 11 = 110$. It may be asked whether this number cannot be reduced. An analysis shows that for each connection through an *A*-selector only one of the 10 associated *B*-selectors is occupied and the other 9 are free. A significant reduction would therefore be possible if the *B*-selectors were accessible to more than one *A*-selector.

A circuit designed in this way (Fig. 5), which requires only 20 selectors, has in common with the previous circuit (Fig. 4) the fact that each *A*-selector can reach all 100 lines. There is, however, one important difference between the two circuits: in the second one it is not possible in all circumstances to reach all the outlets. If, for example, *A*-selector 1 is to be connected to outlet 1 (Fig. 5), this must be through *B*-selector 1. Since this selector provides the only connection path to outlets 1—10, it may be busy with a connection between any of the other 9 *A*-selectors and any of the outlets 2—10. The selector assembly is thus subject to *internal blocking*, which is the price to be paid for the considerable economy (from 110 to 20 selectors) resulting from the simplified circuit.

Fig. 4 X 6629

10-selector assembly for 100 lines made up of 110 10-line selectors

Figs 4a—b are drawn with old symbols, 4b with simplifications. Figs 4c—d are drawn with new symbols. Note the resemblance between 4b and 4c. Fig. 4d shows the complete grouping diagram and Fig. 4e the normal simplifications.



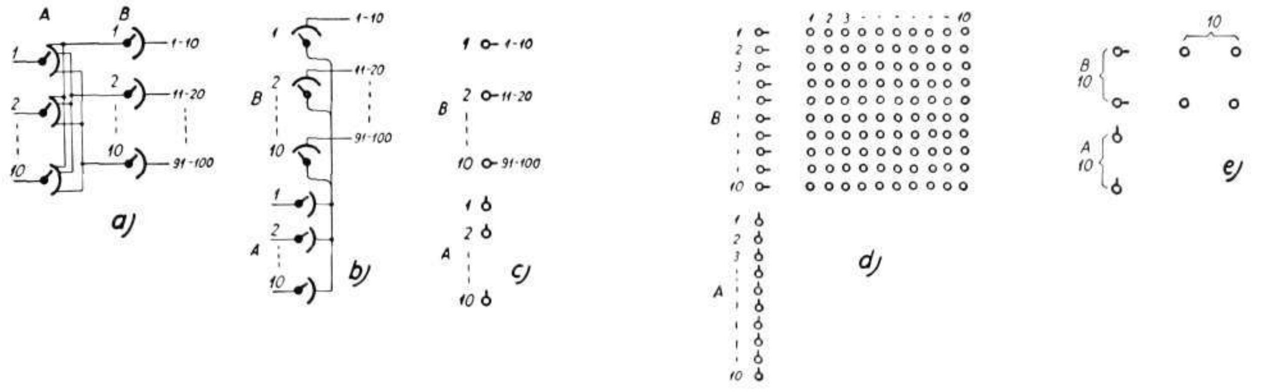


Fig. 5 X 6630

10-selector assembly for 100 lines made up of 20 10-line selectors

Figs 5a—b are drawn with old symbols, 5b with simplifications. Figs 5c—e are drawn with new symbols. Note the resemblance between 5b and 5c. Fig. 5d shows the complete grouping diagram and Fig. 5e the normal simplifications.

If a particular *A*-selector is to reach a particular outlet, which is the case in a final selector circuit, the internal blocking will be high, and the simplified circuit cannot be used advantageously for this duty. In a group selector, however, the A-selector need only reach one of a group of lines in a particular route. For example, route 1 may be taken as consisting of the 10 outlets 1, 11, 21—91. A circuit from *A*-selector 1 to route 1 can be established through all 10 *B*-selectors with the limitation that only one *B*-selector can reach a particular outlet. Blocking in route 1 can thus arise if only outlet 1 is free, while *B*-selector 1 is busy with a connection to another route.

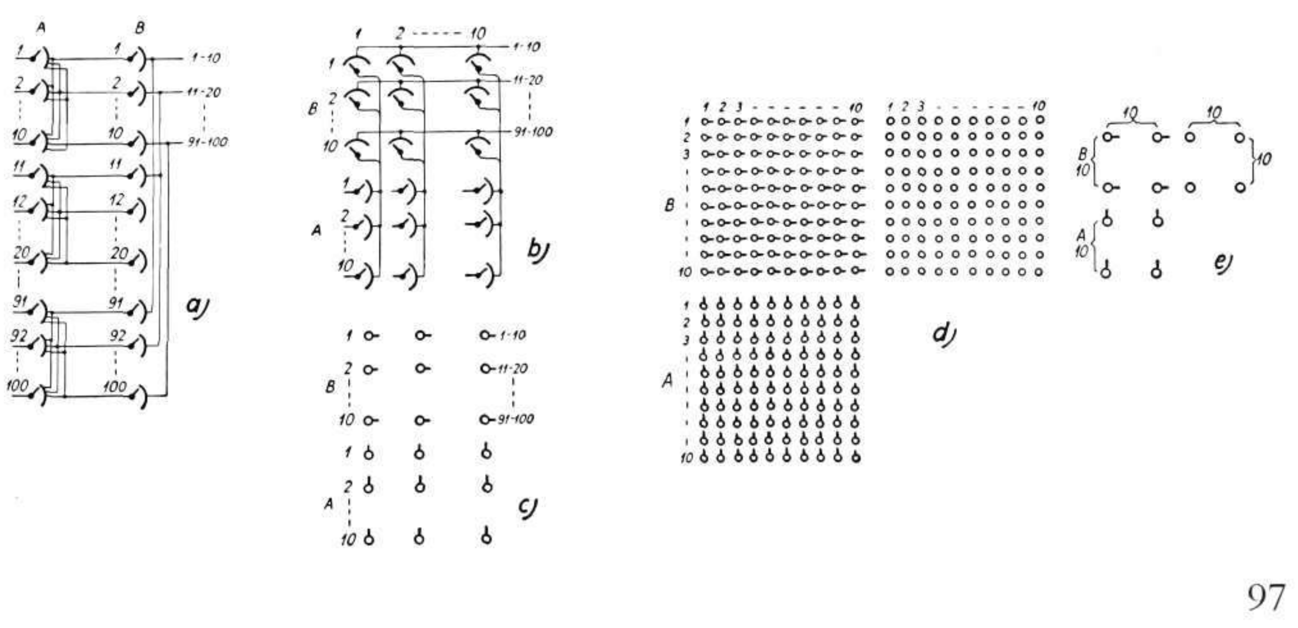
In circuits of this type internal blocking must always be kept in mind, but it can be brought to a low value by various methods. One possibility is to adopt the system known as *conditional selection*. To indicate what this implies, assume that the *A*-selector is started and selects the first free *B*-selector. The only outlet to the required route in this *B*-selector multiple may be busy, and there would be internal blocking although there are free paths through other *B*-selectors to free outlets in the wanted route. Arrangements may be made for the *A*-selector to connect only a *B*-selector which has access to a free outlet in the wanted route. This conditional selection is controlled in the L M Ericsson system by the by-path equipment, which controls both *A*- and *B*-selectors. The by-path equipment first marks all free paths from the calling line to free outlets, and then chooses one of them and sets the *A*- and *B*-selectors to this path.

Fig. 6 X 6631

100-selector assembly for 100 lines made up of 200 10-line selectors

Fig. 6a—b are drawn with old symbols, 6b with simplifications. Figs 6c—e are drawn with new symbols. Note the resemblance between 6b and 6c. Fig. 6d shows the complete grouping diagram and Fig. 6e the normal simplifications.

After this description of the nature of the link circuit, the following definition of the link system may be justified:



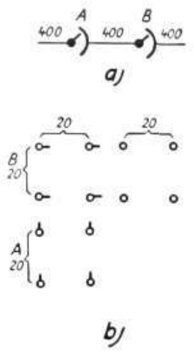


Fig. 7 X 4748

Basic connection with 20-line selectors

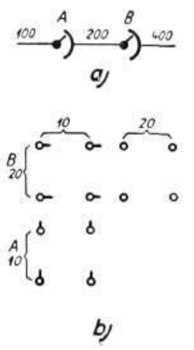


Fig. 8 X 4749

Connection with expansion of 1:2 to the B-stage and a further expansion of 1:2 to the outlets

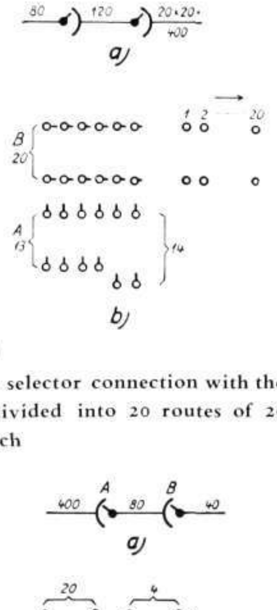


Fig. 9 X 4750

Group selector connection with the multiple divided into 20 routes of 20 outlets each

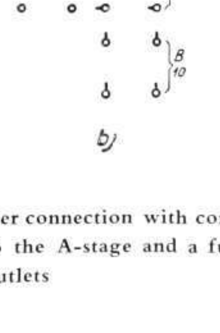


Fig. 10 X 4751

Line finder connection with compression of 5:1 to the A-stage and a further 2:1 to the outlets

A link connection consists of selectors in tandem, which are set dependently on each other in such a way that an available free path is chosen.

If a still greater number of *A*-selectors, say 100, is to be connected so that they can reach 100 lines, see Fig. 6, groups of 10 *A*- and 10 *B*-selectors, which are grouped in the way already described, may be connected in parallel. This connection is usually called *the basic connection,* and shows the principle of most link connections embodied in the L M Ericsson by-path system with crossbar switches. If 10-line selectors are used, the multiple capacity is 10 × 10 = 100 lines. Selectors of different capacity may be used, however, and the L M Ericsson system is normally built up with 20-line selectors. The basic connection, Fig. 7, then obtains a capacity of 20 × 20 = 400 lines.

In the basic connection the numbers of inlets (*A*-selectors), links (*B*-selectors) and outlets are equal. For practical systems the numbers of these components must be modified according to the traffic. In the various stages there is either an increase in the number of lines, *expansion,* Fig. 8, or a reduction in the number of lines, *compression.*

In a group selector connection one outlet from each group of multiple connected *B*-selectors is normally taken to each route. When 10-line selectors are used there are thus 10 routes, each of 10 lines, while circuits using 20-line selectors give 20 routes each of 20 lines (Fig. 9). There is, however, considerable freedom to vary these numbers. It is common to provide 10 routes of 40 lines when using 20-line selectors. If required the routes may be of different sizes.

The link connection is also used advantageously for line finders (Fig. 10). In this case compression is often used in both *A*- and *B*-stages.

Finder and final selector stages for the subscribers' lines are commonly designed as a single stage, the subscribers' stage, of which the selectors nearest the subscribers' lines (the *A*-stage) are used for both directions of traffic, while in the *B*-stage the traffic is split up into incoming and outgoing, Fig. 11. The internal blocking for outgoing traffic can be kept low even when the connection consists only of *A*- and *B*-stages, since there are paths to a large number of *B*-selectors through all the devices in the *A*-stage which have the multiple connected to the calling subscriber's line. If the incoming traffic is connected only through *A*- and *B*-stage, conditions are not good (from each *B*-selector in Fig. 11 connection can only be made to a particular line through a single *A*-selector). To limit the internal blocking one or two *secondary stages* are often incorporated (*C* and *D*, Fig. 11) in tandem for the incoming traffic. In consequence all devices having multiples connected to the wanted subscriber's line can be reached by many different paths, and satisfactory conditions are obtained.

To provide some smoothing of the traffic between the groups of 20 subscribers, the bridges in the *A*-stage are usually split into two groups. Half the bridges are reached from the same group of 20 subscribers, while the other half are reached from an equally large group in which the units and tens digits are exchanged. A connection of this sort, shown in Fig. 12, is called *transposed.*

The Crossbar Switch

The link connection can in theory be carried out with almost any sort of selector, but the crossbar switch is particularly suitable. The fundamental characteristics of this switch will be briefly described below (the detailed construction was described in Ericsson Review 2, 1949).

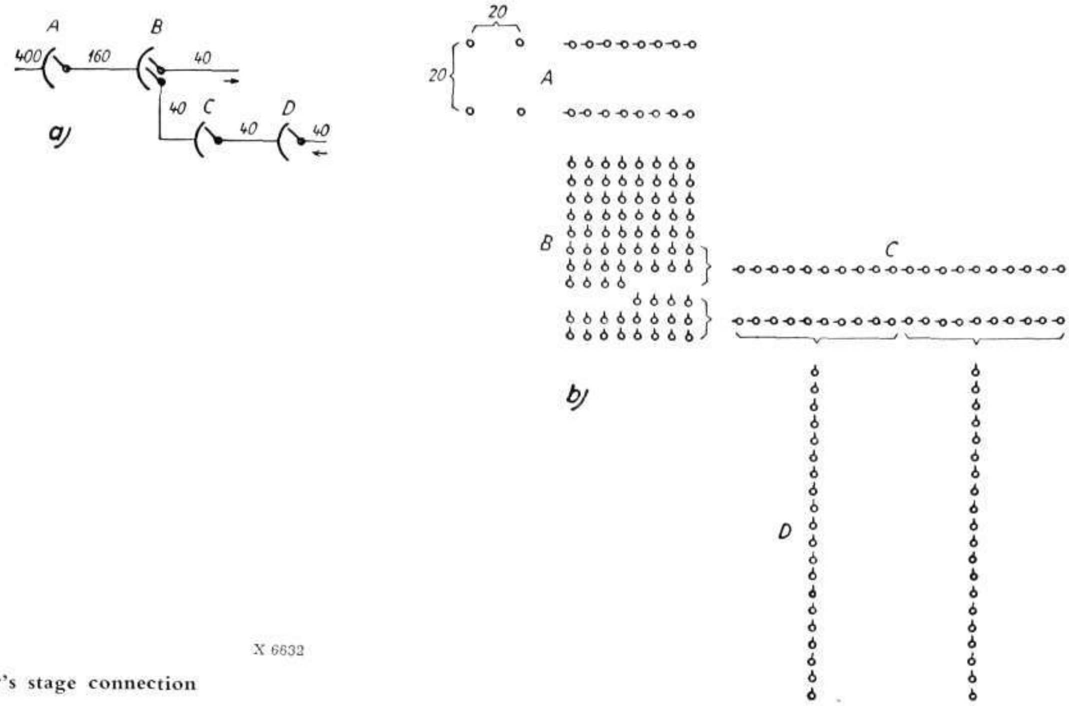


Fig. 11 X 6632

Subscriber's stage connection

The 10 and 20 line selector, the connecting element of the system, consists of one *vertical unit* in the larger unit, the *crossbar switch*. This latter must be regarded in the by-path system as a number of selectors (usually 10) mounted in a common frame with common control equipment.

The vertical unit consists of a magnet *VM* and armature *VA*, Fig. 13, and 10 or 20 spring contact groups, Fig. 14. All contacts are make contacts, one side consisting of a strip *CB* which is common to all spring groups. The number of make contacts in each spring group is suited to the requirements. Fig. 14 shows the contacts for a 10-line switch with 8 poles.

The common equipment for all the vertical elements in a crossbar switch consists of 10 or 12 *selecting bar magnets BM* (Fig. 13) and 5 or 6 *selecting bars B*, each provided with a number of *selecting fingers IW* corresponding to the number of vertical units. When a vertical unit is energized but no selecting bar magnet is energized, the armature *holding bar OB* enters the U-shaped depression in the operating spring *OS* and the spring group is unaffected. If, however, a bar magnet has been energized and has turned the selecting bar to left or right, the selecting finger covers the U-shaped depression in the operating spring *OS* and the corresponding spring group is operated when the vertical unit magnet is energized. The selecting bar magnet may then be released and the selecting bar returns to normal, while the selecting finger remains, fixed under the spring group, until the vertical unit magnet releases. Since the selecting finger is flexible the selecting bar is still free to move and can be used for connecting through other vertical units in the same crossbar switch.

To provide a vertical unit with a capacity of 20 lines it must have 12 spring groups, and the crossbar switch is provided with a sixth selecting bar. Ten spring groups are used for the incoming multiple lines, while the remaining two are used to double the capacity of the vertical units, as shown in Fig. 15. Half the contacts in each of the ten spring groups are used for each group

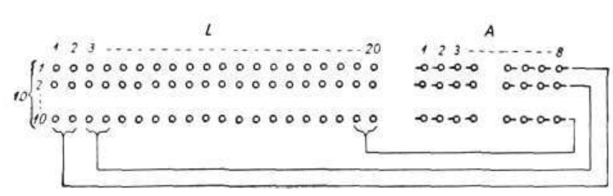


Fig. 12 X 6633

Transposition in A-stage of subscriber's stage

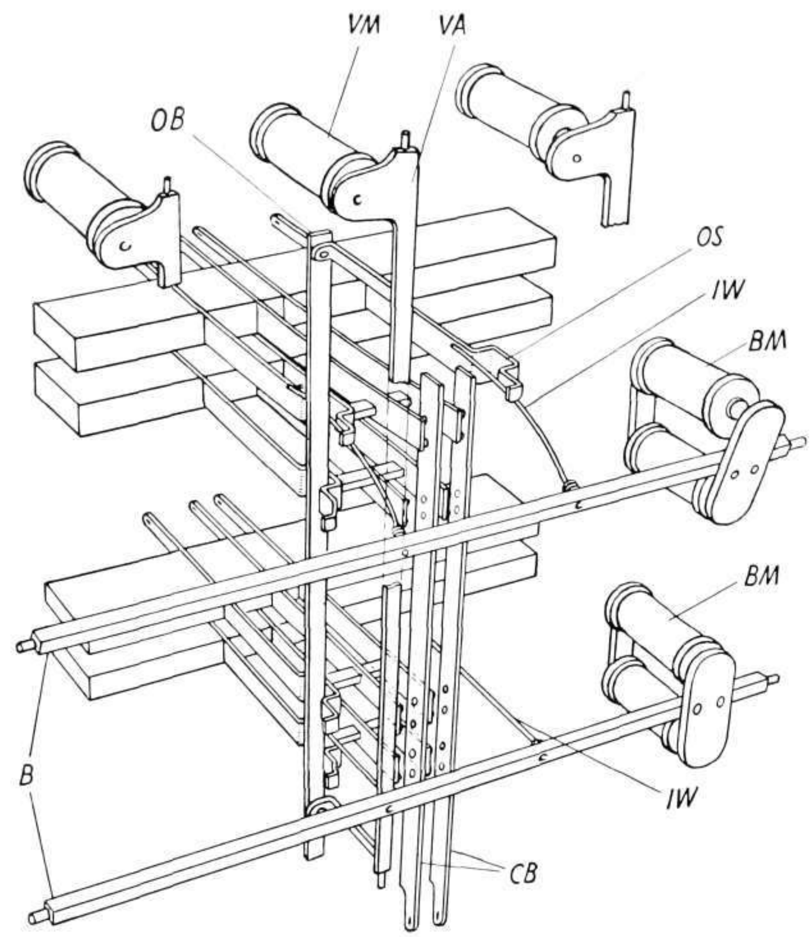


Fig. 13 X 6640

Simplified view of crossbar switch

B selecting bar
BM selecting bar magnet
CB contact strip
IW selecting finger
OB holding bar
OS operating spring
VA vertical unit armature
VM vertical unit magnet

of ten lines, and the inlets are connected to one or other group through the remaining two spring groups. To connect a line in a 20-line bridge the sixth selecting bar and one of the other five selecting bars must be operated. When the vertical unit magnet is operated, one of the ten spring groups and one of the remaining two is operated.

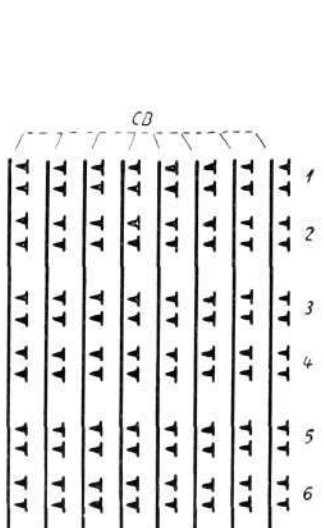


Fig. 14 X 4769

Contact field for 10-line vertical unit

The Marker

It will be seen from the above that the individual devices in the speech circuits are very simple, as a result of the concentration of the functions which actually establish the call into a few devices which are specially designed for this purpose, the *markers*. Since the operation of the marker, the selecting bar magnets and the vertical unit magnets is of short duration, a marker can control up to 1,000 vertical units without any significant reduction in the utilization of the individual switches. The principles of operation of a group selector marker are simple (Fig. 16).

In order to build up larger groups or to increase the accessibility, link connections are often built up of several selectors in tandem. This does not alter the principles of operation of the marker (Fig. 17).

Operating Characteristics

The increased demand for high reliability in operation and good quality of transmission has increased the importance of completely safe contacts in the speech circuits. Close attention must therefore be paid to the noise which can arise by vibrations communicated to the speech contacts from operating selectors in the same rack. This noise, known as *selector noise*, can be reduced by careful cleaning and lubrication, but this implies increased maintenance

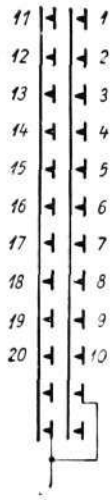


Fig. 15 X 4770

Circuit for 20-line vertical unit

work. The crossbar switches, which have pressure contacts of the same kind as relay contacts, are completely free from these disturbances and need neither cleaning nor lubrication. The excellent contact characteristics are among other things due to the fact that the contact points are of precious metal and that the wear is insignificant. Since they are designed as twin contacts, even occasional disturbances caused by dust are extremely rare.

The maximum safety in operation and minimum maintenance cost are obtained if the selectors have a simple setting method. In the L M Ericsson by-path system with crossbar switches the selectors are set by a simple operation of one bar magnet and one vertical unit magnet. Release is provided by the mere release of the vertical unit magnet. The setting of the selector is thus very simple and the movements are so small that there will be no wear.

The setting of the selector takes *only some tens of milliseconds and the choice* of selectors in each selector stage is carried out by simultaneously testing fast-operating relays in the marker. The high operating speed is of particular importance in traffic from trunk positions fitted with keyboards instead of dials. When the operator has selected the digits on the keyboard, the wanted subscriber is called in less than 1 second. The operator need not wait some seconds, as in less rapid operating systems, for the completion of the selector operation. The operators and lines are thus used more effectively. These characteristics mean that the system opens the possibilities of providing shorter switching times by using a faster connecting device than the normal dial in the subscriber's set. Some telephone administrations have therefore asked for dials of double speed, 20 i.p.s., and the introduction of fast keyboards in the subscriber's instrument is being widely discussed.

The switching devices which remain connected during the conversation are very simple, safe and not exposed to wear in the L M Ericsson by-path system with crossbar switches. The fault location and maintaining selectors in

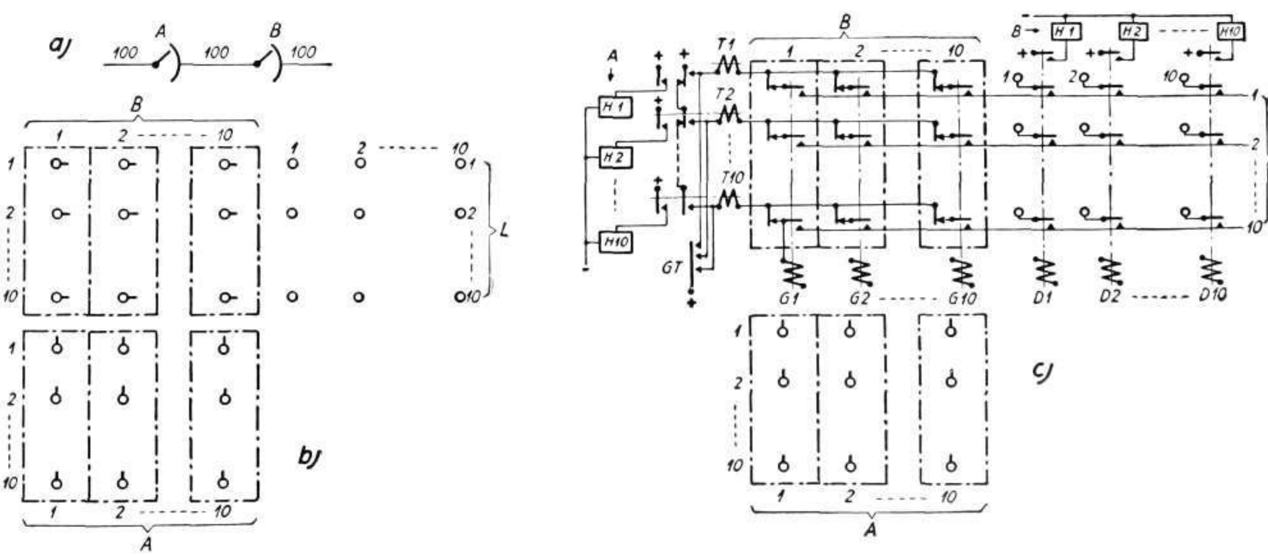
Fig. 16 X 6634

Marker circuit for group selector

Fig. 16a shows an assembly for 100 group selectors with 10x10 outlets, made up of 100 10-line selectors each in A-stage and B-stage. Fig. 16b shows the corresponding grouping diagram. The verticals belonging to the same crossbar switch are framed.

Fig. 16c shows the marker circuits corresponding to the grouping diagram 16b. (The B-selector symbols are replaced by the off-normal contacts ⌋. All contacts with a centre line drawn to a relay winding belong to the corresponding relay in the marker).

A call to vertical unit 2 in crossbar switch A1 has operated relay G1. The marker then receives a signal, indicating that route 2 shall be called, so that relay D2 is operated. Choice and connection of a free connecting path is then carried out in the following way: over contacts on relays D2 and G1 and the off-normal contacts on all free vertical units in crossbar switch B1, circuits are completed from relays T1—T10 to the outlets in route 2 for a short instant while contacts GT are closed. The T-relays which receive current from free outlets are operated. When the contacts GT break, only one of the T-relays is held by current over its own contact. This relay has thus selected a free path, and the corresponding selecting bar magnets H in crossbar switches A1 and B1 receive current and are operated. Current is connected to the vertical unit magnets (not shown in the figure) after which the marker has completed its task and is released.



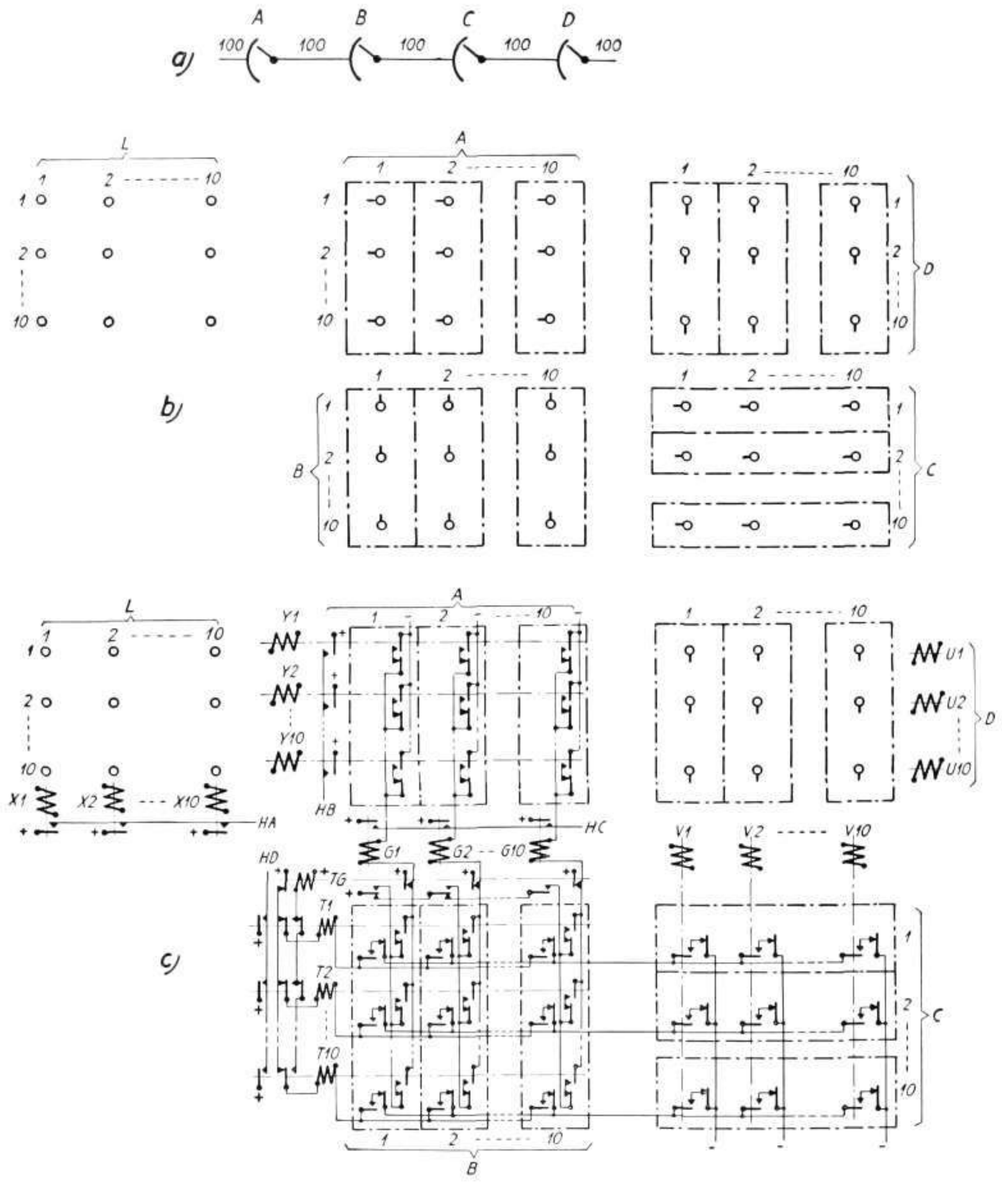


Fig. 17 X 7602

Marker circuit for link connection in 4 stages

Fig. 17a shows a circuit with four selector stages A-D having 100 10-line selectors in each stage.

Fig. 17b shows the corresponding grouping diagram. Vertical units belonging to the same crossbar switch are framed.

Fig. 17c shows the marker circuit expressed in the same form as the grouping diagram Fig. 17b. (The selector symbols in A-, B- and C-stages are replaced by their off-normal contacts ⌉. All contacts with a central line drawn to a relay winding belong to the corresponding relay in the marker.

It is assumed that the marker is to connect line 2 in the first row of L (see 17b) to vertical unit 1 in crossbar switch 2 of the D-stage. From the grouping diagram it can be seen that this inlet can be reached by the 1st vertical unit in all the crossbar switches of the A-stage. These vertical units in turn can be reached by all 100 vertical units in the B-stage. Every vertical in the D-stage can in turn reach 10 verticals in the C-stage, which have access to the 100 verticals in the B-stage. There are thus 100 possible connecting paths in the example chosen. The connecting procedure is as follows (Fig. 17c):

The inlets and outlets in question are marked by the operation of their respective units and tens relays X and Y, U and V. In this case the operated relays are X2, Y, U, and V2. Current is connected over contacts on Y1 and the A-verticals off-normal contacts to relay G1—10, which attract for all free paths through the A-stage. Current is connected over the off-normal contacts of the C-verticals, contacts on relay V2, repose contacts of the B-verticals and contacts on the operated G-relays T1—10, which are operated for all free paths. Relay TG is then connected, breaking the holding path for the T-relays, while one of them is held over its own contact. Relay TG also breaks the holding circuit for the G-relays, although one of these is held over its own contact. A free path is now chosen and marked by operated T- and G-relays. Over contacts on these relays and the operated X and Y relays current is connected to the selecting bar magnets HA—HD. When the selecting bar magnets have been operated current is connected to the vertical unit magnets over relays Y, G, T and V (not shown in the figure). The connection is then established and the marker is released.

good repair is therefore almost completely eliminated. The main operations of connection are carried out by a small number of markers. These consist exclusively of relays, which are particularly safe in operation and do not demand much maintenance. Special safety precautions have been taken to provide complete security in the fundamental parts of the system. These precautions include double pairs of twin contacts in parallel, and arrangements for providing circulating occupation of the connecting devices. In this way faults in markers, which may put larger groups of devices out of action, are avoided. A fault in one contact of a relay in a marker, which owing to its design can only arise exceptionally, will normally cause only one device, or perhaps a small group of devices, to be occasionally blocked and in this case the marker automatically makes the connection through other free devices. The few contacts which are involved in the functioning of large groups of devices are arranged so that the security against faults is greater than for other common equipment such as power supplies, ringing and signalling machines, starting devices, etc., used in all types of automatic exchanges.

It is thus possible in crossbar switch exchanges of by-path system to considerably reduce the staff required for routine maintenance. In addition, there is less work for the more skilled maintenance staff, since complicated faults, for which these are required, are less numerous and since automatic traffic supervision and automatic fault indication can easily be included in the system. As all connections are controlled by a small number of markers, these can be equipped with devices to transmit the nature of any irregularity of operation to recording instruments.

The function of the markers is, as will be seen from the description above, based on simple principles, and the relays used are normal switching relays which do not need close margins of setting. Each marker clearly includes a large number of relays, but it must be remembered that these form mainly a few groups of many identical relays. Normal exchange staff can thus easily become familiar with the operation of the system. The characteristics of the system may be summarized as:

1. Complete contact reliability
2. Simple selector setting
3. Fast operation
4. Little wear
5. High operating reliability
6. Low maintenance costs

Theoretical Aspects of Crossbar Exchange Design

C JACOBÆUS, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U. D. C. 621.395.344.001

A number of constructional principles have been introduced in modern automatic telephone exchanges using crossbar switches which in earlier automatic systems were used only to a very limited extent or not at all. This is particularly true of the grouping arrangements of the exchanges and the switching controls. Both these aspects have presented new problems to the designers, particularly in the quantitative design of exchanges and the connecting circuits between them.

Some important theoretical aspect of this problem are discussed in this paper. It is a summary of a lecture delivered to the 2nd telephone engineers conference in Copenhagen, January 1951. It is reproduced here by permission of »Teleteknik», in which it was published in Danish in No. 2, 1951. The lecture was repeated in German at the Institute of Technology, Belgrade, in November 1951.

Three different methods are used in automatic telephony for connecting the selectors in the different switching stages to the lines between the stages (or to the subscribers' lines). These are *full availability*, *grading* and *link connections*. Combinations of these three methods can also be used. All three methods can be used in exchanges built up with crossbar switches, but in modern crossbar exchanges link systems are dominant, although they are often combined with gradings.

The concept of congestion is the foundation of the dimensioning of the various connection systems. The probability of congestion is defined as the fraction of the time during which a new call cannot be handled because of the loading conditions in the connecting devices. To give a brief description of how congestion can arise in the various cases, the case of a selector group connecting to one route will be considered.

With full availability, Fig. 1, all selectors can reach all lines to the assumed route. The number of lines in this route may therefore not exceed a number fixed by the maximum capacity of the selectors. Congestion will arise here if all lines in the wanted route are loaded. The congestion in a circuit of this type is known to be given by *Erlang's* B-formula.

With grading, an example of which is shown in Fig. 2, the number of lines exceeds the number reserved for the route in question in each selector. The selectors are thus operating with limited availability in this case. To provide better utilization of the lines in the route, and thus also to obtain a corresponding economy, the outlets in the various selector multiples have been partly inter-connected. Each different selector group has access to a portion of the lines which is partly common to other selector groups. Congestion arises here when the lines available to a particular selector group are loaded. The congestion is thus greater than with full availability, since there may be free lines which cannot be reached by the selector group under consideration. As is known, there is no exact method for calculating the congestion in a system with grading. For practical purposes the formula given by *O'dell* may generally be used.

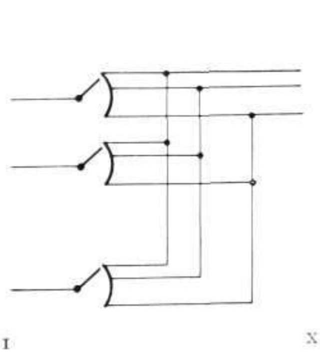


Fig. 1 X 4761

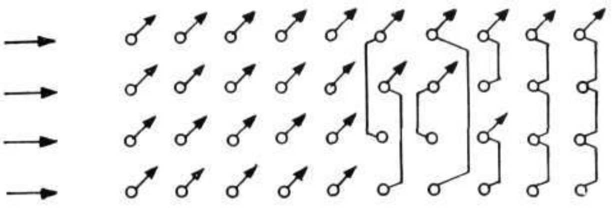
Circuit with full availability

Each incoming line can be connected to each outlet.

Fig. 2 X 6641

Circuit with grading

An incoming line can only be connected to a part of the outlets.



The link connection presents somewhat more complicated grouping of the devices in the system. An example of a two-stage link connection forming a group selector is shown in Fig. 3. It consists of two sub-selector stages in tandem, each sub-selector stage being divided into a number of selector groups. From each selector group in the first stage, the A-stage, an internal connection (link) is made to each selector group in the second stage, the B-stage. The lines in the different routes are taken out from the B-stage in such a way that an equal number of lines — one or more — are taken from each selector group for each route. When connecting to a particular route congestion arises when there is such a combination of loaded links and loaded lines in the route that no free link is available which is connected to a B-selector group having a free outlet in the wanted route. Here again the congestion is higher than with full availability, since the loading on the links can prevent a connection being completed to a free outlet. Link connections can be produced with more than two associated selector stages. A number of approximate expressions have been proposed for calculating the congestion in link systems and these take account of the different loading distributions on the links and the routes.

All three connection systems can be arranged as busy signal systems or delay systems. About the same changes must be made in the congestion formulas for the different connecting systems if they are arranged as delay systems instead of as busy signal systems. It may thus be said that both from the operating point of view and from the subscribers' point of view congestion involves the same effect in all the used connection systems. It must, therefore, be justified to say that the same basis should be used in the design of the various systems. Crossbar systems, which are preferably built up as link systems, should therefore be designed on the same principles as apply to systems using mechanical or electro-mechanical selectors, in which full availability or grading is used. This is true whether the design criterion is to be the congestion in each selector stage, the total congestion for all selector stages, or Moe's principle.

Group Selectors in Crossbar Systems

Two external considerations must be taken into account in the problem of designing equipment for group selectors — that is, designing a group selector stage — in an automatic system. External implies that these are not considerations relating to the exchange itself but are also affected by the grouping of exchanges and the number of lines between them. The number of routes to be fed by the group selector must be a convenient one — in general it can be said that it should not be less than 10, and it should be possible to go somewhat higher. In addition the utilization of the lines out from the group selectors shall be good.[1]

[1] This requirement is not in agreement with Moe's principle. The designer has, however, only to balance the costs for the various parts inside the exchanges so that cheap exchanges can be constructed which satisfy *inter alia* the given external conditions for the group selector stages.

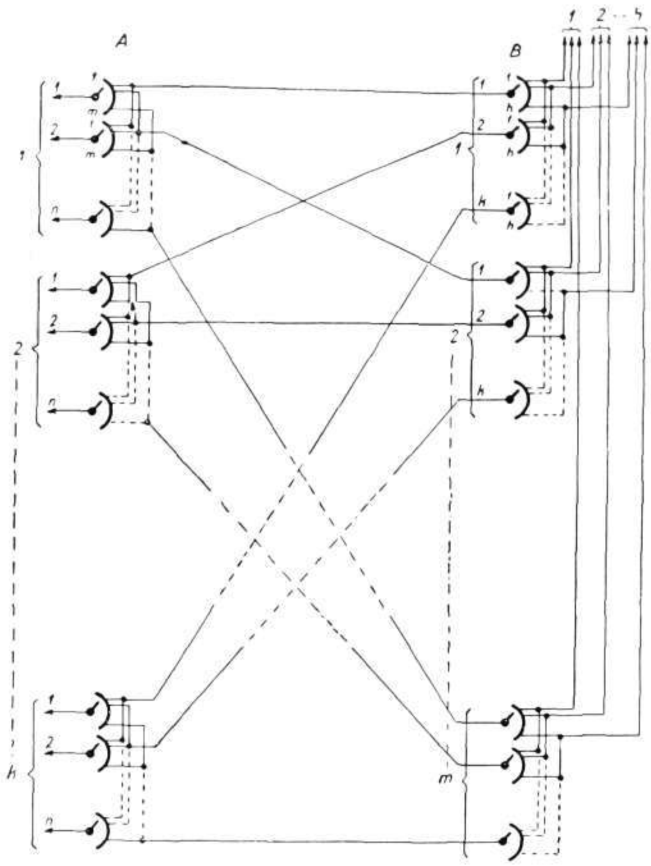


Fig. 3 X 6642

Link system

An incoming line can be connected to an outlet via a link.

The gradings must have an availability of 20 or more for such routes as are made up of the more expensive trunks. In some types of selector with step-by-step or mechanical drive the actual design and control system of the selector are associated with a particular arrangement of the group selector stage. In a Strowger selector there are thus 10 routes with 10, or in newer designs 20, lines in each route. The L M Ericsson 500-line selector provides 25 routes, each with 20 lines. In selector types operating with common control the number of routes and the number of lines in each route can, on the other hand, be varied. In general there are 10 or rather more routes with some freedom to distribute the lines so that better utilization of the more expensive trunks is obtained.

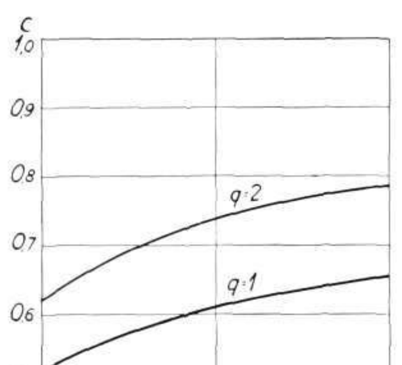


Fig. 4 X 4762

Optimal utilization c of outgoing line group from a two-stage link circuit with $m=20$ B groups and $q=1$ or 2 lines to the route from each B-group, as a function of the expansion $\frac{m}{n}$

Congestion = 0.005

When designing group selectors using crossbar switches with link connection very many possibilities present themselves owing to the fact that the connection is made up with two, or perhaps more, selector stages in combination. In the two systems which have been built in Sweden, by L M Ericsson and by the Swedish Administration (KTV), the connection has been designed with two stages, in general agreement with Fig. 3. This allows simpler markers to be used and the units have not become too large. To achieve satisfactory utilization of the outlets the same solution as in conventional systems, grading, has been adopted. The outlets in a particular route are thus partly parallelled between the different group selector units. This is, however, not sufficient. Since the loading of the links also determines the traffic handling capacity of the circuit, it must be held to a relatively low value. This can be done by the use of expansion, the provision of appreciably more links than there are inlets. Fig. 4 shows how the utilization of a very large group of trunks increases with expansion. These curves, as elsewhere in what follows, are drawn on the assumption that the inlet loading is equal to the outlet loading. The group selector stages are regarded as belonging to a succession of similar stages, and this clearly implies that inlet and outlet loadings must be equal. The grade of service has been taken as 0.005.

Optimal utilization per line

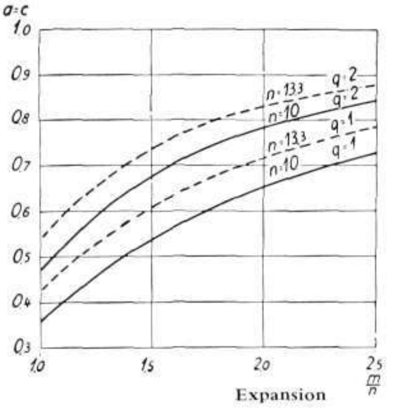


Fig. 5 X 4764

Optimal utilization c of outgoing line group from a two-stage link circuit with $n = 10$ or 13.3 lines in each A-group as a function of the expansion $\frac{m}{n}$

Number of lines from each B-group to the route, $q = 1$ or 2.
Congestion = 0.005

It has been assumed in Fig. 4 that the number of sub-groups in the B-stage (= the number of links from each A-group) is 20 and that 1 or 2 (q) lines from each B-group lead to the route under consideration. As can be seen, there is a relatively large increase in the utilization as the expansion is raised, from 1 to 1.5 and a somewhat smaller increase as the expansion is raised from 1.5 to 2. Fig. 5 shows the utilization for a constant number of lines in the A-group as a function of the expansion. The two cases shown in the figure, of 10 and 13.3 lines (n) in the A-group, correspond respectively to group selectors designed by the Swedish Administration and L M Ericsson. Here we have the effect of an increase of the expansion side by side with an increase in availability. It will be seen that there is a continued rise in the optimal utilization as the expansion increases. If an optimal utilization of 0.77/line is wanted, corresponding to the conditions in a normal 20-grading, the following values may be chosen: $n = 10$, $q = 1$ and an expansion $\frac{m}{n} = 2.7$, or $n = 10$, $q = 2$ and $\frac{m}{n} = 1.9$. For $n = 13.3$, if $q = 1$, $\frac{m}{n} = 2.35$ and if $q = 2$, $\frac{m}{n} = 1.6$.

As the examples given indicate, there are very many different ways of designing group selector circuits to give good utilization of the trunks. The final decision on the problem clearly depends also on the other external condition, the number of routes the group selector is to connect to. In addition a size of group selector unit must be sought which can be mounted on frames in a manner convenient for manufacture and installation. L M Ericsson have adopted for their group selector units 20-line selectors, providing 80 inlets, 120 links and 400 outlets. One such unit occupies 2 bays. The optimal loading of inlets and outlets is 0.73 for a congestion of 0.005 and 40 outlets per route (10 routes). It can also operate with 20 outlets per route (20 routes), when the optimal loading is 0.61. The Swedish Administration uses 10-line selectors with an expansion of 2. For 10 routes the optimal utilization is 0.66. The unit here has only 10 inlets, 20 links and 200 outlets.

The Finder Connector in the Crossbar System

The use of the link system for the finder as well as the line connector function makes it possible to combine these selector stages in the A-stage. This is of particular importance from the economic point of view, since the A-stage in the finder connector circuit is the stage which requires the most material in an exchange.

Although external criteria mainly determine the design of the group selector units, this is not at all the case for the finder connector units. The most significant external condition is that the unit shall operate with a convenient number of subscribers, which implies that the number shall suit a decadic numbering system. In addition it may be important that the inlets are well utilized in the case where the exchange consists only of one finder connector unit (SLV-unit), with the incoming trunks connected directly to the unit. There is never, in general, any difficulty in satisfying these last conditions.

Circuit considerations, rather than external conditions, have played a very large part in the design of the SLV-units. In the American crossbar system each subscriber's line is allotted to a crossbar vertical. It may be said that the

A-stage is designed as a preselector. An advantage is that the cut-off relay is now superfluous, since the vertical itself can provide this function. A number of subscribers corresponding to the traffic capacity of the finder connector is connected to it. The SLV-units are thus similar in traffic but unlike in number of subscribers, an arrangement which clearly has both advantages and disadvantages. A direct advantage of the vertical without cut-off relay is that line blocking cannot occur. The reason why in both Swedish systems the A-stage cannot be built as a preselector is that it is a normal requirement in Europe that an operator should be able to break in on and perhaps disconnect a call in progress. It is thus necessary to provide more than one path to the subscriber. This can be done by connecting the A-stage as a line finder. The subscribers' lines are then divided into groups equal to the capacity of the verticals, 20 or 10 in the LME and KTV systems, respectively. Such small groups give poor utilization of the A-stage switches, especially if uneven traffic distribution between the groups may be expected to play a big part. The lines are therefore connected to the A-stage multiple with transposition. The transposition is nothing more than a grading of unusual type. It should be as nearly as possible a realization of an ideal grading according to Erlang. Transposition gives a considerable gain in the A-devices, particulary with low and moderate traffic per subscriber. As an example of this, with a total traffic of 0.12 E/subscriber the number of A-devices/20 subscriber's lines is reduced by transposition from 8 to 6.

In the two Swedish systems the B-stage is also connected as a line finder, with links to the A-stage in the multiple. When 20-selectors are used the natural group is 400 lines. This group size is relatively inconvenient, since it has no direct application in a decadic system. In addition the utilization of the markers is poor in such a small group. By using 2 ½ 400-groups and mixing the links between A- and B-stages a 1,000- group is obtained with grading in the B-stage multiple. Both group size and marker loading are then convenient. The incoming traffic passes through two selector stages. These stages are rather over-proportioned and would serve a group of twice the size. 2,000 lines is, however, too large a unit and would often give excessive marker loading.

The Swedish Administration's system operates with 100-groups, the natural size when 10-line selectors are used. For outgoing traffic the outlets from ten 100-groups are connected in a grading of the usual kind. The incoming traffic is brought directly from the last GV-stage to the B-stage in the SLV. The markers in the GV-stage and the SLV work together to establish the call through all 4 stages at once.

Overloading Conditions in a Link System

Another aspect of the design problem is the behaviour of the link system when overloaded. It might be feared that since the congestion in the link connection depends on the loading of both links and outlets, an increase in loading could produce a very large increase in congestion. This, however, is not the case. A mathematical treatment of the problem shows that there is approximately the same increase in congestion as with full availability or grading. In some conditions the overload conditions are exactly the same. There is thus no reason to provide in a link system any extra reserve of connecting devices or tie lines to deal with overloads which may occur in excess of those which would be provided in another system of connection.

In this connection it may be of value to consider a design detail of the crossbar system of more practical interest. The bays in the crossbar system are delivered with all the switching devices mounted. There is thus no simple way in which to do as is done, for example, in the L M Ericsson 500-line selector system, namely, provide a relatively large but cheap reserve for traffic handling capacity by delivering larger selector bays than the traffic requires but only the number of connecting devices required in the first phase. The problem is serious only for the finder connector stage. A traffic increase in the GV-stage is easily dealt with by adding extra GV-units and altering the jumpering in the M. D. F:s. If there is so much increase in the subscribers' traffic that the congestion is considered excessive in the SLV-stage, a solution can be found by connecting rather fewer subscribers to each SLV-group. The normal annual turn-over of subscribers is sufficient to enable the loading to be reduced adequately in a short time. An alternative is to construct new SLV-groups with higher capacity. The subscribers are transferred to these groups. No numbering changes are required if the subscribers are transferred in groups. The older SLV-units which have been freed can be used for new subscribers who will have relatively few calls, such as domestic subscribers.

Design of Markers

One problem which arises in connection with crossbar exchanges using the by-path system is that of the loading to be applied to a marker. The markers can be treated as connecting devices. It is therefore justified to follow the normal rules starting with the congestion to determine the number of markers. There are, however, fixed and decisive differences from ordinary connecting devices, which introduce another consideration. The loading time/circuit for the marker is very short — usually 100—600 ms — and it always operates as a delay system. If a marker for a device group is busy, an incoming call must wait until the marker is free. A waiting time of short duration causes hardly any inconvenience to the subscriber, since in most cases he does not observe that his call is not completed immediately. It is very much a question of opinion at what point the delay time becomes a nuisance. The opinion depends greatly on the quality of service to which the subscriber is accustomed. A waiting time of up to 2 s can be accepted in most cases, since this time is short compared with the average time which elapses before the B-subscriber answers, once the ringing signal has been connected.

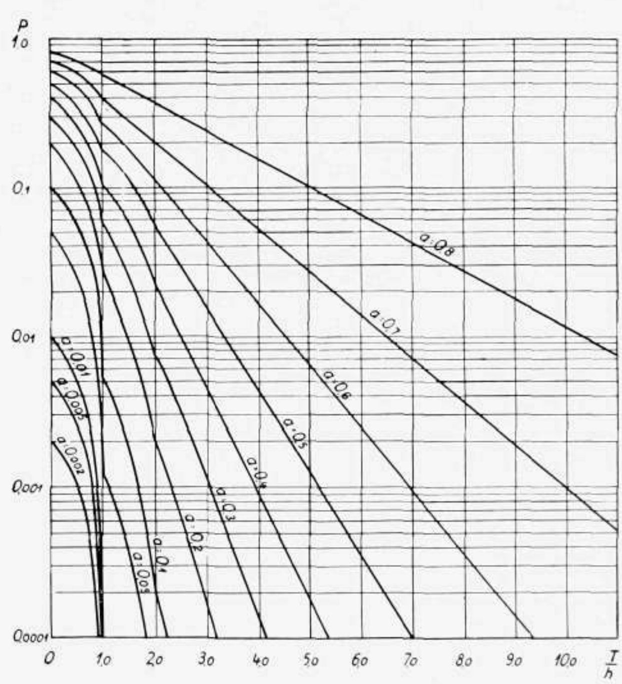
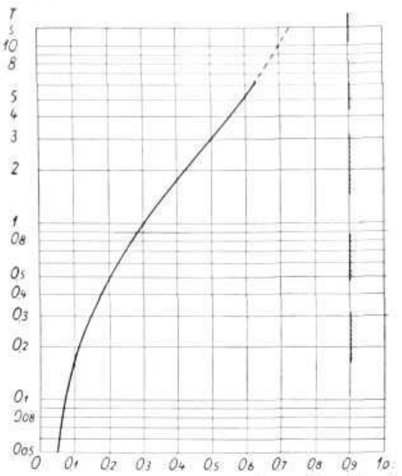


Fig. 6 X 6643

Distribution curves for delay time in one device at different loadings

p = fraction of calls exceeding delay time, a = marker loading, T = delay time, h = marker operating time

Delay time



Operating time h

Fig. 7 X 4763

Delay time as a function of marker operating time, 4 000 calls/hour

The curve shows the maximum delay time for (1—0.001) of the calls.

The relation between loading and delay time for different loading time/circuit ratios in a marker is shown in Fig. 6, which is taken from a paper by Crommelin (POEEJ, 26, 266, [1933]). Since the calls are presented at random, there will always be some which experience a delay time longer than the accepted limit (for example, 2 s). This fraction can easily be taken as equal to one of the normal congestion figures 0.001—0.01. In normal cases the markers are not so heavily loaded that a delay time of the given magnitude will not arise even for the lowest congestion figure. It is only when an exceptionally large device group is served by a marker, or when the average call duration is short that an approach is made to the figures given here as an upper limit. For a group selector-marker, for example, the connecting time/call is 250 ms. The marker is loaded during busy hours with about 3,200 calls, giving a total traffic of 0.22 Erlang. From the curve, for $p = 0.001$, the ratio delay time/loading time is 2.5 giving 625 ms. For a finder connector marker the connecting time/call is 300 ms and with 6,000 calls the loading will be 0.5 Erlang. For $p = 0.001$ the delay time is 300×5.1 ms $= 1.53$ s.

Fig. 7 shows the delay time as a function of the marker operating time. It will be seen that the delay time increases very rapidly as the marker operating time increases. This is because as the operating time increases there is also an increase in the marker loading. It is thus important to make the working time of the marker as short as possible.

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Hydraulic Moulding Presses for Plastic Parts

installed in LM Ericsson's affiliated plant at Karlskrona

P G NYLÉN, TELEFONAKTIEBOLAGET L M ERICSSON, KARLSKRONA, H ÅKERLIND, AB ALPHA, SUNDBYBERG

U. D. C. 679.5.053.7

When, in 1949, the manufacture of telephone instruments was transferred to L M Ericsson's affiliated plant at Karlskrona, this change-over also included the production of certain plastic parts which had previously been made by AB Alpha. Several presses for moulding (100 tons), as well as compression presses (165 and 175 tons) and presses for inverted moulding (200/100 tons) are all used for manufacturing the most important moulded parts, such as instrument casings, microhandles with earpiece and ring, as well as coil bobbins.

The presses are equipped with instruments and control devices for semi-automatic operation and synchronized co-action with high frequency units.

Until 1949 Telefonaktiebolaget L M Ericsson were supplied with the plastic parts needed for their telephone manufacture mainly by AB Alpha's plastic pressing plants at Sundbyberg and Uddevalla. But when the new telephone factory at Karlskrona was planned it was considered suitable for a number of reasons to include a press department for handling some of the phenol-melamine plastic parts used in manufacture. The advantages of this arrangement permitting part production to be carried out in direct relation to the main manufacture would be low transport costs, rapid consumption of materials and small storage requirements, the last mentioned being of particular importance in telephone production, since the casings and micro handles demand relatively large space. Another valuable result of such action would be an increase in the press capacity of the Swedish group.

As the new press department would be engaged in producing a small number of plastic parts in large quantities, it would be possible, by using specially constructed presses and moulds, to reduce manufacturing costs.

Press Methods and Press Equipment

The principles for the actual moulding of the different parts were known already when the new press department was planned. What remained was mainly to find ways of improving the different moulds in order to obtain cheaper parts.

The biggest problem, however, was the selection of suitable press equipment. In solving this, it was possible to draw on AB Alpha's many years of experience in plastic press work and also to make study visits to the various plastic concerns in Europe and the USA. The results arrived at were as follows:

a) For a press department of the size required and with the right potentialities central high pressure supply was more advantageous than individual operation of the presses, both from the technical and economic viewpoints.

b) Among the press designs met with, none was found which was specially suited for telephone instrument parts. Those presses which were already in existence at or had been planned by AB Alpha were, therefore, to be preferred.

When executing the press designs, AB Alpha took the following points into consideration:

1. Running economy

Owing to the high costs of moulds, presses, etc., every shortening of the work cycle brought considerable benefit. The phase of the work cycle known as the »curing period» was most effectively reduced by high frequency pre-heating the material. The other phases of the cycle, the »charging period», becomes shorter if the press goes up and down quickly and the pressing process is made as automatic as possible so that the closing speed of the mould is retarded, high pressure applied in the main cylinder and the high frequency unit started at the appropriate moment.

From the viewpoint of operational economy, it is also important that the press occupies a small space, is easily accessible for repairs and is fitted with arrangements for disconnecting the automatic operation so that the press can be worked by hand during testing or exchanging of moulds.

2. Safety

Accidents in a plastic press plant are happily rare, but even so the presses must be fitted with efficient safety devices. And it is not only a question of protecting the operatives — the costly moulds must also be safeguarded. One step in this direction is to make the press uncloseable if a mould part is not in proper position or if the HF pre-heated material is precured. By using the lowest possible pressure in every anticipated case, there is also less wear on the mould.

3. Rejections

In order to keep the rejection rate as low as possible the hardening period could be automatically adjusted and the parts allowed to be carefully ejected from the mould under the supervision of the operator.

Details of Construction

All the presses are fitted with an electro-pneumatic system for operating the hydraulic valves. The presses are started up by pressing two starting buttons, both of the operator's hands being required for this. There is, therefore, no danger of the press closing. When the starting buttons are pressed, a current circuit in which an electro-magnet is connected is completed normally. This circuit can contain »safety contacts» (micro-switches or time relays) which are placed on the press, in the mould or on the high frequency unit. If everything is in order before the start, these contacts are closed and the electro-magnet is operated as the current passes. But if all is not in order no current impulse is forthcoming and the press does not close. As a result of these contact devices, damage to both machine and moulds is avoided when pressing.

The electro-magnet mechanically actuates an air valve which emits compressed air to an air controlled hydraulic valve. The press is then closed with the help of two side cylinders.

Immediately before the motion is completed, the press platen closes a new contact at which the electric current is connected and a new magnet with pneumatic and hydraulic devices comes into operation. This brings about a slowing of the platen motion. At the same time a red signal lamp lights

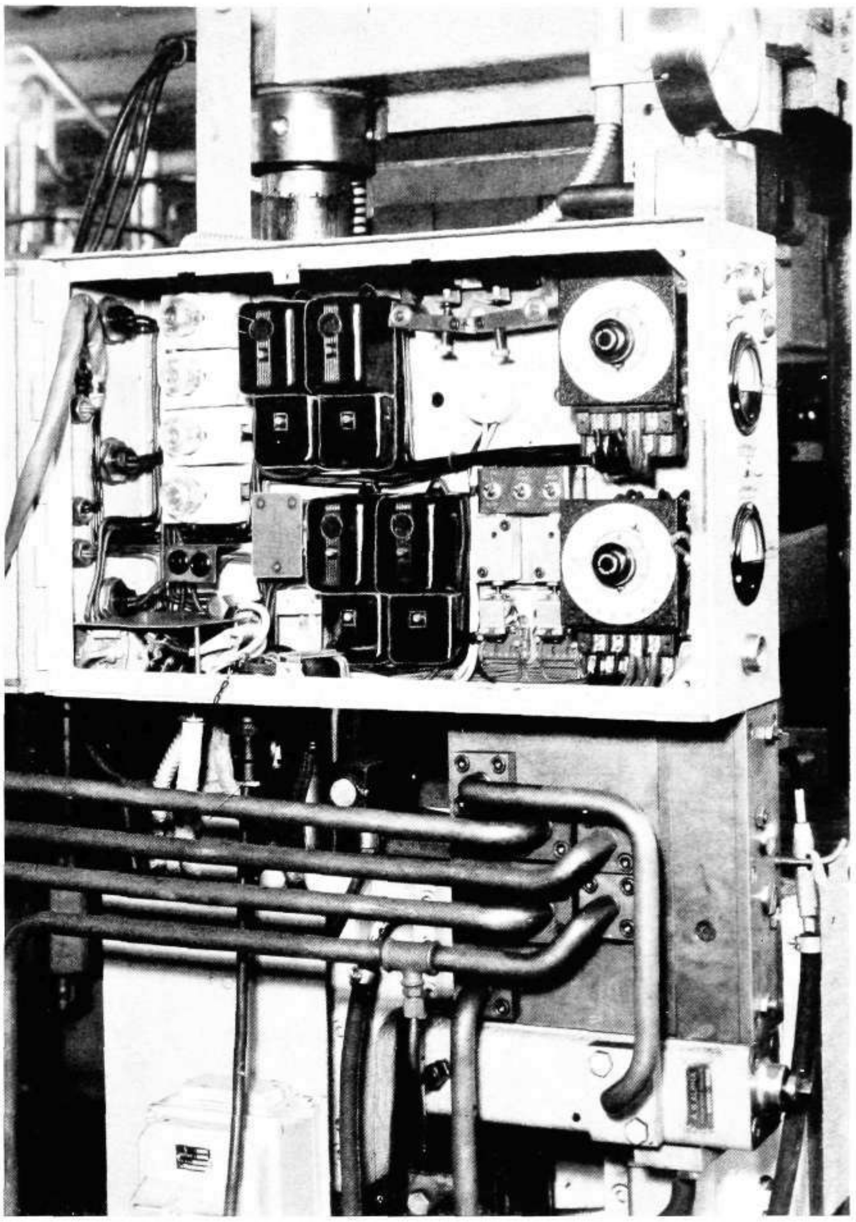

Fig. 1 X 6613

165/35 ton plastic press for micro handles

seen from the side, with the instrument panel at the top. Under this is the air-operated double-valve and reducing valve

up, indicating that the operative can now release the starting buttons. The following phases in the moulding procedure then take place automatically owing to the two adjustable time relays and other contact devices.

Only one of the two *time relays* is used for regulating the »curing period». When the pre-fixed time has expired, the current is broken for both electromagnets, the valves are restored and the press opens.

After it has run out its pre-set time, the other time relay gives an impulse to the high frequency unit in order to pre-heat the compound. The timing of this impulse must be so arranged that the pre-heating is broken off at the same instant as the operative has finished cleaning the mould and is in a position to transfer the compound from the high frequency unit to the press.

As the impulse giving is instantaneous, two or more presses could be connected at the same time to the same unit. The impulses then follow alternately from the one or the other press to the high frequency unit, wherefore the presses could co-act with the least possible loss of time.

When operating a number of presses at the same time it is important that precured press-material is not conveyed to the mould. The best way of avoiding this is by attaching a time relay to the previously mentioned safety contacts for starting. This relay holds the current circuit closed for only a short time after the compound has attained the correct temperature. If this time is exceeded the press cannot be closed.

When pressing with press-compound which must not be high frequency pre-heated, the earlier mentioned impulse relay has another function. It then controls the point of time for introducing the press liquid into the main cylinder. If in this case, as when treating high frequency pre-heated compound, the press does not close at the right moment, not only is the part itself in danger, but sometimes the mould, too, may be damaged.

Under the instrument panel is the air-operated double-valve, and below this, Alpha's specially constructed reducing valve, by means of which the necessary liquid pressure in the main cylinder can be set anywhere between 100 and 25 % of maximum pressure.

The connecting diagram for the instrument panel is shown in Fig. 2. The instrument panel is coupled in with the circuit-closing switch 9. It is possible to set for pressing with or without high frequency pre-heating, and for heating the mould from room temperature. The last mentioned adjustment breaks the current to the magnet *6* and cuts it off permanently for magnet *7*. By this means the press platen can remain in its upper position, independent of the time relays etc. The platen can be made to go down again by restoring the switch to its original position. The upper terminal *14* is intended for the earlier mentioned safety contacts; the terminal *14* at the left of the diagram is connected to the starting relays of the HF-unit.

Fig. 3 shows a section of the air-actuated double-valve. Visible in the centre are both of the hydraulic mushroom-valve systems, which can easily be removed for cleaning or adjusting. Above and below these are the air pistons which actuate the double arms whose adjusting screws regulate the above mushroom-valve systems. At the top of Fig. 3 is the restriction valve which acts as a choke on the supply of press liquid to the main cylinder.

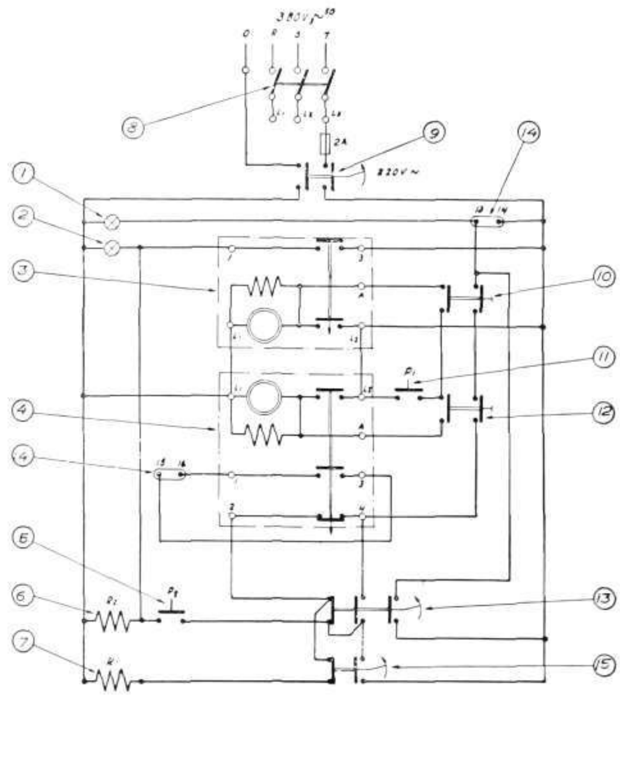

Fig. 2 X 6617

Connection diagram for the electrical operating device of a 100 ton press

1, 2 signal lamps
3, 4 time relays
5 micro-contact
6, 7 magnets for air-valve
8 main switch
9 switch for instrument panel
10 push-button contact, upper
11 micro-contact
12 push-button contact, lower
13 switch
14 terminal
15 switch
16 terminal

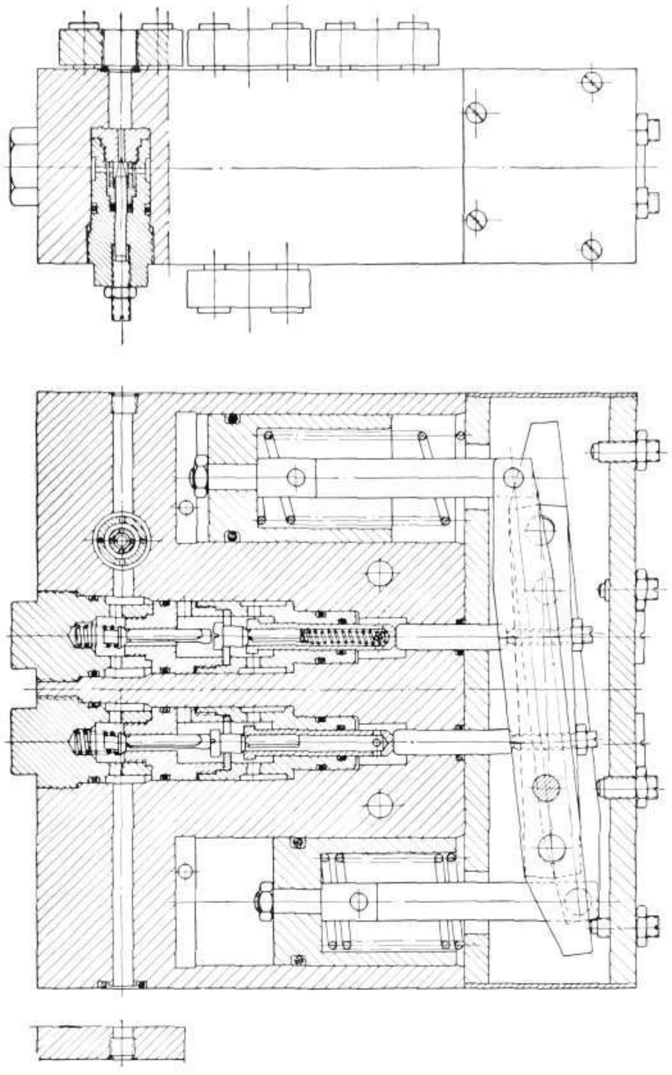

Fig. 3 X 6616

Section of air-operated double-valve

At the top is the restriction valve for press liquid to the main cylinder.

Different Types of Presses

100 ton press for moulding

This press is intended to be used for a number of parts for telephone instruments, among others, casings. Disregarding the above-described automatic arrangement, it is an under-piston press of conventional construction. As is seen from Fig. 4, the press has a main cylinder and two side cylinders as well as arrangements for the hydraulic ejection of parts.

165/35 ton press for injection moulding with off-set injection cylinders

The new micro handle has been designed from the start in such a way that it can be conveniently injection moulded. This is necessary because the shaft must be made with a tunnel for the cables. At the same time it was desirable that no loose cores should occur and that the mould should be mechanised as much as possible. These requirements were fully met when production was started up at the Karlskrona plant.

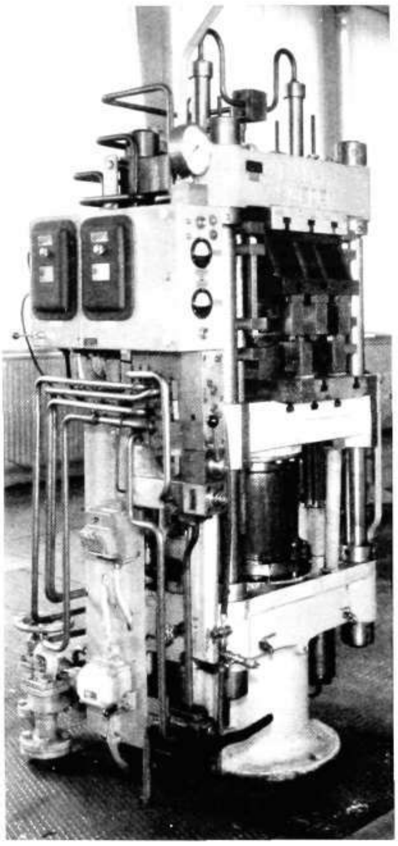

Fig. 4 X 6596

100 ton press for transfer moulding

The new press is also specially built for the moulds in question. It was calculated from the beginning that two presses would work together in conjunction with a high frequency unit; one man would be in control of these. Fig 5 shows both presses mounted and ready for work.

This press, like the 100 ton machine, is an under-piston press with two side-cylinders for quick closing and return movement. Inside the lower platen is a smaller hydraulic cylinder intended for self injection. This cylinder communicates with the main cylinder, but is not placed in the centre line of the latter, but offset about 130 mm to the side so that the pressure distribution on the mould is as even as possible.

The clamping pressure at full liquid pressure is 165 tons and the injection pressure 35 tons. The injection piston has a stroke of 150 mm.

The press lacks arrangements for hydraulic ejection, but is otherwise fitted with all the other previously described devices for automatic control operation.

It has been possible to reduce the working processes to the absolute minimum. After the mould has been air-blown clean, the operative charges the transfer cylinder with compound in tabloid form which has been warmed previously in the HF unit. He then presses in the two buttons on the control board, using both hands for the purpose. The rapid closing movement is first retarded when both halves of the mould are in the immediate vicinity of each other. When the mould is closed, the main cylinder is automatically subjected to high pressure, as is also the injection cylinder.

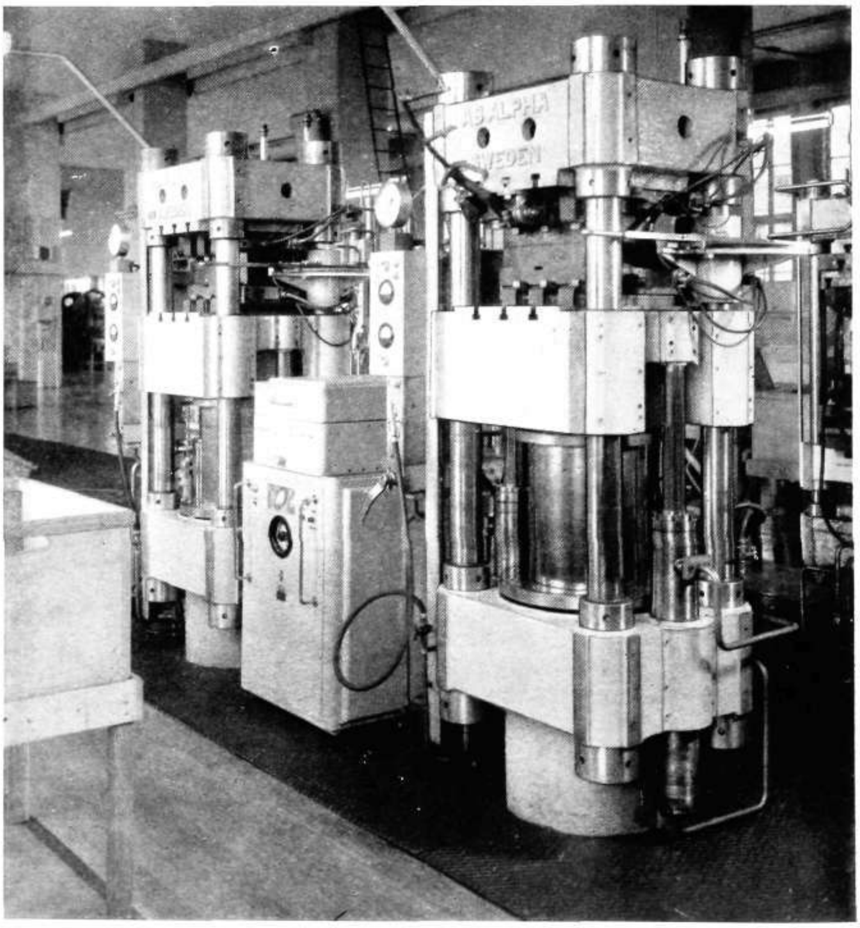

Fig. 5 X 6614

165 35 ton presses working together with a high frequency unit

Thanks to the quick closing and the automatic pressure regulation, the period of transference — the period which runs from the end of the pre-heating to the pressure increase — is exceedingly short, only about 10 seconds. This means that it is possible to heat up the compound to a very high temperature and complete the curing in a correspondingly short space of time.

175/25 ton press for transfer moulding with the injection cylinder placed centrally

On this press several mould cavities may be placed round a central transfer cylinder, the bore in the main ram becoming a centrally placed cylinder for injection ram communicating with the main cylinder. The maximum injection pressure is 25 tons at a clamping pressure of 175 tons. The press is now used, among other things, for induction coil spools and wall-bracket strips. The top elongation of the injection ram has no fixed connection with the transfer plunger, which is fixed to the ejector bars. During injection, the ram elongation actuates a cylindrical projection on the ejection bars, which enters very close to the injection ram through an aperture in the press platen. The bolsters of the mould and the length of the ejector pins are so adapted that the parts cannot be affected by the stroke of the injection ram. The parts are ejected and the return movement of the injector ram is effected by operation of the ejector cylinders. Thanks to the design with the injection cylinder in the main ram, the movable platen attains, in its lowest position, a height over the foot-plate of the press of only about one metre. This is a convenient working height for the operative.

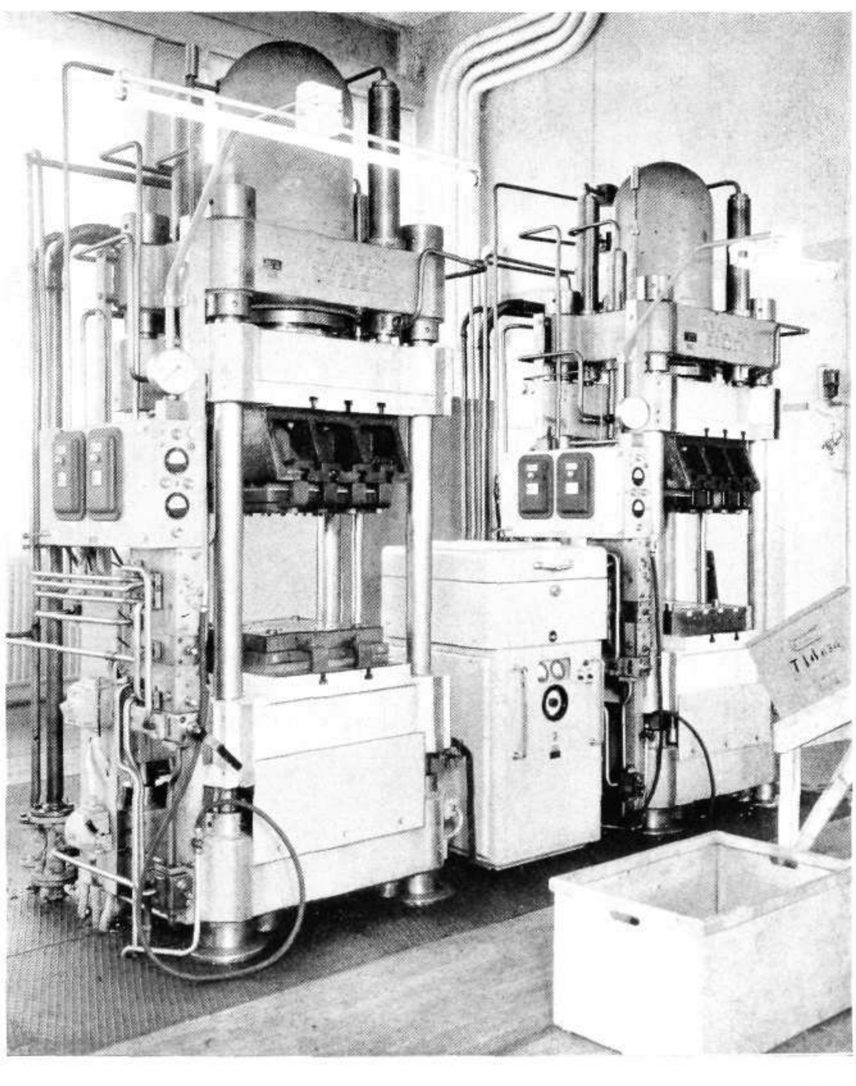

Fig. 6 X 6597

200/100 ton presses working together with a high frequency unit

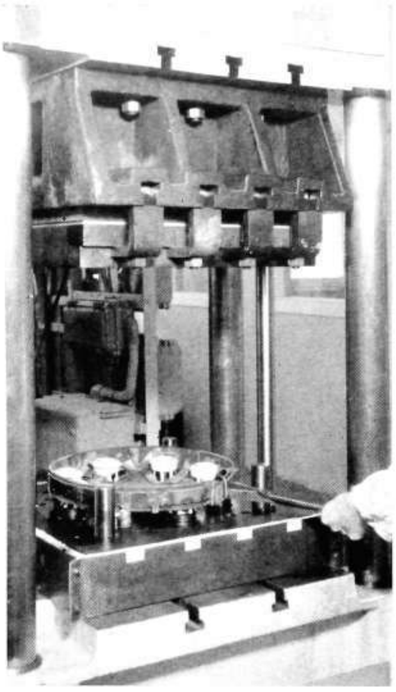

Fig. 7 X 4744

Emptying mould for earphone covers

The press is regulated in the same manner as the presses already described. The 400 mm stroke of the main ram is made in about 4 seconds. The length of stroke of the injection piston is 100 mm.

200/100 ton press for "inverted" pressing of covers and rings

The newly designed micro handle with a lightly marked parting line required a similar appearance for the earphone cover and ring. There was only one rational method of making these parts with the desired profile and without the necessity for further treating the parting line was to use the threaded core as a plunger in the closed mould.

When the press is opened, the lower half of the mould must continue so long down that the part is uncovered for unthreading from the core. The principles of the press's construction are: two movable press platens, each with its own half of the mould and with the effective pressure against each other so matched that the pressure of the upper platen exceeds that of the lower sufficiently to produce moulding pressure against the threaded cores which are placed on the lower fixed table.

Fig. 6 shows a group consisting of two presses working together with a high frequency unit. The button starting of the upper press platen, the rapid travel, the retarding, the slow closing of the mould and the application of the pressure, all take place in the manner previously described. The lower press platen obtains its counter-power of 100 tons from one central and four corner cylinders. The lower platen rises to its charging position when a contact button is pressed. When the press is closed, the lower platen yields so much that the upper table stops against the mould's guiding column. When the press is then opened, the lower platen sinks still lower so that the part is uncovered.

Fig. 7 shows the press at the moment of unthreading after a completed moulding cycle.

Installation

The planning of the new press shop at Karlskrona was not only confined to tools and presses. Considerable care was paid to the supply of material, questions of transport and particularly to the hydraulic and electrical installation. Fig. 8 shows how the presses were erected and pipe-lines laid.

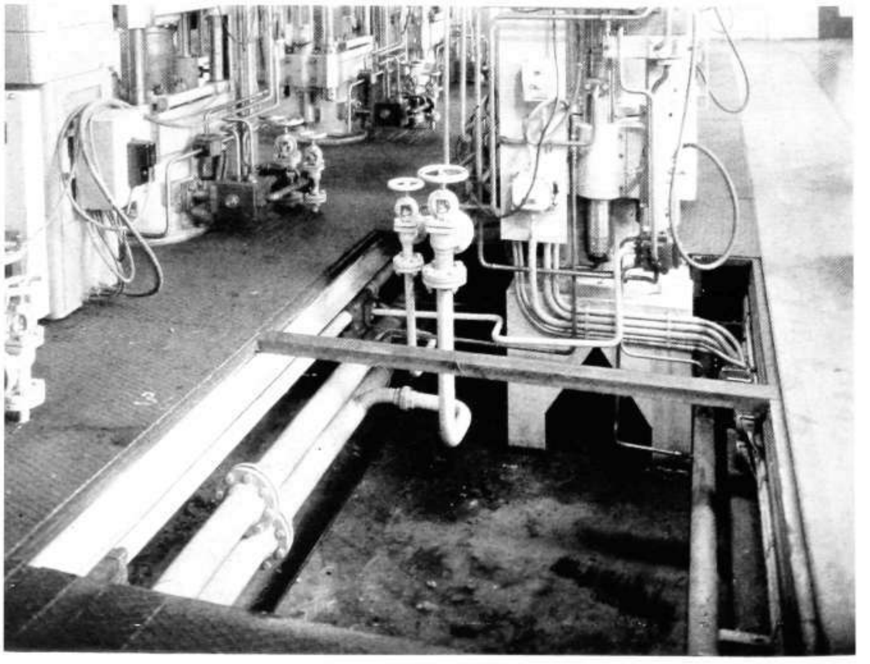

Fig. 8 X 6599

Trench with electric cables and pipes for press liquid

Carrier Frequency Circuits in the State Railways Telephone Network

ARNE PETERSÉN, ELEKTROTEKNISKA BYRÅN, KUNGL. JÄRNVÄGSSTYRELSEN, STOCKHOLM

U. D. C. 621.395.44:656.254.15(485)

At the conference of the Nordiska Järnvägsmannasällskap in Copenhagen, 28—29 September, 1951, Mr A Petersen delivered a lecture to Section E on the use of carrier frequency circuits in the State Railways telephone network. The lecture, which is reprinted below, gives a short survey of the equipment supplied by L M Ericsson and also offers some comments on maintenance.

Single Channel System

After a preliminary investigation which began in the autumn of 1932 with a single channel carrier frequency telephone system on a selector telephone line between Södertälje S and Eskilstuna, a similar circuit was arranged between Ånge and Vännäs and was brought into test operation in the spring of 1935. As the tests proved satisfactory the circuit was made permanent and was quickly followed by more installations of the same kind.

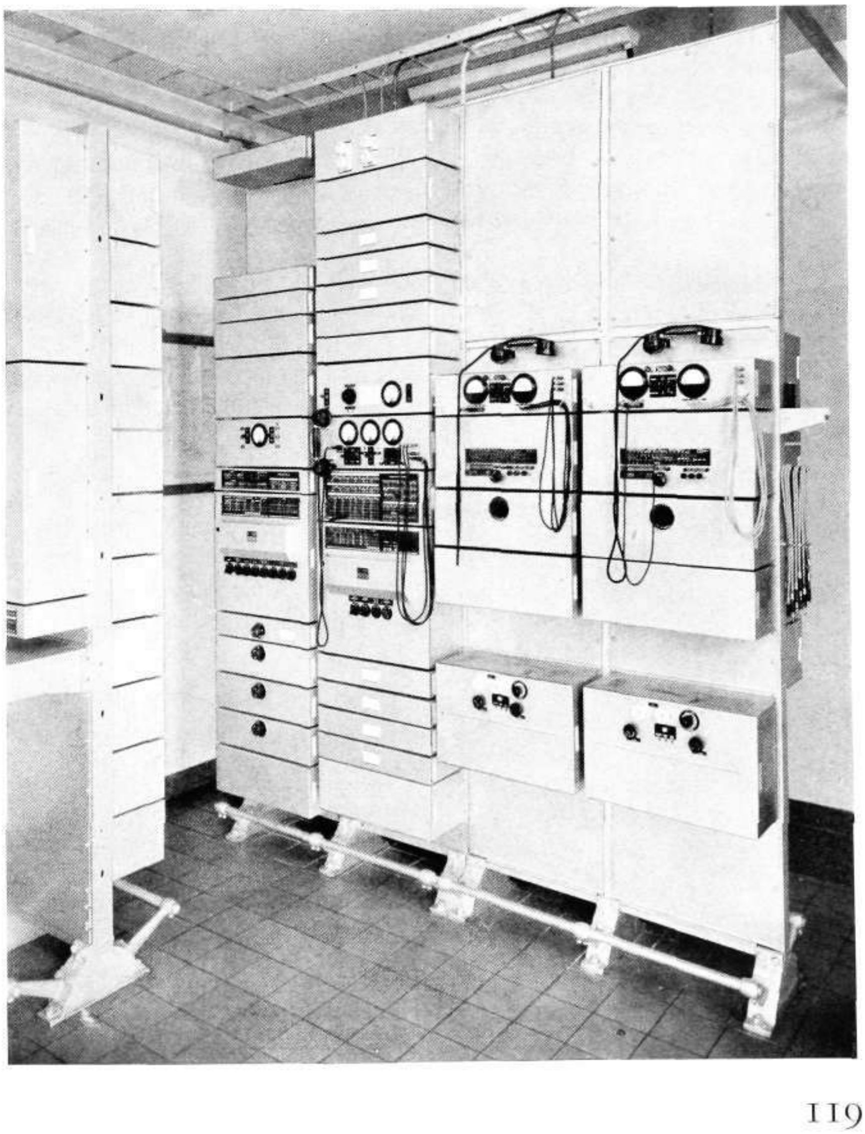

Fig. 1 X 6602

Carrier frequency bay, Växjö

Left: 3-channel terminal with channel bay and v.f. signalling and line bay. Right: Two singel channel terminals

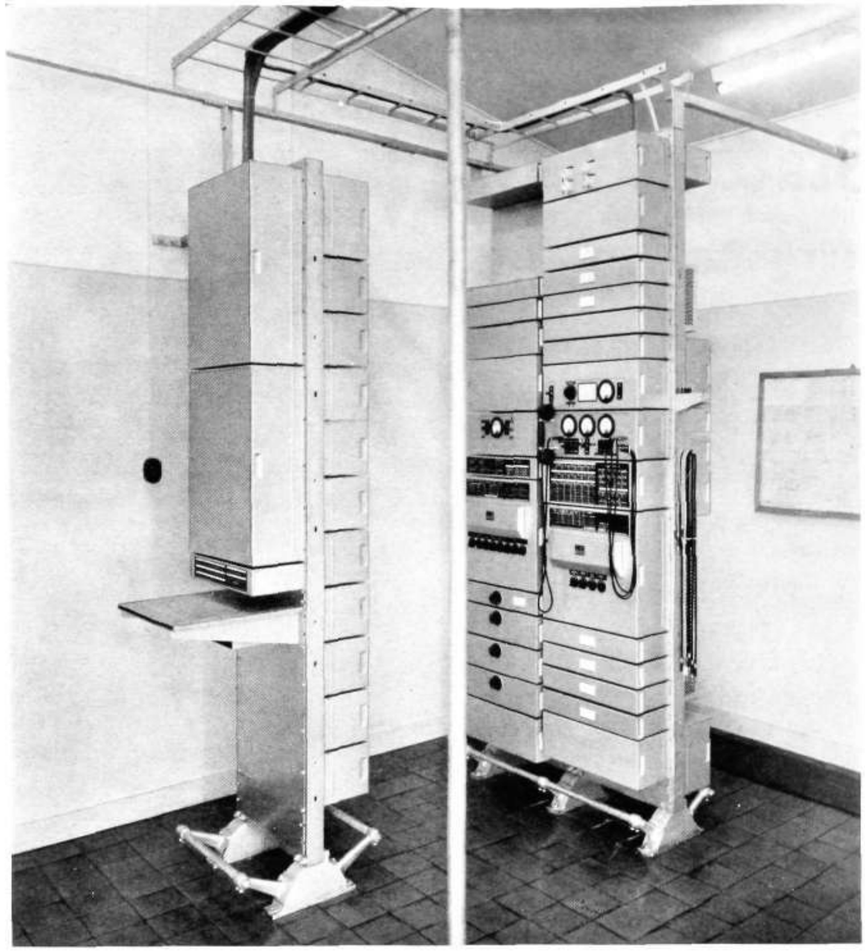

Fig. 2 X 6603

Terminal for 3-channel system, Borås

Left: Two-wire repeater bay

These were first used on the long open-wire lines in Norrland, where it was found economically advantageous to use this system to provide a needed improvement in the existing telephone circuits.

The single channel system was connected to both selector telephone lines and to direct lines. In the first case a filter was required at each outlet for a way-station, while in the latter case terminal amplifiers were needed to compensate the high attenuation of the lines, which were often long. Intermediate repeaters were never found necessary.

Later a number of single channel systems were obtained for south and central Sweden. The number of these systems now in use is 17, with a total length of 1,835 km. When the circuit is required to continue from one physical line to another, a high-frequency shunt is inserted at the junction.

All equipment has been manufactured by L M Ericsson, and is of three different types, corresponding to three stages of development.

The systems all operate with one sideband, but the newer types have the carrier suppressed, while in the older types it is transmitted. In consequence the ringing signal can be transmitted directly in the older system, while in the new systems it must be repeated as a 500 c/s tone.

The equipment was initially mounted throughout on racks fixed to the floor. The latest equipment, however, is designed for wall mounting and is of very small dimensions.

Three Channel System

When the State Railways took over the independent lines in southern Sweden there was a great need for increased telephone facilities, especially between Borås and Växjö, 167 km. A 3-channel system was obtained for the circuit in 1946, the section between Borås and Alvesta being an open-wire line, and Alvesta—Växjö a cable. The junction at Alvesta is provided by a high-frequency shunt.

Eight Channel System

As the telephone requirements increased, especially between Stockholm and the large centres, Gothenburg and Malmö, the railway board was faced with the problem of either laying new cables or adding carrier frequency systems on the old cables. The second alternative was chosen, both as the more economic, and since it gave advantages from the raw material standpoint.

In 1944, therefore, L M Ericsson were asked to provide 8-channel systems, one between Stockholm and Gothenburg, 456 km, and two between Stockholm and Alvesta, 417 km. Unloaded cable pairs were used, and it was necessary to remove the loading from the cable on the Alvesta section. Special precautions against crosstalk between the two systems were required.

Because of the attenuation in the cable, especially at high frequencies, a large number of intermediate amplifiers was required. The maximum repeater section is 36 km, giving 14 intermediate repeaters between Stockholm and Gothenburg and 12 between Stockholm and Alvesta.

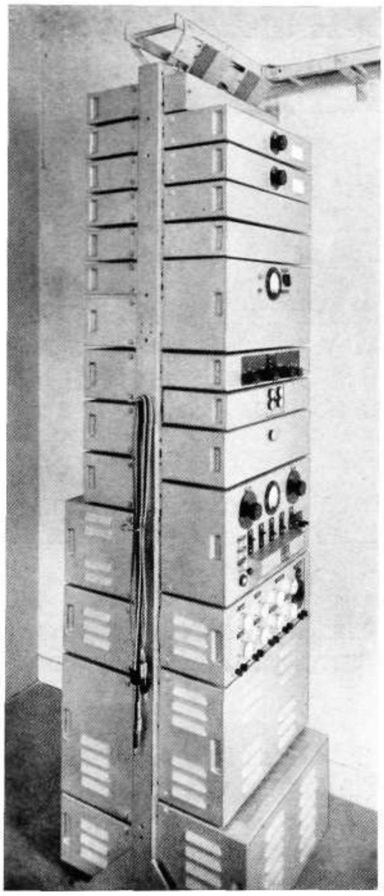

Fig. 3 X 4735

Intermediate repeater for 8-channel system, Gnesta

The locations of the repeaters make it impossible for maintenance staff to be available at them all, and they are mostly unattended. To maintain some watch on their operation, a special alarm system is used to warn the maintenance staff when a fault arises on an amplifier in the section. The physical circuit is used for this alarm and it is thus not available for telephony.

So that all 8 channels shall not fail if an intermediate repeater is defective, each repeater bay contains a spare amplifier which is automatically connected in place of the faulty unit. At the same time the alarm is given.

Levels are regulated manually and should be kept within limits of $\pm$ 0.2 N.

The circuit to Gothenburg was brought into use in 1947, while the Alvesta circuit was ready the year after. A further 8-channel system is now being installed between Gothenburg and Mellerud, 123 km, and is expected to be completed in the autumn. This includes 3 intermediate repeaters. Part of the equipment in Gothenburg, mainly test equipment, will be common with the Stockholm circuit.

Maintenance

From the point of view of maintenance the single channel equipment is particularly good. Since it is easy to move and install, it is suitable for temporary circuits, for example to improve the telephone circuit in an open-wire line which in the foreseeable future is to be replaced by a cable.

The 3-channel system with its more complicated elements clearly requires more attention, but a systematic routine test procedure, in which daily, weekly and monthly programmes are fixed, enables the number of failures to be kept to a minimum.

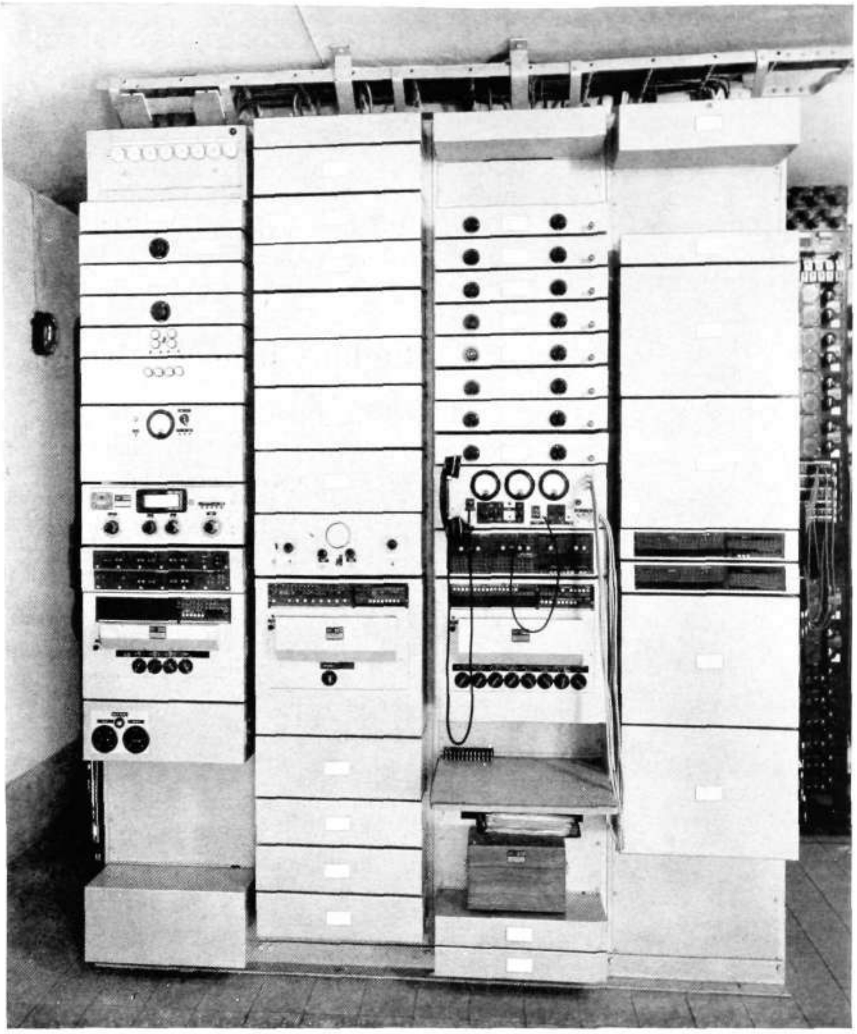

Fig. 4 X 6604

Terminal for two 8-channels systems, Alvesta

The 8-channel circuits require, as was expected, the most attention. In particular the level adjustment at the many intermediate repeater stations calls for supervision. This is partly because when the level is changed at one point, there is a resultant change of level over the whole of the remainder of the line. For test purposes the programme is that the levels are checked beginning from Stockholm on the first working day in each month. Now and then, however, the levels must be re-adjusted between these programme times. The alarm equipment already mentioned is of great assistance in the rapid clearing of faults.

If a break should occur in the circuits between Stockholm and Gothenburg or Alvesta, other routes with physical circuits are provided. The introduction of these requires only a simple order.

In addition, a complete survey of all equipment is carried out twice a year for preventive maintenance. The supplier is carrying out this inspection until further notice.

It may be of special interest to note that the 8-channel system is suitable for teleprinter operation by tone transmission. This is because the channel frequency range extends up to 2,700 c/s (3,400 c/s for channels 1 and 8) while normal cable circuits with repeaters cut off at 2,400 c/s and are thus not suitable for this purpose. In teleprinter transmission a system of sub-band telegraphy is used, the frequency range between 1,500 c/s and 2,000 c/s being taken from the speech band and used to transmit two teleprinter channels, one in each direction. This has no significant effect on the speech.

U.D.C. 621.395.344

BERGLUND, C: *The L M Ericsson By-path System with Crossbar Switches — Fundamental Principles.* Ericsson Rev. *28* (1951) No. 4 pp. 94—103.

The main features of the by-path system with crossbar switches are the by-path principle, the link connection and the crossbar switch. The article surveys the measuring of these ideas, their application and their effect on the operating characteristics of the system.

U.D.C. 621.395.344.001

JACOBÆUS, C: *Theoretical Aspects of Crossbar Exchange Design.* Ericsson Rev. *28* (1951) No. 4 pp. 104—110.

A number of constructional principles have been introduced in modern automatic telephone exchanges using crossbar switches particularly as regards the grouping arrangements of the exchanges and the switching controls. The article deals with some important theoretical aspects of the new problems presented to the designer particularly in the quantitative design of exchanges and the connecting circuits between them.

U.D.C. 679.5.053.7.

NYLÉN, P G & ÅKERLIND, H: *Hydraulic Moulding Presses for Plastic Parts installed in L M Ericsson's Affiliated Plant at Karlskrona.* Ericsson Rev. *28* (1951) No. 4 pp. 111—118.

When, in 1949, the manufacture of telephone instruments was transferred to L M Ericsson's affiliated plant at Karlskrona, this change-over also included the production of certain plastic parts which had previously been made by AB Alpha. The article gives a presentation of the plant as regards press methods and press equipment.

U.D.C. 621.395.44:656.254.15(485)

PETERSÉN, A: *Carrier Frequency Circuits in the State Railways Telephone Network.* Ericsson Rev. *28* (1951) No. 4 pp. 119—122.

Short survey of the equipment for carrier frequency circuits supplied by L M Ericsson to the State Railways telephone network, and some comments on maintenance.

The Ericsson Group

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L M Ericsson A/S *København V*, Tromøsalen 5, tel: C 3438, tgm: ericsson-københavn

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Ericsson Verkaufsgesellschaft m. b. H. *Kronberg im Taunus*, Parkstrasse 1, tel: Kronberg 450, tgm: ericsson-kronbergtaunus

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ASEA Electric (N Z) Ltd. *Wellington C. 1*, Huddart Parker Building, tel: 42086, tgm: aseaburd-wellington