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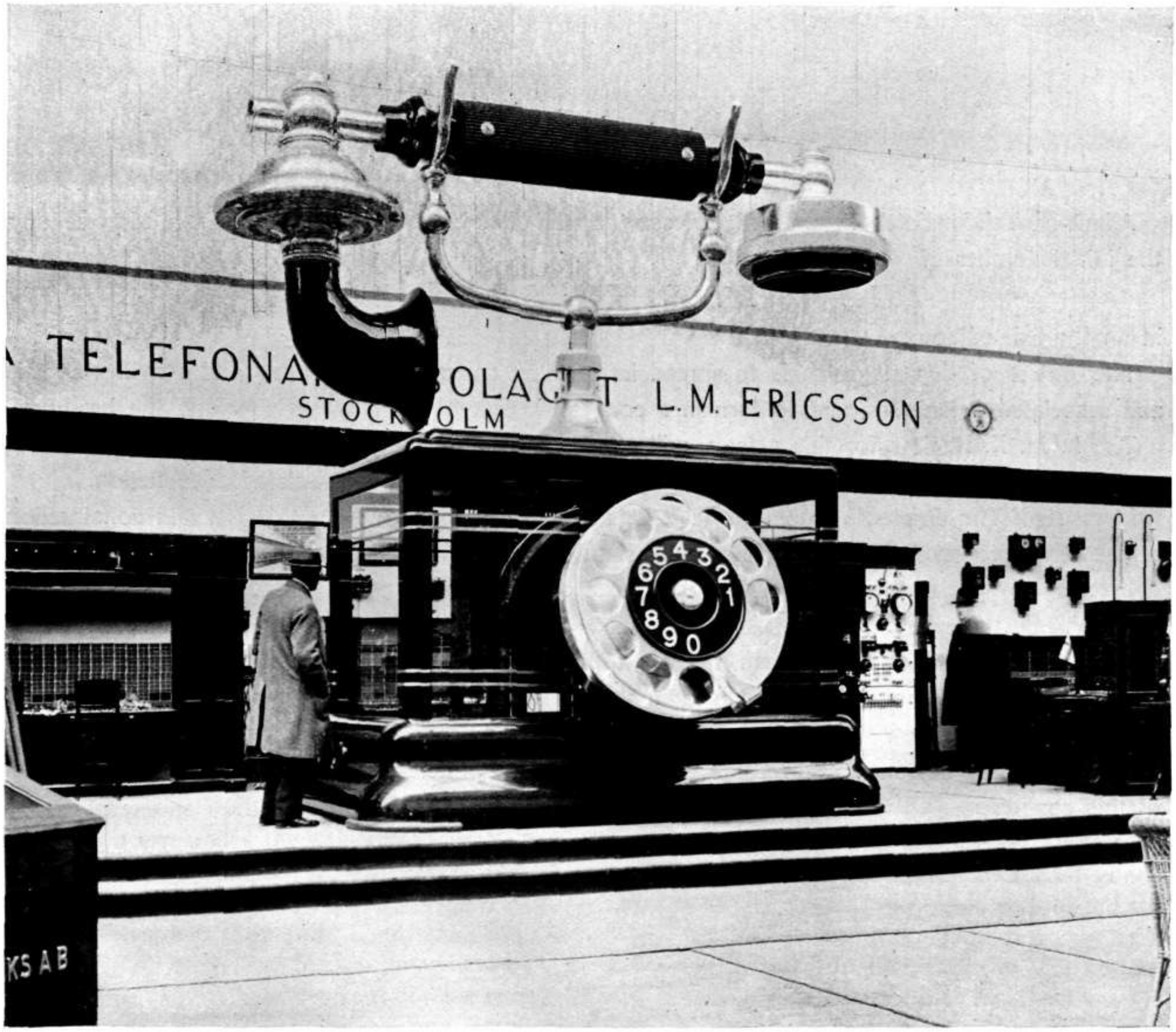

THE L. M. ERICSSON STAND AT THE GOTHENBURG EXHIBITION 1923

ENGLISH EDITION

L. M. Ericsson

THE L. M. ERICSSON REVIEW

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JOURNAL OF

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ANNOUNCEMENT.

Allmänna Telefonaktiebolaget L. M. Ericsson, Stockholm, herewith have the pleasure of presenting the initial number of

THE L. M. ERICSSON REVIEW

in an English edition.

The object of this magazine is to spread information concerning the work and activities of this and associated enterprises, and to furnish a connecting link between these latter and the head firm.

The L. M. E. Review, for this reason, will contain articles relating mainly to design, construction, and installation within the fields of telephony, railway signalling, and fire-alarm construction.

It is also The Review's intention to take up for discussion points of design and construction which have not yet reached a stage of final standardization. Further, notices regarding orders and deliveries of special interest together with data concerning the development of this and affiliated firms will be published.

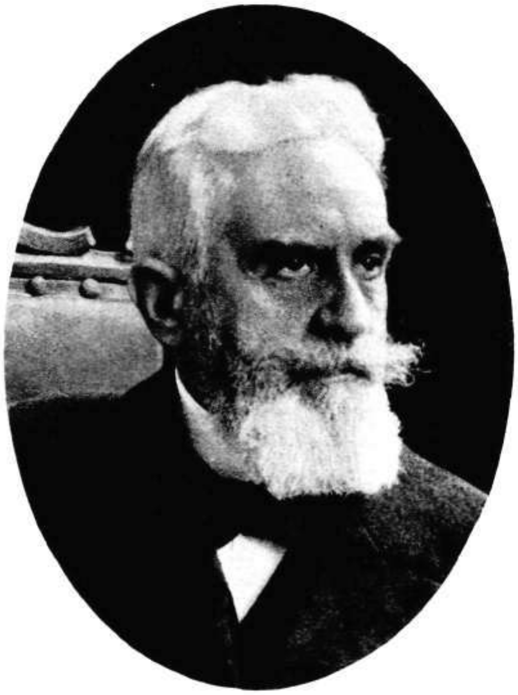
The Review's staff of contributors includes officials and employees of both the head and branch offices, as well as other experts occupied in the same field of activity.

The L. M. E. Review hopes, through its columns, to prove both useful and of interest to the Company's many customers as well as to all who take an interest in the activities and development of this concern.

THE EDITOR.

Growth and Present Development of the L. M. Ericsson Organization.

The name of L. M. Ericsson was associated with but one concern, i. e. the head firm in Stockholm, when, during the nineties, it began to be recognized throughout the world as a mark of quality on telephones and switchboards. This firm, founded in 1876 and therefore as old as the telephone itself, carried on its work as a private concern under the name of L. M. Ericsson & Co. until 1896, in which year it was taken over by a joint stock company — Aktiebolaget L. M. Ericsson & Co. (The L. M. Ericsson Co., Ltd.). There were no foreign branch offices at this time, neither was the staff of representatives very large. The constantly growing demand for the company's products, however, together with the express desire of its customers to be in closer contact with the firm, necessitated, time after time, the establishing of branch offices in various foreign countries and the successive increase of its permanent staff of representatives.



R 33 H. T. Cedergren.

R 34 L. M. Ericsson.

In certain foreign countries, where the Government Departments themselves were large customers, the manufacture of ordered goods in the country of destination itself was made a stipulation for further business. This gave rise to the establishing of branch factories, the first of which was put in operation in St. Petersburg in 1897.

The first foreign office not combined with a manufacturing plant was established in London, in 1898. The scope of the company was thus broadened from time to time, so as to finally extend over the entire civilized world.

Meanwhile — and parallel with the Ericsson company — another Swedish enterprise had successfully pushed its way to the front in the field of telephony, i. e. Stockholms Allmänna Telefonaktiebolag (The General Telephone Company of Stockholm, Ltd.), founded in 1883 by H. T. Cedergren. During its first years of activity this company built and operated exchanges in Stockholm and other parts of the country, but in 1891 an agreement with the Royal Telegraph Office was arrived at whereby the plants and operating rights of the company in the provinces were acquired by the Swedish Government, reducing the field of activity of the company to Stockholm and surroundings.

After having reached a prominent position and acquired a high reputation in the world's telephone industry, the necessity for expansion beyond the comparatively small field of operation offered in Sweden made itself more and more urgently felt. The first attempt to gain a footing on foreign territory resulted in the acquisition, in 1900, of a franchise for operating telephone exchanges in Moscow and Warsaw, and subsidiary companies were formed to take charge of this work.

In 1908 Stockholms Allmänna Telefonaktiebolag surrendered its Swedish operating rights to a newly formed subsidiary company, Aktiebolaget Stockholmstelefon (The Stockholm Telephone Co., Ltd.) This concern sold its telephone systems to the Royal Telegraph Office in 1918, but continued under the name of Allmänna Industri Aktiebolaget H. T. Cedergren (The H. T. Cedergren General Industries, Ltd.) with the manufacture of miscellaneous line equipment, begun several years earlier.

In the above mentioned year 1918 the private Swedish telephone interests, consisting of Aktiebolaget L. M. Ericsson & Co. and Stockholms Allmänna Telefonaktiebolag formed a coalition, the present Allmänna Telefonaktiebolaget L. M. Ericsson (The L. M. Ericsson General Telephone Company, Ltd.).

After this fusion Allmänna Industri Aktiebolaget H. T. Cedergren remained the resulting company's most important subsidiary company from a financial point of view. In 1921 this company was also merged into the head concern.

This, in short, is the history of the Stockholm Ericsson company's gradual development. As has already been mentioned, it has time after time created a large number of branch companies in different parts of the world, and forms — together with its agencies, subsidiary companies, etc. — a net which covers practically the whole world.

A synopsis of this organization is given below, in which, however, the agents employed by the various companies are not included.

Allmänna Telefonaktiebolaget L. M. Ericsson in Stockholm has the following daughter companies:

(a) Manufacturing companies (Location of head office indicates nationality of concern).

The British L. M. Ericsson Mfg. Co., Ltd., Head office: International Buildings, 67/73, Kingsway, London, W. C. 2, and factory at Beeston, Notts.

Russische Actien-Gesellschaft L. M. Ericsson & Co. Office and works: Gr. Sampsoniewsky Prospekt 70, Petrograd.

Société des Téléphones Ericsson, Main office: 37, Boulevard Haussmann, Paris, and works at Colombes, Seine.

»Ericsson» Oesterreichische Elektrizitäts-Aktiengesellschaft vorm. Deckert & Homolka, with office and works Pottendorferstrasse 25/27, Vienna XII.

»Ericsson» Ungarische Electricitäts-Aktiengesellschaft vorm. Deckert & Homolka, with office and works Fehérvári-ut. 70, Budapest I.

»Ericsson» Elektrizitäts-Kommanditgesellschaft Scholta & Co. Main office: Malé nám 1, Prague; branch office in Brünn and works in Prague.

Nederlandsche Ericsson Telefoonfabrieken, with the main office at Heerengracht 370, Amsterdam; and works at Gilze-Reijen.

Telephonbauaktiengesellschaft of Moscow, for the building of telephone plants and the manufacture of line equipment, with office and works in Moscow.

Compañía Española de Teléfonos Ericsson S. A., with the head office at Príncipe 12, Madrid, and works under construction at Getafe outside Madrid. In addition, the telephone plant of Valencia is owned by this company.

(b) Operating companies.

Empresa de Teléfonos Ericsson S. A., 2ª Calle Victoria 53 y 55, Mexico D. F., which owns the telephone system of Mexico City and the Federal District. Head office in Stockholm.

Svensk—Dansk—Ryska Telefonaktiebolaget of Moscow, which owns the telephone system of Moscow. Head office in Stockholm.

Polska Akcyjna Spółka Telefoniczna, owning telephone systems in Warsaw and other Polish cities. Main office: Zielna 37, Warsaw.

Compañía Entre-Riana de Teléfonos, which owns the telephone system of the province Entre Rios in The Argentine. Main office in Concordia.

Compañía Española de Teléfonos Ericsson, S. A., Principe 12, Madrid (see above, under manufacturing companies).

(c) Construction and sales companies.

Aktiebolaget L. M. Ericsson of Finland. Main office: Esplanadgatan 25, Helsingfors.

»Ericsson» Polska Akcyjna Spółka Elektryczna. Main office: Ceglana 11, Warsaw.

Compañía Sudamericana de Teléfonos L. M. Ericsson S. A. Main office: Esmeralda 1000, Buenos Aires.

Companhia Geral de Telephones; branch of the head company in Stockholm with offices at Rua São Pedro 106, Rio de Janeiro.

Donauländische Telephonbau- & Vertriebsgesellschaft L. M. Ericsson G. m. b. H. Main office: Pottendorferstrasse 25/27, Vienna XII.

Ericsson India Office; common branch concern for both the Stockholm company and British Ericsson, with offices at No. 15 Central Avenue, Calcutta.

Förenade Signalverkstädernas Försäljningsaktiebolag »Signalbolaget», for the sale of the company's line of railway signal equipment, with offices at Vasagatan 9, Stockholm.

Ericsson Telephone Manufacturing Co., with offices at 7 Macquarie Place, Sydney, N. S. W., and 509 Collins Street, Melbourne, Victoria.

(A list of agents and representatives will be printed in our next issue.) *H. J.*

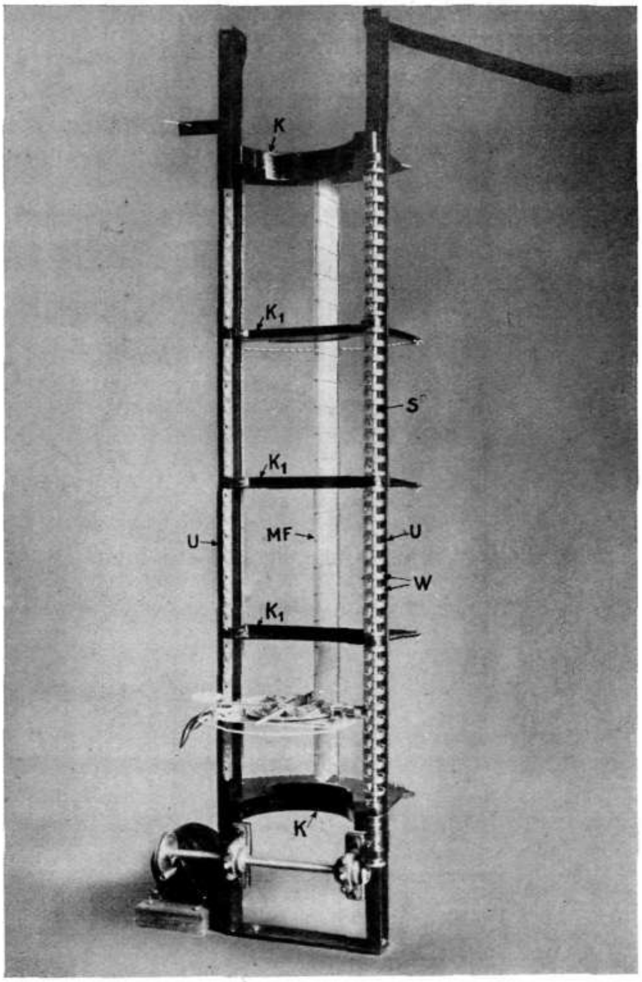
R 35

The L. M. Ericsson Automatic Switching System with 500 line selectors.

The L. M. ERICSSON full automatic telephone system is to be classified as a »power driven» system, inasmuch as the necessary selectors and sequence switches are mechanically propelled by rotating shafts continuously driven by small motors, common to a given number of racks.

The Ericsson system uses register sets, the function of which is to receive and register the impulses sent out from the subscribers' telephone instruments (or, in the case of a semi-automatic station, from an operator's keyboard) and to direct the group selectors and connectors to their correct positions. This directing is accomplished by means of revertive impulse control.

The chief characteristic of this system is that all selectors, i. e. the line finders, group selectors, and connectors, are of the same construction, except for some minor details, all having a capacity of 500 lines. Another feature of this system is the multiple, consisting of vertical, bare wires, forming so-called multiple frames.



R 11 Fig. 1. Selector rack for 40 selectors.

I. Description of the switching apparatus.

A. *The selectors.*

The selectors are mounted in racks accommodating 40, 50, 60 or 70 selectors. Figure 1 shows a rack for 40 selectors. Such a rack consists of two vertical channel irons connected both at the top and bottom by means of the brackets K. Additional brackets K_1 are inserted for each group of 10 selectors.

On the insides of the channel irons are fastened metal strips with horizontal notches into which the selectors are slipped and locked in place.

The vertical driving shaft is mounted in ball bearings on the right hand side of the rack and furnished with double, toothed drivers W one for each of the selectors.

The multiple consists of 25 multiple frames MF (fig. 1 shows such a frame in position) placed radially in relation to the selector's centre of rotation, as shown in fig. 2. Each multiple frame is composed of vertical bare wires for 20 lines, held by strips of insulating material.

Fig. 2 shows in outline a selector rack with one selector, seen from above. A selector is shown in fig. 3. The main selector parts are:

Base plate .... BP
Magnet coupling .... MH—MV
Rim gear wheel .... KR
Rotary disc .... TS
Locking magnet for the same CV
Contact arm .... KA
Locking magnet for the same .... CR.

The magnet coupling, mounted directly on the base plate, has two magnet coils MH & MV. The shaft M, carrying the toothed wheels FR & FR_1, is run through the armature, which is common to both coils. The armature can be attracted by either the coil MH, giving it an upward movement, or the coil MV, giving it a downward movement. These movements cause the toothed wheel to be brought against either the upper or the lower driver W, thereby giving the shaft M a rotary movement in either the one or the other direction.

The function of the rim KR is to convey the movement from the wheel FR_1 to the rotary disc and the contact arm. The teeth on its outer edge gear into the wheel FR_1 and those on its inner edge gear into the wheel ZR, which is pivoted on the rotary disc TS, and whose function is to convey movement to the contact arm. The rear part of the contact arm is formed into a rack geared to the wheel ZR, as is shown in fig. 2. (ZR consists actually of two wheels, pivoted on the same shaft, the under one being geared to the rim KR and the upper one to the rack on the contact arm).

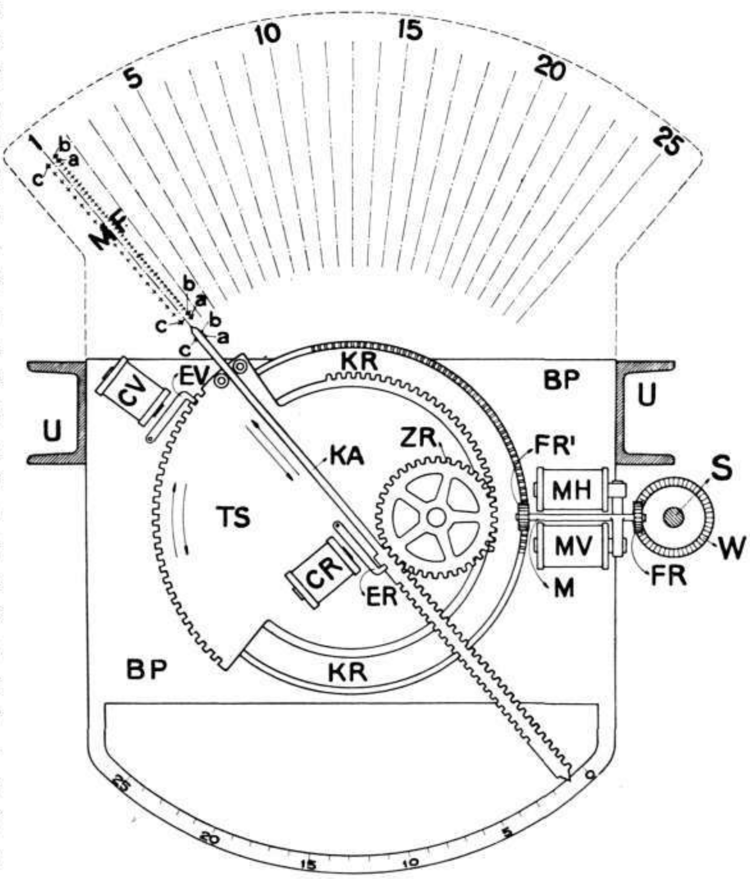
Movably mounted on the rotary disc TS is the contact arm KA, the front part of which is covered by an insulating sleeve of rectangular section, carrying the three selector contact springs, a, b and c. The contact arm has two different movements, namely, a rotary movement, in which it follows the turning of the disc around its axis, and a radial movement, by which it moves in to or out of a multiple frame.

The movements of a selector are controlled by means of the two locking or centering magnets CV and CR.

The magnet CV controlls the rotary movement of a selector, its armature being shaped to a dog EV, which fits into notches on the rotary disc, thereby locking it. The notches are spaced so as to exactly conform to the position of the contact arm in relation to the multiple frames. In fig. 2, for example, the contact arm is centred exactly opposite frame number 1.

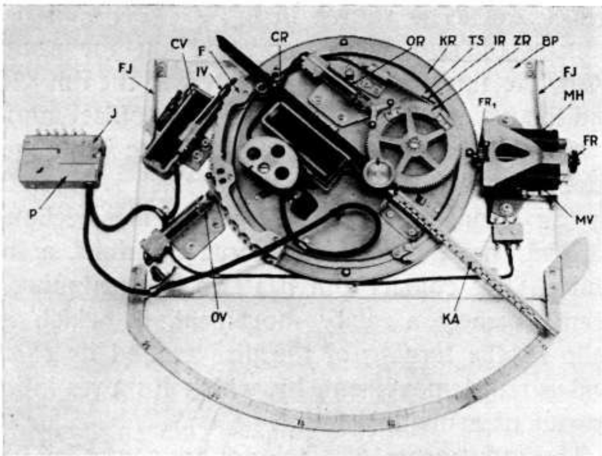
The magnet CR controlls the radial movement by means of its armature, which forms the dog ER, whose function it is to centre and lock the contact arm. This it accomplishes by striking into notches on the contact arm, corresponding to the positions of the 20 lines of a multiple frame.

The magnets MH and MV are furnished with the necessary current through con-



R 12

Fig. 2. Working principle of a 500 line selector.



R 13 Fig. 3. Connector.

tacts located on the locking magnet armatures, when these latter are attracted. The two following cases can then occur:

(1.) If the locking magnet CV is actuated, the selector is released for rotation and the rotary disc, together with the contact arm, will start turning. This movement continues until the circuit through CV is broken and the dog engages a notch, thus locking the rotary disc, the current supply to the magnet coupling being simultaneously cut off. A left- or right-handed rotary movement is obtained depending on which of the magnet coupling coils MH or MV is energized.

(2.) If the locking magnet CR is actuated the contact arm is released for radial movement. This movement continues until the circuit through CR is broken and the dog engages a notch on the contact arm, thus locking the same, the supply of current to the magnet coupling being simultaneously cut off. The contact arm is either thrust into or withdrawn from a multiple frame, depending on which one of the magnet coupling coils MH or MV is energized.

As has already been mentioned, the three different types of selectors used in this system, i. e. line finders, group selectors, and connectors, are mainly of the same construction. The details in which they differ are as follows:

Each line finder is provided with a special test spring, mounted on the rotary disc (does not occur in fig. 3, which shows a connector), by means of which that multiple frame is found, in which an incoming call is located. The vertical front bars of the multiple frames in the line finder racks are, for this purpose, used as test bars, with which this test spring comes into contact during the line finder's rotary movement.

Group selectors and connectors have always a definite starting position for the rotary movement. They are provided with a cam plate F, mounted on the rotary disc, which alternately closes and opens a group of switching springs IV, thus sending impulses back to the register.

The connectors are further provided with a switching group IR for the sending of impulses to the register when the contact arm is moving into a multiple frame. This switching group is actuated by means of a cam wheel, mounted under and on the same shaft as the toothed wheel ZR.

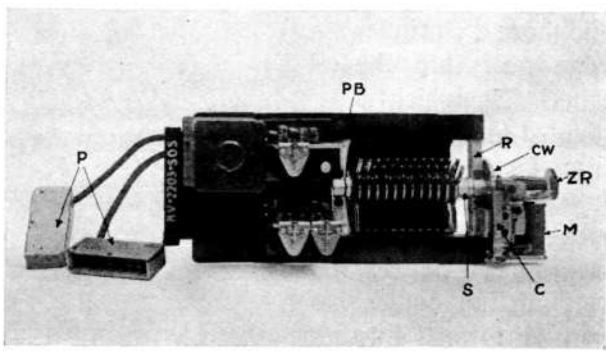
All selectors are furnished with two switching groups OV and OR, mechanically actuated in the extreme positions, one of their functions being to reverse the movements. OV reverses the rotary movement and OR the radial movement.

The connecting of a selector's wiring to the trunk lines is accomplished by means of an 18-point plug P, fitting into a corresponding jack J, mounted on the rack.

After being pushed into place in the rack, the selector is firmly locked in position by means of the two springs FJ.

B. *The sequence switches.*

Each selector is furnished with a sequence switch and relays, the appearance of which is shown in



R 14 Fig. 4. Sequence switch.

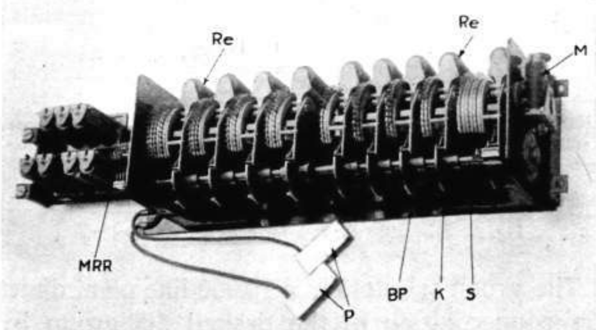
fig. 4. The contact bank consists of circular segments (the length of the arc being 1/3 of a full circle) in which metal contacts are embedded. Each segment has two rows of metal contacts, and a maximum number of 13 segments can be screwed upon a frame R, which, in turn, is screwed to a second framework BP. This framework BP acts also as a support for the sequence switch relays.

As a sequence switch of this type has 12 positions and 13 rows of double contacts, it follows that $12 \times 13 = 156$ different contact combinations are possible, but additional combinations can be obtained by making the bank contacts of different widths, so as to extend over more than one contact position.

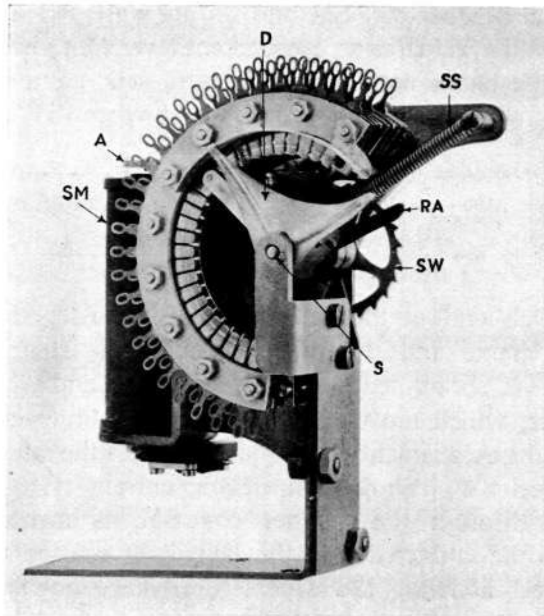
The sequence switches are power driven in the same manner as the selectors. M is the magnet coupling, with the toothed wheel ZR pivoted on its armature. The attracting of this armature causes ZR to engage a driving wheel mounted on the common driving shaft, the rotary movement being transmitted to the shaft S and the wiper arms.

Each sequence switch is furnished with an electrically controlled centering device, consisting of a cam wheel CW and the switching group C. Its function is to control the movements of the wiper arms by keeping the circuit through the centering spring closed until the wiper arms have reached the exact desired position.

Sequence switches are connected to the trunk lines by exactly the same method as selectors, i. e. by means of plugs P to jacks, which are mounted on the racks.



R 15 Fig. 5. Complete register set for a 10,000 line system.



R 16 Fig. 6. Register unit.

The sequence switches are mounted on both sides of the rack, each side or panel accommodating 20 switches, with their fuses and alarm devices.

C. *The register sets.*

A register set is shown in fig. 5, the most important parts being:

The Base .... BP
» Register units .... Re
» Restoring mechanism, consisting of:
A Magnet coupling .... M
» Shaft S with discs .... K
» Sequence switch .... MRR

The relays with which a register set is equipped are mounted on the base BP, as shown at extreme left in fig. 5.

A register unit — shown in fig. 6 — is a step-by-step selector. The bank of contacts consists of circular segments of insulation (extending over slightly more than a half circle) in which the metal contacts are secured. The wiper arms are mounted on the shaft S, which also carries the ratchet wheel SW and the restoring arm RA. A register unit has 27 contact positions, i. e. the starting position 0, 25 positions from 1 to 25, and one extra position 26.

The ratchet device of the register unit consists of a magnet coil SM and its armature A. The armature actuates an escapement lever (not visible in the illustration) which, in turn, acts as a releasing mechanism for the ratchet wheel SW.

R 17 Fig. 7. Line finder and group selector.

One end of the coil-spring SS is fastened to the frame and the other encircles the shaft S.

This spring tends to rotate the shaft and wiper arms, which movement, however, is counteracted by the escapement lever, which engages the ratchet wheel SW. Should an electric current now be led through the magnet coil SM, its armature will be attracted and the lever will release the wheel, allowing the wipers to advance one step. A renewed breaking of the current will readjust the lever, allowing the wipers to advance one more step. The wipers are thus advanced two steps for each full impulse (i. e. one closing and one breaking of the circuit).

D is an indicator, which shows the position occupied by the wipers.

The register units forming part of a register set are mounted on the base BP (fig. 5).

The shaft S with the discs K is made to rotate when the restoring magnet coupling is brought to engage the vertical driver shaft. The discs K are provided with studs which operate the restoring arms RA of the register units, thus restoring the wiper arms to the starting position, 0.

Register sets are also removably connected to the trunk lines in the same way as selectors and sequence switches, i. e. by means of plugs fitting into jacks mounted on the racks.

The register sets are mounted on either one- or two-sided racks, with 10 to 12 sets to each panel.

D. *The relays.*

The relays used in an automatic exchange are practically identical with the well-known Ericsson type. A few improvements have been adopted, however, such as the eliminating of all internal connections, all switching group and coil connections being carried out to soldering tabs. The advantage of being able to remove and replace coils and switching groups is hereby gained. The relay armatures have been re-designed so as to make them more sensitive and quick-acting. Special pains have been taken to obtain a correctly balanced pressure for the contact points.

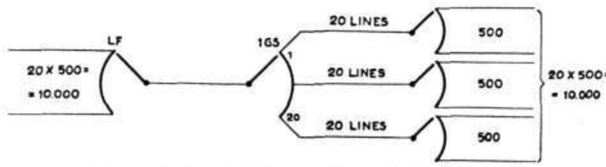
II. The building up of the system.

A. The extending of calls to the group-selectors, in the Ericsson automatic system, is accomplished by means of line finders. The subscribers' lines are brought together in groups of 500. Every such group is connected to the multiple in a line finder rack. The number of line finders necessary for 500 lines depends on the traffic (i. e. the number and average duration of calls during the busy hour) and usually varies between 30 and 50.

B. Each line finder is associated with a group selector, as shown in fig. 7, LF signifying a line finder and GS a group selector. Should 40 line finders be required, the corresponding group selector rack will also contain 40 group selectors. Trunks lead from the multiple frames in the group selector racks to connectors or to further group selectors.

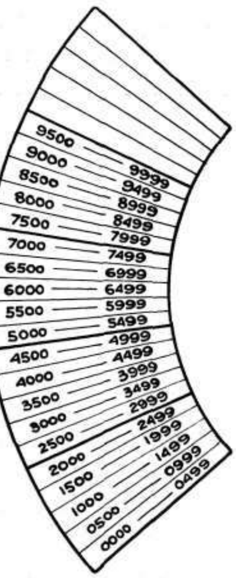
If the full capacity of the twenty five multiple frames of a group selector rack is utilized for trunks to connectors, a capacity of $25 \times 500 = 12{,}500$ lines is obtained. For practical reasons, however, it is not customary to use more than the first 20 frames for this purpose, the remaining 5 (21 to 25) being used for special lines.

A capacity of $20 \times 500 = 10{,}000$ lines is thus reached by the use of only one group selector, as shown in fig. 8.



R 18 Fig. 8. Schematic diagram for a 10,000 line system.

The group selectors in a 10,000 line plant direct the connecting in of the desired 500-group by means of the rotary movement, while the radial



R 19 Fig. 9. Numbering of multiple in a group selector rack.

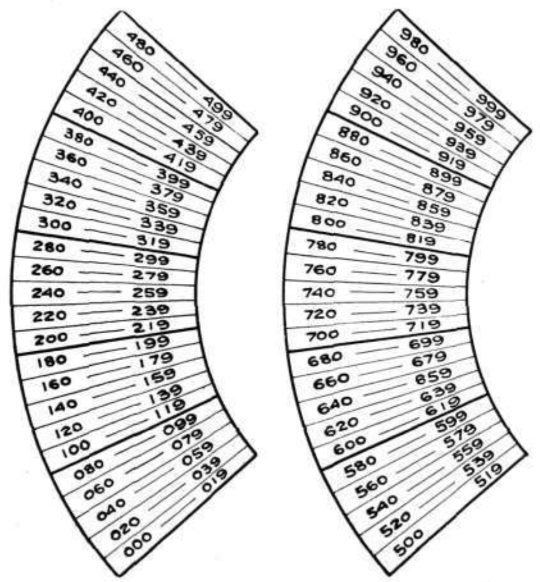
movement is utilized to search out a disengaged connector (that is, when the contact arm enters the multiple frame).

C. The connector makes the final connection to the desired number. The group of 20 which contains the desired number is sought out by means of the selectors' rotary movement, and the final connection is accomplished by means of the radial movement.

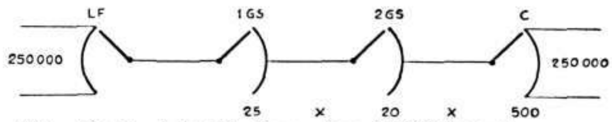
A connector multiple contains 500 lines, similar to the line finder multiple. Each group of 500 lines, therefore, has its connector rack, containing a certain number of connectors, their number depending on the intensity of traffic.

Fig. 9 shows the method of numbering the multiple frames in a group selector rack for a 10,000-line plant, while fig. 10 shows how connector multiples are numbered.

Each group of 1,000 occupies 2 frames in the group selector multiple, the first containing the 5 lower hundreds — from 0 to 4, and the second containing the 5 higher hundreds — from 5 to 9.



R 20 Fig. 10. Numbering of multiple in a connector rack.



R 21 Fig. 11. Schematic diagram for a 250,000 line system.

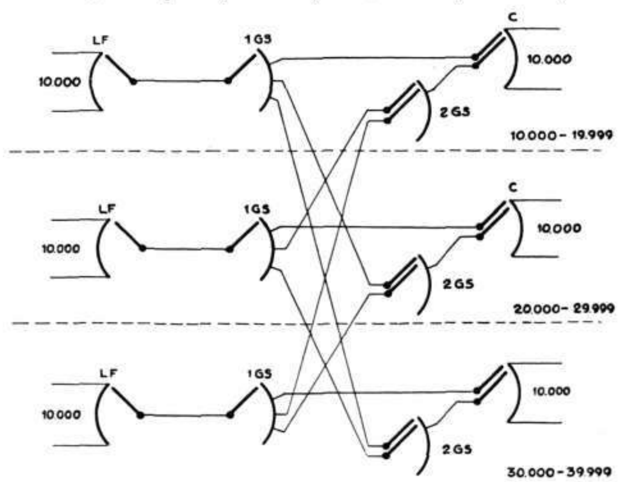
D. The capacity can be increased to $25 \times 20 \times 500 = 250{,}000$ by adding one more group selector, as shown in fig. 11.

Trunks are carried from the first group selectors 1GS to 25 ten thousands groups. These trunks end in second group selectors 2GS, the multiples of which are trunked to the connectors C of the respective five hundreds groups.

E. Another system, in which either one or two group selectors are used to complete the connections, is applicable to plants of from 10,000 to 60,000 lines. A schematic diagram of this system, for a plant of 30,000 lines, is shown in fig. 12.

The 30,000 lines are grouped in 3 ten thousands. The traffic between subscribers whose numbers are within the same ten thousands group is handled by one group selector 1 GS, since the multiple frames of the first group selector rack contain trunk lines to the 20 five hundreds corresponding to their own 10,000 group. Trunk lines from the multiple frames 21 to 25 proceed to the second group selector 2 GS, the multiples of which are in turn trunked to connectors.

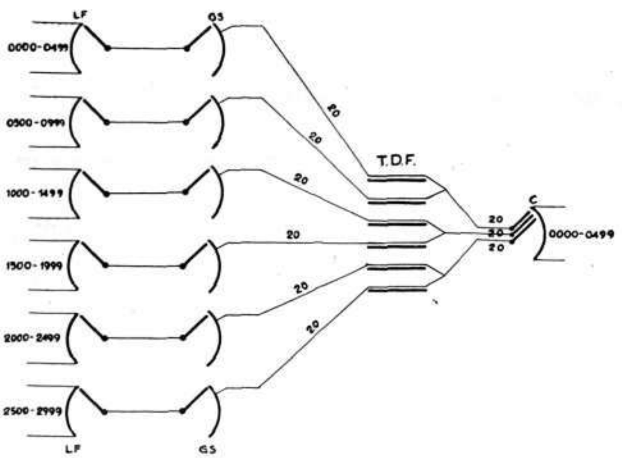
Thus, a capacity of $10{,}000 + 5 \times 10{,}000 = 60{,}000$



R 22 Fig. 12. Schematic diagram for a 30,000 line system.

is reached by this system when all the multiple frames of the first group selectors are utilized.

F. The connecting in parallel of the group selectors' multiples, and the connecting of the cables to the connectors is done in a traffic distributing frame. These frames are composed of two vertical angle irons furnished with tab strips to which the cable wires coming from the group selectors' multiple frames are connected and coupled in parallel so as to obtain an even distribution of connectors in relation to the amount of traffic. An example is illustrated in fig. 13. LF and GS are line finder and group selector racks for 6 five hundreds groups. Trunking to



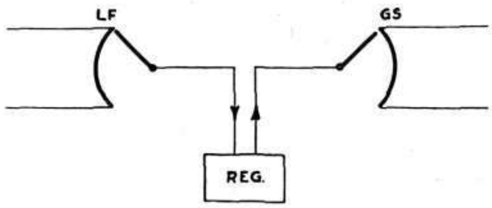
R 23 Fig. 13. Connection of group selector to T. D. F.

the traffic distributing frame is shown from the first multiple frame only, corresponding to the five hundreds group 0000 to 0499. Thus a 20-line cable is led from frame no. 1 in each group selector frame to the T. D. F. Suppose that traffic conditions necessitate the use of 60 connectors for 500 lines; the distribution can then be arranged as shown in fig. 13, for example, by parallel coupling the multiples in pairs, each pair with 20 trunk lines to the connector rack in question.

G. Connecting of the register sets.

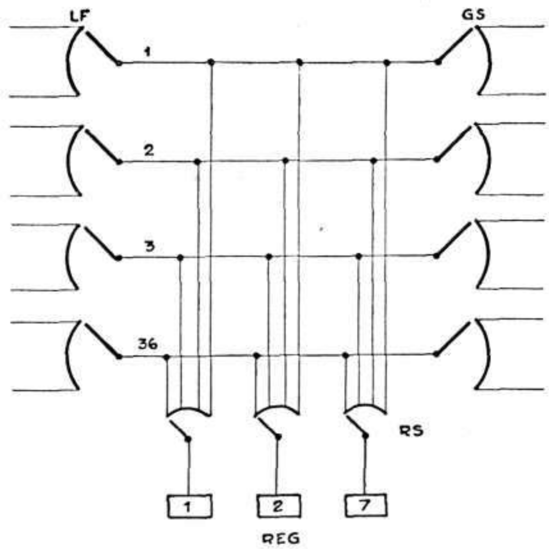
When a line finder is connected to a subscriber's line, a register set must also be connected for the purpose of directing the movements of the group selectors and connectors. Consequently, the register is placed between the line finder and group selector, as shown in fig. 14.

In view of the fact that a register set is engaged only as long as it takes the subscriber to dial the desired number and for the group se-



R 24 Fig 14. Schematic diagram for line finder selector and register.

lectors and connectors to move to their respective positions, while line finders, group selectors, and connectors, on the contrary, are engaged as long as the conversation lasts, it is easily understood that it would be highly uneconomical to provide a register set for each individual line finder, especially as they are comparatively expensive and bulky devices. For this reason, only a certain number are allotted to each group of line finders, the number being determined by traffic conditions. Special selectors are used for connecting the register sets to the line finders. Two different principles can here be applied, clearly illustrated in figs. 15 and 16.

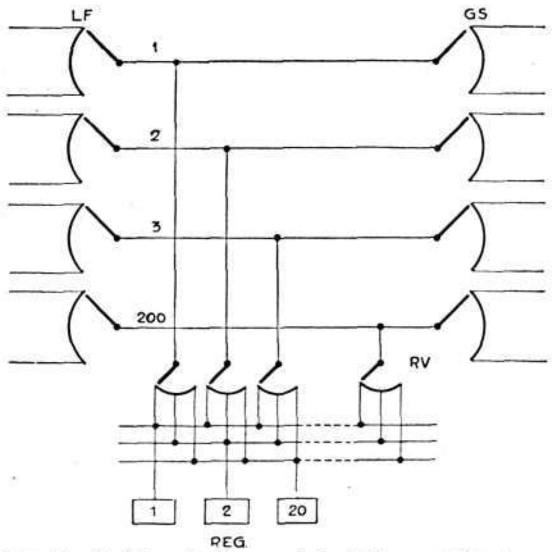


R 25 Fig. 15. Schematic diagram of circuit for connection of register by means of register finder.

In fig. 15 the connecting is accomplished by means of so-called register finders. Each register set is furnished with a register finder (the construction of which corresponds to that of a sequence switch) accomodating 35 lines.

In this case, therefore, the line finders will form groups of 35. To each such group is alloted a certain number of register sets (6 to 9, depending on the traffic). A call entering such a group sets all the register finders RS belonging to disengaged register sets in motion, and the one that first finds the calling line finder LF is connected.

In fig. 16 the register sets are connected by means of register selectors RV, of which one is alloted to each line finder LF. The contact banks of these selectors — consisting of 20 contact



R 26 Fig. 16. Schematic diagram of circuit for connection o register by means of register selectors.

positions — are coupled in parallel and connected to 20 register sets. The number of line finders LF which can be connected to a group of 20 register sets depends on traffic conditions. (One group of 20 sets can, as a rule, be connected to the line finders for 3 or 4 five hundreds groups).

III. **Functioning of register set.**

The mechanical construction of a register set has already been described under II--C. When considering its functions, a register set may be divided in two parts, namely the registering part, which receives and »registers» the numbers dialled from the subscriber's telephone (or, in the case of a semi-automatic exchange, the numbers called from the operator's keyboard), and the controlling part, which directs the proper setting of the group selectors and connectors.

The schematic diagram of a register set for a plant with subscribers' numbers of four digits (0000 to 9999) is shown in fig. 17.

A. Registering part of the register set.

That portion of the register set which registers the numbers consists of:

The impulse relay R_1.

The main function of this relay is to receive the impulses which are sent out by means of the subscriber's dial D. Simultaneously with the connecting of a register set to a subscriber's line, a circuit from earth over the subscriber's line and telephone, and through the impulse relay R_1, to battery, is closed, resulting in the actuation of the relay R_1. The dialling of a digit creates a train of circuit breaks or impulses, causing the relay R_1 to be released as many times as the circuit has been interrupted in the dial. (The number of circuit breaks corresponds in this case to the dialled digit. The figure 1 will cause the circuit to be interrupted once, the figure 2 twice,etc., and the figure 0, lastly, will cause the circuit to be interrupted 10 times.)

The restoring relay R_2.

The function of relay R_2 is to restore the register to normal after a connection is completed. This relay is constructed so as to be slow-releasing only. It is attracted through the contact a) in the relay R_1 at the same moment that the register is connected to a subscriber's line, and retains this position until the connection is completed. Owing to its slow releasing, relay R_2 remains attracted during the impulsing of relay R_1.

The controlling relay R_3.

The relay R_3 controls the movements of the control switch SOR_1. It is a slow acting relay similar in design to R_2, and is, for this reason, attracted once for each train of impulses sent, that is, once for each figure dialled.

The control switch SOR_1.

This apparatus is similar in construction to a register unit, described under II-C, and its function is the successive connecting in of the units Re_1 to Re_4. Its magnet is energized over a contact in the controlling relay R_3.

The registering units Re_1 to Re_4.

The object of these units is to register the dialled numbers. They are successively connected in by the controlling switch and take the positions which correspond to the dialled numbers.

Re_1 is in circuit when the thousands digit is dialled.

Re_2 is in circuit when the hundreds digit is dialled.

Re_3 is in circuit when the tens digit is dialled.

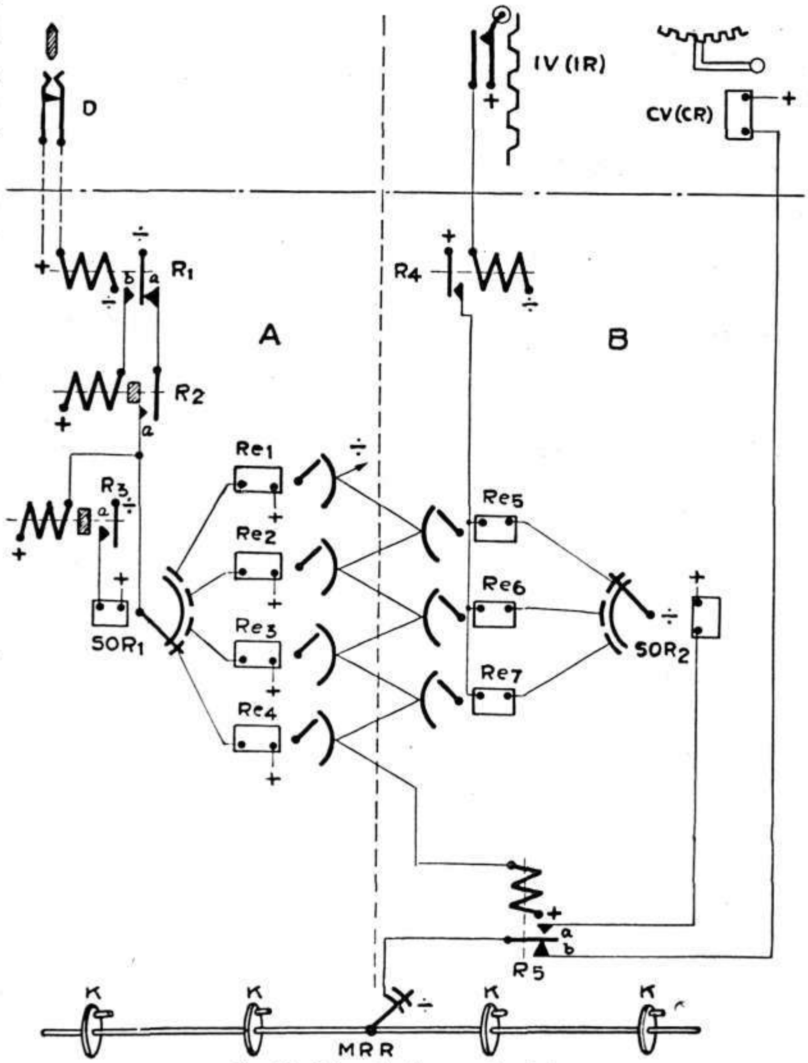
Re_4 is in circuit when the units digit is dialled.

B. Controlling part of the register set.

This part of the register set is composed of:

The revertive impulse relay R_4.

The function of this relay is to receive the impulses sent out by the group selectors during their rotary movement and by the connectors during their rotary and radial movements, and repeat them to the controlling units Re_5 to Re_7. These impulses are generated over the impulse contact IV (IR), and correspond in number to the number of steps which the selector and connector movements have advanced.



R 27

Fig. 17. Schematic diagram of register.

The stop relay R_5.

The relay R_5 cuts off the starting current to the group selectors and the connectors and serves also to close the circuit to the magnet of the control switch SOR_2.

The control switch SOR_2.

The function of this control switch is to successively connect in the controlling units Re_5 to Re_7.

The controlling units Re_5 to Re_7.

The controlling unit Re_5 is set by the rotary movement of the group selector,

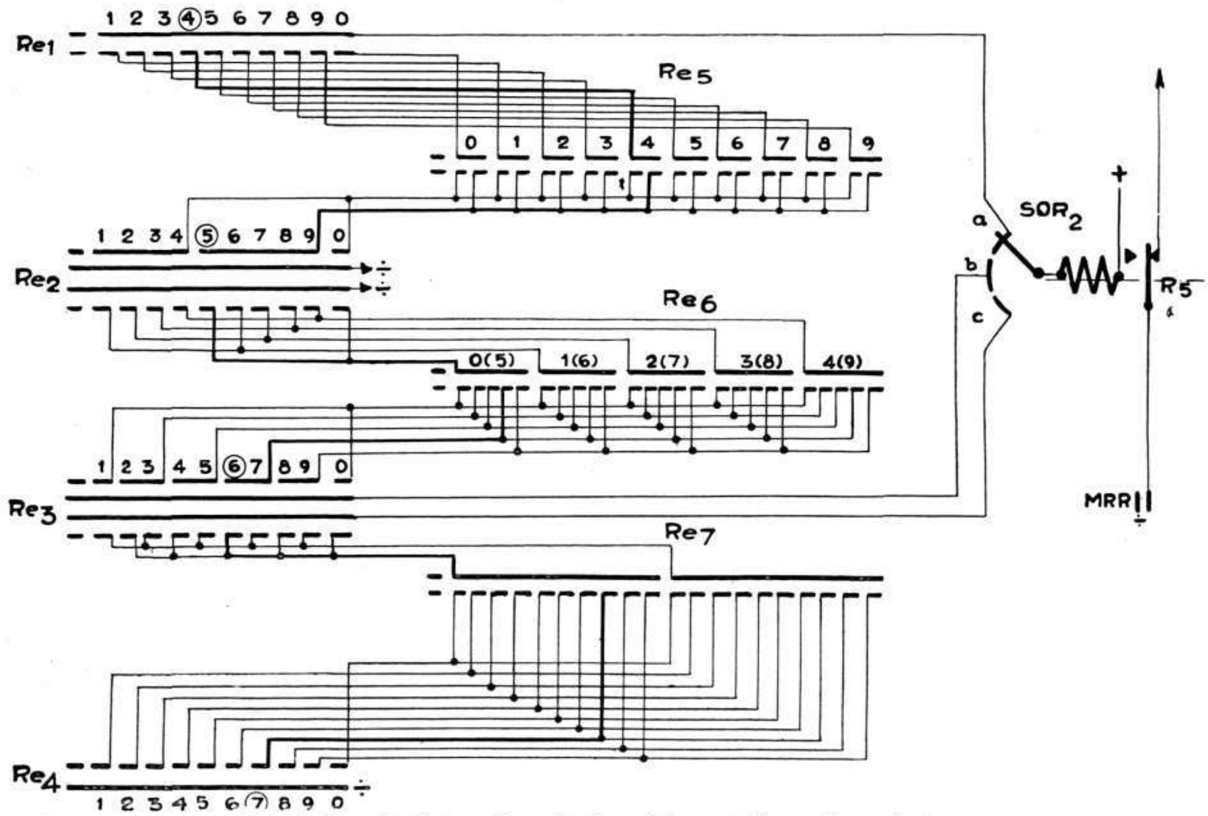
The controlling unit Re_6 is set by the rotary movement of the connector,

The controlling unit Re_7 is set by the radial movement of the connector.

These controlling units, which receive their impulses from the revertive impulse relay R_4, exactly follow the selector movements, for example, when the rotary movement of a group selector has advanced 11 steps, the controlling unit Re_5 has also been advanced 11 steps, etc.

The restoring mechanism with discs K has a sequence switch MRR connected to its shaft, one of whose functions is to connect in the battery for starting the group selectors and connectors.

The setting of the group selectors and connectors is accomplished by means of so-called revertive impulse control. When a sufficient number of digits has been dialled and registered by the registering units Re_1 to Re_4 (the two first digits for a four-digit numbering system), the sequence switch MRR is reset so that battery is connected in for starting the group selector. The centering magnet for rotary motion CV is energized (over a special relay which, for the sake of simplicity, is omitted in fig. 17), whereby its armature releases the rotary disc and simultaneously closes the circuit to the magnet coupling. Impulses are sent out to the register while the group selector is rotating, whereby the controlling unit Re_5 is properly set. When the selector movement has advanced a number of steps corresponding to the first two figures in the dialled number (the thousands and hundreds figures), a circuit is closed over the registering units Re_1—Re_5—Re_2 through the relay R_5, which hereby attracts its armature and breaks the selector-starting current at the contact in R_5.



R 28 Fig. 18. Connection between the registering and the controlling register-mechanisms.

The principle of setting for the connectors is the same as for the group selectors. The setting of a group selector, as has already been mentioned, is determined by the first two digits of a four figure number, the first digit determining the thousands group while the second digit determines whether the switching shall be directed to a five hundreds group of a low or high hundreds figure. This principle of setting is also made evident by the numbering of the group selector multiples, as shown in fig. 9.

The rotary setting of a connector is determined by the hundreds and tens figures (see fig. 10). It may here be noted, that the low hundreds figures 0, 1, 2, 3 and 4 are equivalent to the high hundreds figures 5, 6, 7, 8 and 9.

The radial setting of a connector, lastly, is determined by the tens and units figures.

Fig. 18 shows how the connection is made between the registering units Re_1 to Re_4 and the units Re_5 to Re_7, which control the correct setting of group selectors and connectors, so as to accomplish translation from the decimal system to a system corresponding to the grouping of lines in the group selectors and connectors. Suppose that the number 4567 has been dialled. The circuit a) attracts the stop relay R_5 and stops the group selector in front of the tenth multiple frame, circuit b) stops the rotating connector in front of the fourth frame, and circuit c), lastly, stops the connector's radial movement when the contact arm has reached line 7 within the frame.

IV. Connecting a calling to a called subscriber.

The process of establishing a speaking circuit between two subscribers is shortly as follows:

A. The call is connected to an idle line finder.

B. The call is connected through the line finder and a register selector (or register finder) to a disengaged register set.

C. The number called is registered within the register set.

D. The group selector is set to its rotary position.

E. The contact arm of the group selector enters the multiple, hunting an idle connector.

F. The connector is set to its rotary position.

G. The connector is set radially.

H. The register set is restored to normal after having completed its function.

I. The connector is testing to see whether the desired number is free.

K. A ringing current is sent out to the called number.

L. The called subscriber answers, thereby breaking the ringing circuit.

M. The selectors are restored to normal when the call is cleared, the call being recorded on the calling subscriber's service meter.

A more detailed description of the connecting process will be given in a future article.

G. G.

Development of the L. M. Ericsson Telephone Plant in Mexico.

The Mexican Ericsson telephone company, owners of the telephone plant of Mexico City and surroundings, has cabled information concerning the number of subscribers enrolled by the company at the beginning of this year. According to this report, the number of subscribers' stations has increased from 16,602 at the beginning of 1923 to 17,581 at the close of the same year, the increase amounting to 979 subscribers. The Mexico City plant has two exchanges at present, namely, the main exchange, Victoria, built in 1907 for a capacity of 15,000 lines, and the sub-exchange, Tacubaia, built in 1911 for a capacity of 5,000 lines, both of which are built according to the common battery system. As the Victoria exchange is now utilized to almost its full capacity, the company has made arrangements for the building of still another exchange in the quarter called Colonia Roma. This exchange, which will be full automatic, will have a capacity of 10,000 lines, with a first equipment for 3,000, and will also be equipped with all the necessary apparatus for co-working with the existing exchanges. Junction traffic in the direction manual to automatic will be handled by B-operators at the automatic exchange. For traffic in the opposite direction, the dialled numbers will be automatically recorded at a B-operator's position in the manual exchange by means of call indicators (carriage call).

This entire plant, as a whole, will be made the subject of an article to appear in The L. M. E. R. columns at a subsequent date.

Readable Type of Calling Device for Automatic Telephone Systems.

The calling device generally used in connection with full automatic telephone systems consists of what is known as a dial (see telephone reproduced on front page). By means of the dial a series of impulses corresponding to the different digits is sent to the switching station. The method of dialling, as we know, is to insert a finger in turn into the respective finger holes on the face of the dial, each time rotating the dial until the finger comes in contact with the metal stop; the dial being then released, it automatically returns to normal. To call a number consisting of six digits, the subscriber must consequently rotade the dial six times. This method of building up the desired number, however, requires no small amount of concentration, and a slip of the finger or the direct dialling of a wrong numeral can only be corrected by commencing all over again and making a new call.

R 5 Telephone with readable calling device.

With a view towards affording subscribers a more convenient method of making calls, a new calling device has been designed by L. M. E. on which all the digits of the desired number are simultaneously visible after the number has been set up. The accompanying illustration shows such a device built into a table set CG 400. The mechanism of this automatic impulse transmitter is equipped with revolving, knurled buttons projecting above the case. The desired number is set by revolving these buttons until the correct digits become visible in the small apertures, thus making it possible for the subscriber to check his call. On the right hand side of the device there is, in addition, a larger disc or control by means of which the mechanism is wound up and the impulse sending started. The method of making a call is as follows:

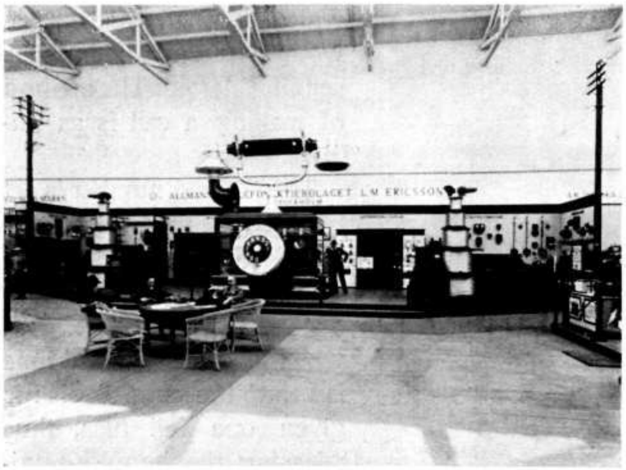
The desired number is set by means of the buttons and checked on the visible digits. The micro-telephone is then lifted from its cradle, and when the so-called dial tone is heard, the control disc is given one full turn, thus releasing the impulse-sending mechanism.

The following are some of the advantages possessed by this calling device over the usual dial:

1. The number called is constantly visible for verification by the subscriber.
2. Wrong connections due to incorrect dialling are entirely eliminated. This is a very important factor in countries where tens and units occur in reversed order (example: fünf- undzwanzig).
3. The numerical setting remains unaltered after making a call. Should the desired number be busy, there is consequently no need of resetting it when repeating the call. All that is necessary is to give the control disc one full turn after making sure that the dial tone is heard.
4. Manual influence does not affect length or duration of impulses.

L. M. Ericsson at the Gothenburg Exhibition 1923.

L. M. ERICSSON's exhibit at the Gothenburg Tri-centennial Exhibition was located in »Electricity Hall», in the centre of its west wall. As



R 1 General view of exhibit.

there was occasion to assume that the visiting public would be largely of an international character, an attempt was made to effect a display that would clearly give evidence of the company's high standing in the field of telephony.

It must also be admitted that L. M. E.'s exhibit attracted all the attention to which it was entitled. An enormous telephone — a copy of L. M. E.'s standard table set with microtelephone and finger dial — enlarged 8,000 times (that is, to a linear scale of 20 to 1), standing in the centre of the exhibit, was an attraction towards which visitors could not help turning their eyes. Inside of this great telephone had been erected a complete, full automatic exchange of the Ericsson system for 500 lines, clearly visible through the plate glass windows forming the sides of the telephone. A few telephones were connected to the exchange, with which visitors could experiment and make calls, and the automatic switching process could be followed by observing the selectors' various movements as the digits of the called number were being dialled. Numbers of interested visitors stood here daily, awaiting their turn to take part in the demonstration. It must be regarded as having been of distinct benefit to both the operating Government Office and the general public, to have thus spread practical information concerning the full automatic telephone and its manner of operation.

The model af a full automatic Ericsson exchange also formed a part of the Government Telegraph Office's historical exhibit, in which it represented the final stage of evolution in modern telephone practice.

Among the L. M. E. products to be seen at the exhibition were displays of the following plant details:

Small automatic exchanges.

Two small automatic exchanges, the one for 50 lines, with a maximum of 25 simultaneous calls as the limiting factor for future extension, cor-

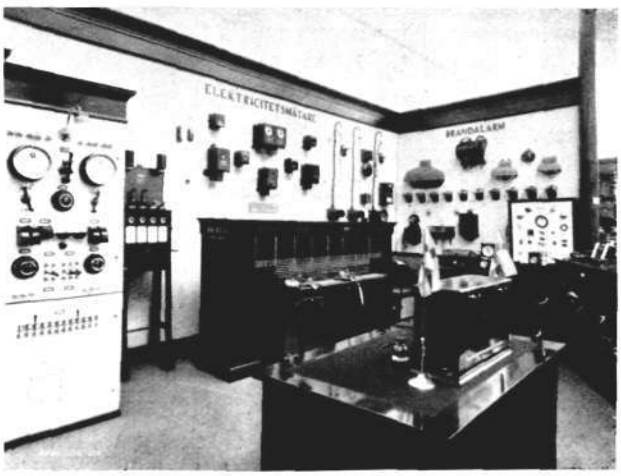
R 2 The manual station with 26,000 lines multiple.

responding to an average total of 300 lines (type OL 500), and the other a smaller type for only 20 lines (type OL 20), were connected up and in full working order.

Large manual exchange.

A section of a large, manual exchange of the usual type with multiple switchboards was also erected and in working order. The switchboard itself attracted no little attention on account of the multiple's unusual capacity, 26,000 lines. This was apparently more than one of the visitors was able to grasp, as he was inclined to believe that the demonstrating engineer was exagerating when told that L. M. E. had constructed an exchange in Moscow, before the war, whose capacity is 66,000 lines.

As previously stated, this group was part of a modern exchange, giving an excellent idea of how such a station is designed and operated. The subscribers' lines were carried from the connected telephone instruments to a distribution box and from there through a 600- pair leaded cable to a pothead, from where they continued through six 100-pair cables to a combined arrester and cross-connecting frame. From this frame the lines were led through braided cables over a cable support to a relay and selector frame, continuing partly by cable to the multiple jacks and partly through automatic selectors to the connecting cords. The automatic selectors, whose function it was to distribute incoming calls to an unoccupied operator,



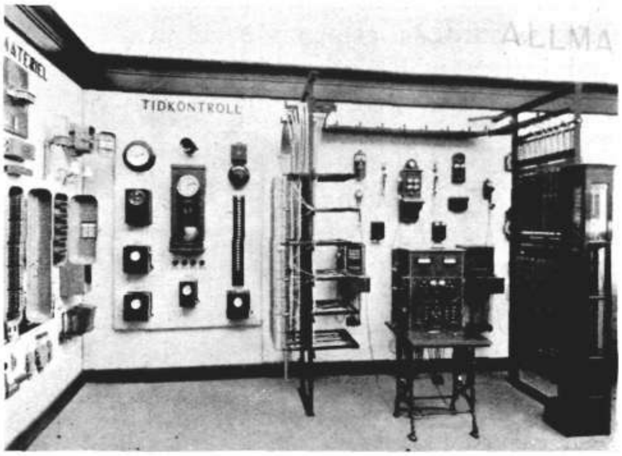
R 3 Electric meters and fire-alarm apparatus.

were of two distinct types, partly the usual step by step selector, and partly a new power driven type, the so-called cylinder selector.

A separate article will, in a coming issue, be devoted to this last type of selector.

Toll switch boards.

Beside the above described multiple exchange was erected a toll board, forming part of an order for a plant of rather unusual size — 350 positions —, which is being built in Rotterdam. This toll board is of the most modern type hitherto designed for such an exchange, and it is mainly



R 4 Time control system and line equipment.

the facilities for fitting the front equipment, together with the wiring of the same, that attract special attention. All of this equipment, consisting of switches, lamps, telegraph key, finger dial, etc., is mounted on the key-shelf in such a manner that any part of it can, by a single manipulation, be easily removed for inspection or replacement. The calculagraphs for which the board is designed are also of special interest on account of the controlling and summation devices which they actuate. They will receive more detailed attention in a coming article.

Additional equipment displayed included:

Chief operator's desk.

This desk is designed for the purpose of enabling a chief operator to ascertain that subscribers are given fast and courteous service.

Test board,

for trouble finding and testing of lines both inside and outside the exchange.

Power switchboards,

for the distribution of power and lighting current within a telephone plant, including two storage batteries and the necessary charging and ringing machinery.

The several exchange units included in the exhibit were furnished with necessary current from this plant.

Multiple switchboards for small exchanges.

Such boards of different types and of various systems, such as common battery with lamps, local battery with drops, signal jacks or visual indicators, etc., were displayed, their capacity ranging from 600 to 3,000 lines.

Switchboards without multiple.

Boards of this type were shown in various designs. Those attracting most attention were of a new construction enabling additional local lines and cords to be installed when traffic conditions should make it necessary.

Telephones.

Only such models as are in general use were displayed. Most of the prevailing types were represented, such as instruments for battery and magneto ringing, for common battery and full automatic exchanges, and finally interphones. Other equipment, such as telephones for mines and for military purposes, coinbox telephones, amplifiers, church telephones for the deaf, various bells and extension line switches, etc., was also displayed in this group.

Telegraph instruments.

The well known types now in general use in all Swedish telegraph offices and railway stations, and various accessories, such as a key, relay, sounder, line selector switch, serrated protector, etc., were displayed.

Testing instruments.

A number of finer instruments, such as Wheatstone bridges in various models, resistance boxes, galvanoscopes, etc., were on display in a large showcase.

Electric meters.

L. M. E. has kept pace with developments in this line and exhibited meters of modern construction for both D. C. and A. C. A twin meter for checking the power factor in power distributing systems was of special interest.

Line equipment.

Leaded and braided cables, cords, wire, air line equipment, together with various types and sizes of distribution and terminal boxes, were included under this heading. A full size manhole had been constructed, to which visitors had access, showing various cable splices. A 600-pair leaded cable with paper insulated wires was laid in a 19-duct cement conduit leading to the manhole, where it entered a Y-splice, the wires continuing on to a 600-line distribution cabinet through two 300-pair leaded cables. All cable, cords, and wire on display were delivered from the company's own cable factory at Älvsjö, near Stockholm.

Fire alarm equipment.

A complete fire alarm switchboard was shown, with time recording clock and telegraph instruments, fully equipped to receive one or several simultaneous alarms. Suitable types of alarm boxes as well as automatic alarm and controlling devices completed this group.

We will here take the opportunity to mention that the entire exhibition grounds were safeguarded by a complete fire alarm system, consisting of some twenty alarm boxes and a fire alarm switchboard, installed by L. M. E.

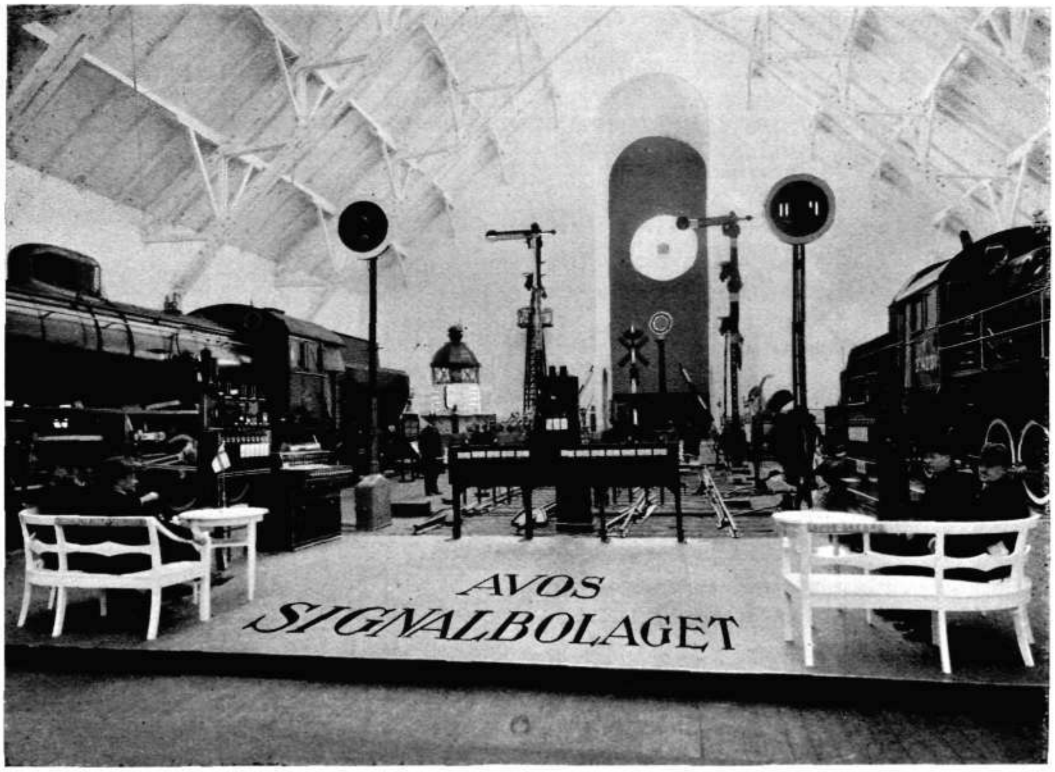
A night-watchman's service clockand accessories were also shown here.

Time recorders for factories and offices.

Since the general adoption of an 8-hour working day has made accurate time checking in factories a necessity, the manufacture of time checking devices for this purpose has been included in the activities of this concern. A complete plant, consisting of a central clock, an electric impulse clock, a so-called program clock by which the signalling devices are controlled, time recorders for monthly, weekly, or piece work time, and racks for employees time cards, was mounted for demonstration. An electric horn and a large bell, to be sounded at the opening and close of working hours, completed the equipment.

Railway signalling devices.

Only one quadruple block field instrument and an electric light-flashing plant were shown at our exhibit in »Electricity Hall».



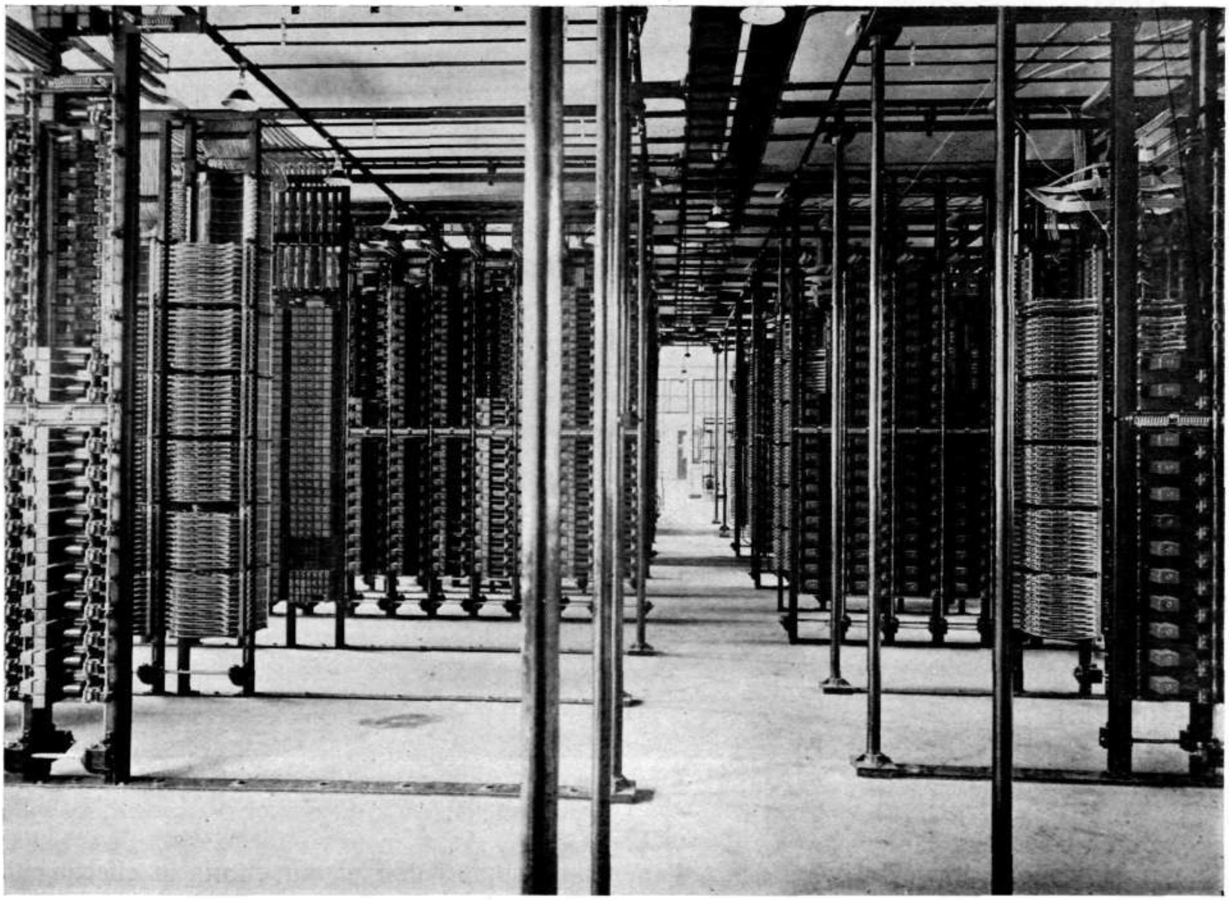
Interested visitors, however, were directed to the great »Machinery Hall», where a larger exhibit of such equipment had been arranged by L. M. E.'s Railway Signalling Department, the Avos Company in Örebro, and their common sales corporation, Signalbolaget in Stockholm. This exhibit included three block field instruments and an electric interlocking machine from which switch points and a semaphore signal could be manoeuvered.

An electric detector lock and an electric point lock together with an automatic warning signal for railway crossings were also included in this exhibit.

A visitors' autograph album, covering the duration of the Exhibition from its opening on May 8th until its close on October 15th, gives ample evidence of the large number of visitors from various parts of the world such as Tokio, Rio de Janeiro Buenos Aires, Batavia and Soerabaya, New York, Chicago, Cairo, Melbourne, etc., who showed their appreciation of our efforts in effecting this comprehensive exhibit.

A lively interest in L. M. E.'s exhibit was evidenced by the participants in the International Pressmens Convention. Mr Bento Carquejas from Portugal has written a book in which his impressions from Sweden and the Exhibition are portrayed with true South European vividnes and where he states that — — — »The automatic telephone holds an unusually eminent position within the field of applied electricity, and the practice of telephony has in Sweden its greatest empire.» *G. C.*

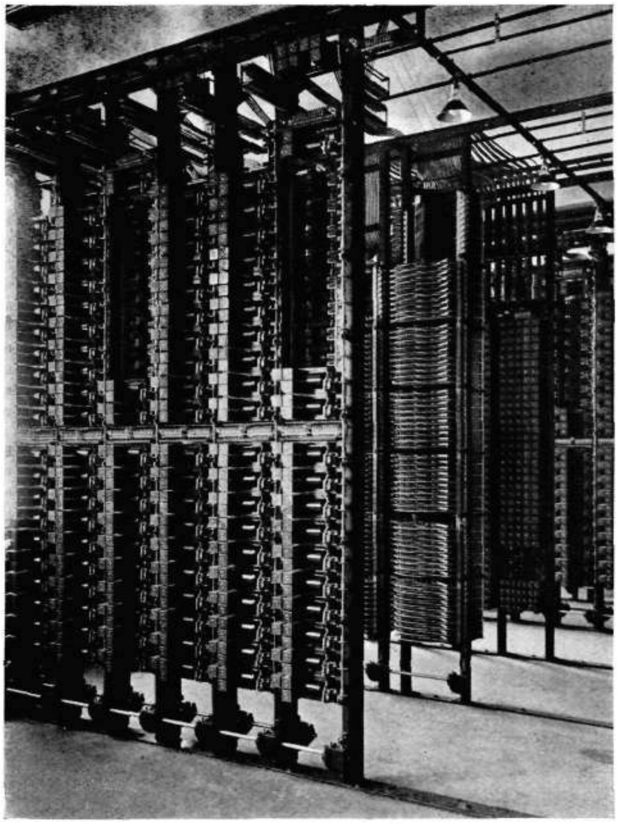
The Ericsson Automatic in Rotterdam.



R 8 General view of machine switching room.

THE L. M. E. REVIEW has just had the pleasure of receiving the accompanying photos of Rotterdam's new automatic exchange, which has recently been completed and put in operation. As this is one of the first large plants to be equipped with the Ericsson system and is giving excellent service, it may be of interest to give some data concerning its size and equipment.

This station constitutes the first stage in the construction of a 60,000 line system and has, therefore, a capacity of 10,000 lines, at present equipped for 5,000, besides about 500 P. B. X. lines. This so called »West» exchange shares the traffic with the old manual C. B. exchange — »Centrum» — of approximately 15,000 lines, and also, in another year, with the »Nord» automatic exchange, which is under construction and will have the same capacity as »West», although



R 9 Rack for line relays together with line finders and appurtenant sequence switches.

R 10 Semi-automatic operating room.

not more than 4,000 lines will be equipped for the present.

The handling of traffic in the direction automatic to manual exchange is of special interest, as provisions have, for the first time, been made to accomplish this without the services of a B operator at the manual exchange. This usual method of solving the problem had to be abandoned as the necessary space was not available. Instead, the automatic handling of this traffic from the »West» exchange has been made possible by letting the junction lines at »Centrum» enter group selectors and connectors there, the multiples of the latter being connected directly in parallel with the manual multiple.

This subject will be more fully considered in a subsequent issue of this journal.

New Telephone Plant in Verona.

Negotiations for the construction of a complete new telephone plant in Verona, Italy, have been successfully concluded, during December, with the operating company of that city.

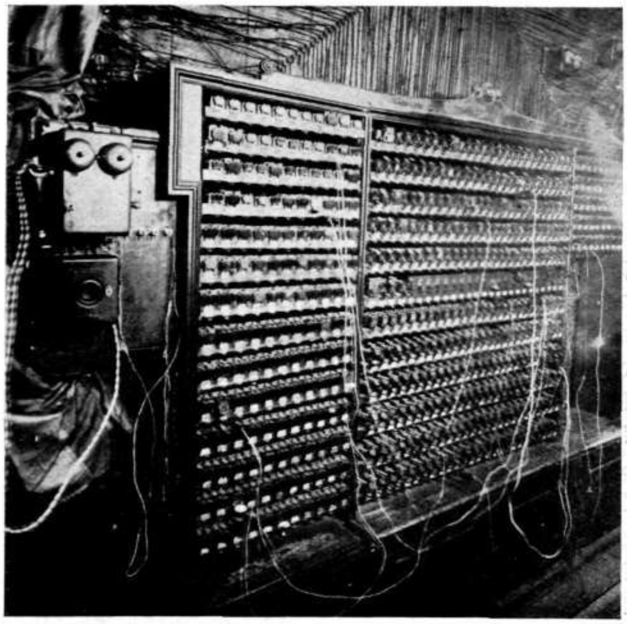
This order includes:

(1) A complete line system consisting of underground cables laid in concrete conduits for the city's central portion, together with overhead cables for distribution and a few bare wire lines in the outskirts of the city.

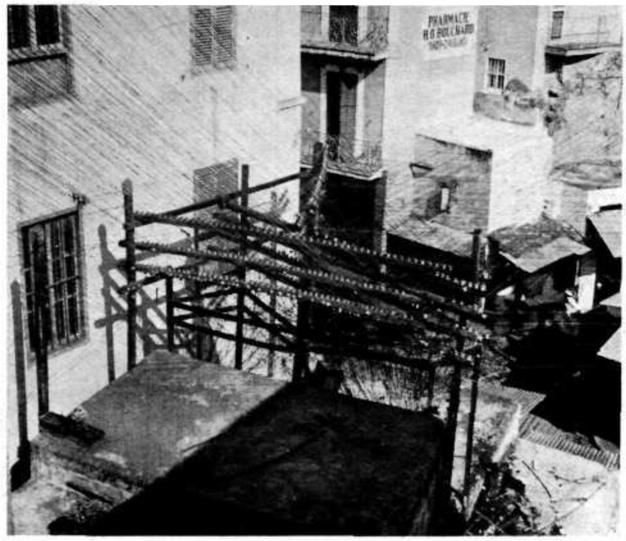
(2) A full automatic telephone exchange with a capacity of 10,000 lines — present equipment for 1,000 lines — and provisions for connecting on to the interurban net.

(3) All the necessary dial-equipped telephone instruments are included in the order.

Ericsson Telephones in Tangier.



R 6 Telephone exchange built in 1883



R 7 Aerial entrance of line wires to station.

In the city of Tangier, in Morocco — one might say between the desert and the deep, blue sea — a complete new telephone plant is now under construction. L. M. E. is delivering the material and doing the work, which includes a new exchange as well as the necessary lines.

»The L. M. E. Review» reproduces herewith some rather interesting photos that have just been received from the Company's engineer in charge. They give a good idea of what the previous, old plant, dating back as far as 1883, looked like, and illustrate, in their way, the progress which has been made in the field of telephone practice since that time.

»The L. M. E. Review» will, as concerns the new plant's appearance, return to this subject in a following number.

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Present Development of the L. M. Ericsson Organization.

II.

An account of the Company's growth and a synopsis of the existing daughter companies was given in the foregoing number of this journal, to which reference is made.

The parent company — Allmänna Telefonaktiebolaget L. M. Ericsson — has the following agents and general agencies:

Europe:

Sweden: Aktiebolaget Zander & Ingeström, Fredsgatan 4, Stockholm, general agents in Sweden for electric meters.

»Signalbolaget», Vasagatan 9, Stockholm, sales corporation for the railway signalling material manufactured by the company.

Sam. Lagerlöfs Maskinbyrå, Olofsgatan 10, Stockholm, general agents in Sweden for time control plant.

Norway: Ingeniørsfirman O. Østmo, Græensen 4, Christiania.

Maskin-Aktieselskapet Zeta, Stortingsgaten 8II, Christiania, for cable, line plant and electric meters.

Denmark: Oberstløjtnant G. C. Wassman, Strandboulevard 60, Copenhagen.

Sophus Berendsen A/S, Postbox 272, Copenhagen, för cable and line plant.

Iceland: Ingeniör H. Hliddal, Reijkjavik.

Finland: Aktiebolaget L. M. Ericsson of Finland, Norra Esplanadgatan 25, Helsingfors.

Russia: Russische Actien-Gesellschaft L. M. Ericsson & Co., Gr. Sampsoniewsky Prospekt 70, Leningrad.

Telephonbauaktiengesellschaft, Moscow.

Poland: »Ericsson» Polska Akcyjna Spółka Elektryczna, Ceglana 11, Warsaw.

England: The British L. M. Ericsson Mfg. Co. Ltd., International Buildings, 67/73, Kingsway, London W. C. 2.

Germany: Dörner, Jentzen & Co., »Christianshof», Kl. Reichenstrasse 21—23, Hamburg, exporting agents.

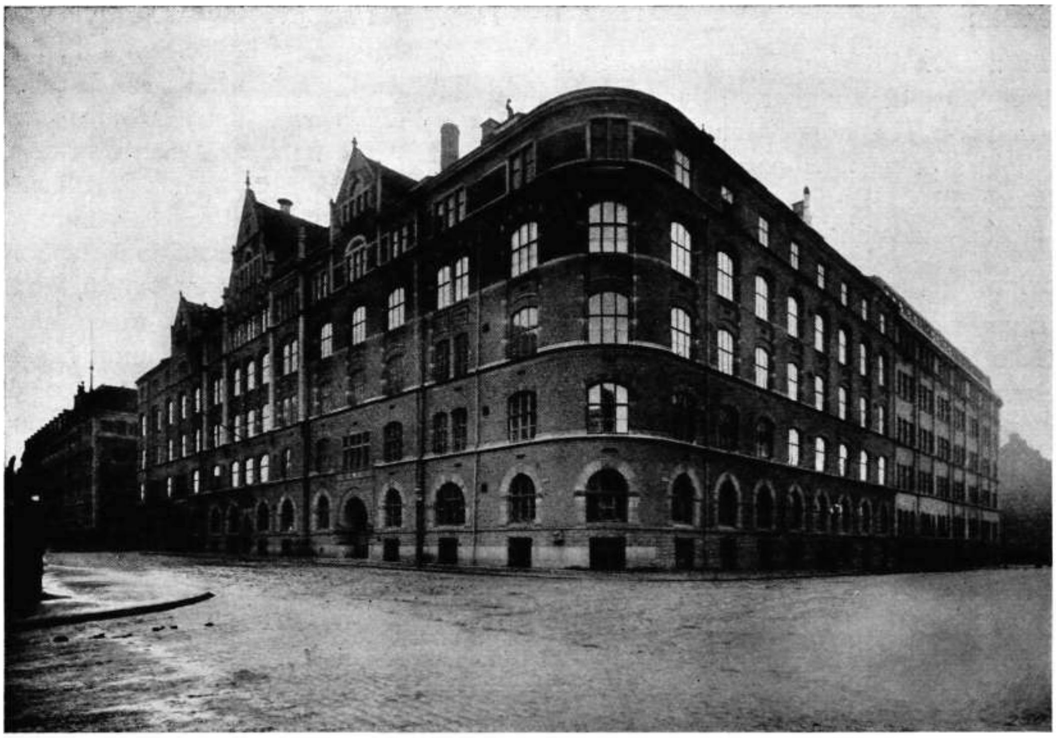
Holland and Colonies: Koopman & Co., Heerengracht 370, Amsterdam.

France and Colonies: Société des Téléphones Ericsson, Boulevard Haussmann 37, Paris.

Estonia: O.-Ü. Embag, Jaani uul 9, Tallinn (Reval).

Lettland: Herbst & Petersen, L. Pils ielä 13—15, Riga.

Spain: Viuda y Sobrinos de R. Prado, Sdad. Ltda., Príncipe 12, Madrid. Sole agents for Spain.



R 77 One of the L. M. Ericsson Factory Buildings in Stockholm.

Italy: Società Industriale Italo-Svedese, Via XX Settembre, 32, Genoa.

Czecho-Slovakia: »Ericsson» Elektrizitäts-Kommanditgesellschaft Scholta & Co., Malé Nám. 1, Prague.

Austria: »Ericsson» Oesterreichische Elektrizitäts-Aktiengesellschaft vorm. Deckert & Homolka, Pottendorferstrasse 25/27, Vienna XII.

Hungary: »Ericsson» Ungarische Electricitäts-Aktiengesellschaft vorm. Deckert & Homolka, Fehérvári-ut. 70, Budapest 1.

Bulgaria, Roumania & Jugo-Slavia: Donauländische Telephonbau- & Vertriebsgesellschaft L. M. Ericsson G. m. b. H., Pottendorferstrasse 25/27, Vienna XII.

Africa.

Egypt: Bergstrand & Ahlberg, P. O. Box 1846, Cairo.

South Africa: Rogers-Jenkins & Co., Greenmarket Square 12/14, P. O. Box 1425, Cape Town.

Rogers-Jenkins & Co., Main & Simmonds Streets, P. O. Box 654, Johannesburg.

Rogers-Jenkins & Co., Smith Street, P. O. Box. 1876, Durban.

Rogers-Jenkins & Co., Port Elizabeth.

Canary Islands: Compañía Escandinava de las Canarias Ltda., Las Palmas.

Compañía Escandinava de las Canarias Ltda., Santa Cruz de Tenerife.

Asia.

India: Ericsson India Office, 15 Central Avenue, Calcutta.

Siam: Borneo Company with offices in London and Bangkok.

South China: Aktiebolaget The Swedish Trading Co., with offices in Stockholm and Hongkong.

North China: Ekman & Co., with offices in Gothenburg and Shanghai.

Japan, Korea, Eastern Siberia and Manchuria: Gadelius & Co., with offices in Stockholm, Tokio, Kobe, Dairen (Manchuria).

Australia.

New South Wales: Ericsson Telephone Manufacturing Co., 19 York Street, Sydney.

Victoria: Ericsson Telephone Manufacturing Co., 509 Collins Street, Melbourne.

New Zealand: B. L. Donne, Australasia Bank Chambers. Customhouse Quay, Wellington.

America.

Mexico: Empresa de Teléfonos Ericsson S. A. 2ª Calle Victoria 53 y 55, Mexico City.

Central America & the West Indies: Empresa de Teléfonos Ericsson S. A., 2ª Calle Victoria 53 y 55, Mexico City.

The Argentine, Uruguay & Paraguay: Compañía Sudamericana de Teléfonos L. M. Ericsson S. A., Calle Esmeralda 1000, Buenos Aires.

Chile & Bolivia: Compañía Sudamericana S. K. F., Calle Estado 50, Santiago de Chile.

Peru & Equador: Compañía Sudamericana S. K. F., Calle Union Boza 825, Lima.

Brazil: Sociedade Geral de Telephones L. M. Ericsson, Rua São Pedro 106, Rio de Janeiro.

Business relations with those countries, in which no form of representation has been established, are maintained by means of direct correspondence between the parent company and the respective governments and other customers.

The Hamar Full Automatic Telephone Exchange.

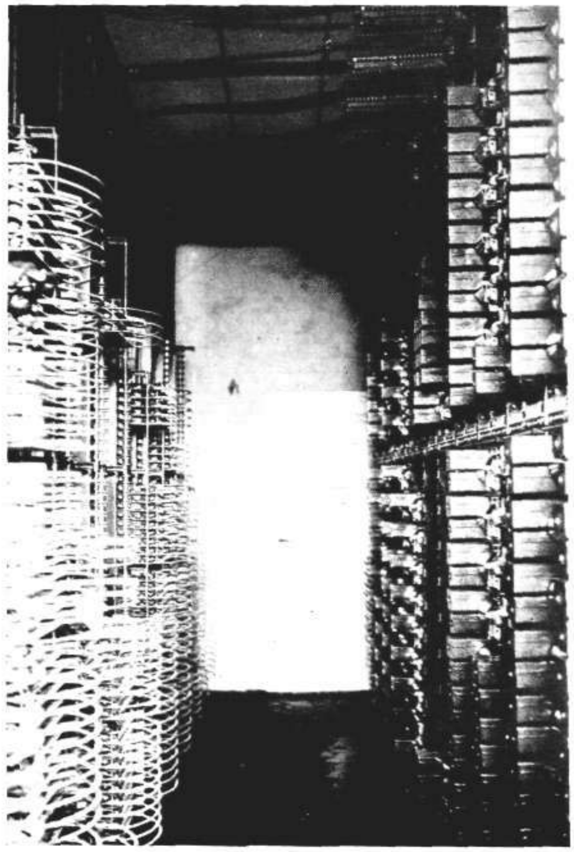
The full automatic exchange of Hamar, in Norway, was put in service in the middle of August last. This plant, built for the Hamar Telefonförening (The Hamar Telephone Society) has a capacity of 3,000 lines, the system being on the 5,000 line basis, with 1,200 equipped at present.

The city of Hamar is located in one of the wealthiest parts of the country, »Hedemark», of which it is the commercial centre. This fact has given rise to an unusually lively suburban and interurban traffic, which seeks its way through Hamar to neighbouring cities, mainly Christiania. The automatic exchange has therefore been furnished with the necessary equipment for handling this traffic, which includes some sixteen nearby rural exchanges together with the Government owned interurban net.

The junction lines for traffic from the automatic exchange to the rural exchanges are arranged as P. B. X. lines. This arrangement makes it unnecessary to furnish each rural exchange

R 73 Register Test Desk.

R 72 Sequence Switch Rack.



R 74 Line Finder Rack with Appurtenant Sequence Switches.

with more than one number, although they have several lines. When a call is made, a line selector automatically selects an idle line. The traffic in the opposite direction is handled over a rural line B-switchboard, from which »automatic» subscribers are called by means of a dial.

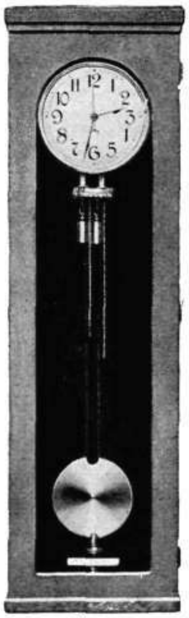
The interurban traffic is handled over toll junction lines, connected to the automatic exchange in such manner, that these lines are furnished with dials at the toll exchange for the calling of subscribers.

As the Government owned toll exchange is closed during the night, certain lines to the neighbouring cities of Christiania (100 km.), Lillehammer and Gjövik are connected directly to the automatic exchange during these hours. It is thus possible for the automatic subscribers in Hamar to come in direct contact with the toll exchanges in the above named cities by calling certain numbers. The desired connections are then completed at these exchanges in the customary manner.

The subscribers in Hamar, in their turn, can be called from the above mentioned toll exchanges, the positions of which are furnished with dials for this purpose. The introduction of special devices and arrangements has made possible a satisfactory transmission of impulses over these interurban lines, in spite of the fact that they are subject to large attenuation losses. *D. L.*

Time Recording Systems.

The well known saying »Time is money» is truer at the present time than ever before, and especially so within the industrial world. With our present high wages, short working hours and the



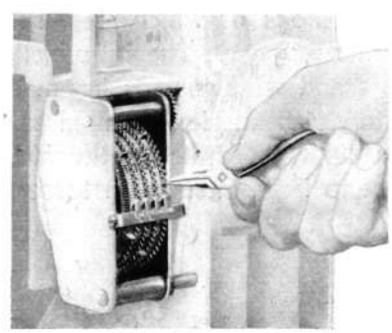
R 81 Fig. 1.

R 82 Fig. 2.

expensive machinery with which a modern factory is necessarily equipped, it is absolutely necessary that time be utilized in the most efficient manner possible. Every wasted minute in a factory means a lost value, corresponding not only to the ineffectively spent wages but also to the overhead expenses for equipment, rentals, heating, etc.

The keeping of careful cost records of a company's various products is a necessary part of efficient manufacturing, without which the fundamental requirement for the rational development of production is entirely lacking. Cost of materials, wages and overhead expenses form the basis for the computation of the cost of manufacture of any industrial product. The cost of materials is determined with comparative ease, but the cost of labour is more difficult to determine and can only be done by introducing an efficient system of time control.

Time control has two important functions to fill, the first of which is to keep records of the workers' starting and stopping times, so as to give quick and accurate information for the making out of pay-rolls, safeguarding the company from the paying out of wages to a worker for time during which he has not been actually present in his departement. By this means it is also possible to ascertain whether equipment and working space are being put to effective use.



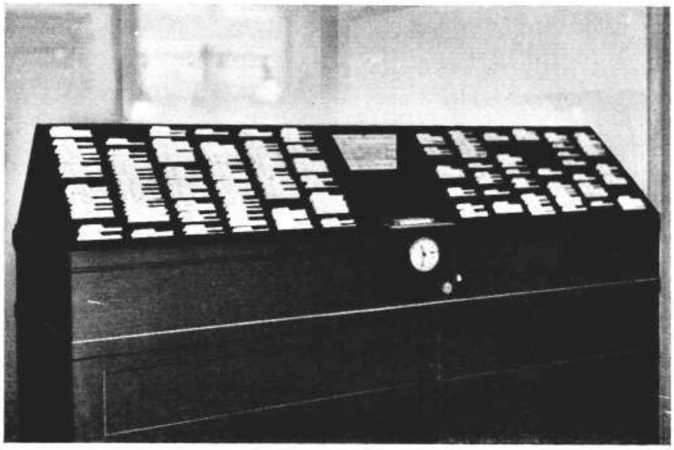
R 80 Fig. 3.

R 83 Fig. 4.

The second function of time control is to give accurate information as to how much time has been required for the execution of various jobs, and to furnish the basis for the computation of labour costs for the company's various products. Such control is done in like manner, either it is a question of piece work or time work, and alike for productive or unproductive labour.

All manner of time control is best accomplished by means of time clocks or time recorders, installed in the various departments whose personnel and work are to be controlled, and in such manner that a separate card for each worker and piece of work is stamped or punched. These cards can, in addition, be formulated and arranged for the notation of material used for a certain article or job as well as of the machine or department where the work has been executed, so as to quickly and automatically give accurate information concerning the respective costs of production. Furthermore, the fact that this information is successively available while the work is advancing, makes possible the efficient planning of work and a saving of personnel in the time-keeping department. Also, the stamping by means of time recorders gives absolutely accurate and impartial data as to time, eliminating all controversies on this subject between workers and their foremen. Another advantage is the habit of punctuality which the personnel necessarily acquires, the importance and value of which every manufacturer needs must be aware of.

L. M. E. has for some time been occupied with the manufacture of time recording apparatus of a new type, which offers distinct advantages over other types heretofore offered to the public. The type used is one in which the stamping is done on cards, one for each employee. The apparatus is electrically actuated by means of a main clock which transmits electric impulses to the recorders mounted in the various departments, thus insuring a perfectly uniform time and movement for all the recorders. Electric impulse clocks — for showing time only — and signalling devices can also be included in the circuit, so that signals can be automatically sounded at certain definite times, such as at the beginning and close of working hours, or for other purposes.



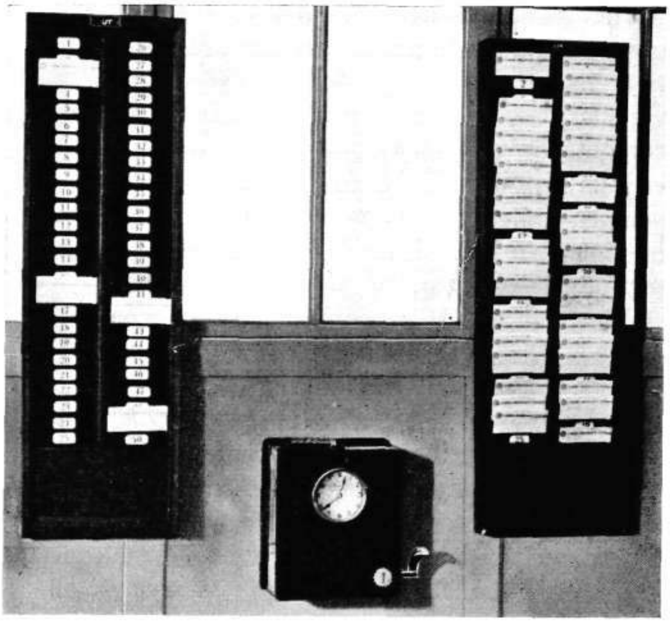
R 84 Fig. 5.

Several different types of recorders are made, for either weekly or monthly payments of wages, and for the recording of piece work, on either cards or paper forms.

The main clock, fig. 1, is regulated by means of a pendulum and is actuated either electrically or by weights, according to the wish of the purchaser. The contact device is so constructed as to transmit impulses with alternate reversing of poles. Electric winding of the works, when such is desired, is accomplished by means of

R 85 Fig. 6.

R 86 Fig. 7.

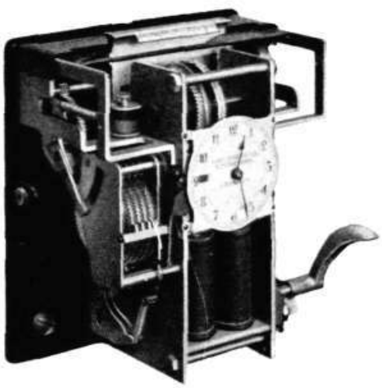


R 88 Fig. 9.

the same contacts and current which actuate the recorders included in the circuit, except in plants of such size that an actuating current of higher voltage is used, in which case current for winding the main clock is furnished by a small storage battery.

A programme clock, fig. 2, is used when several devices are connected in the same circuit. The programme clock is controlled by the main clock so as to transmit an electric impulse to the connected recorders once every minute, also closing the signalling device circuit at definite times for announcing the beginning and close of working hours. The signals can be timed so as to be sounded at varying hours throughout the week; a great advantage for works having shorter working hours on Saturdays. The correct timing of signals is very simple and can be done by anyone without any special tools by the insertion of small pawls in certain toothed wheels. (See fig. 3). The contact device is of a very sturdy construction and can be easily removed by a single manipulation for cleaning or replacement. The programme clock has also a dial and a day-indicator, making it an easy matter to check whether it is correctly set or not.

Monthly wage time recorder. This apparatus, shown in fig. 4, is intended for the stamping of incoming and outgoing times in such cases where the wage period does not exceed one month. Figs. 5 and 6 show how it is placed for the use of operators at one of the Stockholm telephone exchanges. In this case, the large

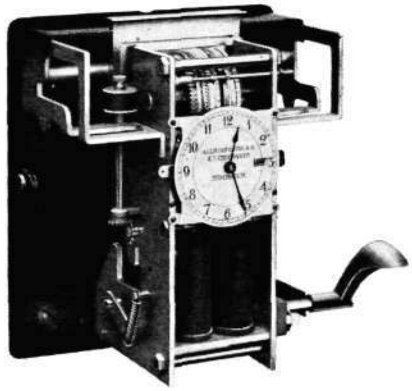


R 87 Fig. 8.

R 89 Fig. 10.

number of cards necessitates the use of specially constructed filing cabinets. This special recorder can be used by a large number of employees,

R 90 Fig. 11.



R 91 Fig. 12.

R 92 Fig. 13.

their working hours being divided into shifts so that only a small number stamp their cards at the same time.

Figs. 17 and 18 illustrate the type of card used with this recorder, the time for the first sixteen days of the month being stamped on the front of the card, and the remainder on the back. This card is intended not only for the stamping of starting and stopping times, but also for the annotation of each day's pay, time off, etc. It is also used as a receipt, the telephone operator signing her name on the card when receiving her month's salary.

The recorder can also be fitted with a shifting device for the use of a two-coloured stamping ribbon in red and blue, as shown in figs. 17 and 18, shifting automatically from one colour to the other, showing at a glance whether the card has been stamped before or after starting time. The card is in either case adjusted to the correct position for the stamping of different starting and stopping times during the same day by moving the card holder laterally by hand. Adjustment for the different days of the month is automatic. The recorder stamps either date or ·name of day as well as hour and minute.

R 93 Fig. 14.

Weekly wage time recorder. The recorder shown in figs. 7 and 8 is entirely automatic and is especially intended for the controlling of factory workers' starting and stopping times. The various stampings during one single day are done in the same column, the vertical position of the card for each succesive stamping being determined by means of a hole, which is punched through the card at the same time as it is stamped. The lateral adjustment of the card holder for the different days of the week is automatic and takes place instantaneously at 12 o'clock midnight, under normal conditions, so as not to interfere with the stamping process. Figs. 9 and 10 show this recorder in use, the cards being filed in racks on both sides of the same in the customary manner.

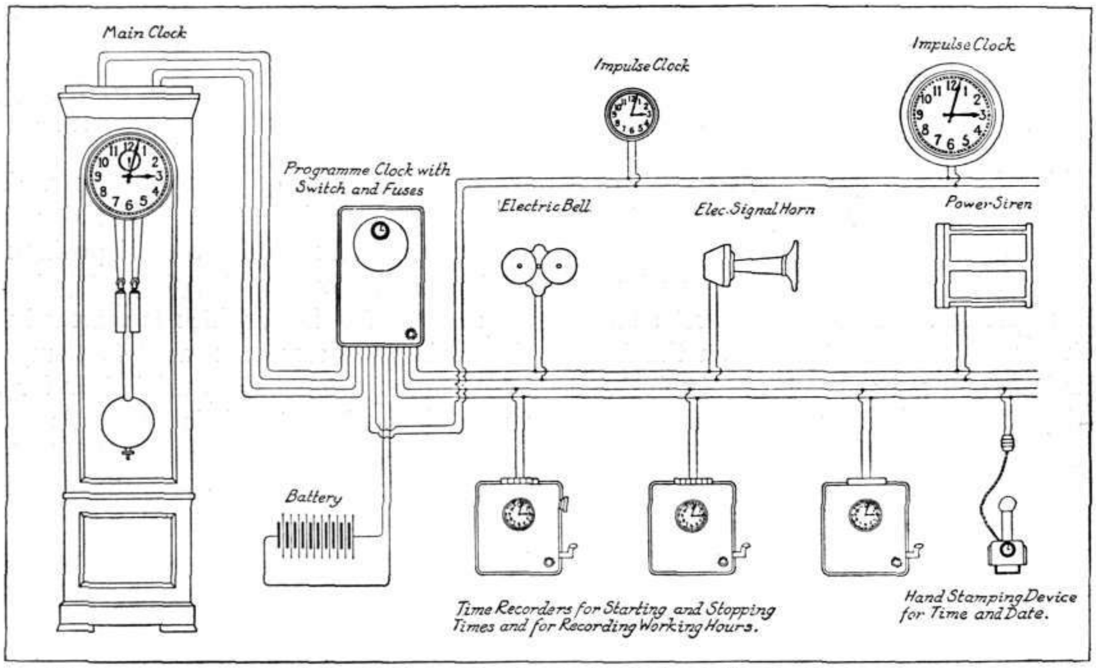
Figs. 19 and 20 show a time card intended for the stamping of time records for a period of one week. This card is also designed for annotations concerning wages and is made use of for receipting wages and the control of time off. The recorder makes note of late arrival by the automatic shifting of the stamping ribbon. This ribbon shifting can be separately adjusted on the different recorders, thus permitting adjustment for different working hours for separate groups of workers or for the different working departments.

Recorder for piece-work time. This apparatus, shown in figs. 11 and 12, is also entirely automatic and is used to keep a record of the time required for completing a certain job. Thus it stamps the week number, day, hour and minute, and can, if so desired, be designed for one tenth hour time-division, or for the division of long job-time into shorter periods, each period corresponding to one tenth of an hour. The stamping is done vertically, as shown on the piece-work time card illustrated in figs. 21 and 22. This card constitutes, at the same time, an order for a certain job and the material required for the same, containing a check on this material and information as to time consumed and amount of wages spent for this particular job. An accurate record of the entire procedure is thus made, greatly facilitating the organizing of rational and efficient methods of manufacture.

The piece-work time card can also include an additional part for checking purposes. This docket contains a duplicate of the order and is torn off at the time the order is given, being kept on file in the timekeepers office, making it possible to check whether the work is being done on schedule time.

Paper form time recorder, fig. 13, is used for time recording on forms of paper, as denoted by the name, instead of on paste board cards as with the other recorders described. It is also used for the same purpose as piece-work time recorders. Since the successive positions of thin paper slips cannot be automatically determined by the aid of punched holes, however, the worker must hold his slip in the correct position — determined by means of printed marks on the slip and an indicator at the mouth of the card holder — while stamping his time. The recorder is constructed for stamping of month, day, hour and minute, but can also be arranged for other time subdivisions.

The *impulse clocks,* fig. 14, are actuated in the same manner as the time control clocks, i. e. by means of minute-impulses. The works are of a very simple construction and are sturdily built, consisting of an electromagnet placed between two permanent magnets and equipped with two armatures, which actuate the hands of the clock with a perfectly noiseless movement when receiving impulses from the main clock. The magnet



R 94 Fig. 15. Schematic Diagram for Time Control Plant with Signalling Devices.

No 105 JOHANSSON, E.A.
(Name)

ALLMÄNNA TELEFONAKTIEBOLAGET L. M. ERICSSON

Telephone Works Dept. No. 15

February 1921.
(Month)

Day	Time						Total
	Arr.	Left	Arr.	Left	Arr.	Left	
1	724	1131	1224	503			
2	724	1131	1226	508			
3	726	1133	1234	504			✓
4	725	1132	1226	504	106	256	-2
5	723	1001	1014	117			
6							
7	734	1133	1228	506			✓
8	727	1133	1228	509			
9	730	1132	1229	506			
10	728	1132	1229	506			
11	728	1133	1231	507			✓
12	727	1001	1014	117			
13							
14	727	1134	1229	510			
15	728	1133	1229	503	531	631	+1
16	729	1133	1228	503			

Carried forward ....

Fig. 17.

No. 860 LUNDGREN, A.L.
(Name)

ALLMÄNNA TELEFON-A.-B. L. M. ERICSSON

Telephone Works Dept. No. 16

Week No. 3

Granted Time Off					
Date	Time	Sign.	Date	Time	Sign.
19-1	2-3	B. P.			

	Sunday	Monday	Tuesday	Wednesd.	Thursday	Friday	Saturday	Total
Arr.		734	724	728	727	724	728	
Left.		1131	1132	1133	1134	1132	1001	
Arr.		1228	1228	1229	1229	1223	1012	
Left.		502	508	205	503	503	118	
Arr.			600	259				
Left.			803	506				
Arr.								
Left.		✓						
Reg. time				-1				47
Over time			2					2

Fig. 19.

1 2 3 4 5 6 7 8 9 10 11 12 13

No. 128 Jansson

Workers Numbers Sharing Job ....

Telephone Works Dept. No. 2 Group No. 1 e

Order No. T. 12548 Drawing No. 1320

Turning of sleeves

10,000 pcs @ 4,45 per 1000	43	61
9800 pcs approved S. L. (Sign.)		
200 pcs rejected		
34 hours @ 0,90	30	60
Paid: 11-2 (Date) Piece Work Surplus	13	01
hours overtime @		
" " @		
Cost of Labour	43	61

		No of week	Time		Reg. time	Overtime
Order issued 18-12-20 by V. J.	Started	4	Mo. 823			
	Finished	4	Th. 825		25.5	
Job shall be completed on 15-2-21	Started	4	Sd. 930			
	Finished	5	Mo. 109		8.5	
Order for remainder of lot issued on	Started					
	Finished					
	Started					
	Finished					
				Total hours	34	

Piece Work Surplus = 42.5 %

Fig. 21.

ALLMÄNNA TELEFON-A.-B. L. M. ERICSSON

Order issued by (Initials)	Material	Ordered: Amount Met. Kgs.	Issued: Amount Met. Kgs.	Issued: Sign.	Returned to storeroom: Material Kgs.	Material Sign.	Scrap Kgs.	Scrap Sign.	Stock Kgs.	Stock Sign.
V.S.	8 mm. dia. brass bolts	77-.	77--	a.k.			15-	a.k.	61,5	O.?
O. [illegible]	[illegible] machine oil	1 lit.	1-	a.k.						

Fig. 22.

Wages 21-1 1921.

No. of Hrs	Nature of Work		[Currency]	
47	Regular time @	1.50	70	50
2	Overtime @	2.03	4	06
38	Piece Work Surplus	1380	14	20
		Total	88	76
Deductions: Sick fund 1.50	/ Fines	0.75	2	25
		Total Wages	86	51

Above Wages Received:

A. F. Lundgren
(Name)

Fig. 20.

No. 105 JOHANSSON, E.A.
(Name)

Granted Time Off: Date	Time	Sign.	Date	Time	Sign.
4-2	1-3	F.S.			
25-2	9-10,30	F.S.			

Day	Time: Arr.	Left	Arr.	Left	Arr.	Left	Total
					Brought forward		
17	17 722	17 1131	17 1225	17 502			
18	18 723	18 1131	18 1227	18 506			
19	19 728	19 1001	19 1014	19 117			
20							
21	21 728	21 1131	21 1233	21 508			✓
22	22 727	22 1132	22 1226	22 506			
23	23 727	23 1132	23 1229	23 506			
24	24 738	24 1131	24 1229	24 509			✓
25	25 726	25 1135	25 1227	25 511	25 901	25 1028	-1.5
26	26 726	26 1001	26 1015	26 120			
27							
28	28 728	28 1132	28 1228	28 508			
29							
30							
31							

Regular time, total 188.5 hours @ 2.-	377	—
Overtime, " 1 " @ 2.70	2	70
	379	70
Deduct 5 fines @ 1.-	5	—
Total	374	70

Fig. 18.

which furnishes the driving power is geared to the hands by means of a worm gear. This construction has made it possible to eliminate the large number of wheels with which clock-works are usually equipped, making the works extremely light running in spite of the ample dimensions of the bearings. The clock is also practically unaffected by knocks and vibrations, and owing to the fact that it is hermetically enclosed, it can be placed in damp or dusty localities without endangering its reliability.

Signalling apparatus. Either electric gongs or horns are used for the sounding of signals at the beginning and close of working hours, adjustment being possible for a varying volume of sound.

All of this apparatus is designed with a view towards its manufacture on a large scale. The recorders are fitted with sheet iron covers attractively finished in black lacquer, while the impulse clocks are commonly furnished with a lacquered sheet iron frame. The scheme in fig. 15 shows how the apparatus is connected in the circuit. If so desired, the plant can be connected directly to an electric light circuit, provided it is D. C. with a voltage not exceeding 220, otherwise a small 24 volt storage battery can preferrably furnish the required current. This battery can be conveniently charged from an A. C. circuit by means of a pole changer and furnished with a device for automatic breaking of the circuit when charged.

C. E. J. N.

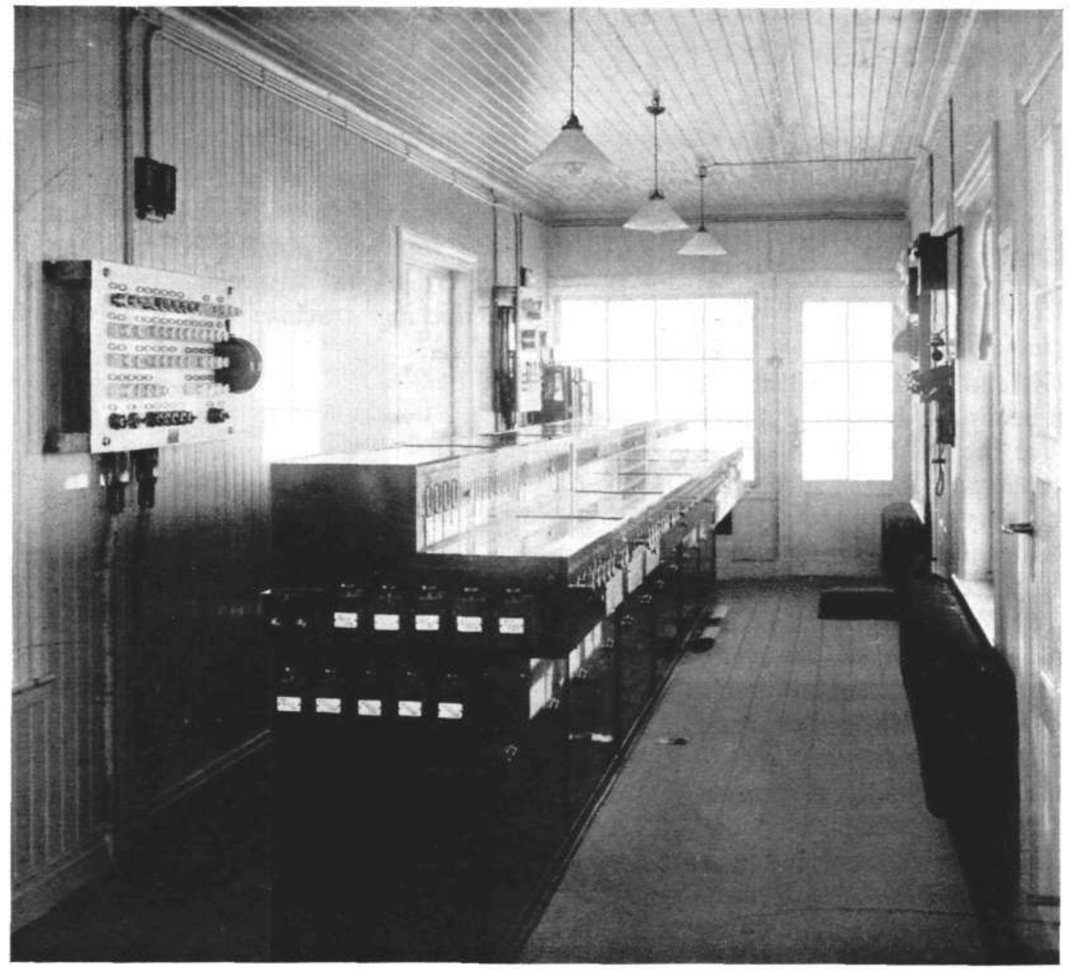
R 32

The Nässjö Electric Interlocking Plant.

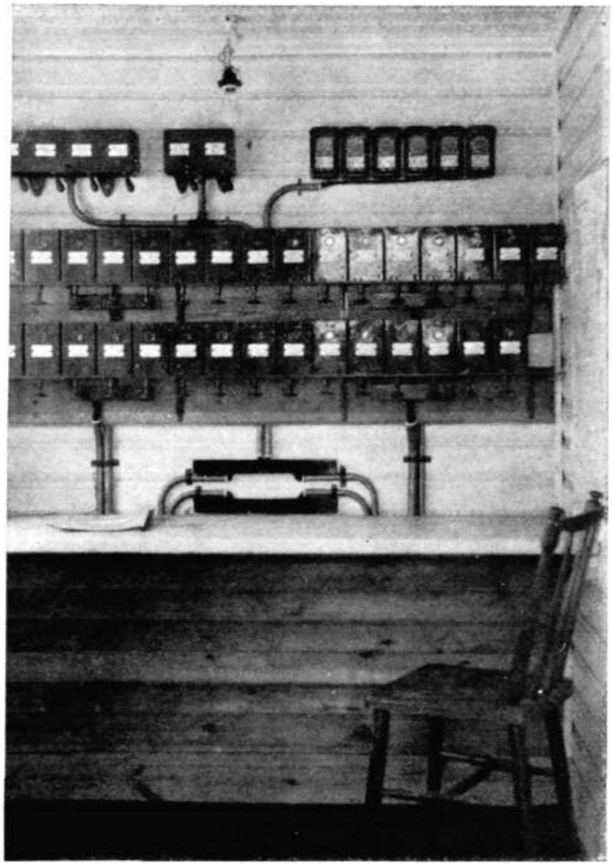
The greater part of the Swedish public, during its travels, has undoubtedly passed through the Nässjö railway station and had its attention attracted to the lively railway traffic existing at this point, Nässjö being a very important multiple junction from which lines branch out both to the East and the West from the Stockholm—Malmö State Railway main line. To the East we have the Nässjö—Oskarshamn Railway, with the Kalmar Railway a little further south, while the state line to Jönköping and Falköping branches off to the Northwest, with the Halmstad—Nässjö Railway to the Southwest. All of these railways, in turn, form main lines for others of a more local character. It is therefore evident that Nässjö must be a very lively centre of traffic, where, to a large extent, both passengers and goods »change trains». Should the old adage »In darkest Småland» still be applicable to any part of this honourable province, it certainly cannot be applied to Nässjö since the station has now been completely modernized and equipped with an electric interlocking plant.

A schematic view of the modern arrangements of this passenger station is shown on the above track plan. Three wide intermediate platforms (2, 3 & 4) have been constructed, and are connected to platform 1, outside the station house, by means of a tunnel, making it unnecessary for passengers to cross the tracks when changing trains. The tracks which are situated next to the platforms are used for passenger trains, and

R 40 Signal Tower at North End of Station Yard.



R 39 The North Interlocking Machine.



R 43 Release Apparatus, Emergency Switch and Indicators in Release Apparatus Cabin on Platform 3.

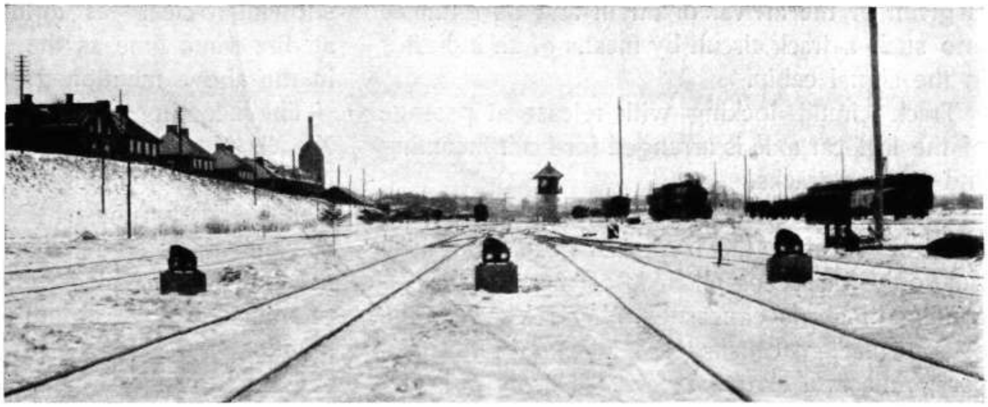
The release apparatus, which prevents the setting of incoming signals to clear without the consent of the station master, is housed in a cabin (release apparatus cabin) on platform 3. This gives the station master absolute control of incoming trains. There are 33 release field instruments, corresponding to the number of incoming tracks. Should an incoming semaphore have been set to clear from either one of the interlocking machines, it is possible for the station master, if necessary, to reset it to stop by means of the emergency switch arrangement in this cabin. The incoming signals are repeated by means of indicators in the release apparatus cabin.

Nineteen points and three skotch blocks, one three-armed and two double armed incoming signals, all provided with distance signals, and three one-armed and two double armed starting signals are operated from the south interlocking machine I, located at the south end of the station yard, east of the incoming track from Gissebäck. In addition, the positions of three points are electrically recorded at this interlocking machine by means of point circuit breakers, and the positions of two points are mechanically recorded by means of mechanical point locks. The interlocking machine has twenty eight levers

tracks XI, XII and XIII for freight trains, which can be directly brought out over a hump for the making up of trains at the shunting station situated west of the incoming track from Äng.

The electric interlocking plant, comprising the passenger station only, has been built by Signalbolaget, the electric apparatus being delivered by L. M. Ericsson and the mechanical details (semaphores, skotch blocks, base parts and connections for the operating devices, etc) by Avos. This plant, at the present time the largest in Sweden, is divided into two signal cabin zones, one at each end of the station yard. Each zone is equipped with an interlocking machine from which points and signals are operated.

R 42 Double Point and Starting Signals at South End of Siation Yard.



R 44 Shunting Signals M_I—M_{III}, Arranged as Dwarf Signals.

for the above named purposes, and is four metres long.

The north interlocking machine (II) is located within the track system at the north end of the station yard. Not less than fifty eight points and five skotch blocks, one double armed and two three-armed incoming signals with distance signals; one three-armed, three double armed and three one-armed starting signals, and finally, three shunt signals are connected to the same. Forty eight of the points and four of the skotch blocks are operated from this interlocking machine, while five of the points and one of the skotch blocks are merely locked, the positions of the remaining five points being recorded at the same by means of point circuit breakers. This machine is, therefore, one of the largest built by L. M. E. and is furnished with fifty three levers. Its length is six metres.

R 41 Signal Bridge in North Signal Cabin Zone.

The crowded space within the track system has made it necessary to place the starting signals for tracks XI and XII, as well as a special shunt signal for shunting over the aforementioned hump, on a signal bridge. All other signals stand free.

The shunting signals (M_I to M_{III}) which are connected to interlocking machine II — for regulating shunt movements from the engine-house in the north end of the station yard — are of the American type and are designed as light signals. They are now being used in Sweden for the first time, and give a »stop» signal by means of two horisontally placed white lights and a »clear» signal by means of two vertically placed white lights.

Points operated from the interlocking machines and from which they are not clearly visible, have been connected to track circuits so as to prevent a too early turning over of the points. The placing of a car on such a track circuit automatically causes the lever of that point, to which the circuit is associated, to become locked, preventing the turning over of the point until the car has been removed from the track circuit.

Track circuits have also been arranged for some of the tracks for the control of clearance at points, thus simplifying the station master's inspection duties. In like manner, track circuits have been arranged between the incoming signals for the incoming tracks from Solberga, Äng and Grimstorp, and their respective distance signals for giving notice of the arrival of trains. Warning is given of the arrival of a train and its entrance into such a track circuit by means of an indicator in the signal cabin.

Track circuit locking with release at passage of the last car axle is arranged for both incoming and starting tracks.

The setting of incoming and starting signals to clear — after the track has been cleared — can only be accomplished, as far as the incoming track is concerned, after release by the station master, causing the locking of the proper points and skotch blocks. This is done by shifting the position of the proper signal lever. The track circuit lock is released when a train has advanced over a track and the last axle has passed an insulated rail and a rail contact, usually placed after the last point in the track, after which the signal lever can be returned to normal, all obstacles preventing the turning over of points etc., having been removed when the train passed the points group. The incoming or starting signal, showing »clear» is automatically set to »stop» at the same time as the signal lever is released in the above mentioned manner.

The incoming of trains from the South to tracks X, XI, XII and XIII require the receiving of a release signal by interlocking machine I not only from the station master, but also from interlocking machine II, as some of the points controlled by machine II must also be locked for the admitting of trains from the South to any one of the above mentioned tracks.

Electric power required for this plant is furnished by two Nife storage batteries, the one with a potential of 130 V. for the point and signal motors, and the other with a potential of 30 V. for the circuit to relays, point and signal lever magnets, etc. These batteries are charged by means of two mercury rectifyers which, together with the batteries, are placed in signal cabin II and are tended by its personnel.

E. G. W.

The Handmicrotelephone.

Pictures and Rhymes.

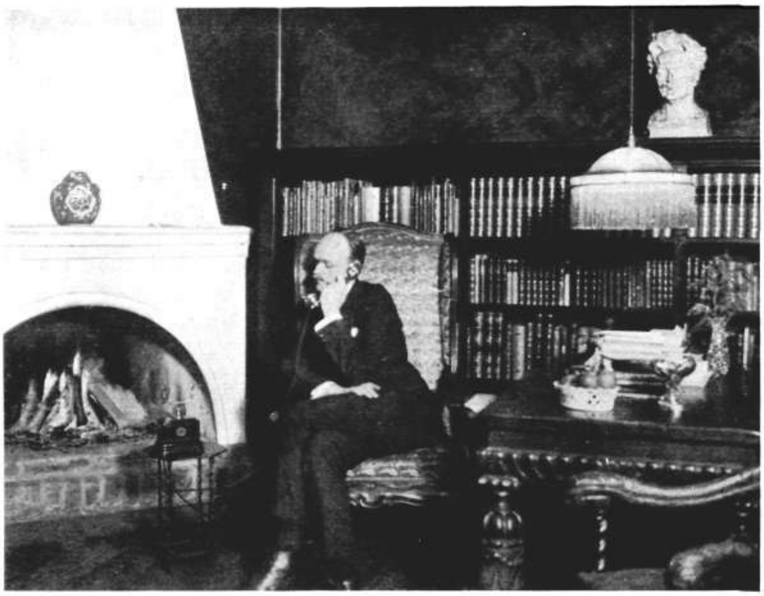
R 54 Fig. 1.

R 53 Fig. 2.

The attitudes that here are shown
Mean handsets give you concentration
And comfort at the telephone
Of which we give a demonstration

With simple verse to make it rhyme
Not scientific explanation
For telephones from Ericsson
Have earned a world wide reputation.

R 55 Fig. 3



R 56 Fig. 4.

The young man shown in picture one
Explains a point some others lack
To see and speak he twists his spine
Although he has a solid back.
The youth that's shown in picture two
Has made a far, far better choice
For he can reach both far and wide
And still retain his normal voice.

A pleasing view is picture three
A lady writing to dictation
The handset's made by L. M. E.
That is the happy explanation.
For should the guv'nor make remarks
The point of which she cannot see
A timely word back now and then
Will simplify stenography.

R 59 Fig. 6

R 57

Fig. 5.

And then again in picture four
The master has his handset there
He need not walk across the floor
But sits in comfort in his chair
But just before, in picture five
This gentleman was settled down
With news and smoke, was at his ease
Till he received this call by phone.

In picture six, the lady shown
Is not too ill to raise her head
And move the microtelephone
Off from the cradle to the bed.
A friend rings up from picture seven
Hoping her headache is not much
And entertains her with the news
Of so and so and such and such.

R 58

Fig. 7.

R 60 Fig. 8. A Moroccan Café in Tangier.

But Ericsson's microtelephone
Is utilized by every nation.
In picture eight a view is shown
Given by way of illustration

Though this chap talks from right to left
And gets reply in wierd cantation
He sits in comfort, for the 'phone's
Adapted to his education.

R 102 A Little Swedish Cinema Star — 5 years old.

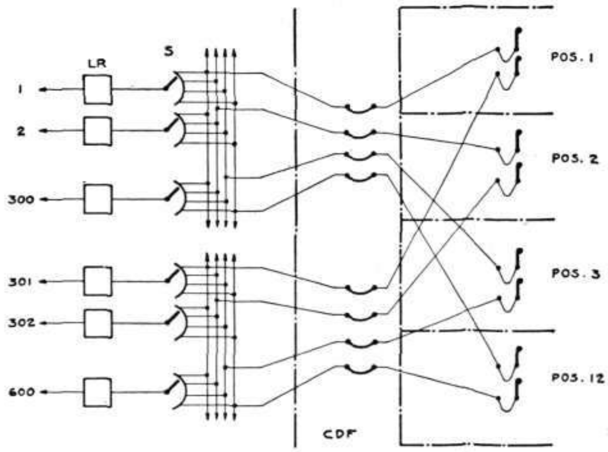
TYPICAL MANUAL TELEPHONE EXCHANGES.

A SERIES OF DESCRIPTIONS.

It is the intention of the Editor to group together, under this title, descriptions of various completed exchanges considered typical to the various systems, with an intimation as to why the system under consideration has been chosen in the cases dealt with, the first being

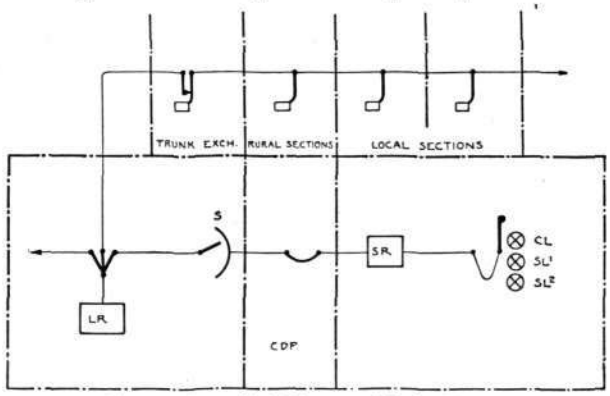
The Åbo C. B. Exchange with Automatic Distribution.

The new telephone exchange in Åbo (Finland), which was opened for traffic in the middle of 1923, was delivered by L. M. Ericsson to Aktiebolaget Åbo Telefonförening. The plant has been built according to Ericsson's common battery system with automatic distribution, and as it can serve as an example of this type of manual exchange, we will here give a short description of both system and equipment.



R 79 Fig. 1. Schematic Diagram of Cord Distribution.

The initial equipment comprised apparatus for 3,600 subscribers' lines and a rural line switchboard for 100 lines, the exchange being designed for a maximum capacity of 9,600 lines. The former exchange, also delivered by L. M. Ericsson, was a magneto exchange, being put out of service simultaneously with the connecting of the subscribers' lines to the new exchange. The outside plant has been reconstructed, the majority of lines now being underground. Junction traffic with other exchanges does not exist, the new exchange constituting one complete plant.



R 78 Fig. 2. Theoretical Diagram of Entire Plant.

The system with automatic distribution, which has been applied to this exchange, is illustrated in figs. 1 and 2.

Each subscriber's line is connected to a cord selector S, which automatically directs incoming calls to disengaged cords in idle positions. The selectors are of the step-by-step type and have 25 contact positions of 4 contacts each, only 20 contact positions being used. These are parallelled, giving the selectors for 300 subscribers' lines one common multiple. Each contact position is connected to a single-cord circuit with calling lamp CL, double clearing signal lamps SL^1 and SL^2, and operator's key for speaking and ringing.

Since the total number of subscriber-groups is $\frac{3,600}{300} = 12$, a total number of 240 cords is required.

The number of positions for handling the local traffic is at present twelve, with twenty cords each. The twenty cords connected to one subscribers' line group are distributed over the twelve positions, two cords being allotted to each of eight positions and one cord to each of the remaining four.

An even distribution of traffic between the several positions is accomplished by the shifting of jumpers between the selectors and cords in the intermediate cord-distributing frame CDF.

As has already been mentioned, incoming calls are automatically directed over the cord selectors S to disengaged cords in idle positions. An operator's position is therefore blocked, after having received a call, until the desired connection has been completed. Should all twelve positions have each received a call, one more call can nevertheless be directed to each position.

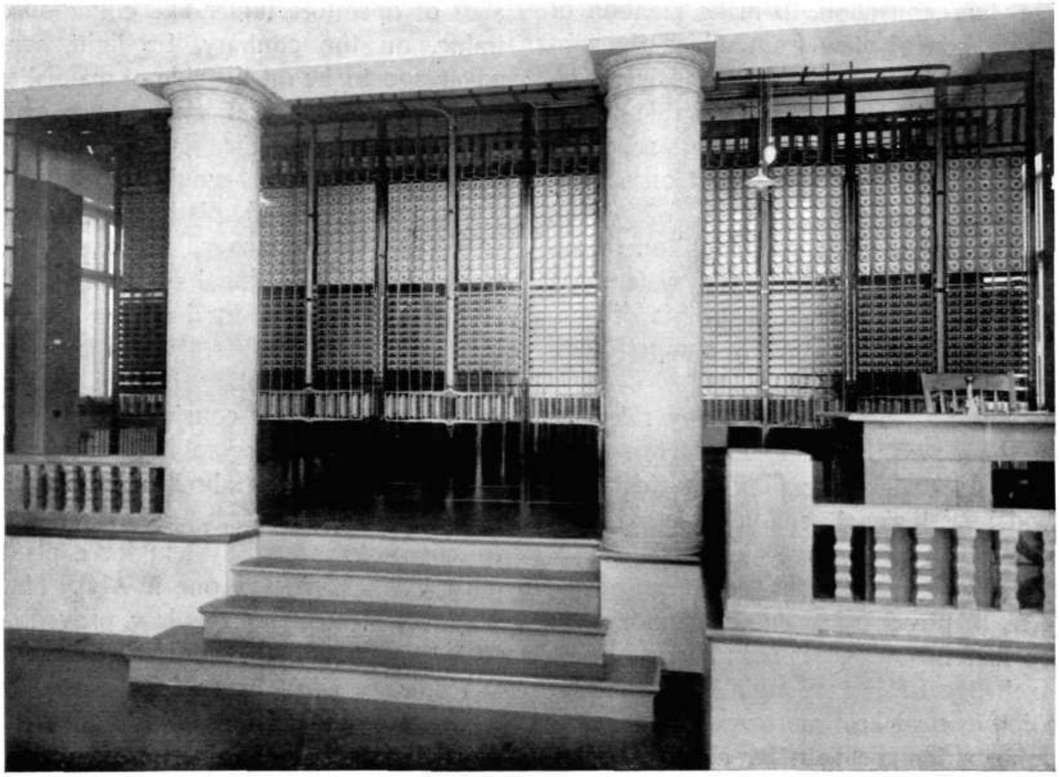
Arrangements have been made for the coupling of positions, making it possible for two or three to function as one, from an operating point of view. Such an arrangement makes it possible to adapt the number of operators to the intensity of the traffic.

R 38 Fig. 3. Main Distributing Frame and Power Board.

The line is cleared when a clearing signal is received from the calling subscriber, i. e. when the conversation is ended and the calling subscriber hangs up his receiver, the circuit over the selector is automatically broken, enabling the subscriber to make a new call immediately.

As the local multiple is repeated in the interurban and rural switchboards, no separate positions are required for this service. Furthermore, the connecting devices in the switchboards are designed so as to permit the breaking of a local connection by the toll operator.

The new exchange is housed in the building of the Telefonförening (Telephone Society) on Strandgatan. The main distributing frame and power plant are located in the basement. The main distributing frame and testing desk are shown to the right in fig. 3. To the left are shown the power board and a part of the machine equipment. The storage batteries, with a potential of 24 volts, are placed in a separate room.



R 37

Fig. 4. Relay and Selector Rack.

The line relay and selector rack room, shown in fig 4, is situated in the story above the main distributing frame. The racks are built in units for one hundred numbers, six such racks forming one row. A total of six rows have therefore been erected for 3,600 lines. The intermediate cord-distributing frame is also placed in this room.

The operating room — a view of which is shown on the title page — is located in the top story. There are six multiple switchboards of three positions each. The first one was originally intendend to serve as a toll switchboard, but was remodelled for the handling of local traffic, and now stands as a spare board. The second one is a rural line switchboard, the remainder being local boards. All the switchboards are eight-panelled. In addition, there are two six-panelled turning sections. The toll board stands in a separate room in the same story as the relay room. The cables from the relay room are carried up through the operating room floor, after first having been connected to the multiple of the toll board, and are run to the local multiple through the cable turning section shown at extreme left in the illustration.

A telephone exchange, built according to the above described system, offers the following advantages over the usual common battery exchange with local jacks and double cord equipment:

(a) The fact that only one cord is necessary for completing a connection permits each operator to handle from 20 to 25 % more calls than is otherwise possible.

(b) Time delay until operator answers is shortened by the distribution of calls to idle operators.
(c) Required number of operators on duty can better be regulated to suit fluctuations of traffic than by the double cord system without automatic distribution.
(d) Total number of operators required is reduced.

As there is an ever growing tendency towards the supplanting of manual telephone exchanges by those of the automatic type, it may be of interest, in this conection, to make mention of the various points of view from which the subject should be considered when choosing a telephone system. It always is desirable that a telephone plant be a paying enterprise, so, when choosing a system, one must not let oneself be too strongly influenced by the trend of general opinion, pointing towards the adoption of automatic equipment, for no automatic system has yet been devised which, from all points of consideration, is able to successfully compete with modern manual systems.

It is hardly possible to set up any rules for the choice of a system, as various factors must in each special case be taken into consideration, but we will nevertheless mention some points of view which may well deserve attention:

The costs of construction for an automatic exchange is, at present day prices, from two to two and a half times greater than for a modern manual exchange of corresponding size, making expenses for interest and mortgage considerably higher for an automatic than for a manual plant. Cost of maintenance and current is also generally higher for an automatic exchange. When considering the outside plant, we must again figure with a greater cost for the automatic than for the manual plant, as automatic equipment requires better insulation than manual C. B. equipment, especially when figuring with automatic systems requiring a 48 or 60 volt working current. On the other hand, the operators' salaries constitute an added expense for systems of the manual type.

A great intensity of traffic, which, in addition, is fairly well distributed over the different hours of the day, speaks advantageously for automatic switching, as a manual exchange requires a large staff of operators under like conditions. Should traffic, on the contrary, be light, we find the advantage to be on the side of manual switching, especially if one can also figure with a high concentration of traffic.

Automatic service would undoubtedly be advantageous where the plant embraces a large area with several exchanges, for the reason that a similar plant with manual switching would require additional operators for handling junction traffic between the exchanges. Where small or medium sized plants, consisting of not more than one exchange, are under consideration, we find conditions that speak favourably for a manual system.

When taking the above mentioned points of view into consideration, one would not hesitate to choose a manual system for a plant of a similar character to the one in Åbo. The intensity of traffic is comparatively low, proved by the fact that 12 positions are sufficient for serving 3,600 subscribers. There is no junction traffic between this and other exchanges.

Furthermore, all possibilities of creating the most favourable operating conditions, from a financial point of view, for a plant of this size, have been made use of by choosing a common battery system with automatic distribution. *G. G.*

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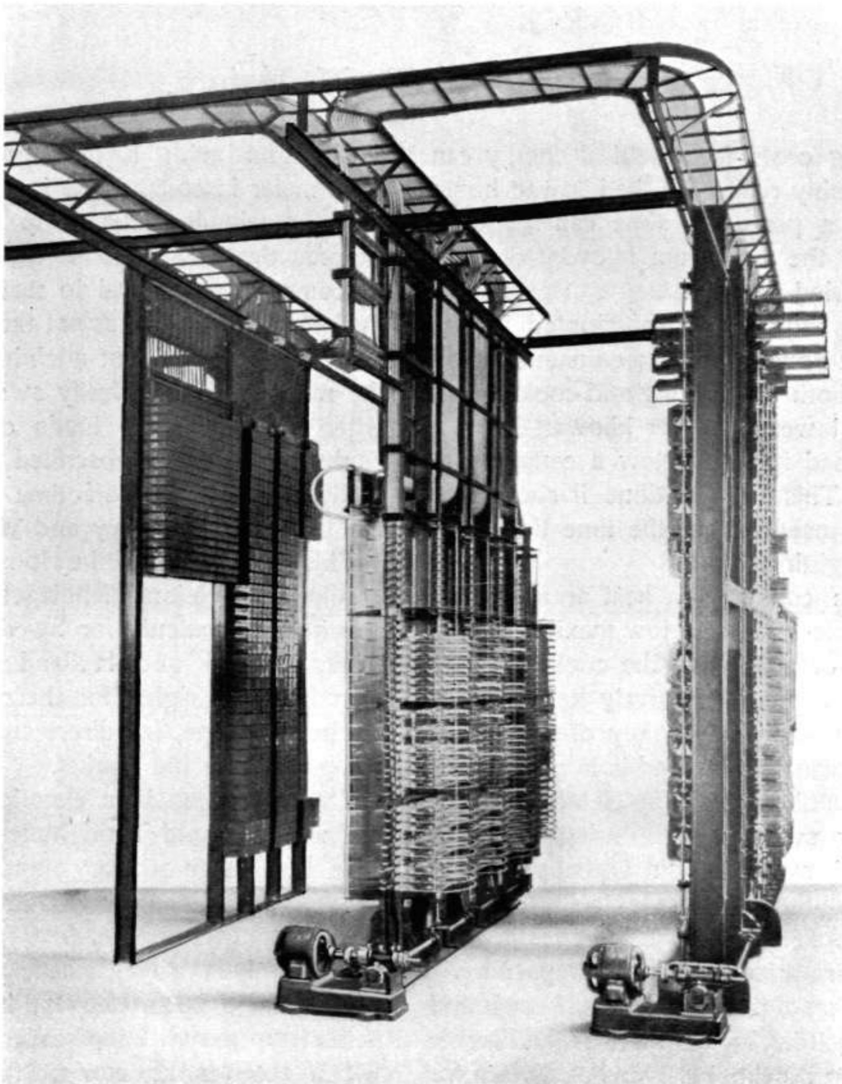

THE PARKVIEW AUTOMATIC TELEPHONE EXCHANGE
JOHANNESBURG, SOUTH AFRICA

ENGLISH EDITION

L. M. Ericsson

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Household Tariff Meters.

The generating costs for electrical energy can be considerably reduced if the kilowatt hours generated over a period of time can approach the product of the maximum kilowatt demand by the same period of time.

According to modern tariffs adopted by the Swedish Electric Power Works, a consumer using electric energy both for lighting and cooking can count upon a lower price per kilowatt hour, if the maximum load is held below a certain subscribed value. This can be done if energy for cooking is not used during the time this value is utilized for lighting.

If the electric cooker is a heat accumulating one, it is possible to hold a low maximum load, as the supply of current to the cooker can be intermittently cut off for relatively long periods without reducing the practicability of the cooker.

A means of balancing the load is to provide the cooker with a number of heating elements, which are successively switched off during increased lamp load, and switched on when the lamp load is reduced. Such an arrangement, however, necessitates a cooker of complicated construction, requiring constant attention by the subscriber.

Another solution of this problem has been found by Mr Axel Widström, an Engineer of the Electric Power Works in Stockholm. He has divised for this purpose an electricity meter for use in conjunction with a heat-accumulating cooker. This meter is constructed in such a manner, that when a simultaneous lamp and cooker load exceeds the subscribed value, the average effect is constant and equal to that value as long as the lamp load alone does not exceed the subscribed value. The manner of attaining this is to cause the meter to automatically switch off the cooker when the combined loads of the lamps and cooker exceed the subscribed effect, termed Bulk limit; the switched off time lengthening when the lamp load is heavy and vice versa.

This meter is termed the Household Tariff Meter.

Allmänna Telefonaktiebolaget L. M. Ericsson has acquired the patents for Sweden, Norway, Denmark, Finland and Holland and thus also the manufacturing rights for these countries.

The first type, for direct current, is now ready for putting on the market.

The following is a description of the meter.

The Household Tariff Meter for direct current, type *L2H*, is an ordinary ampere hour meter with kilowatt hour recording train, built as per the magnet-motor principle.

Figure 1 is a diagramatic view of the meter. *1*, *2* and *3* is an electrical installation, where *1* is the lamp circuit, *2* the heat accumulating cooker, which receives its current through the sealed mercury switch *39*, and *3* the meter registering the total energy on its recording train *16* and the energy exceeding the subscribed value on its recording train *31*.

8 is the armature of the meter. This is an ordinary break disc provided with three flat fine wire coils. The three coils are placed between two aluminium discs and are attached to a three-segment commutator *6* made of gold-silver alloy. The armature is free to rotate between the shanks

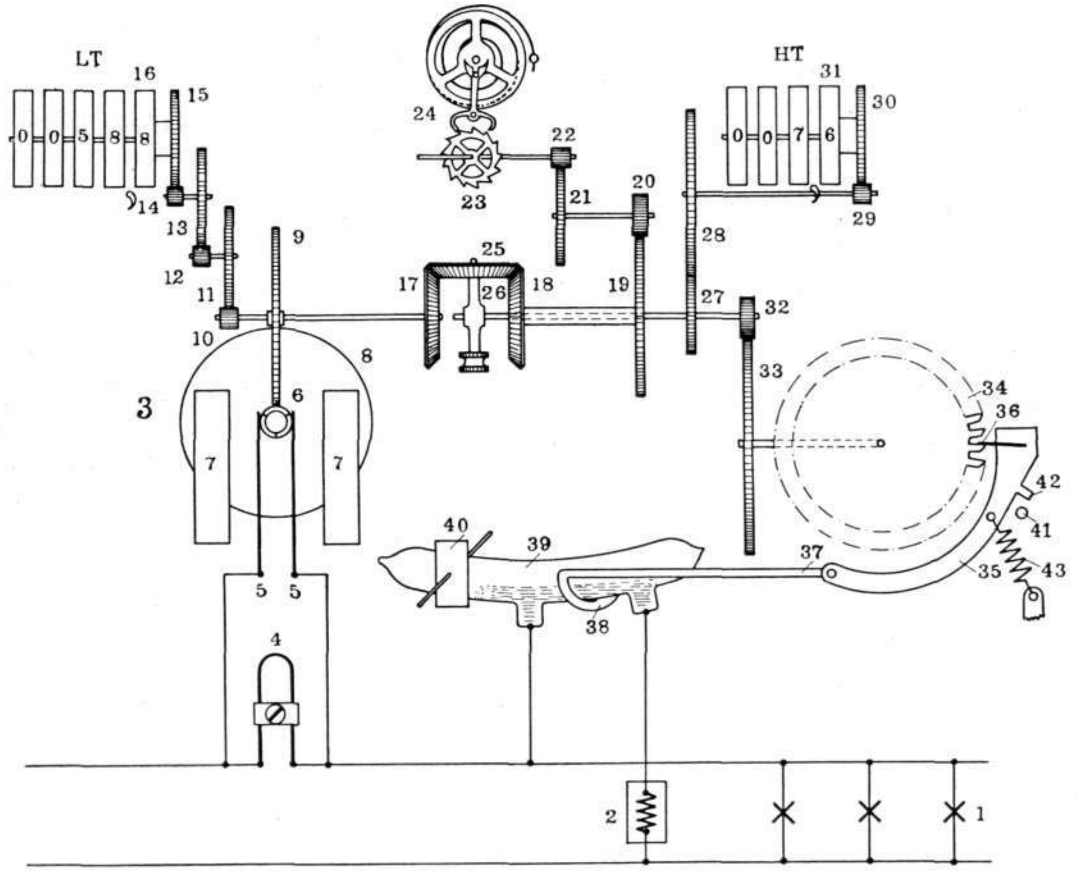


Fig. 1.

of two steel permanent magnets *7* each with the field Φ.

The brushes *5* are each provided with three extremely thin strips of gold-silver alloy. They are connected to an adjustable shunt resistance *4* made of manganin, therefore of a low temperature coefficient. Of the total current flowing, the main current I_s passes through the shunt *4*, the remainder I_a passing through the armature.

The co-operation between the field of the armature coils and the field of the permanent magnets causes a torque M_v, which is proportional to the armature current I_a and the field Φ.

$$M_v = C_1 \times \Phi \times I_a.$$

C_1 is a constant, depending upon the construction of the meter. Under the influence of this torque the armature begins to rotate. Through the rotation of the aluminium discs in the field Φ eddy currents are produced in the same, which together with the field Φ act on the armature a breaking moment M_B proportional to the square on the field Φ and the armature speed n.

$$M_B = C_2 \times \Phi^2 \times n$$

C_2 is a constant, depending upon the construction of the armature, the thickness of the aluminium discs and their conductivity.

In stationary condition the rotating and breaking moments are equal, thus

$$M_V = M_B$$

or

$$C_1 \times \Phi \times I_a = C_2 \times \Phi^2 \times n$$

R 108 Fig. 2.

from which

$$n = \frac{C_1 \times I_a}{C_2 \times \Phi}$$

Now Φ is constant, thus

$$n = C_3 \times I_a.$$

Thus the speed n being propotional to the armature current I_a, and the armature current I_a proportional to the total current I, the armature speed n is proportional to the total current I

$$n = C_4 \times I.$$

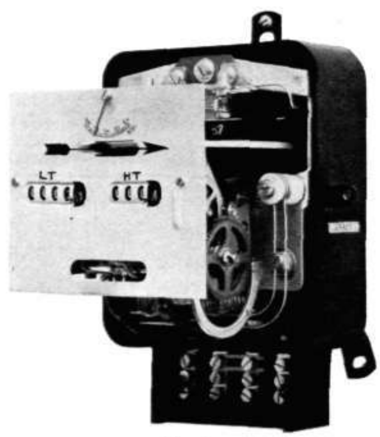
If the armature movement is transmitted to a recording train this will register the number of ampere hours. If the voltage of the system is constant, which usually is the case, the recording train can be provided with such a gearing that it registers the consumed amount of electric energy in kilowatt hours.

The movement of the armature is transmitted by a worm to a wheel *9* and further through the gears *10/11*, *12/13* and *14/15* to the recording train *16* of cyclometer pattern, which registers the total amount of the consumed electric energy in kilowatt hours. This train is provided with five digits of which one is a decimal thus registering a max. 9999.9 of kilowatt hours.

17, *25* and *18* is a differential gearing. The wheel *17* is combined with the wheel *9* thus getting its movement from the meter *3* itself. The bevel wheel *18* is driven with a constant speed from a clockwork *23/24* through the gears *21/22* and *19/20*. The planet wheel *25* transmits the movement necessary for manipulating the sealed mercury switch *39* through the shaft *26*, the gear *32/33* and the ratchet wheel *34*. This mercury switch is pivoted at the point *40* and by means of an arm *38* is normally held in such a position that the cooker circuit is closed. The arm *38* is solid with the control lever *35* through the shaft *37*. The ratchet tooth *36* on arm *38* engages with the teeth of the ratchet wheel *34* over a defined arc after which owing to their divergence they disengage.

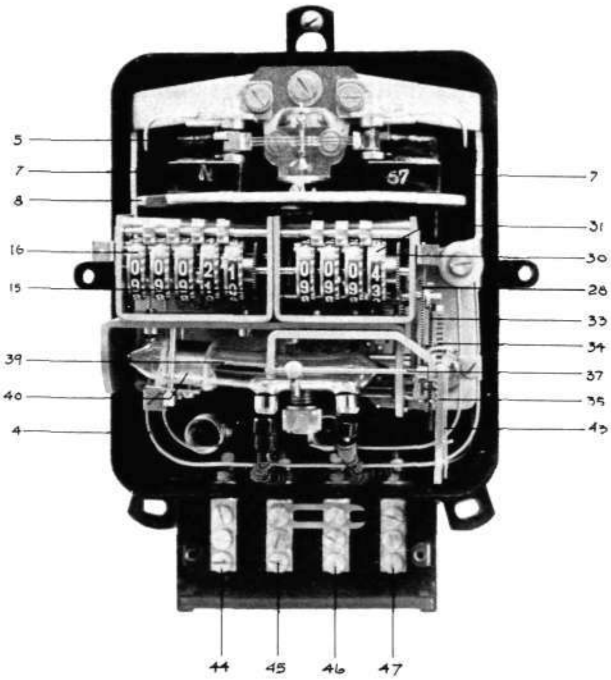
The speed of the planet wheel *25* is proportional to the difference between the speeds of the wheels *17* and *18*. If these wheels rotate with equal speed the planet wheel will remain stationary. If the load of the system is of such a value that the speed of the wheel *17* is greater than that of the wheel *18*, the ratchet wheel *34* moves counter-clockwise and lifts the ratchet tooth *36* thus tilting the sealed mercury switch *39*, which breaks the cooker circuit. Then the load of the system decreases. If the decrease is of such a value that the speed of the wheel *17* is less than that of the wheel *18*, the ratchet wheel *34* moves clockwise and thus the cooker circuit is switched on again.

The ratchet wheel *34* and the ratchet tooth *36* are so constructed that the wheel *34* is free to



R 109 Fig. 3.

continue its movement counter-clockwise, whereby the ratchet trips from tooth to tooth maintaining its extreme displacement. The movement of the



R 110 Fig. 4.

sealed mercury switch is determined by stops *41/42*. The clockwork driving force is the resultant of the driving force of the meter counteracted by the weight of the mercury switch aided by a spring *43* acting through the differential gearing. The clockwork is primarily at a standstill. As shown before, the ratchet tooth *36* and the mercury switch *39* are lifted when the armature begins to rotate. The counteracting force is transmitted through the gear *25/18* to the clockwork *23/24*. As soon as it has reached a sufficient value, the balance wheel *24* starts and the movement is released, i. e. the planet wheel reverses, the ratchet tooth falls and the clockwork comes to a standstill. The movement is then repeated until the total value of the lamp and cooker loads reaches the bulk limit, when the clockwork runs at a constant speed.

Through the gearings *27/28* and *29/30* the planet wheel *25* is combined with a recording train of cyclometer pattern registering the energy value exceeding the subscribed value in kilowatt hours. This train is provided with four digits of which one is a decimal, thus registering 999.9 kilowatt hours.

The complete mechanism works in the following manner.

The bulk limit is A watts. This limit may not be exceeded without extra charge for excess value.

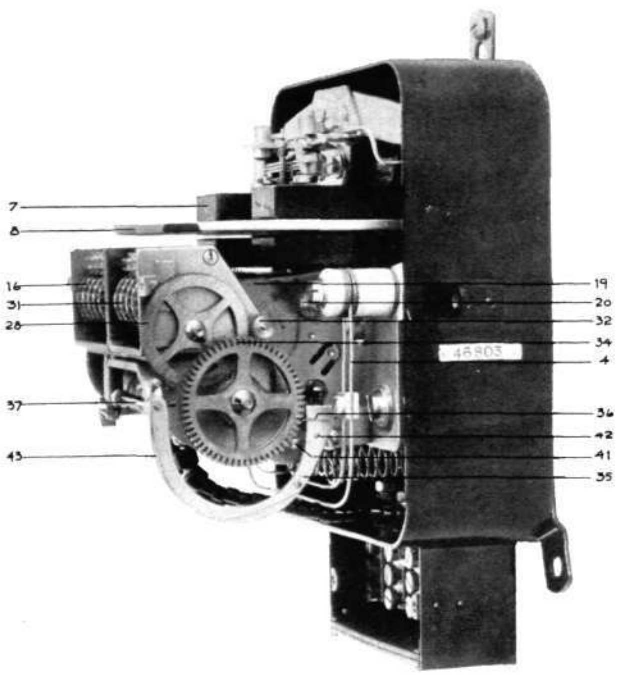
(As per the household tariff adopted by the Electric Power Works of Stockholm the consumer pays 220 Swedish Crowns per kilowatt year as the fixed cost and 0.06 Swedish Crowns per kilowatt hour for energy below the bulk limit added with 0.60 Sw. Cr. per kilowatt hour over this limit.)

The apparatus is therefore arranged in such a manner that at the bulk limit A watts the speeds of the bevel wheels *17* and *18* are equal. If the limit is exceeded by a certain value, for example M watts, the planet wheel *25* moves counterclockwise with a speed proportional to M and breaks the cooker circuit after a certain time T_i. The load then decreases below the bulk limit with a certain value N watts. The planet wheel *25* then moves clockwise with a speed proportional to N and closes the cooker circuit after a certain time T_u.

Thus the average load is

$$\frac{(A + M)\,T_i + (A - N)\,T_u}{T_i + T_u}$$

As the range of the ratchet tooth for breaking and making is the same and the speed of the



R 111 Fig. 5.

planet wheel is proportional to M and N, so

$$T_i \times M = C$$

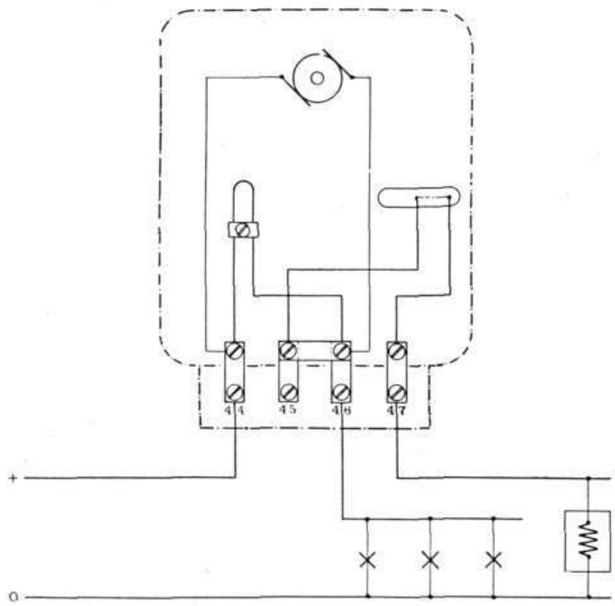
and

$$T_u \times N = C.$$

If these are put into the equation for the average load, the value of this will be

$$\frac{(A+M)\frac{C}{M} + (A-N)\frac{C}{N}}{\frac{C}{M} + \frac{C}{N}} = A$$

From this it will be seen that if the sum of the lamp and cooker loads exceeds the bulk limit



R 112 Fig. 6.

A watts, the average load of the system is equal to A watts as long as the lamp load alone does not exceed the bulk limit. If this is the case the planet wheel *25* and thus also the ratchet wheel moves with a speed proportional to the value with which the lamp load exceeds the subscribed value. This excess value is registered by the recording train *31*. The cooker remains switched off as long as the lamp load exceeds the bulk limit.

The household tariff meter is constructed for bulk limits of 200, 250, 300, 350, 400, 450, 500, 550 and 600 watts. The meter can be altered from one bulk limit to another by means of a simple re-adjustment. The position of the clock mechanism in the meter is adjustable to allow the proper intermeshing of the gears *20* and *19*, the gear *20* varying in the number of teeth for the different bulk limits. It is not necessary to alter the meter if the effect of the cooker is altered. A meter of a bulk limit of 500 watts holds an average effect of 500 watts whether the cooker is constructed for 250, 300 or 400 watts.

Fig. 2 is a photograph of the meter with cover. The cover is provided with the usual plate, stating type, serial number, main voltage, current and number of revolutions per kilowatt hour. The readings of the two recording trains can easily be read through a window in the cover, the one for Low Rate being marked *LT* and that for High Rate *HT*. The armature and the sealed mercury switch can be observed through slots in the dial. The dial is also provided with a pointer and a scale graduated from 0.2 to 0.6 kilowatts stating the bulk limit adjustment of that particular meter. Fig. 3 is a photograph of the meter without cover. Fig. 4 is a front view of the meter without cover and dial. Fig. 5 is a photographic side view of the meter without cover and dial. The before mentioned terms for the different details are used for these photograps.

Other details of the meter type *L2H*, such as jewel post, jewel screw, magnets etc. which have not been mentioned in this description, are of the standard pattern as used on meter type *L2*.

Fig. 6 shows the connecting diagram of the meter.

Figs 7 and 8 show curves characteristic to a meter of the type *L2H*. They refer to a meter of 220 volts, 3 amps, 10,000 revs per kilowatt hour regulated for a bulk limit of 300 watts, for use in conjunction with a cooker of 250 watts.

1) The switched on time T_i of the cooker in seconds as a function of the lamp load W_L in watts.

For values of W_L below 50 watts T_i is infinity, i. e. the cooker is constantly switched on.

For values of W_L between 50 and 300 watts

$$T_i \text{ (seconds)} = \frac{2700}{0.1\, W_L - 5}$$

When $W_L = 50$ watts, $T_i = \infty$ seconds. If W_L increases, T_i decreases. When $W_L = 300$ watts, $T_i = 108$ seconds. For values of W_L above 300 watts the cooker is constantly switched off.

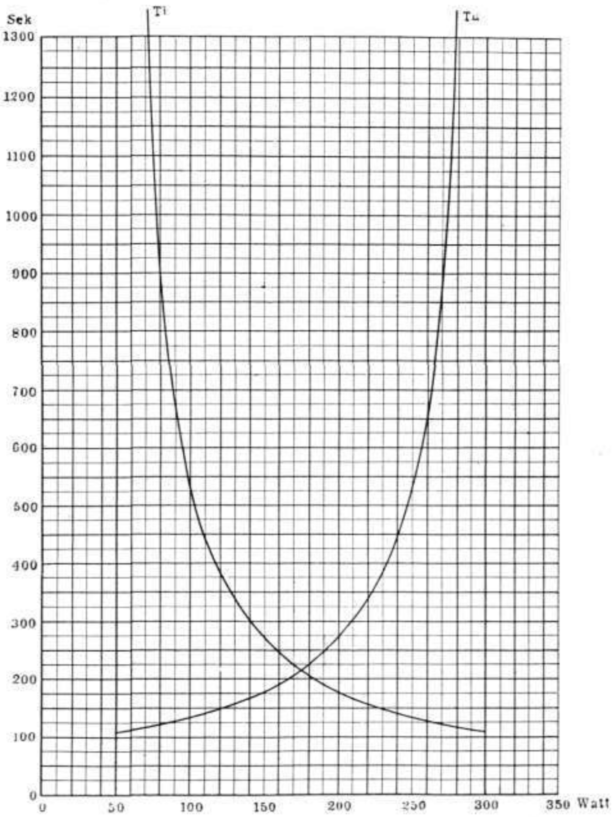
2) The switched off time T_u in seconds as a function of the lamp load W_L in watts.

For values of W_L below 50 watts the cooker is constantly switched on.

For values of W_L between 50 and 300 watts

$$T_u \text{ (seconds)} = \frac{2700}{30 - 0.1\, W_L}$$

When $W_L = 50$ watts, $T_u = 108$ seconds and when $W_L = 300$ watts, $T_u = \infty$ seconds, i. e. for



R 113 Fig. 7. Lamp Load.

values of W_L above 300 watts the cooker is constantly switched off.

When $W_L = 0$, $T_u = 90$ seconds, i. e. if the lamp load is broken at the same time as the cooker is switched off, the cooker is switched on after a period of 90 seconds.

3) The average effect of the cooker, $W_{S\,med}$, in watts as a function of the lamp load W_L in watts.

For values of W_L below 50 watts, $W_{S\,med} = W_L = 250$ watts.

For values of W_L between 50 and 300 watts

$$W_{S\,med} \text{ (watts)} = \frac{250 \times T_i}{T_i + T_u} = 300 - W_L$$

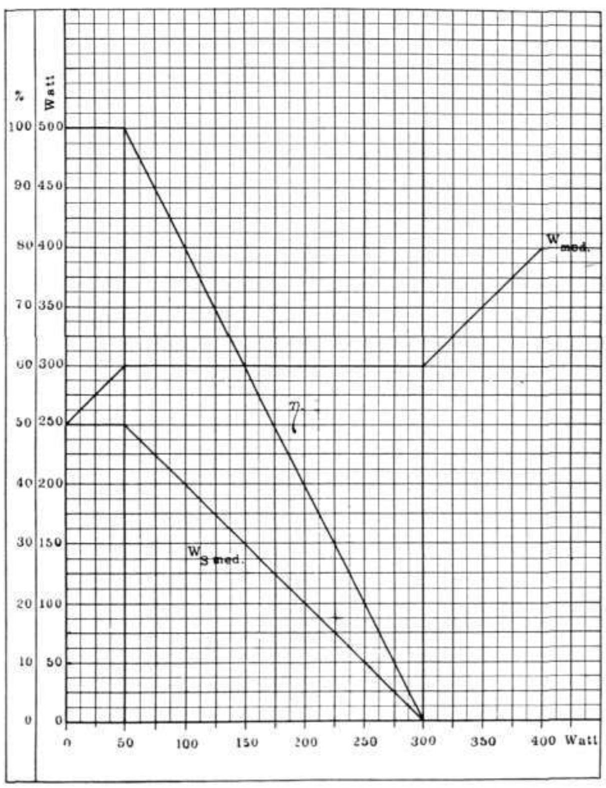
When $W_L = 50$ watts $W_{S\,med} = 250$ watts

» $W_L = 300$ » $W_{S\,med} = 0$ »

» $W_L > 300$ » $W_{S\,med} = 0$ »

i. e. the cooker is constantly switched off.

4) The average effect of the cooker in per cent of the stationary effect of the cooker (η %) as a function of the lamp load W_L in watts.



R 114 Fig. 8. Lamp Load.

For values of W_L below 50 watts, $\eta = 100$ %.

For values of W_L between 50 och 300 watts

$$\eta\,(\%) = \frac{T_i}{T_i + T_u} \times 100 = 120 - 0.4\, W_L$$

When $W_L = 50$ watts, $\eta = 100$ %

» $W_L = 300$ » $\eta = 0$ %

» $W_L > 300$ » $\eta = 0$ %.

5) The average effect of the system, W_{med}, in watts as a function of the lamp load W_L in watts.

For values of W_L below 50 watts

$$W_{med} \text{ (watts)} = W_S + W_L = 250 + W_L.$$

For values of W_L between 50 and 300 watts $W_{med} = 300$ watts.

For values of W_L over 300 watts

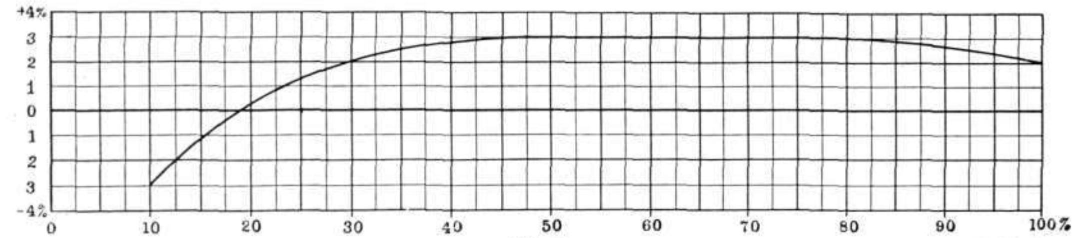
$$W_{\text{med}} = W_L \text{ watts.}$$

Fig. 9 shows the accuracy in per cent of the meter at different loads in per cent of full load. From the curve it is seen that the error of the meter does not exced $\pm$ 3 per cent at full load down to $^1/_{10}$ load. This may be considered sufficient owing to the increased friction moment

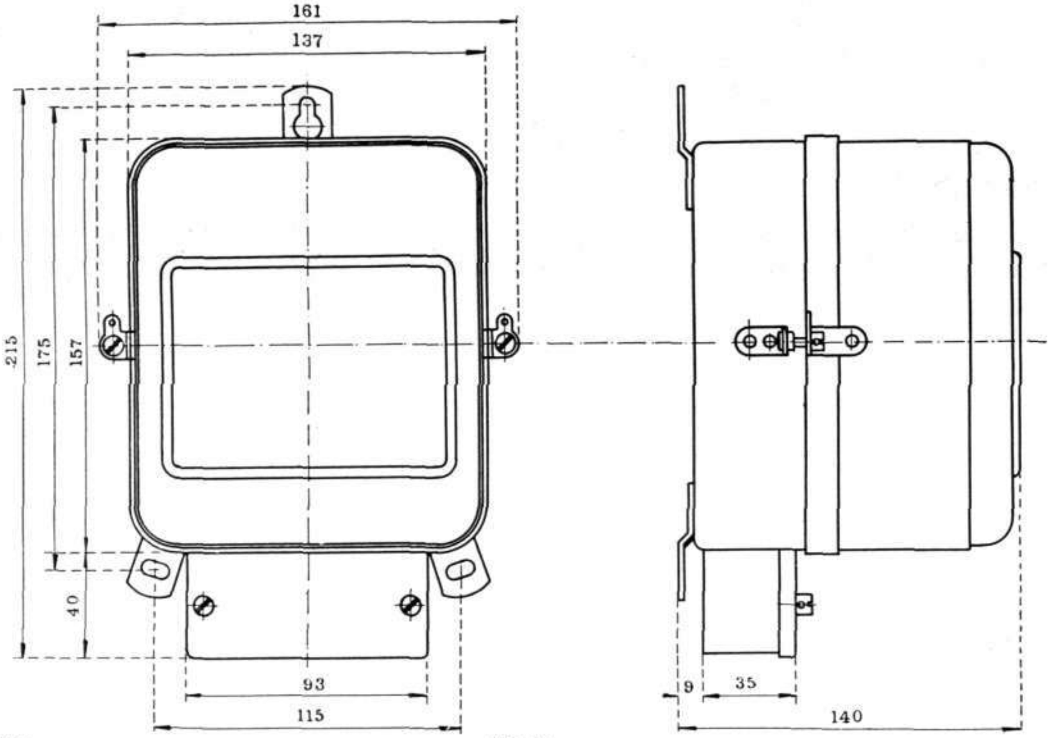
Minimum running current. When a current equal to one per cent of the marked current of the meter traverses its main circuit, the rotor starts and continues running steadily.

Speed of rotation. 110—120 revolutions per minute at full load.

Energy losses. The pressure drop in the meter circuit does not exceed 1.6 volts at full load.



R 115 Fig 9. Of full load.



R 113 Fig. 10.

caused by the clock work and the mercury switch. This result has been reached by designing the meter to obtain the greatest possible torque (about 20 gcm.).

Fig. 10 shows the dimensions of the meter.

To meters of type *L2H* the following technical data may be applied:

Limits of error. The error of the meter does not exceed $\pm$ 3 per cent at full load down to $^1/_{10}$ load.

Excess current. The meter will not be injured and its accuracy will not be permanently impaired by a current 50 per cent in excess of its marked current, the rotor being free to rotate.

Torque about 20 gcm. at full load.

Pressure of brushes about 0.5 gram.

Weight of armature about 70 grams.

Nett weight 3.5 Kg. *Mark.*

Calculation of the Required Number of Switches for Automatic Telephone Exchanges.

It is not the intention, in this article, to deal with the theoretical investigations on which the plotting of the curves here shown is based, but to give the reader an idea of the practical application of these curves for the calculation of the number of switches and trunk lines required in an automatic plant, and more especially as regards the Ericsson automatic system.

A new problem has presented itself with the introduction of automatic telephone switching systems. The change from a manual to an automatic system is warranted only in cases where the automatic system is superior to the manual in operating conditions and economy. The two following items will be taken into consideration for judging the question of economy, namely, the purchase price and the yearly expenditures. The purchase price includes the first cost of outside plant and subscribers' stations, exchange equipment and, in some cases, the exchange building. As the purchase price for an automatic exchange is greater than for a manual exchange almost without exception, it must lie within the interest of the manufacturers to do all in their power to reduce this cost by developing to the utmost the mechanical possibilities existing within the automatic systems, thereby bettering their chances of succesfully competing with the manual systems. The gist of the problem is this: How calculate the number of switching units required so as to obtain the best possible results, and at the same time reach the highest possible degree of reliability in operation.

It is to the interest of the contractor to submit some authoritative basis to convince the purchaser that the equipment to be supplied is fully adequate to deal with the requirements laid down. Should the equipment subsequently prove inadequate, it can be readily found whether the purchaser has understated the requirements. It can therefore be of interest to here present the methods of computation applied by L. M. Ericsson.

We will first indicate the factors which are necessary for the computation. They are:

1. Size of plant, i. e. number of subscribers' lines at the initial capacity and at the assumed final capacity.
2. Number of exchanges at the initial capacity and at the final capacity. (Distance between exchanges is of no direct interest in this connection, as this article does not deal with cost of outside plant.)
3. Average number of calls per subscriber per day.
4. Average length of calls.
5. Concentration, which indicates how large a part of total number of calls occurs during the busy hour. It is self evident that calls are not equally distributed over a twenty four hour period, but that their frequency varies to no small extent. The distribution of calls can be graphically shown, as indicated in fig. 1.

The number of calls are marked off along the ordinate and the hours of the day along the abscissa. The hours between 5 a. m. and 9 p. m. only are included. The total number of calls during this period amounts to 60,000. The busy hour is evidently between 1 and 2 p. m., with a total of 7,500 calls. Concentration will in this case be $\frac{7,500}{60,000}$ or $\frac{1}{8}$. Traffic as a whole, as well as concentration, can vary to a large extent, and for this reason, one should obtain information as to the maximum values for traffic and concentration from statistics covering a period of one year. When doing this, one naturally must not let oneself be influenced by extreme fluctuations in traffic caused by exceptional conditions.

Concentration varies for different exchanges, depending on whether the telephones served by these exchanges are mainly business or private phones, and can vary from $\frac{1}{6}$ to $\frac{1}{12}$. $\frac{1}{8}$ can be taken as a mean value.

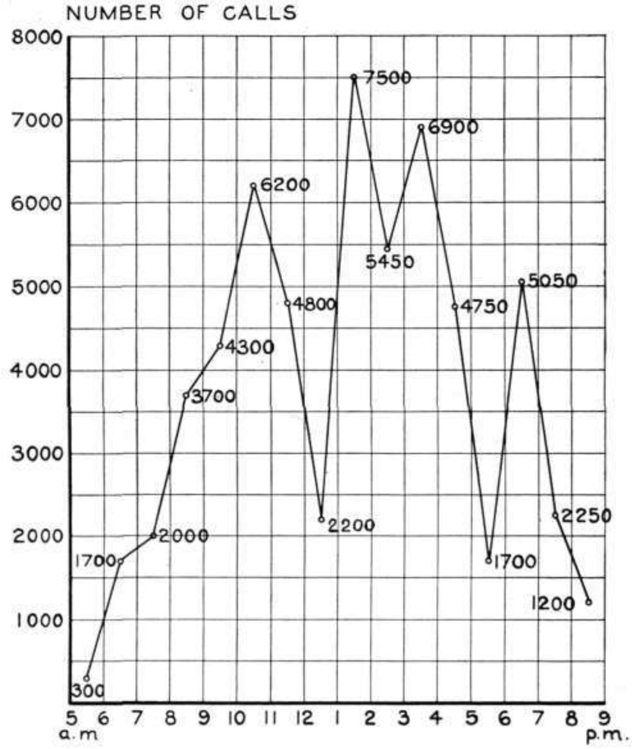
We will now introduce the following indication marks:

C = number of subscribers
s = number of calls per subscriber during busy hour.
m = average gross length of calls expressed in minutes. By gross length is understood length of conversation plus time required for making and breaking of connection, i. e. the length of time which expires from the moment a calling subscriber lifts the handmicrotelephone until all the switching devices which have been engaged in making the connection have been restored to normal after the conversation is finished.
$S = Cs$ = number of calls during busy hour from C subscribers.
$A = Sm$ = number of speaking minutes during the busy hour in a group of C subscribers, each making s calls of a mean length of m minutes.

The number of trunks or switches required to handle the traffic in a group of C subscribers is dependent on A, i. e. the number of speaking minutes within that group, and in some cases also on the factors C, S and m separately. For the application of the calculations to the Ericsson automatic system, however, only the product A need be taken into consideration, as those cases where each separate factor by itself is of importance occur only in very small groups.

If A is known, one can now read off the required number of switches direct from the curves, shown in fig. 2.

The problem of plotting curves and computing formulae from which — with a knowledge of the factor A — it is possible to determine the number of necessary switches or connecting lines, has been taken up by several mathematicians. The curves here shown have been plotted by Mr. Erlang and are applied by the British Post Office, among others. These curves, as well as the methods propounded by other authors, are all founded on the theory of probability. The



R 62 Fig. 1. Example showing Distribution of Calls over the Consecutive Hours of the Day.

loss of a certain number of calls — say one pro mill —, on account of all the accessible selectors or connecting lines being busy, is allowed for. The problem to be solved will then be as follows:

How many selectors are required so that all calls — within a margin of p ‰ — occuring in a group having a load of A speaking minutes may, in all probability, be given service?

The curves shown in fig. 2 are computed for five different values of the permissible loss or grade of service i. e. 10 ‰, 5 ‰, 1 ‰, 0.5 ‰

and 0.1 ‰. The number of speaking minutes A are marked off along the abscissa and the required number of switches x along the ordinate.

Although, as has already been mentioned, many mathematicians have accupied themselves with this problem, most of them having applied different methods of computation, the results attained coincide to a marked degree. The table here below, for example, gives the necessary number of switches according to various authors. All values are valid under the assumption that the grade of service equals 1 in 1,000.

Computed by	Number of Selectors when	
	$A = 195$	$A = 4{,}500$
Erlang	11	100
Poisson	10	103
Spiecker	10	93
Christensen	11	105
Engset	10	104
Holm	9	94
Campbell	9	91
Lubberger	10	95
Pleijel	10	99
Mean value	10	98

As is evident from the above table, the values given by Erlang are amply proportioned, both that for a small load as well as that for a large load lying above the mean value.

The curves given in fig. 2 are applicable only in such cases where all calls occurring within the group can be reached by one and all of the switches which are connected to this group, as is the case in fig. 3.

Five hundred trunk lines are connected to the multiple in a selector rack. $A = 2{,}400$ speaking minutes. With a grade of service of 1 in 1,000, 58 selectors will be required, according to the curves. In such cases, where each call occuring within a group can only be connected to a limited number of trunks — an example of which is shown in fig. 5 —, the computations must be made with due regard to this fact.

The »hour service» that can be accomplished, or, in other words, the number of speaking minutes per hour that can be given service by each trunk in a trunk group, depends upon the size of this group. Obviously, one can not figure with so large an hour service per trunk in a group of ten trunks as in a group of one hundred, as the probability of all trunks being simultaneously engaged is greater when selection is limited to ten, than when it is limited to one hundred.

The permissible hour service per trunk in a group can be figured directly with the aid of the curves in fig. 2. A group of say, ten trunks can receive a load of 180 speaking minutes, with a grade of service of 1 in 1,000. The hour service per trunk amounts in this case to $\frac{180}{10} = 18$ speaking minutes. The corresponding value for a group of one hundred trunks is $\frac{4{,}500}{100} = 45$. One can also say, therefore, that the efficiency per trunk in a group of ten is $\frac{18}{60} = 30\,\%$, while for a trunk in a group of 100 it amounts to $\frac{45}{60} = 75\,\%$.

The load allowed per trunk in groups of various sizes and for various grades of service is obtained from the curves in fig. 4, the values of which are calculated from the curves shown in fig. 2. The number of trunks x are laid off along the abscissa and the assumed hour service per trunk u, along the ordinate.

We will now consider the case illustrated in fig. 5.

The number of speaking minutes entering the 36 group selectors GS equals 1,324. This number of speaking minutes must also pass through the outgoing trunk group x_1. Each group selector may choose between 20 trunks. If we assume the grade of service to be 5 in 1,000, we get a value for u of 33.5 from the curve in fig. 4. The required number of outgoing trunks is therefore $\frac{1{,}324}{33.5} = 40$.

By introducing special arrangements indicated in figs. 5 and 7, one can — in certain cases — figure with a larger hour service per trunk. In fig. 5 one speaks of uniform selection, trunks x_1 to x_{20} being available to selectors 1 to 16, and trunks x_{21} to x_{40} being available to selectors 19 to 36. Furthermore, each selector begins by choosing over the trunk x_1 and x_{21} respectively, thereafter over x_2 and x_{22} resp., finishing up by choosing over the trunks x_{20} and x_{40} respectively.

The trunks 11 to 20 in fig. 6 are common, i. e. are available to all the selectors *A—S*. In addition, there are ten trunks 1 to 10, available to selectors *A—I* only, and ten trunks 21 to 30, available to selectors *K—S* only, the principle here applied being that those trunks which are selected first are common to a smaller number of selectors than those which come into use when the first trunks are already engaged.

In fig. 7, the outgoing trunks are coupled in parallel, so that selector *A*, for example, chooses first over line 1, then over line 2, then over line 3, etc. Selector *B* begins by choosing over line 10, then over line 1, etc. The outgoing trunks are put to a uniform use by means of this arrangement, permitting a somewhat larger hour service per trunk. On account of the construction of the multiples (the 20 line multiple frames composed of bare wires, serving both as contact bank and multiple connections) in the Ericsson automatic system, the case illustrated in fig. 5 will mainly be applied. A distribution according to fig. 6 or a redistribution of the trunks in relation to each other, as shown in fig. 7, can only be accomplished when the corresponding multiple frames are coupled in parallel. This coupling is then taken care of in the intermediate distributing frame.

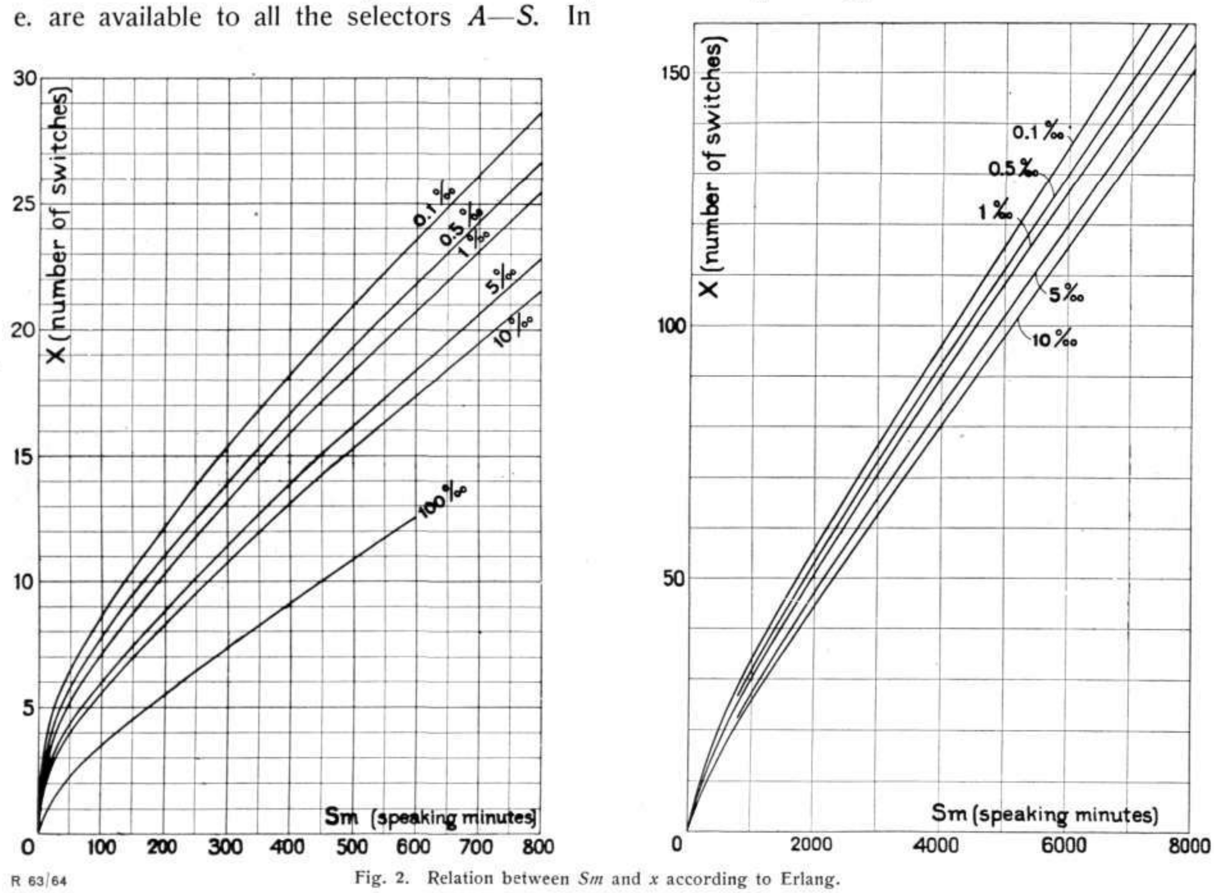
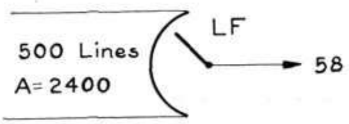


Fig. 2. Relation between *Sm* and *x* according to Erlang.

It is not customary — when making calculations — to take into consideration any increased hour service which might possibly result from a redistribution of the trunk lines, the values for *u* obtained from the curves in fig. 4 for selection over 20 being always used.



R 65 Fig. 3. Relation between Speaking Minutes and Switch within a Group.

We will now go on to a closer scrutiny of the meaning »grade of service». The good functioning and reliability of an automatic exchange is dependent — among other things — upon the interconnecting possibilities. The number of switches and trunk lines must not be too closely calculated, i e. one must not set out by assuming too high a value for the grade of service, or the interconnecting possibilities will naturally be diminished. This in turn, causes dissatisfaction on the part of the subscribers, and one is then forced to increase the number of switches and corresponding trunk lines so as to gratify the demands for satisactory service.

Diverging opinions and varying requirements make it very difficult to determine a definite, normal value for the grade of service. It may be stated, however, that the permissible grade of service may be somewhat larger for an exchange with very heavy traffic during the busy hour than for one with light traffic. If we consider the fact that, during heavy traffic, for example in business centres, as many as 20 % of the called numbers are busy, a grade of service of 1 % can not be considered too high, as this additional amount of 1 % will not be noticed by the subscribers.

The total loss of calls theoretically possible consists of the sum of the assumed losses for the various stages of selection and is therefore determined by the number of stages of selection and the value of the assumed loss at each stage, as shown in fig. 8.

A plant for 200,000 lines is here shown, built according to the different systems. Fig. 8 a shows a Strowger system. Here seven selectors are required to complete a connection between two subscribers, namely the first and second preselectors 1 *PS* and 2 *PS,* four group selectors 1 *GS* to 4 *GS* and the connector *C*.

In fig. 8 b the plant is assumed to be built according to a system with 200-line selectors. The number of selectors necessary for a complete connection will in this case be six, i. e. the first and second line finders 1 *LF* and 2 *LF*, three group selectors 1 *GS* to 3 *GS* and a connector *C*.

Fig. 8 c, lastly, shows a 200,000-line plant built according to the Ericsson system. The number of selectors is here four, i. e. line finder *LF*, two group selectors 1 *GS* and 2 *GS* and a connector *C*.

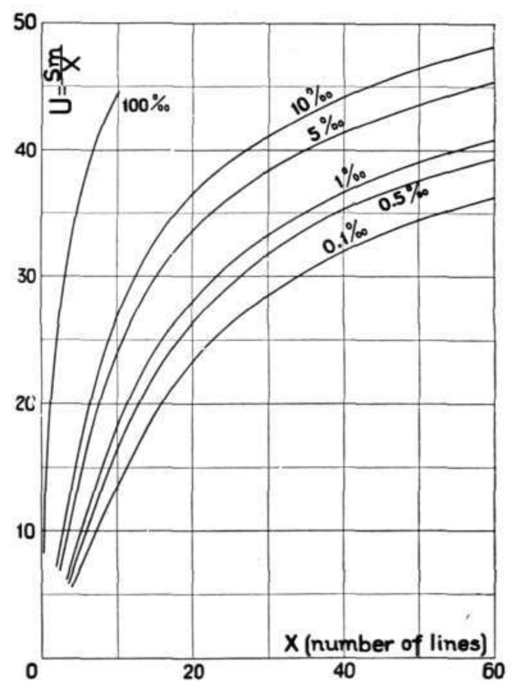
If we now in all three cases assume a grade of service of 2 in 1,000 for each stage of selection, the total loss will then be as follows:

The Strowger system with six stages of selection, total loss = 12 ‰.

System with 200-line selectors with five stages of selection, total loss = 10 ‰.

The Ericsson system with three stages of selection, total loss = 6 ‰.

When a prospective purchaser is comparing bids, based on different systems as concerns switch provision, it is the total loss which, in this connection, must be taken into consideration when judging the interconnecting possibilities of the systems under consideration. If one desires

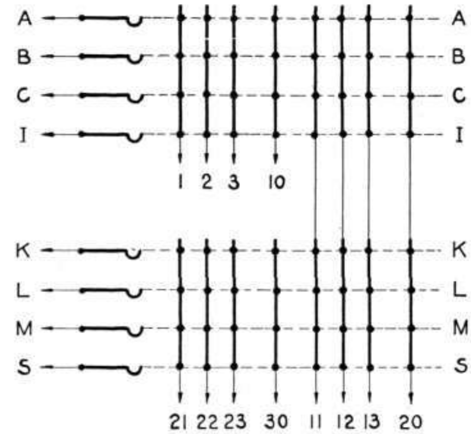


R 66 Fig. 4. Relation between x and u $\left\{\frac{Sm}{x}\right\}$ according to Erlang.

to determine the grade of cervice, when making a request for bids, one must state the total loss and not the loss per stage of selection without regard to the construction of the various systems, as is often the case. This will be clearly observed in fig. 8, where a grade of service of 2 in 1,000 has been determined for each stage of selection, with the result that the total loss in the Strowger system is twice as large as in the Ericsson system.

Still another point of view must be taken into consideration as concerns the term loss. In the Strowger system, the selection of a disengaged trunk line by the group selectors is accomplished by means of a rotating contact arm, which chooses over ten lines. Should all the trunks be engaged, the contact arm will come to rest in an eleventh position (a busy tone being sent back to the calling subscriber). In such a case, one can speak of an actual loss, since the connection to the desired number cannot be completed, the calling subscriber being forced to hang up the receiver and put in a new call, to get a connection.

In the Ericsson system, a disengaged trunk is chosen by the plunging of the contact arm of the selector into a multiple frame. Should all twenty lines connected to this frame be engaged, the movement of the contact arm is automatically reversed after passing the last line, and it selects anew over the twenty lines while moving back out of the frame or, in other words, the



R 68 Fig. 6. Mixed Multiple of Combined and Individual Groups.

choosing continues until a disengaged line is actually found. In this case, therefore, one need not figure with an actual loss. The loss is merely seeming, in reality consisting of a prolongation of the time required for making the connection. Furthermore, this prolongation is in most cases imperceptible to the subscriber, as the movements of the group selectors are going on while the subscriber is busy dialling the desired number. It is evident that a system with seeming losses gives more effecient cervice than one with actual losses. One is able, on this account, to further raise the grade of service in systems of the former type and still obtain the same efficiency of service as in systems of the latter type.

Calculating the number of junction lines between different exchanges.

If we assume a plant consisting of n exchanges, the number of outgoing calls from each exchange to all the other exchanges in the same net shall be figured according to the following formula:

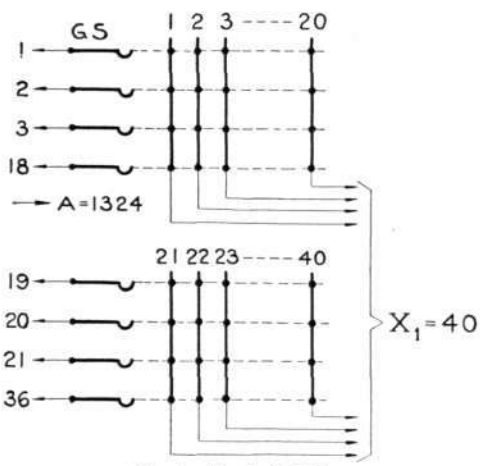
1. Outgoing total from exchange No. 1

$$p \times \frac{(CS - s_1 \times c_1) \times s_1 \times c_1}{CS}$$

Outgoing total from exchange No. 2

$$p \times \frac{(CS - s_2 \times c_2) \times s_2 \times c_2}{CS} \text{ etc.}$$

For calculating the number of outgoing calls from a certain exchange to each one of the other exchanges, the following formula is used:



R 67 Fig. 5. Simple Multiple.

2. From exchange No. 1 to exchange No. 2

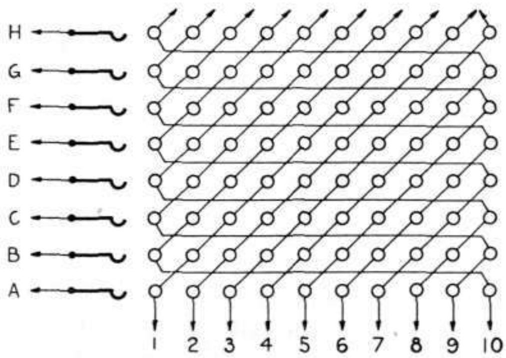
$$p \times \frac{s_1 \times c_1 \times s_2 \times c_2}{CS}$$

From exchange No. 1 to exchange No. n

$$p \times \frac{s_1 \times c_1 \times s_n \times c_n}{CS} \quad \text{where}$$

$c_1, c_2 \ldots c_n$ is the number of subscribers connected to the respective exchanges,

$s_1, s_2 \ldots s_n$ is the number of calls per subscricer occurring at the respective exchanges during the busy hour,



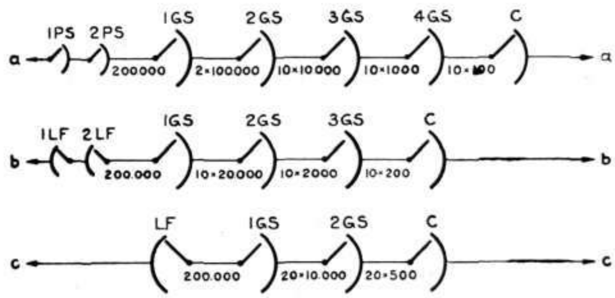
R 69 Fig. 7. Staggered Multiple.

CS is the total number of calls occurring at all the exchanges during the busy hour. CS, therefore, equals $s_1 \times c_1 + s_2 \times c_2 + \ldots + s_n \times c_n$.

p is a coefficient determined by experience. If one assumes traffic to be absolutely uniform, i. e. if the outgoing calls from a certain exchange are distributed among the other exchanges in direct proportion to the size of (number of calls originating at) these exchanges, the coefficient $p = 1$. Experience has proved, however, that traffic is seldom uniform, as sometimes a greater part and sometimes a lesser part of the traffic determined by the proportion between the exchanges is retained within the exchange where it originated. It is impossible to give any approximate values of p as, in each case, this value depends upon several factors, such as the different character of the exchanges with reference to the nature of their subscribers, regulations regarding the restriction of the number of free calls, zone tariffs, and so forth. As a rule, however, the coefficient p is largest for traffic from suburban exchanges with mostly house telephones to exchanges in central business districts, and smallest for traffic in the opposite direction. The value of p can vary between 0.5 and 1.5, and 0.75 may be taken as a mean value.

The number of outgoing speaking minutes from each exchange may now be determined by multiplying the values for the number of calls — calculated by means of the formulae herein — with the length of the calls.

When determining the number of trunk lines



R 70 Fig. 8. A 200,000-Line Plant According to Various Systems.

for the Ericsson system, we must consider the fact that selection takes place over twenty lines.

One must, therefore, use the values of u obtained from the curves in fig. 4, the value of x being 20.

Significance of the size of groups.

If an exchange of 10,000 lines, having 20,000 *Sm* during the busy hour — i. e. an average of 2 *Sm* per subscriber — be split into groups of 100 lines, it is not at all certain that the average traffic load per group will be $\frac{20{,}000}{100}$ or 200 *Sm*, as it is possible for the loads in different one hundreds groups to vary quite extensively, one group having 250 *Sm*, for example, while another group may not have more than 125 *Sm*. Should we choose still smaller groups, the variation between them will be still larger. It is therefore necessary to consider the size of the groups when calculating the number of switches required for systems designed with individual contact banks for the selectors and permanent connections. One is forced to make so called group additions, so as to be on the safe side. The Ericsson system makes use of as large groups as 500 lines — the variations being consequently relatively small — and racks and switches so constructed as to allow the easy removal of switches from one rack to another. For this reason there is no need of concidering these load variations, but the same average value may be used for the five hundreds groups as for the whole exchange. Racks, multiple frames and cables are always figured with a certain safe margin of, say, from 15 to 25 %. Later on, when the traffic loads within the various groups have been determined by experience, a transposition of switches from groups with light loads to heavily loaded groups can be very easily accomplished, should it prove necessary.

Example Illustrating the Calculation of number of Switches for an Automatic Telephone Plant.

For the purpose of making what has here been set forth more readily understood, we will illustrate the manner of calculating the number of switches in a plant by means of an example.

We will assume the following qualifications:

(a) The plant shall be designed for a final capacity of 50,000 lines, distributed among five automatic exchanges of 10,000 numbers each.

(b) There is at present a manual exchange of 8,000 lines, called *A*, which will be retained for the time being, and which, for this reason, will be completed for the purpose of working in conjuction with the new automatic exchanges.

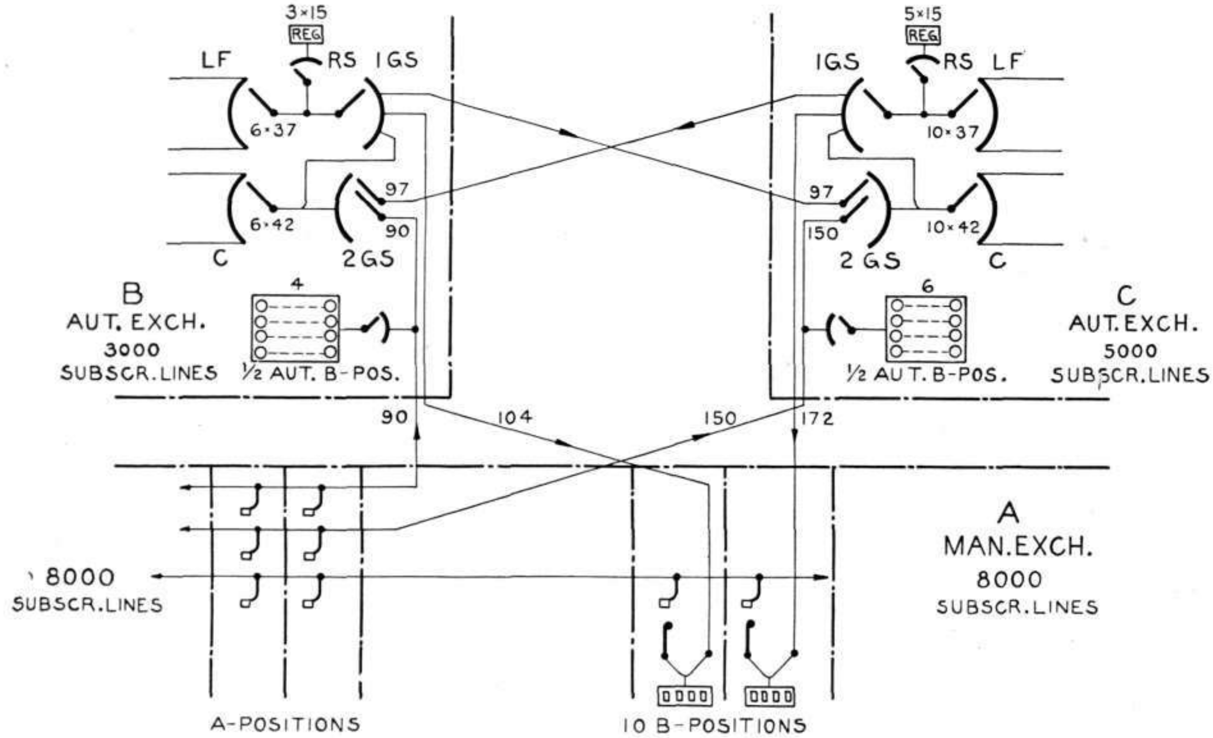
(c) The initial plant will consist of two automatic exchanges, i. e. exchange *B*, with an initial capacity of 3,000 lines, and exchange *C*, with an initial capacity of 5,000 lines.

(d) The number of calls per subscriber per day is
For the manual exchange *A* — 8 calls
For the automatic exchange *B* — 12 calls
» » » » *C* — 12 » .

(e) Concentration of traffic is the same for all three exchanges, amounting to $\frac{1}{8}$.

(f) Average length of calls = 1 min. 40 seconds net for all three exchanges.

(g) Traffic is assumed to be uniform, i. e. the coefficient p has a value of 1 in all cases.



R 71

Fig. 9. Schematic Diagram of an Automatic Plant.

A schematic diagram is now drawn up with the above qualifications as a basis, as shown in fig. 9. As the final capacity has been fixed at 50,000 lines, the automatic exchanges are arranged for a so called 60,000 system, the internal traffic being carried over two group selectors, 1 *GS* and 2 *GS*.

Service in conjunction with the manual exchange is arranged as follows:

The junction lines going from the automatic exchanges to the manual central exchange terminate at single-cord *B* positions, these positions being furnished with call indicators (carriage call).

The junction lines going to the automatic exchanges terminate in group selectors 2 *GS*. These lines are led in multiple through the *A* positions at the manual exchange, traffic being handled over semi-automatic *B* positions at the automatic exchanges.

In addition to the qualifications (a) to (g) set down by the purchaser, we will now establish the following values:

(h) Time required for connecting is twenty seconds for line finders and first group selectors, fifteen seconds for second group selectors, twelve seconds for connectors and fifteen seconds for registers.

The total connecting time required for each call may be made practically equal to that required by the line finders, i. e. twenty seconds. The functioning of the other switching devices will partly coincide with that of the line finders. We have assumed that the registers are engaged fifteen seconds during each call. About three seconds of this time are employed for the connecting and restoring of the registers and for the radial setting of the line finders. The remaining time of twelve seconds we have allotted to the subscriber for the dialling of a five-digit number. This time depends entirely upon the dexterity of the subscriber, and we count twelve seconds as being amply sufficient. Eight seconds may be taken as a good average, when the subscribers have become more accustomed to the use of the dial, thereby reducing the total time required for making a connection from twenty to sixteen seconds.

(i) The grade of service is established at a maximum of 16 in 1,000, distributed as follows:
   5 in 1,000 when calculating line finders and first group selectors,
   5 in 1,000 when calculating second group selectors and junction lines,
   5 in 1,000 when calculating connectors,
   1 in 1,000 when calculating registers.

The value of u derived from the curves in fig. 4 for selection over twenty with a grade of service of 5 in 1,000, will therefore be used when calculating second group selectors, outgoing junction lines and connectors. This value is 33.5.

When calculating the junction lines incoming to the automatic exchanges, we figure with $u = 38.4$, corresponding to selection over thirty with a grade of service of 5 in 1,000. The reason for counting with selection over thirty is the assumption that each *B* operator can handle thirty lines and, since traffic is carried over speaking lines, it is the register selectors *RS* — which are connected to these positions — that select disengaged lines.

Distribution of traffic.

The number of outgoing calls from exchange A during the busy hour $= \frac{8{,}000 \times 8}{8} = 8{,}000.$

The number of outgoing calls from exchange B during the busy hour $= \frac{3{,}000 \times 12}{8} = 4{,}500.$

The number of outgoing calls from exchange C during the busy hour $= \frac{5{,}000 \times 12}{8} = 7{,}500.$

The calls are distributed as follows:

Outgoing from exchange *A* to exchange

$A, \quad \frac{8{,}000}{20{,}000} \times 8{,}000 = 3{,}200$ calls

$B, \quad \frac{4{,}500}{20{,}000} \times 8{,}000 = 1{,}800$ »

$C, \quad \frac{7{,}500}{20{,}000} \times 8{,}000 = 3{,}000$ »

Total 8,000 calls

Outgoing from exchange B to exchange

A, $\frac{8,000}{20,000} \times 4,500 = 1,800$ calls

B, $\frac{4,500}{20,000} \times 4,500 = 1,013$ »

C, $\frac{7,500}{20,000} \times 4,500 = 1,687$ »

Total 4,500 calls

Outgoing from exchange C to exchange

A, $\frac{8,000}{20,000} \times 7,500 = 3,000$ calls

B, $\frac{4,500}{20,000} \times 7,500 = 1,687$ »

C, $\frac{7,500}{20,000} \times 7,500 = 2,813$ »

Total 7,500 calls.

The number of speaking minutes are distributed as follows: (Calls internal to the exchange go directly from the first group selectors to the connectors, so that the time employed for making a connection is, in this case, only twelve seconds. The gross length of these calls will therefore be 1 min. 52 sek. = 1.87 min. For calls to other exchanges, on the other hand, the gross length will be 1 min. 55 sek. = 1.92 min.)

Outgoing from exchange A to exchange B
$1,800 \times 1.92 = 3,456$ *Sm*

Outgoing from exchange A to exchange C
$3,000 \times 1.92 = 5,760$ *Sm.*

(Traffic $A \longrightarrow A$ is of no interest in this connection.)

Outgoing from exchange B to exchange A
$1,800 \times 1.92 = 3,456$ *Sm.*

Outgoing from exchange B to exchange B
$1,013 \times 1.87 = 1,894$ *Sm.*

Outgoing from exchange B to exchange C
$1,687 \times 1.92 = 3,239$ *Sm.*

Outgoing from exchange C to exchange A
$3,000 \times 1.92 = 5,760$ *Sm.*

Outgoing from exchange C to exchange B
$1,687 \times 1.92 = 3,239$ *Sm.*

Outgoing from exchange C to exchange C
$2,813 \times 1.87 = 5,260$ *Sm.*

Calculating the number of line finders and first group selectors.

The number of gross speaking minutes handled by the line finders in a group of five hundred subscribers' lines is $\frac{500 \times 12 \times 2}{8} = 1,500$, giving a value of $x = 37$, in accordance with the curves.

Thirty seven line finders and thirty seven group selectors are therefore required for five hundred lines.

Exchange B therefore requires:
$6 \times 37 = 222$ line finders and
$6 \times 37 = 222$ first group selectors.

Exchange C requires:
$10 \times 37 = 370$ line finders and
$10 \times 37 = 370$ first group selectors.

Calculating the number of connectors.

The number of speaking minutes handled by the group selectors in a 500-line group is $\frac{500 \times 12 \times 1.87}{8} = 1,403$, giving $\frac{1,403}{33.5} = 42$ connectors.

Exchange B therefore requires $6 \times 42 = 252$ connectors, and exchange C $10 \times 42 = 420$ connectors.

Calculating the number of second group selectors.

1. *At exchange B.*

(a) Traffic from exchange C.

According to the above we have incoming from C to B 3,239 *Sm.*, giving

$$x = \frac{3,239}{33.5} = 97.$$

Traffic $C \longrightarrow B$ therefore requires 97 trunk lines and second group selectors.

(b) Traffic from the manual exchange A.

Incoming number of speaking minutes from A to B is 3,456, giving

$$x = \frac{3,456}{38.4} = 90.$$

Traffic $A \longrightarrow B$ therefore requires 90 trunk lines and second group selectors. Assuming an operator can connect 500 calls per hour, the number of B positions required at exchange B will be $\frac{1,800}{500} = 4.$

2. *At exchange C.*

(a) Traffic from exchange B.

Number of trunk lines and group selectors as according to 1. (a), i. e. 97.

(b) Traffic from the manual exchange A.

Incoming number of speaking minutes from A to C is 5,760, giving

$$x = \frac{5,760}{38.4} = 150.$$

Traffic $A \longrightarrow C$ therefore requires 150 trunk lines and second group selectors.

Number of B positions will be

$$\frac{3,000}{500} = 6.$$

Calculating the number of outgoing junction lines from the automatic exchange to the manual exchange.

1. *From exchange B.*

3,456 *Sm.* go from B to A, requiring $\frac{3,456}{33.5} = 104$ junction lines.

2. *From exchance C.*

The traffic $C \longrightarrow A$ amounts to 5,760 *Sm.* during the busy hour, requiring $\frac{5,760}{33.5} = 172$ junction lines.

The number of incoming calls to A from B and C during the busy hour is 1,800 + + 3,000 = 4,800.

Assuming an operator can connect 500 calls per hour, the number of B positions required at exchange A for handling the traffic from the automatic exchange will be

$$\frac{4,800}{500} = 10.$$

Calculating the number of registers.

The connections between the registers and the line finders are made over the register selectors. Each line finder is equipped with a register selector with twenty contact positions.

The number of calls in a 500 line group during the busy hour is $\frac{500 \times 12}{8} = 750.$

Since the time required by a register for making a connection has been established at fifteen seconds, the total time required by the registers in a group of 500 subscribers will be $\frac{750 \times 15}{60} = 187.5$ min.

The register selectors have twenty contact positions, an hour load of $28.5 \times 20 = 570$ *Sm.* being permissible in a group of twenty lines (the value for u of 28.5 is obtained from the curve in fig. 4, for selection over 20 and a grade of service of 1 %). For this reason, one might let a group of twenty registers be common to 1,500 lines, as the total time required by these twenty registers for making connections would in that case be $3 \times 187.5 = 562.5$ min. This, however, is not practical, as only 7.5 min. would then remain in reserve. For this reason we allow each register group to be common to only 1,000 lines. The total time for connecting will then be $2 \times 187.5 = 375$ min., therefore requiring 15 registers. We now have the possibility of adding five registers per group, corresponding to an increase in traffic of about 55 % (an increase in traffic from 375 to 570).

A total of $3 \times 15 = 45$ registers is thus required for exchange B, and $5 \times 15 = 75$ for exchange C.

The figures in fig. 9 denote the number of the different switching devices arrived at by means of the above calculations. This schematic drawing now forms the basis from which the project is to be developed, at the same time giving a clear conception of how the plant has been planned and facilitating a criticism of the calculations.

After the plant has been put in operation, and by the introduction of special traffic-control devices, it is possible to check the calculated values against existing conditions. A description of such control devices will be given in a subsequent article.

G. G.

The Compañía Entrerriana de Teléfonos in the Argentine.

The Argentine is — next to Brazil — the largest country in South America as regards both area and population, a country that within the near future is bound to command the world's attention to no small degree, partly on account of its wealth of articles of export, and partly on account of its need of all manner of industrial products.

The area of the Argentine is approximately 2,800,000 sq. kilometres, or about equal to the combined area of the following European countries: Sweden, Norway, Denmark, Finland, the British Isles, Holland, Belgium, France, Switzerland, Germany and Austria.

The country extends from 22° to 55° South Lat. and offers — on account of its great range — the most varying climatic conditions; from tropical heat in the North to rigorous winter in the South, from mountain climate along the mighty range of the Andes in the West to temperate lowland climate along the shores of the Atlantic in the East.

Lying between the great Paraná and Uruguay rivers — both emptying into the so called La Plata river, which in reality more resembles a large bay — is a fertile tract of land which, on account of its location, is often called »the Mesopotamia of the Argentine» or the land between the rivers.

R 51 The Province of Entre Rios in the Argentine.

This tract of land is composed of the self-governed provinces Entre Rios in the South, next Corrientes, and in the North the province of Missiones, administered by a governor appointed by the Federal Government.

In the province of Entre Rios — whose Spanish name also means »between the rivers» — is located the telephone concern Compañía Entrerriana de Teléfonos, in which Allmänna Telefonaktiebolaget L. M. Ericsson has acquired an interest through the purchase of stock, and which, for this reason, will here be taken into closer consideration.

Entre Rios is a fertile plain, gradually changing into a marshy lowland in the South which is subject to frequent inundations and which constitutes a part of the delta of the Paraná river.

The province has an area of about 76,000 square kilometres, corresponding approximately to »Götaland» in Sweden. Its population has been subject to a considerable increase during the last years, and consists at present of about

600,000 inhabitants, which, for the most part, belong to the strong, white race, the so called creols, descendants of the latin peoples which migrated to the South American countries at an earlier period. Among these, the Basques are esqecially noted for their intelligence, diligence and law-abiding qualities.

The two main occupations in Entre Rios are cattle raising and farming, together with wonderfully developed fruit-growing in some districts (mandarins).

Some idea of the importance which cattle raising and farming has attained within the province, can be gained from the following figures.

The number of domestic animals in Entre Rios was — according to official statistics — in 1921:

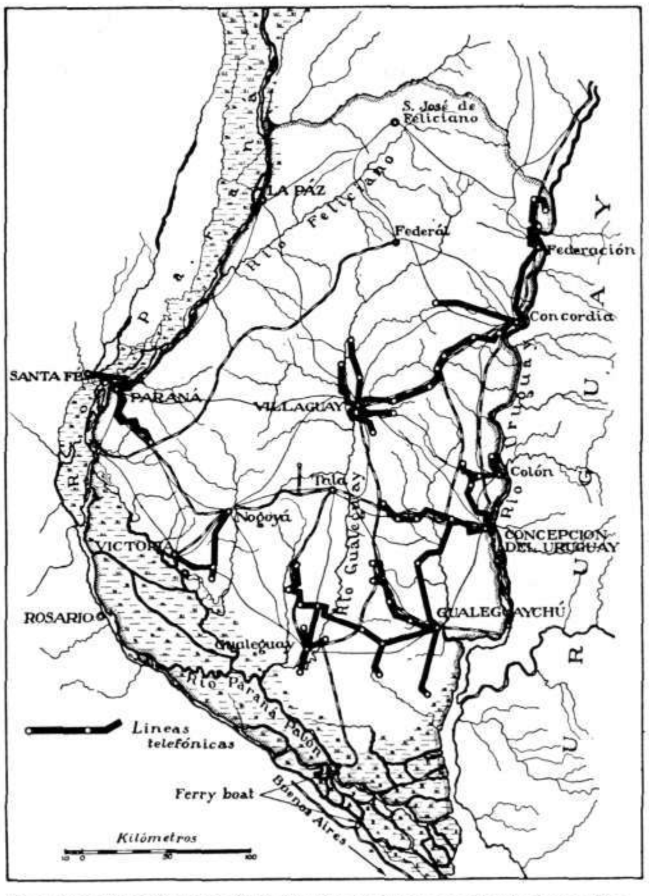
Cattle ...	2,714,007	head
Horses ...	509,174	»
Sheep ...	2,710,355	»
Hogs ...	79,025	»
Goats ...	14,744	»
Mules ...	17,441	»

Farming products during the same year amounted to:

Wheat ...	252,113	tons
Flax	254,133	»
Corn	156,385	»

Cattle raising — which not only produces hides and wool, but also furnishes such large packing houses as Armour, Liebig, etc. with meat — together with farming has caused business within the province to grow and flourish to a marked degree during the latter decades. The excellent shipping facilities afforded by the large rivers have also been a contributing cause to this end. Their enormous breadth and great depth permit ocean going steamers to touch at those cities and towns of the province which are located along the rivers. As a natural result excellent harbours, such as one otherwise finds only in coast ports, have been built far inland.

A good system of railways, comunicating with railways on the other side of the river by means of ferrys accomodating from ten to twelve coaches, has made complete the requisites necessary for the development of a flourishing trade.



R 52 Pregent Expansion of the Interurban Telephone Net in Entre Rios.

Paraná, the capital of Entre Rios, is situated on the river of the same name and at a distance from Buenos Aires of about 400 km., measured along the course of the river, its population now being about fifty thousand. Next after Paraná we have the city of Concordia on the river Uruguay, with a population of about thirty thousand, and after that the important cities Gualeguaychú, located near the effluence of the river Uruguay into the La Plata (22.000 inh.), Gualeguay in the southern part of the province (16,000 inh.) and Victoria, also with 16,000 inhabitants.

As previously mentioned, the succesful development of trade within the province is to a large degree due to the exellent means of communication afforded by the rivers and railways, at the same time creating a demand for the further development of these same means of communication.

A few farsighted business men from among the leading men of the province, Domingo Isthilart, Joaquín Goldaracena, Benito Legerén and others, realized this fact with the result that the

R 47 Street With Pole Line in Concepción del Uruguay.

Compañía Entrerriana de Teléfonos was formed in Concordia on the first of April 1916 for the main purpose of providing telephone comunictions for the different counties of the province.

This company started its activities by purchasing some telephone plants already in existence with a total of 937 subscribers, and, in june 1923, had reached a total of 4,200 subscribers, partly through the development of the original plant and partly through the purchase of additional nets.

When taking into consideration the adverse conditions existing during the great war with the accompanying difficulties of obtaining telephone equipment, the development of the Company during these years must be considered very satisfactory.

From the very beginning, the leading forces within the Company have planned its activities with a view towards the successive interconnecting of the various comunities within the province by means of telephone lines, and towards the popularization of the telephone by offering the public satisfactory service.

Also, no means have been spared for the attainement of this purpose and, at the present moment, the Company can boast of widespread telephone nets surrounding the various commercial centres of the province.

In 1920 the stockholders of the Company, realizing the need of support in their work and seeking at the same time to associate themselves with reliable experience in the field of telephony, proffered an invitation to Allmänna Telefonaktiebolaget L. M. Ericsson to become shareholders in the Company and take part in its management.

Carlos Rogberg, Swedish Consul General in Montevideo, and Gerhard Victorin, principal of the Concordia Business College, where he is also teacher of Spanish, have become members of the board of directors as representatives of the Swedish company.

Intense building activities have prevailed within the Company during the years 1920 to 1923, resulting, among other things, in the complete rebuilding of the old telephone plant in Paraná, which city can now boast of a modern C. B. exchange and a modern underground cable system of Ericsson's manufacture.

The building of the cable line connecting Paraná with the city of Santa Fé on the other side

R 46 »The Smallest Telephone Exchange».

R 49 One of the Docks in Santa Fé.

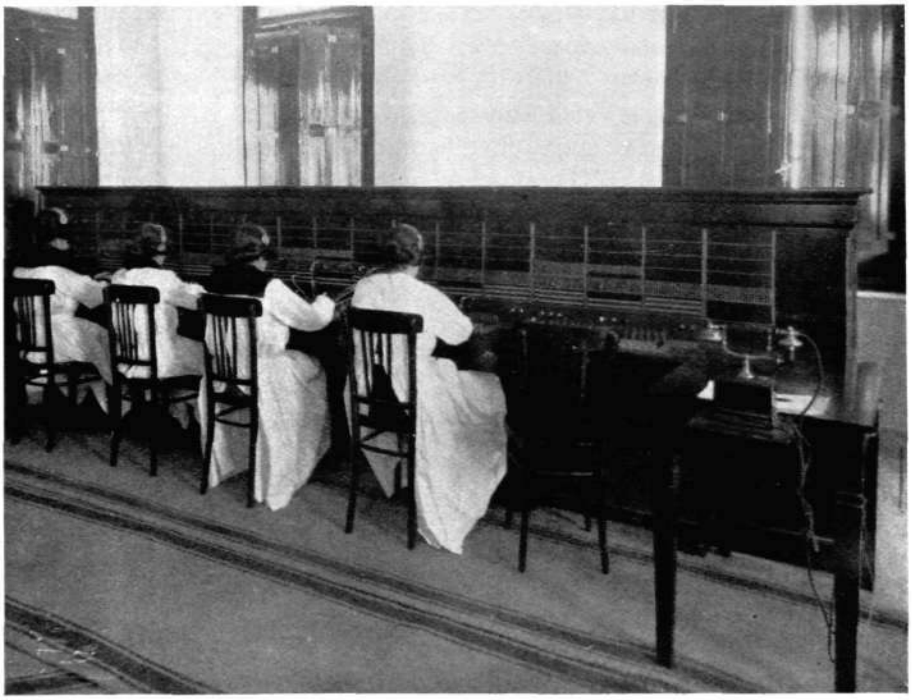
R 48 View from a »Rancho» in the Rural District of Entre Rios.

of the Paraná river, a troublesome and tedious piece of work, has been completed during the past year.

The building of this new plant has been accomplished by the Ericsson daughter company in the Argentine, Compañía Sudamericana de Teléfonos L. M. Ericsson in Buenos Aires.

The abovementioned cable line — which, together with the Paraná exchange, will be made the subject of a more detailed description in a future issue of this journal — has been the means of providing intertraffic, not only between the provinces of Entre Rios and Santa Fé, but also with the large Argentine cities of Rosario (260,000 inh.) and the federal capital, Buenos Aires (1,750,000 inh.) by means of an interurban line owned by the Argentine telephone company Telegráfico-Telefónica Nacionál.

The developments which will first command



R 45 Interior of the New Telephone Exchange in Paraná.

the attention of the Entrerriana company will consist of necessary extensions and new exchanges, first consideration being given to the installation of modern equipment, eventually for full automatic switching where conditions make it practicable.

The interconnecting of isolated parts of the telephone net by means of interurban lines, and also a second means of communication with Buenos Aires, will be given special attention. This last will eventually be accomplished by means of wireless telephone stations, providing communication without the extra work which the laying of submarine cables across the vast and marshy delta of the Paraná river would entail.

It can be stated with no small degree of satisfaction that collaboration has been established between L. M. E. and many prominent men in the Argentine. It is our sincere hope that this collaboration will result in providing the province of Entre Rios with a well developed and well operated telephone system.

It this matter, L. M. E. will naturally do all within their power to vindicate, in the Argentine, the good reputation they have earned in the field of telephony; a reputation of which plants in Stockholm, Moscow, Warsaw, Rotterdam, Mexico City and all parts of the world — ranking amongst the foremost as regards both construction and administration — give ample testimony.

R. L.

Automatic Telephone Exchange in San Sebastian.

The City Council of San Sebastian passed a decision in the latter part of May to sign a contract with L. M. Ericsson for the delivery to the city of an automatic telephone exchange.

The plant is designed for a total capacity of 20,000 lines, the initial capacity being 5,000. A number of smaller rural exchanges, also automatic, will be connected to this exchange, forming so called satelite exchanges. Therefore, these exchanges will be equipped only with line finders, connectors and their associated devices, each call to and from such an exchange being carried over the main exchange. As this plant is of exceptional interest from a technical point of view, it will be made the subject of a more exhaustive article in a subsequent issue of The L. M. E. R.

San Sebastian has a population of about 60,000, and is regarded by the Spaniards as the second capital of Spain, the Royal family as well as both the government departments and the foreign diplomatic corps making it their place of residence during the hot summer months.

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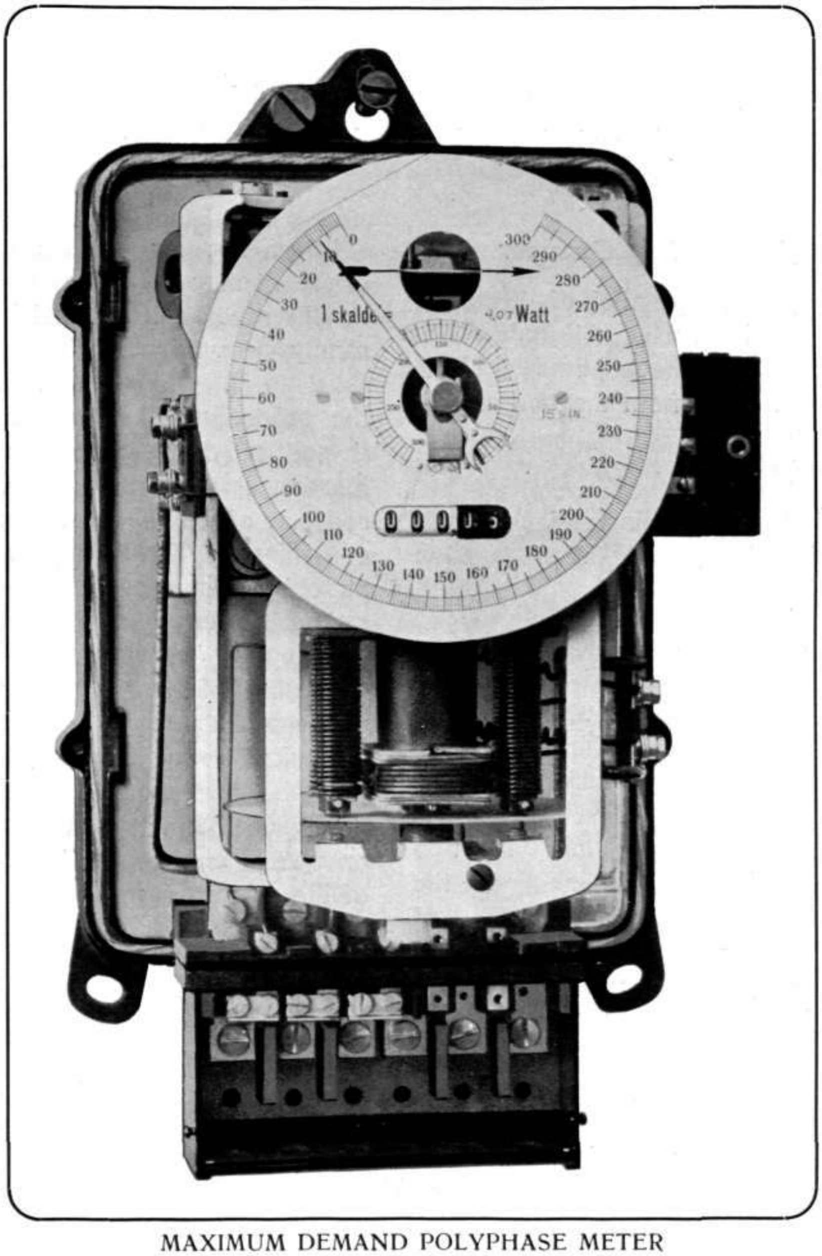

MAXIMUM DEMAND POLYPHASE METER

ENGLISH EDITION

L. M. Ericsson

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Amplifiers for wire telephony.

The Attenuation of Alternating Currents.

As per the theory for propagation of alternating currents on infinite lines with uniformly distributed electrical constants, the amplitude I_l of the current at a point l miles from the transmitting end is

$$I_l = I_o \times e^{-\gamma l},$$

I_o being the current at the sending end, e the base of the Napierian logarithms and γ the propagation constant of the line.

$$\gamma = \beta + j\alpha$$

is a complex value, whose real part β, the attenuation constant, states the degree of the attenuation of the speech currents during the propagation on the line, and whose complex part α, the wave length constant, states the variation of the phase displacement during the propagation. The two line constants α and β are depending on the capacity, the self inductance, the resistance and the insulation of the line. The transmission possibilities depend upon the attenuation constant.

Regardless of the phase displacement the above equation can be written

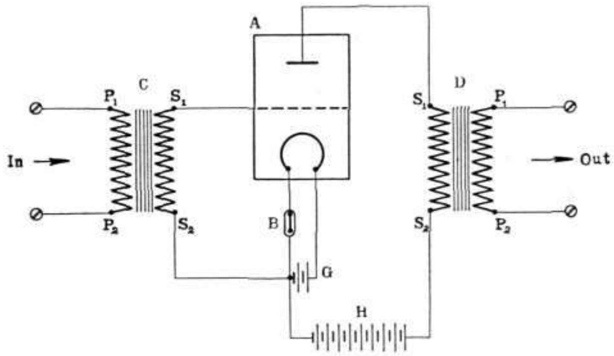
$$I_l = I_o \times e^{-\beta l},$$

βl being the attenuation exponent.

Experience has shown that the attenuation exponent may not increase above a certain value or the speech at the receiving end is not sufficiently clear. The maximum value of βl is thus fixed to 3.5 (Paris 1910). If the attenuation in the subscribers' instruments and the local lines is subtracted the maximum attenuation of the junction line may be $\beta l = 3.0$. The attenuation constant of a double-wire aerial telephone circuit consisting of 600 lbs. copper is 0.00279. A commercial conversation can thus take place on such a line between two points, situated about 1075 miles apart. The attenuation constant of a cable consisting of 10 lbs. copper is 0.167 and a line corresponding to $\beta l = 3.0$ has thus a length of 18 miles. From this it will be seen that the possibilities of transmission are restricted but can be extended by introducing expensive aerial lines or special arrangements to counteract the effect of the attenuation.

Loading of Telephone Circuits.

The capacity and resistance of the line are increasing the attenuation constant, the self inductance working in the opposite direction. It is therefore possible to eliminate the effects of capacity by inserting induction coils (loading coils) on certain points of the lines (aerial lines as well as cables). This method has been extensively used.



R 130 Fig. 1.

Mechanical »Telephone Relays».

Experiments have been made in the past with special »telephone relays» for amplifying small alternating currents. The nearest solution was to mechanically combine a receiver and a transmitter. The latter was connected to a telephone transformer and to a battery which supplied the energy necessary for amplifying the small telephonic currents. In other constructions the transmitter was replaced by a contact which was influenced by the vibration of the diaphragm of the receiver. These and other mechanical constructions have not been used parctically as, on account of the inertia of the vibrating parts, the distortion caused by these relays was very great.

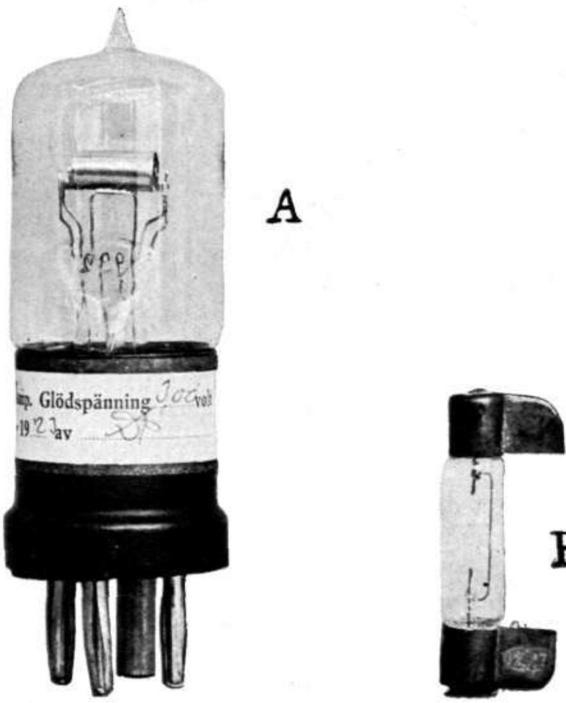
Devices have also been made based on the fact that the pressure drop in an electric arc depends on the current. Such devices are not, however, of any practical use owing to the difficulty of stabilising the arc.

Thermionic Valve Relay.

The development of the vacuum tube has solved the problem of producing practical amplifiers for wire telephony. The first amplifier with a vacuum tube was constructed by Mr R. v. Lieben (Vienna 1910), who used a tube filled with mercury gas at a certain pressure. The cathode was a Wehnelt one, i. e. a platinum band covered with oxide of calcium and brought to a white heat by means of a current flowing through the filament. The action of this amplifier proved complicated and irregular.

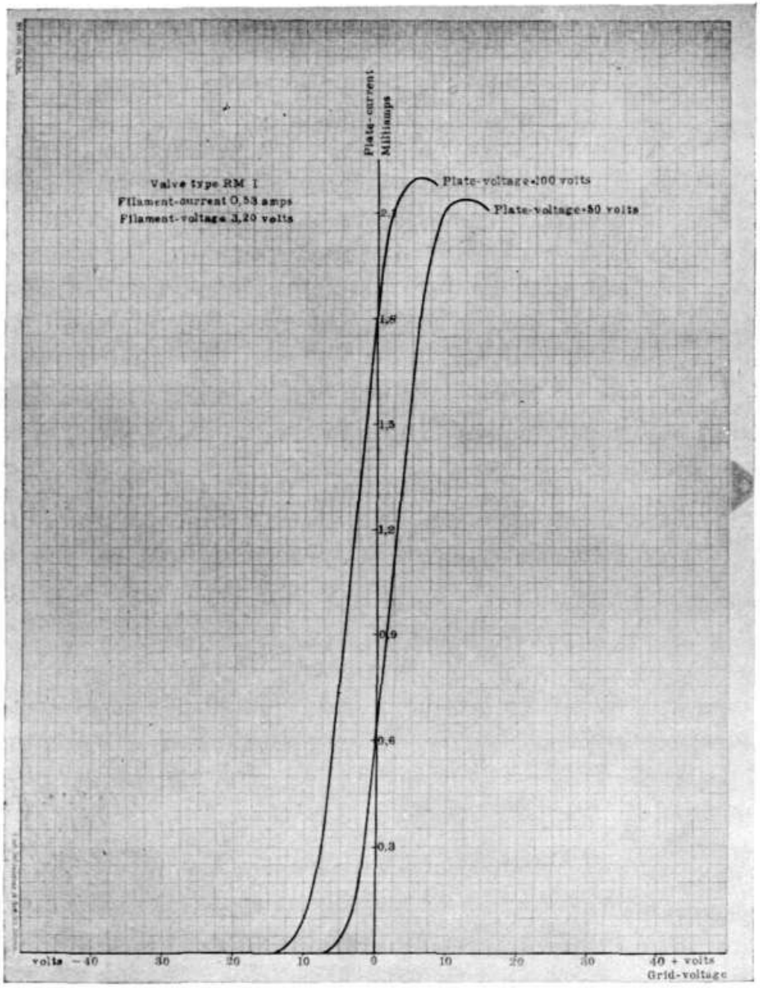
Simultaneously Mr. L. de Forest, U. S. A., constructed a telephone repeater. He was the first to introduce the third auxiliary electrode, the so-called grid, in his valves. After that Mr. Langmuir found a method of producing high vacuum valves with tungsten filaments, which acted satisfactorily, thus solving a problem which had occupied telephone people for several years.

The amplification of the valve depends upon its characteristic, i. e. a small alteration of the grid voltage causes a great alteration of the anode current. Fig. 1 shows the principle of an amplifier working in one direction only. The incoming currents pass through the primary of the input transformer *C*, the secondary of which is connected across the grid and the negative pole of the filament battery *G*. In order to maintain a constant filament current, within certain limits,



R 131 Fig. 2.

uninfluenced by the fluctuations of the filament battery voltage, an iron resistance *B* is inserted between the negative pole of the battery and one side of the filament. The other side of the filament is connected to the positive pole of the filament battery. The anode is connected to the output transformer *D* and then to the positive pole of the anode battery *H*, the negative pole of which is connected to the negative pole of the filament battery. The voltage of the grid, owing to the connection of the secondary of the input transformer, is equal to the difference between the voltage of the filament battery and the pressure drop in the filament and thus negative with reference to the filament. By using a suitable filament battery the negative voltage of the grid can therefore be of such a value that the valve works on the slope of its characteristic, i. e. at its greatest amplification. On the other hand, the grid voltage being negative, the grid current is zero, i. e. the input transformer works as if its secondary were open. The small telephone currents are therefore causing a variation of the grid potential which is producing a change of current in the anode circuit. The secondary of the output transformer thus receives a pulsating current, i. e. an alternating current superposed on a direct current, having exactly the same wave form as the incoming speech currents. The output current is thus of exactly the same wave form but of a greater amplitude.



R 132

Fig. 3.

Amplifiers for Wire Telephony, Type FG 100—FG 500.

The manufacture of amplifiers for wire telephony was undertaken in Sweden by the Svenska Radioaktiebolaget and later on taken up by L. M. E. who introduced new designs to conform to other telephone material of of their manufacture.

The L. M. E. patterns, for use with existing telephone instruments are as follows:

For Local Battery Systems:

Type FG 100 For amplifying incoming and outgoing speech currents. This amplifier can be connected to the subscriber's telephone instrument without rearrangement.

Type FG 110 For amplifying incoming speech currents only. This amplifier can be connected to the subscriber's telephone instrument without rearrangement.

Type FG 200 Portable amplifier for amplifying incoming and outgoing speech currents. This amplifier is for military purposes.

For Central Battery System.

Type FG 300 For amplifying incoming and outgoing speech currents. The connection of this amplifier to the existing subscriber's C. B. telephone instrument necessitates certain modifications as regards the connections in the telephone instrument.

Type FG 310 For amplifying incoming and outgoing speech currents. The amplifier is combined with a table telephone set of type CG 400.

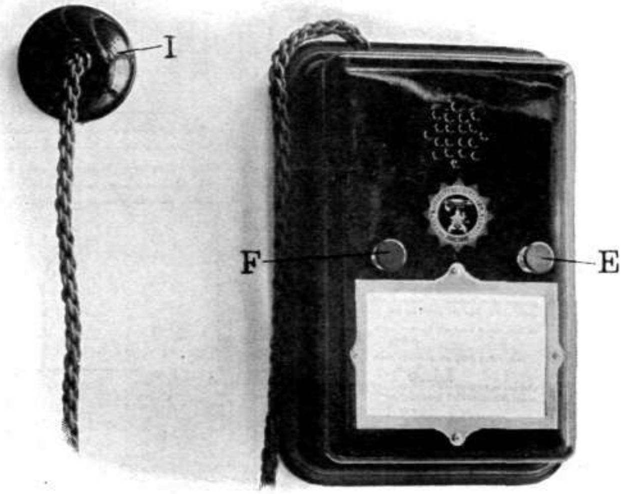
Type FG 320 For amplifying incoming and outgoing speech currents. The amplifier is combined with a wall telephone set of type CD 1140.

Type FG 500 For amplifying incoming and outgoing speech currents. The amplifier is for use with a C. B. telephone instrument of G. P. O., London, standard pattern.

The valves used in amplifiers of types FG 100—FG 500 are of the Svenska Radioaktiebolaget's make, type RM1, with German fittings. Fig. 2 shows this valve. Its technical data are as follows:

Anode Voltage 50—100 Volts.
Filament Voltage about 3.0 Volts.
Filament Current about 0.53 amps.
Internal Resistance (dynamic) 30,000—40,000 ohms.
Amplification factor (dynamic) about 10.

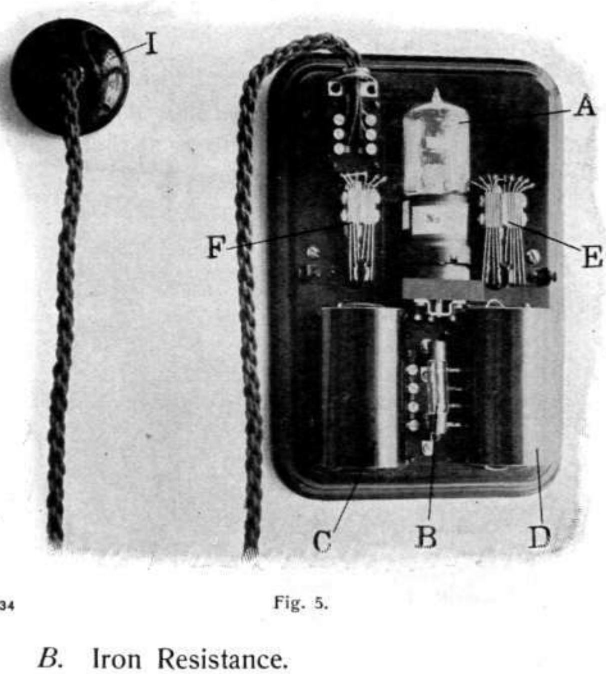
The curves in fig. 3 show the static characteristic of the valve, i. e. the anode current as a function of the grid voltage, due to the negative side of the filament at an anode voltage of 100 volts and at 50 volts. It will be seen from these curves that the amplification of the valve is greatest at an anode voltage of 100 and at a negative grid voltage of about 3. Valves of other manufacture with German fittings and with the same characteristics can be used in these amplifiers. As it appears that the French fitting for valves is becoming the more popular L. M. E. amplifiers will in future be provided with French fittings.



R 133 Fig. 4.

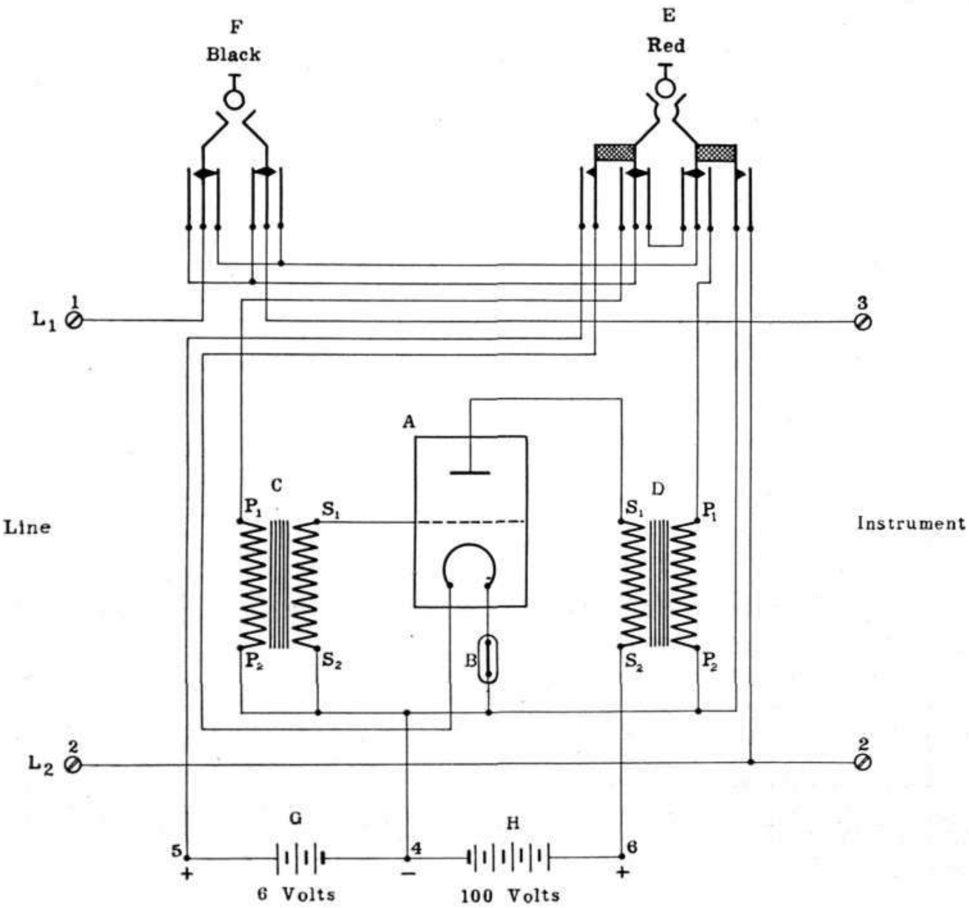
Fig. 4 shows an amplifier of type FG 100 with cover; fig. 5 without cover. The letters used in these figures refer to:

A. Valve.



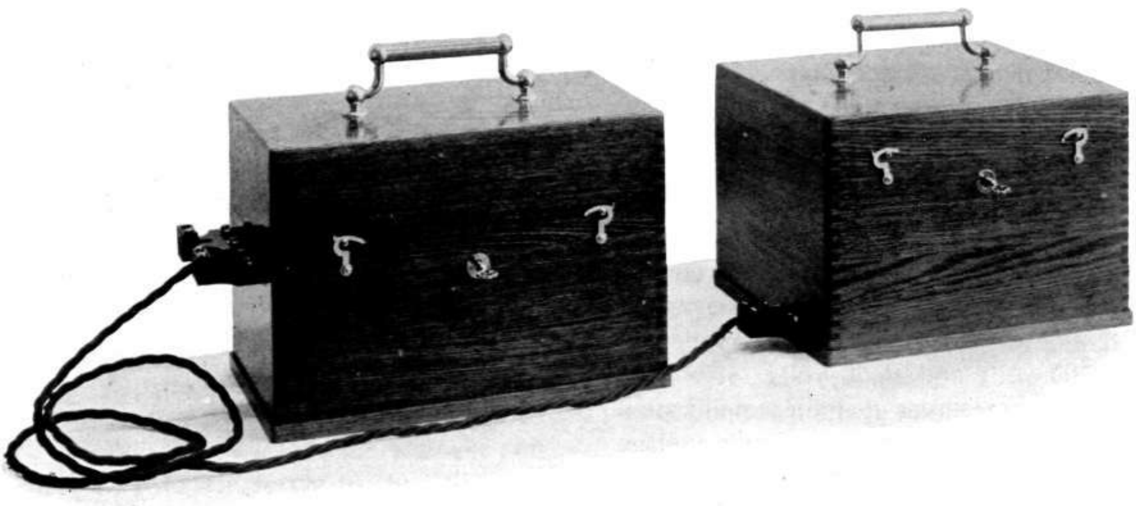
R 134 Fig. 5.

B. Iron Resistance.
C. Input transformer.



R 135

Fig. 6.



R 136

Fig. 7.

D. Output transformer.

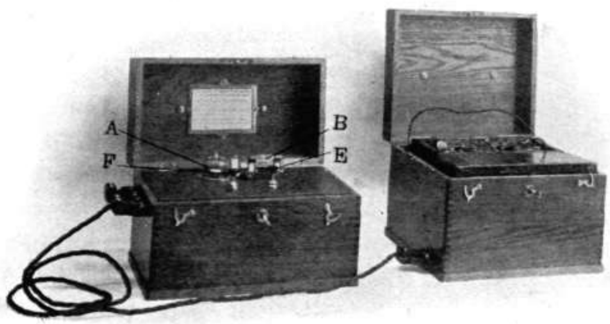
E. Press button (red) with stop, to be pressed when amplifying the outgoing currents.

F. Press button (black) without stop, to be pressed when amplifying the incoming currents.

G. Storage Battery for the filament current. About 6 volts. Capacity about 10 amp. hours. Maximum discharge current about 0.55 amps.

H. Anode Battery. 100 volts. This battery can consist of flash lamp elements. Maximum discharge current about 2.5 milliamps.

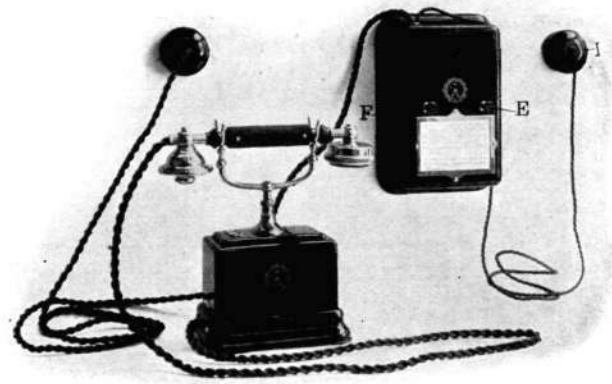
I. Terminal Box. The terminals in the box are numbered *1—6* and are connected as follows: Nos. *1* and *2* to the line, *L1* to *1* and *L2* to *2*; *2* and *3* to the instrument; *4* and *5* to the filament battery, *4* to the negative pole and *5* to the positive pole; *4* and *6* to the anode battery, *4* to the negative pole and *6* to the positive pole.



R 137 Fig. 8.

All current carrying parts of the amplifier such as terminals, fittings for the valve and iron resistance etc. are mounted on ebonite. The two transformers are screened and are mounted at such a distance apart as to prevent regeneration, with its accompanying disturbances.

The windings of the transformers are of such a nature that the smallest possible coil capacity is obtained. The valve and the iron



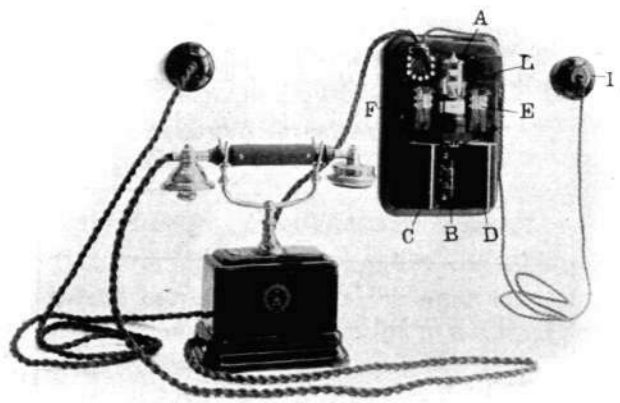
R 138 Fig. 9.

resistance are so placed that they can be readily changed. The cover is perforated above the valve to observe if the filament is glowing.

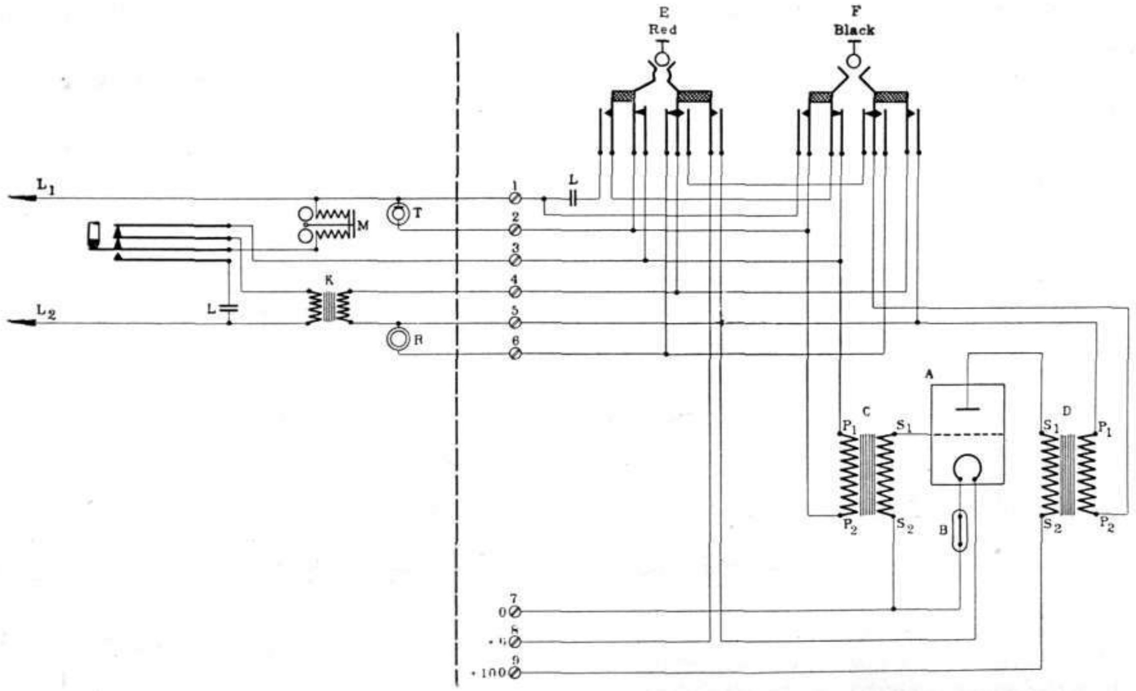
The amplifier is operated in the following manner:

1. When amplifying outgoing speech currents the red button is pressed. The valve glows.
2. When amplifying incoming speech currents the black button is also pressed. When speaking the black button must be released.
3. The amplifier is disconnected by restoring the red button, when the valve ceases to glow.

Fig. 6 shows a diagram of an amplifier of the type FG 100. It will be seen from the same that when the amplifier is disconnected there is no metallic connection between the lines and the batteries.

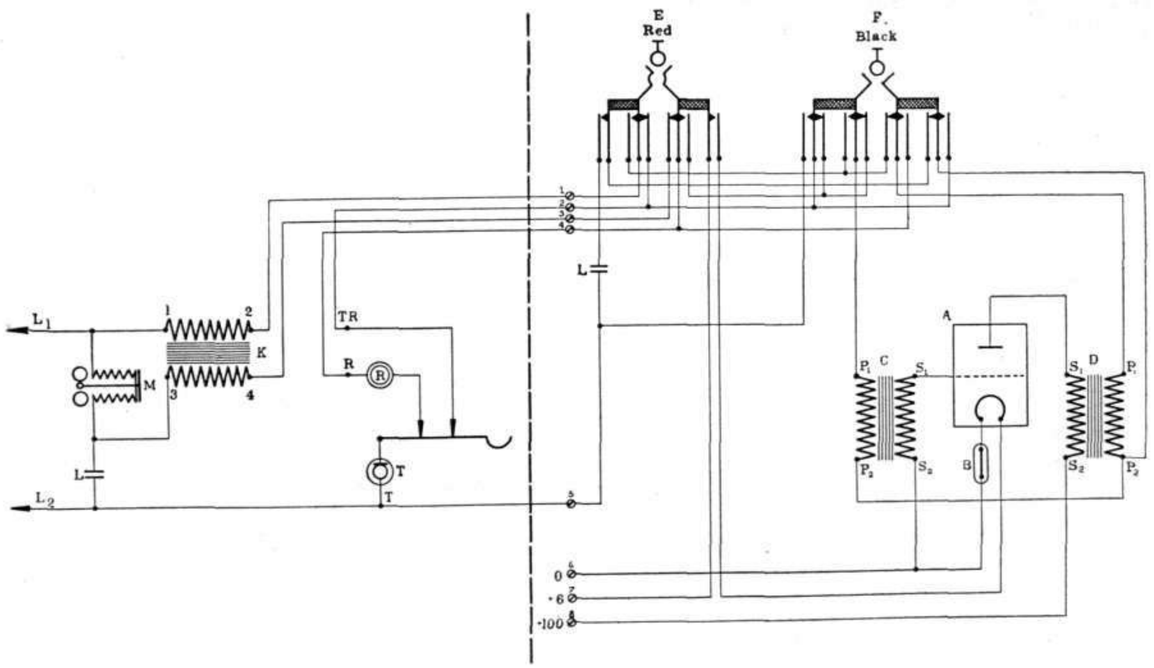


R 139 Fig. 10.



R 140

Fig. 11.

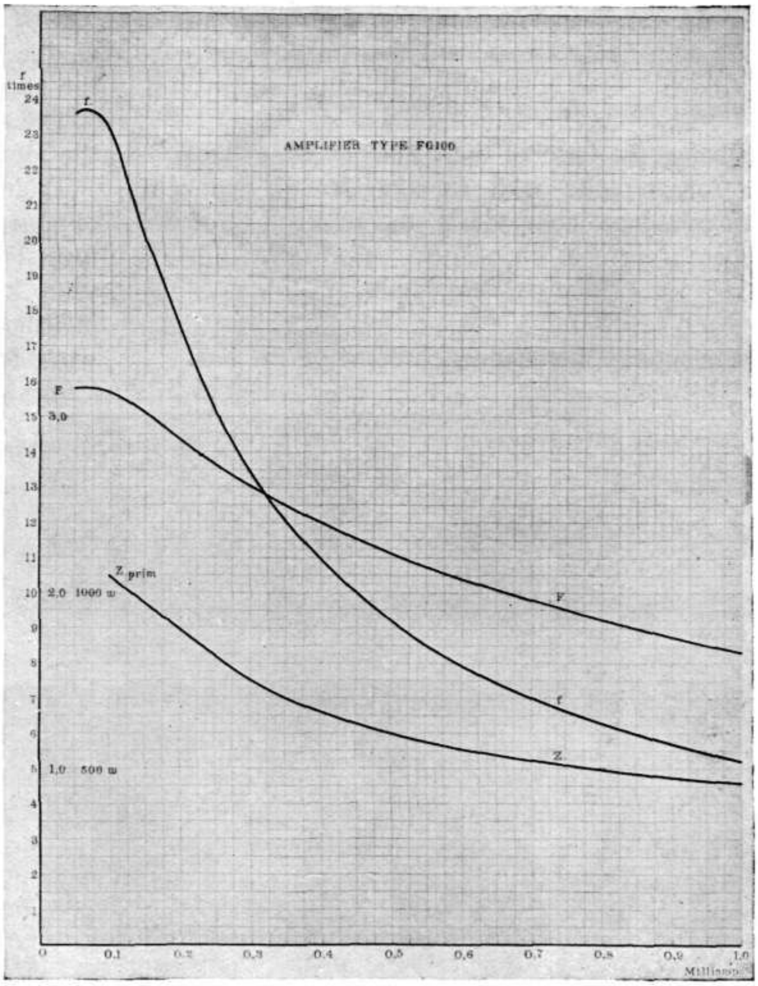


R 141

Fig. 12.

Fig. 7 shows an amplifier, type FG 200, with battery box and Fig. 8 the same apparatus with opened lid. The boxes are of oak. (Fig. 6 shows the diagram.)

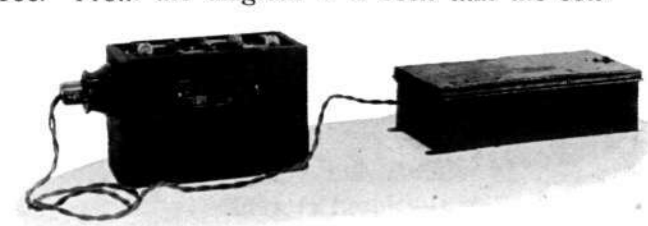
Figs. 9 and 10 show an amplifier type FG 310 combined with a C. B. telephone instrument, type FG 400. The same letters, as employed for the amplifier FG 100, are also used in these figures. The terminal block *I* is provided with 9 terminals, marked *1—9,* for connecting as follows: *1* to the line *L1* and to the one side of the transmitter, *2* to the other side of the transmitter, *3* to the one end of the primary of the induction coil, *4* and *5* to the secondary of the induction coil, *5* and *6* to the receiver, *7* and *8* to the filament battery, *7* to the minus pole and *8* to the plus, *7* and *9* to the H. T. battery, *7* to the minus pole and *9* to the plus. In order to eleminate regeneration, the windings of one of the transformers are in such a direction relative to one another that the reaction caused by the condenser, is negative. Further, the amplifier is so constructed that when amplifying outgoing speech currents the receiver is switched off and when amplifying incoming speech currents the transmitter is short circuited. Provision is also made to prevent interruption of the line current when operating.



R 143 Fig. 14.

Fig. 11 is a diagram of an amplifier type FG 310 combined with a C. B. table set, type CG 400.

Fig. 12 is a diagram of an amplifier type FG 500. From the diagram it is seen that the connection between the amplifier and the telephone instrument does not necessitate any alteration in the wiring of the telephone instrument.



R 142 Fig 13.

Fig. 13 shows a storage and a H. T. battery as used with amplifiers of types FG 100, 110, 300, 310, 320 and 500.

Amplification. Amplification exponent.

The amplifier has to amplify the attenuated speech currents. If i_1 is the input current the amplifier magnifies this value to a output value of i_2.

The rate

$$f = \frac{i_2}{i_1} \qquad i_2 > i_1$$

is the amplification of the amplifier and if F is the amplification exponent then

$$i_2 = i_1 \times e^F \text{ or } e^F = f$$

e being the base of the Napierian logarithms.

An amplifier with an amplification exponent F can thus compensate the attenuation of the speech currents on a line

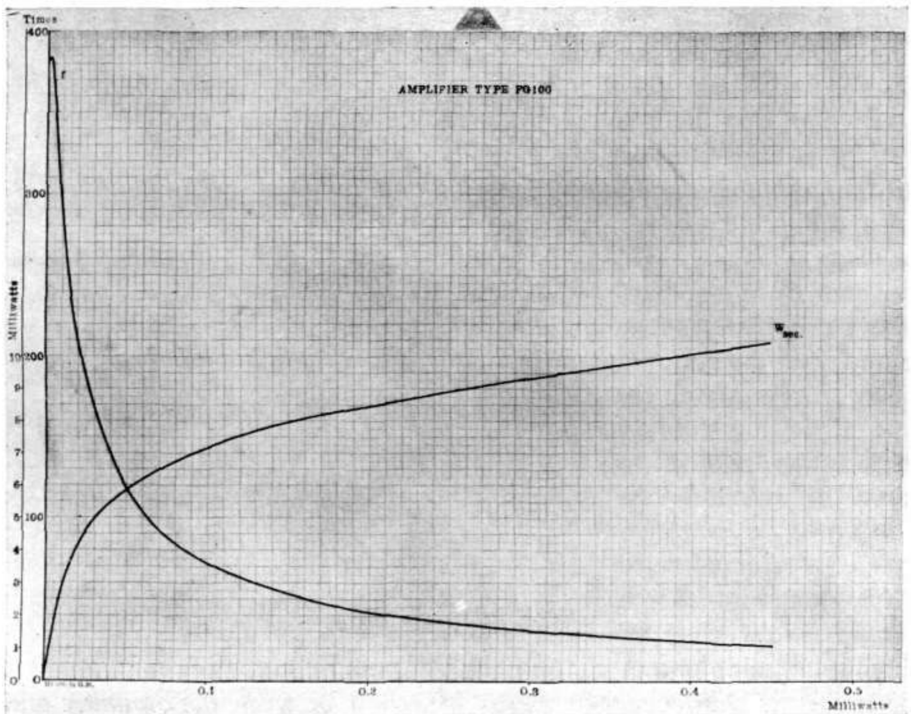
$$\beta l = F,$$

β being the attenuation constant of the line.

If $\beta l = F$, then $i_2 = i_0$, i. e. the speech current at the transmitting end of the line is equal to the speech current at the receiving end.

The amplification and the exponent vary with the input current.

Table No. 1 shows the values of amplification, exponent and input impedance of an amplifier, type FG 100, at different input currents from a value of 0.05 milliamps. up to a value of 1.02 milliamps, the input current being of the sine wave form at a frequency of 800 cycles per se-



R 144 Fig 15.

If i_0 is the speech current in the transmitting end of a long line, the current i_1 at a point l miles from the transmitting end is, as before

$$i_1 = i_0 \times e^{-\beta l}$$

If an amplifier is inserted at this point, the output current i_2 is

$$i_2 = i_1 \times e^F$$

But

$$i_1 = i_0 \times e^{-\beta l}$$

thus

$$i_2 = i_0 \times e^{F-\beta l}.$$

cond. The values are measured with a Franke machine and a compensator. The secondary of the amplifier is connected to an artificial cable of 31.63 M. S. C., i. e. $\beta l = 3.358$, and closed at the receiving end by an impedance of 460 ohms (equal to the characteristic impedance of the cable

$$Z_0 \diagdown \varphi = 460.3 \diagdown 52°35'.)$$

Fig. 14 shows the values of table No. 1 as functions of the input current.

From the curves it will be seen that the maximum value of the amplification is 23.7, the

Table No. 1.

Input current m. a.	Input Impedance		Output current m. a.	Amplification	Exponent
	Ohm	Degrees			
0.05	—	—	1.18	23.6	3.16
0.07	—	—	1.66	23.7	3.17
0.10	1043.5	56°20′	2.30	23.0	3.14
0.20	892.6	39°45′	3.50	17.5	2.86
0.31	747.5	29°0′	4.15	13.4	2.60
0.40	655,7	23°30′	4.40	11.0	2.40
0.51	592.2	20°20′	4.69	9.2	2.22
0.61	549.0	18°45′	4.82	7.9	2.07
0.71	516.2	17°30′	4.97	7.0	1.95
0.81	491.5	16°45′	5.10	6.3	1.84
0.96	462.8	16°0′	5.28	5.5	1.70
1.02	452.8	15°30′	5.41	5.3	1.66

Filament current 0.539 amps.
Plate voltage 99.2 volts.

maximum exponent thus being $F = 3.17$ which value corresponds to an improvement of nearly 30 Miles of Standard Cable.

The amplification exponent by amplifying the incoming speech currents is practically fixed to 3,0 which value corresponds to an amplification of 20. By amplifying the outgoing speech currents the amplification exponent is fixed to 2,1 corresponding to an amplification of 8.

Table No. 2 shows the values of the output power in microwatts for varying values of the input power in microwatts and the magnification. These values are measured with a Franke machine and a compensator at a frequency of 800 cycles per second, the current being of the sine wave form. The secondary load of the amplifier is a reactionless resistance of 500 ohms.

Table No. 2.

Input Power microwatts	Output Power microwatts	Magnification
1.3	510	383.5
5.5	1882	342.2
26.6	4774	179.5
58.9	6125	104.0
94.3	7069	75.0
140	7841	56.0
188	8348	44.4
243	8989	37.0
306	9202	30.1
409	9901	24.2
446	9946	22.3

Filament current 0.535 amps.
Plate voltage 99.0 volts.

Fig. 15 shows the values of table No. 2 as functions of the input power in microwatts.

From the curves it is seen that the maximum magnification is 384.

Amplifiers, permanently inserted on the lines, also Cord Circuit Amplifiers.

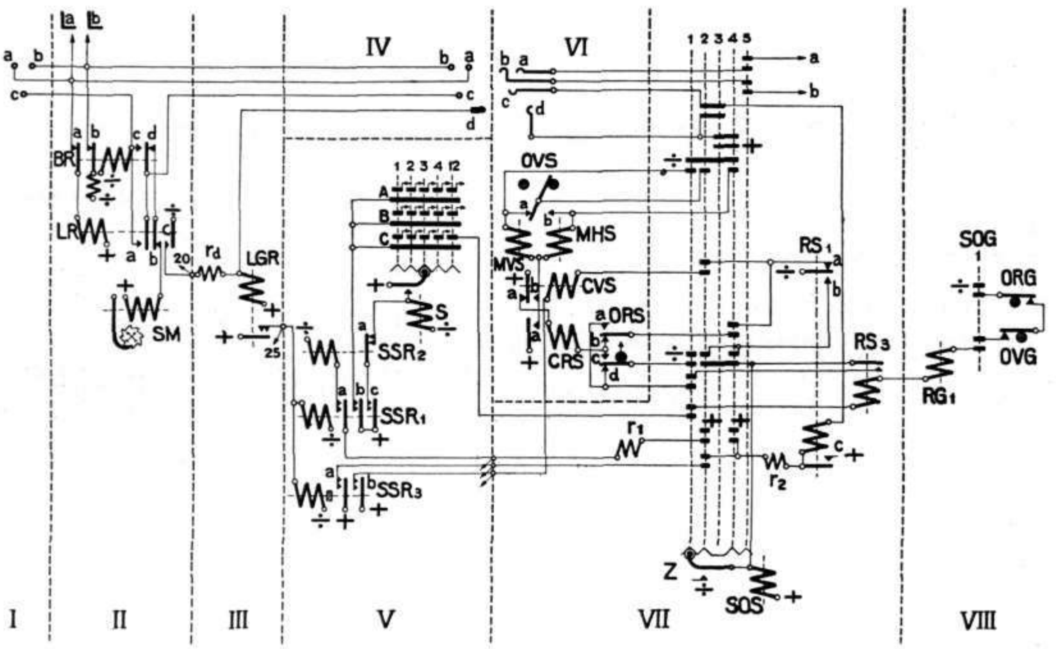
In a future number of the L. M. E. Review a description will be given of amplifiers, permanently inserted on the lines and of Cord Circuit amplifiers.

Mark.

The Ericsson Automatic Telephone System.

DESCRIPTION OF CIRCUITS.

In the first issue of the L. M. Ericsson Review we have described the apparatus and given an account of the functioning of the Ericsson automatic system, i. e. the functions of the various selectors, the grouping of the lines and the object and method of functioning of the register. In the present article it is our intention to describe the simplified diagrams and to give a general account of the switching processes.



R 119

Fig. 1. Diagram of Line Relay, Starting Distributor and Line Finder.

A. *The calling station is connected to an idle line finder.*

Section II in fig. 1 shows an incoming subscriber's line L^a, L^b with its line relay *LR*, cut-off relay *BR* and service meter *SM*. The connection of the subscriber's line to the multiple bank in the connector rack is shown in section I, and its connection to the multiple bank in the line finder rack is shown in section IV. *a* and *b* are the two speaking lines and *c* the test line.

A line group relay *LGR* and a resistance *rd* are common to the 20 lines which are situated in the same multiple frame of the line finder rack. One terminal of the line group relay is connected to the test bar *d*.

The three relays SSR_1, SSR_2 and SSR_3, together with a so-called starting distributor — consisting of a sequence switch, the magnet coupling of which is denoted by the letter *S* —

are common for all of the 500 lines in the line finder rack.

Theoretically, it would suffice to set only one line finder in motion for each call, but this method is not advisable from a practical point of view, as the chances are that the waiting time will be too long. The other extreme is to allow all the idle line finders in a rack start when a call is being made. This, however, is excessive and would only cause unnecessary wear and consumption of power. A middle course has therefore been chosen in the Ericsson system, the switching being arranged so that from five to ten line finders are simultaneously set in motion for each call. The line finder which first finds the multiple frame in which the call is located completes the connection and the other line finders immediately stop in readiness for the next call.

It is the function of the starting distributor to successively connect the line finders for service and to regulate their number so that it will not drop below a certain permissible minimum.

In section VI we have a line finder. *a*, *b* and *c* are the contact springs of the contact arm. *d* is a test spring which comes in contact with the test bars *d* of the multiple frames during the line finder's rotating movement. *MHS* and *MVS* are the coils of the line finder's magnet coupling, *CVS* the locking magnet for rotation and *CRS* the locking magnet for the radial movement. *OVS* is a switching group mechanically influenced at the extreme positions of the rotating movement, thus reversing the movement from right to left and vice versa. The position of the contact spring on the diagram shows that the extreme right position was last passed, the coil *MVS* now being in circuit for rotation counter clock-wise. *ORS* is a switching group mechanically actuated at the extreme positions of the radial movement.

In section VII are shown the sequence switch *SOS* and relays RS_1 and RS_3, belonging to the line finder. The sequence switch is actually furnished with twelve contact positions, of which only the four first are shown, however. RS_1 is the line finder's testing relay and RS_3 a relay which, among other things, functions during the setting of the sequence switch.

In section VIII, lastly, are shown the details for the connecting of the group selector and its sequence switch which are of interest in this connection.

The switching process which takes place during the connecting of a calling subscriber to an idle line finder is as follows:

When a subscriber calls the exchange by lifting his microtelephone, the line relay *LR* and the line group relay *LGR* — which latter is connected over the contact *LRc* — energize.

The call is indicated by means of the test wire *c* and test bar *d* in the line finder rack, negative being connected to the test wire *c* through the winding of the cut-off relay and over the contact *LRa*, and to the test bar over the contact *LRc* and through resistance *rd*.

The starting relays SSR_1 and SSR_3 — which are common for the five hundreds group — energize when the armature of the line group relay *LGR* is attracted.

The magnet coupling *S* of the starting distributor is now connected over the contacts SSR_1—*c* and SSR_2—*a*, causing the starting distributor to rotate. The following circuits are closed for each contact position passed by the wiper arms. (Only the circuit over the position *C*—12 is shown on the diagram. If the starting distributor has five rows of contacts, it follows that five circuits will be closed for each position passed.)

1. Positive, SSR_1—*b*, *S*—C_{12}, contact in position 1 of the sequence switch *SOS*, relays RS_3 and RG_1, contact in position 1 of sequence switch *SOG*, contacts *OVG* and *ORG* in group selector, contact in position 1 of sequence switch *SOG* and negative.

Circuit 1 causes relay RS_3 (and RG_1) to energize. The energizing of relay RS_3 connects the magnet coil of sequence switch *SOS*, this switch being reset from position 1 to position 2. Therefore, for each position passed by the wiper arms of the starting distributor, a number of sequence switches (e. g. five) belonging to idle line finders will be advanced from position 1 to position 2. The following circuit is closed for each sequence switch thus advanced:

2. Positive, contact in position 2 of sequence switch *SOS*, resistance r_1, contact $SSR_1—a$, relay SSR_2 and negative.

The resistances r_1 are so adjusted as to provide relay SSR_2 with insufficient current for it to energize until say six resistances r_1 have been coupled in parallel, or, in other words, relay SSR_2 does not energize until the starting distributor has sufficient time to allow at least six line finders to be connected for service, i. e. their sequence switches have been advanced to position 2.

When relay SSR_2 energizes, the circuit over the magnet coupling *S* is broken and the starting distributor stops after having moved say two steps and connected in ten line finders.

The starting distributor will not be set in motion for the calls immediately following, as relay SSR_2 energizes and breaks the circuit to the coil *S*. The starting distributor starts functioning anew for the connecting in of additional line finders for service only when the number of line finders has dropped so low (for example to five) that relay SSR_2 has not the power to energize.

The following circuit is now closed over contact *b* in relay SSR_3:

3. Positive, $SSR_3—b$, parallel through the locking magnets *CVS* belonging to idle line finders, contact in position 2 of sequence switch *SOS*, $RS_1—a$, negative.

The locking magnets *CVS* energize and release the line finders for rotation. Either one of coils *MVS* or *MVH* is brought in circuit over contact *CVS—b* and the line finders start rotating. During the rotating movement, the test springs *d* of the line finders brush against the test bars of the multiple frames. When a line finder reaches that frame in which the call is located, the following circuit is closed:

4. Positive, $SSR_3—a$, contact in second position of *SOS*, resistance r_2, relay RS_1, contact in second position of *SOS*, test spring *d* and test bar *d*, resistance *rd*, *LR—c*, negative.

Relay RS_1 energizes and is held over its contact *c*, resistance r_2 being shortcircuited.

Circuit 3 is broken at $RS_1—a$, causing the locking magnet *CVS* to release its armature. When the contact arm has been locked in position directly opposite the sought multiple frame, the dog engages a corresponding notch on the rotary disc and the line finder stops, the current supplied to the magnet coupling being simultaneously cut off.

At the same moment as circuit 4 is formed, the line group relay *LGR* is shunted by relay RS_1 and de-energizes. The relays SSR_1 and SSR_2 are hereby also de-energized, thus cutting off the current to all the line finders in motion, causing them to stop (unless the starting relays SSR_1 and SSR_2 should be kept energized by a call in some other multiple frame). When the test relay RS_1 energizes, the coil *SOS* of the magnet coupling is connected over the second contact position of the sequence switch and over $RS_1—b$, resulting in the advancement of the sequence switch from second to third contact position.

In the third position the coil *SOS* is energized over a contact in the locking device *Z* of the sequence switch, causing the sequence switch to advance to position 4.

When the sequence switch passes position three, test relay *RS* is short-circuited and de-energizes.

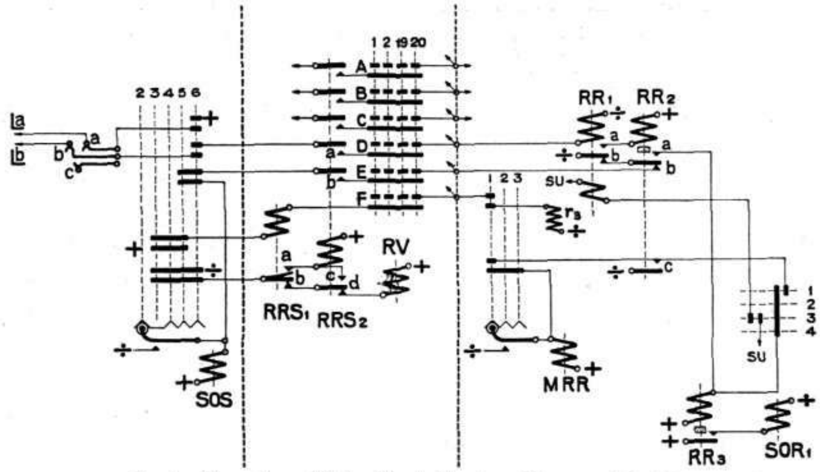
In the fourth position of the sequence switch, the circuit to the locking magnet *CRS* is closed over the contacts in *CVS*, RS_1 and the sequence switch.

CRS attracts its armature, thus releasing the line finder for radial movement. The coil *MHS* of the magnet coupling is put in circuit over contacts in *CRS* and in the sequence switch the contact arm of the line finder being thrust into the multiple frame. When the test spring *c* comes in contact with the test wire *c* of the calling line, the following circuit is closed:

5. Positive, contact in fourth position of *SOS*, relay RS_1, test spring and test wire, *LR—a*, relay *BR*, negative.

Relays RS_1 and *BR* energize and are held over their contacts *c*.

When the test relay RS_1 energizes, the current supply to the locking magnet *CRS* is cut off.



R 120 Fig. 2. Connecting of Subscriber's Line to a Disengaged Register.

When the contact springs of the line finder have been brought into their correct positions, the dog engages a corresponding notch on the contact arm and the radial movement is discontinued, the supply of current to coil *MHS* of the magnet coupling being simultaneously cut off.

At the moment that relay RS_1 is connected to the calling line, this line becomes blocked for the connecting in of other line finders and connectors.

Simultaneously with the energizing of cut-off relay *BR*, the line relay *LR* is disconnected and de-energizes.

When relay RS_1 is energized, the magnet coupling *SOS* is connected over contact RS_1—*b* and the sequence switch is advanced from position 4 to position 5.

The calling subscriber has now been connected to a line finder.

B. *The call is connected to an idle register.*

We will assume that the connecting of the registers to the line finders is accomplished in accordance with the principle described in fig. 16 of the first issue, i. e. by means of register selectors. Those switching units which function during the seeking and connecting of an idle register are shown in fig. 2. At the extreme left is shown the subscriber's line L^a, L^b connected with the line finder. Contact positions 2 to 6 are shown in the sequence switch of the line finder.

RV is the register selector with the test relay RRS_1 and the connecting relay RRS_2.

At the extreme right are shown some details from a register. *MRR* is the register's sequence switch, mounted on the same shaft as the restoring mechanism.

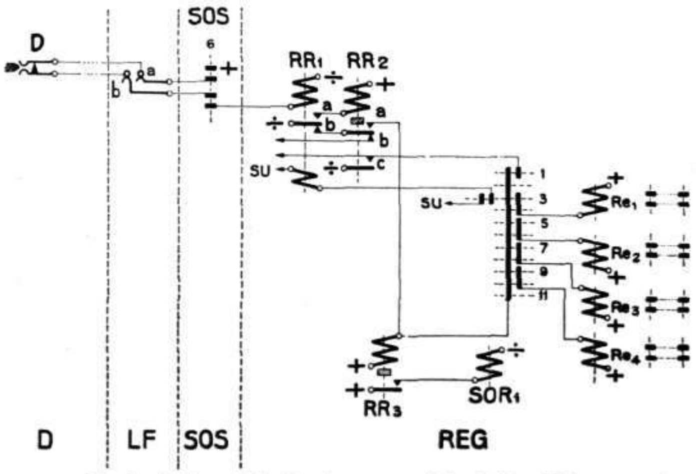
SOR_1 is a control switch for the successive connecting in of those registers (not shown herein), whose function it is to receive and register the dialled numbers.

RR_1 is the impulse relay of the register and RR_2 its restoring relay. RR_3 controls the movements of SOR_1.

The selecting and connecting of an idle register takes place as follows:

When the sequence switch of the line finder is in any of the contact positions 3 to 6, a circuit to the magnet coupling *RV* is formed over the sequence switch and the contacts RRS_1—*b* and RRS_2—*d*, setting the register selector in motion. When an idle register is found, the following circuit is closed:

6. Positive, contact in one of the positions 3 to 5 of the sequence switch, test relay RRS_1, contact in the register selector and the sequence switch *MRR* of the register (assuming that the register is idle, i. e. that the sequence



R 121 Fig 3. Setting of Register by means of the Calling Dial.

switch *MRR* occupies position 1), the resistance r_3 and negative.

Test relay RRS_1 energizes, breaking the current supply to the magnet coupling *RV* and the register selector stops. The connecting relay RRS_2 energizes over contact $RRS_1—a$. Simultaneously with the connecting of the call to the register, this register becomes blocked for the receiving of further calls. When relay RRS_2 energizes and the sequence switch *SOS* has been set to position 5, the following circuit is closed:

7. Positive, magnet coupling *SOS*, contact in the sequence switch *SOS*, $RRS_2—b$, contact in the register selector, $RR_2—b$, $RR_1—b$, negative.

This circuit now causes the sequence switch *SOS* to be advanced from position 5 to position 6. In this position the current for test relay RRS_1 is cut off and this relay de-energizes. Relay RRS_2 remains energized, as the current, which holds it, now passes over the contacts $RRS_2—c$ and $RRS_1—b$. (The switching group in RRS_1 is so constructed as to close the contact *b* before breaking contact *a*, when de-energizing.) In position 6 a circuit is now closed over the subscriber's line and telephone instrument through the impulse relay RR_1 and this latter energizes.

Relay RR_2 is connected over contact $RR_1—a$ and energizes. The current for the controlling relay RR_3 is furnished over a contact in the first position of the control switch SOR_1 and over $RR_2—c$, and RR_3 is energized. The stepping magnet SOR_1 is hereby put in circuit and the control switch is advanced to position 2. In position 2 the current to RR_3 is again cut off, causing SOR_1 to be advanced to position 3.

In position 3, the dial tone current *SU* is admitted to the inner winding of relay RR_1. This current is subject to induction in the outer winding and is sent out over the subscriber's line.

The calling subscriber receives a signal which denotes that he has been connected to a register and that he may therefore proceed with the dialling of the desired number.

C. *The number is registered in the register.*

The functioning of the register has been described in the article on the automatic system to be found in the first issue of this journal. Fig. 17 shows a schematic diagram of a register and fig. 18 the connections between the register-mechanisms for a four-digit system with numbers from 0000 to 0999. However, we now wish to describe more fully the setting of the registering mechanisms Re_1 to Re_4 by means of the dial. The sequence switch *SOS*, the line finder, the dial of the instrument and those parts of the register which are of interest in this connection, are shown in fig. 3.

When the mechanism SOR_1 has been set to position 3 and a dial tone has been sent out to the calling subscriber — as described under B —, the dialling of the number may begin. The impulse relay RR_1 is energized, the current passing over the line and the subscriber's telephone instrument. Relay RR_2 is also energized over contact $RR_1—a$.

The dialling of the first digit produces a series of breaks in the circuit, the number of breaks corresponding to the dialled digit. Thus the figure 1 produces one break, the figure 2 two breaks, etc., and lastly, the cipher 0 ten breaks. Relay RR_1 de-energizes for each such breaking of the circuit. The slow acting relay RR_2, however, remains energized during this impulse sending.

For each break in the current, i e. for each impulse, the following two circuits are closed:

8. Positive, relay RR_3, contacts $RR_2—a$ and $RR_1—b$, negative.

Simultaneously with the arrival of the first impulse, circuit 8 causes relay RR_3 to energize. On account of its slow action, this relay remains energized during the entire series of impulses and does not de-energize until relay RR_1 remains energized for a longer period, i. e. during the time elapsing between the dialling of the first and second digits. When relay RR_3 energizes, the stepping magnet SOR_1 is connected and the control switch SOR_1 is set to position 4, where it remains until the first digit is dialled.

9. Positive, stepping magnet Re_1, contact in the third and fourth positions of the control switch SOR_1, contacts RR_2—*a* and RR_1—*b*, negative.

The stepping magnet Re_1 energizes at the first breaking of the circuit and de-energizes anew at the closing of the circuit, which follows immediately after. The mechanism Re_1 will therefore be advanced two steps for each impulse (consisting of one opening and one closing of the circuit). Since only every other position in this mechanism (as in Re_2, Re_3 and Re_4) is connected (see fig. 18 in first issue) it will be set to a position, the number of which corresponds to the dialled digit.

Impulse relay RR_1 remains energized after the termination of the first impulse series, causing the controlling relay RR_3 to de-energize. The current to the stepping magnet SOR_1 is broken and the control switch SOR_1 is advanced from fourth to fifth position. The mechanism Re_1 is thus disconnected, the mechanism Re_2 being connected in its stead for the dialling of the second digit.

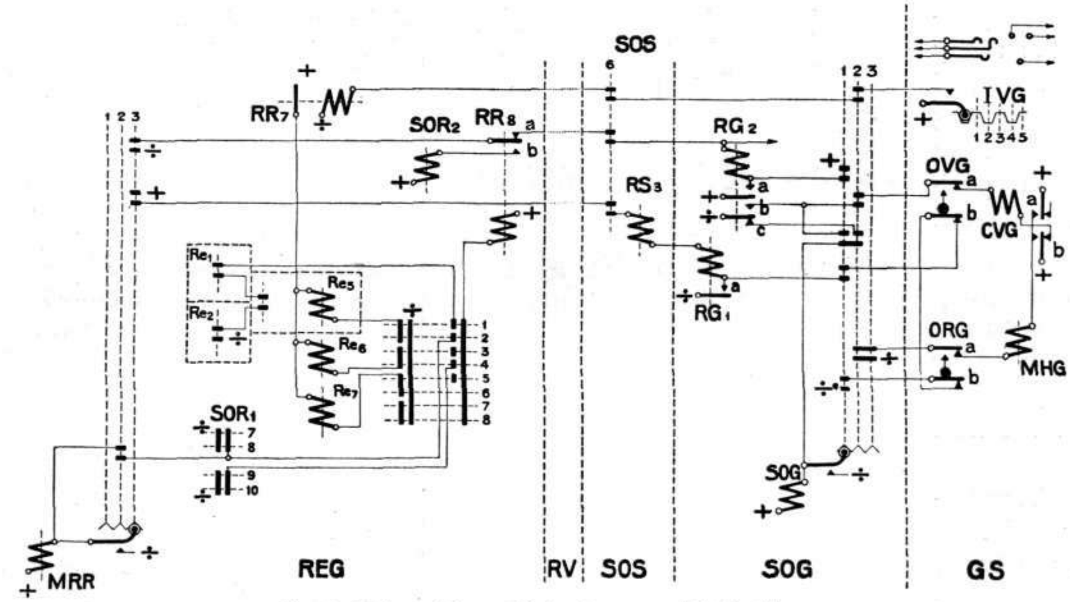
During the dialling of the second digit, the control switch SOR_1 is advanced from fifth to sixth position, mechanism Re_2 being simultaneously set.

After the dialling of the second digit, SOR_1 is again advanced, and so forth, so that after the dialling of the fourth digit SOR_1 has been advanced to position 11.

The number called by means of the dial has now been registered by the mechanisms Re_1 to Re_4.

D. *The group selector is set to its rotary position.*

The switching process for the setting of the group selector to its rotary position can be followed in fig. 4. At the extreme left are shown parts of the register with the sequence switch *MRR*, contacts in the control switches SOR_1 and SOR_2, the registering mechanisms Re_1 and Re_2, the controlling mechanisms Re_5 to Re_7 and the relays RR_7 and RR_8. The reciprocal connections between the registering mechanisms are not shown, the reader being referred to fig. 18 of the article in the first issue of this journal. A group selector is shown at the extreme right. *IVG* is a switching group over which impulses are sent to the register during the rotary movement of the selector. These impulses consist of closings and openings of the circuit, alternately for each position the selector advances during its rotary movement. For example, when the



R 122 Fig. 4. Setting of Group Selector by means of the Register.

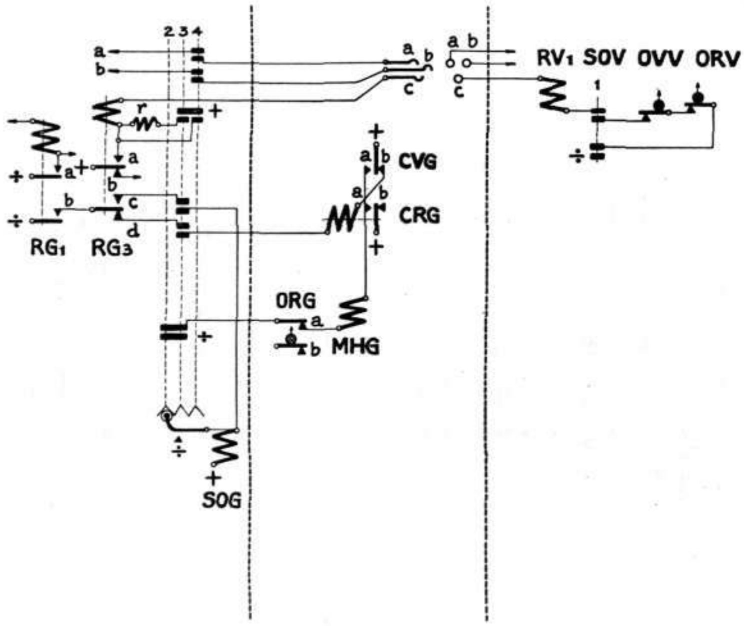
contact arm is located directly opposite multiple frame No. 10, ten impulses, i. e. five closings and five breakings of the circuit will have been produced.

CVG is the locking magnet for the group selector's rotary movement and *MHG* the magnet coupling for the setting of the selector, i. e. for rotation to the right and radial movement in the direction of the multiple. (Neither the locking magnet for the radial movement nor the magnet coupling coil for restoring to normal are shown in diagram 4.)

OVG is a switching group actuated in the extreme positions of the rotary movement, and *ORG* a switching group actuated in the extreme positions of the radial movement.

SOG is the group selector's sequence switch, only the three first positions of which are here shown.

RG_1 is the restoring relay and RG_2 the starting relay of the group selector.



R 123 Fig. 5. The Group Selector seeks an idle Connector.

In the following is given a short description of the switching process which takes place when a group selector is set to its rotary position.

When the number of digits required for determining the rotary position of the group selector have been dialled (the two first digits in the assumed case with four-digit numbers), the sequence switch of the register is advanced from position 2 to position 3, the magnet coupling *MRR* being connected to negative over contact position 7 in the control switch SOR_1, which is set to this position after the dialling of the first two digits.

In position 3 the two following circuits are closed:

10. Positive, contacts in *MRR* and *SOS*, relays RS_3 and RG_1, contact in the first position of sequence switch *SOG* and negative.

Relays RS_3 and RG_1 energize. Relay RG_1 is held over its contact *a*.

11. Negative, contact in *MRR*, RR_8—*a*, contact in *SOS*, relay RG_2, contact in *SOG* and positive.

Circuit 11 causes the starting relay RG_2 of the group selector to energize, the relay being held over its contact *a*.

When relay RG_2 energizes, the magnet coupling *SOG* is connected over contact RG_2—*b*, causing the sequence switch *SOG* to be advanced from first to second position.

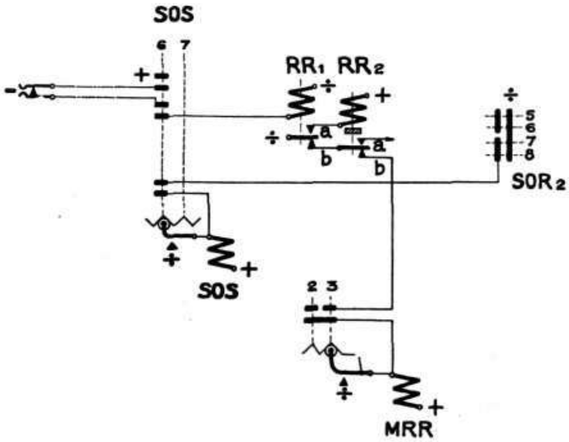
In the second position, the locking magnet *CVG* is connected in, the group selector being released for rotation. The magnet coupling *MHG* is connected over contact *CVG*—*a* and the group selector starts rotating.

Revertive impulses are now sent out during the rotary movement. The impulses are first received by the revertive impulse relay RR_7, being repeated over the contacts in this relay to the stepping magnet Re_5. The register mechanism Re_5 is thus advanced one step for each impulse, following the rotary movement of the group selector.

When the movement has advanced the number of steps stipulated by the position of the mechanisms Re_1 and Re_2, the following circuit is closed:

12. Negative, contacts in Re_2, Re_5, Re_1 and SOR_2, relay RR_8 and positive.

Relay RR_8 energizes and cuts off the current to the group selector's starting relay RG_2, resulting in the de-energizing of this relay. This causes the current to the locking magnet CVG



R 124 Fig 6. Restoring of the Register.

to be cut off, and when the contact arm of the group selector is directly opposite the multiple frame, the dog of the locking magnet engages a corresponding notch in the rotary disc and the rotary movement ceases. The current to the magnet coupling MHG is also simultaneously broken.

When relay RG_2 de-energizes, current is supplied to the magnet coupling SOG and the sequence switch is advanced from second to third position.

When circuit 12 causes the cut-off relay RR_8 of the register to energize, the stepping magnet SOR_2 is connected, causing the advancement of the control switch SOR_2 from first to second position. In this position relay RR_8 remains energized over contacts in the seventh and eighth positions of the control switch SOR_1, until the third digit has been dialled and SOR_1 is advanced to position 9.

The control switch SOR_2, therefore, is not advanced from second to third position until three digits have been dialled. In position 3 the mechanism Re_5 is disconnected and mechanism Re_6 connected in its stead, its function being to control the rotary setting of the connector.

E. *The contact arm of the group selector enters the multiple frame seeking for an idle connector.*

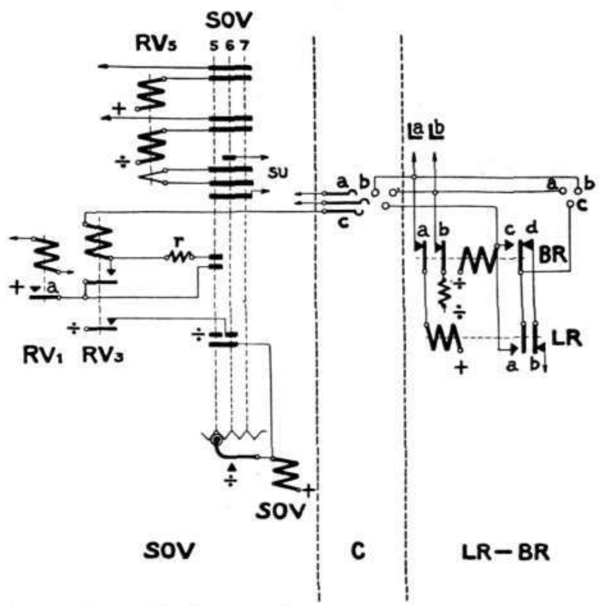
When the contact arm of the group selector plunges into the multiple frame, its function is to find an idle connector within the five-hundreds group corresponding to the rotary position of the group selector. The switching process which takes place while the group selector is seeking for and connecting itself to an idle connector may be followed in fig. 5. To the extreme left are shown the group selector and its sequence switch, restoring relay RG_1 and test relay RG_3. To the right are shown the connector's restoring relay RV_1, the first contact position in the sequence switch SOV and the switching groups OVV and ORV in the connector. The switching process is shortly as follows:

When the sequence switch SOG is advanced from second to third position, as mentioned above, the following circuit is closed:

13. Positive, contact $CVG—b$, locking magnet CRG, contact in SOG, $RG_3—d$, $RG_1—b$ and negative.

The armature of the locking magnet is attracted, releasing the group selector for radial movement. The magnet coupling MHG is connected over contact a in CRG, starting the radial movement.

When the test spring c of the contact arm



R 125 Fig. 7. The Connector is testing the Called Number.

comes in contact with the test wire c — which latter is connected to an idle connector — the following circuit is closed:

14. Positive, contact in *SOG,* test resistance *r*, test relay RG_3, test spring and test wire, relay RV_1, contacts in *SOV*, *OVV* and *ORV*, contact in *SOV* and negative.

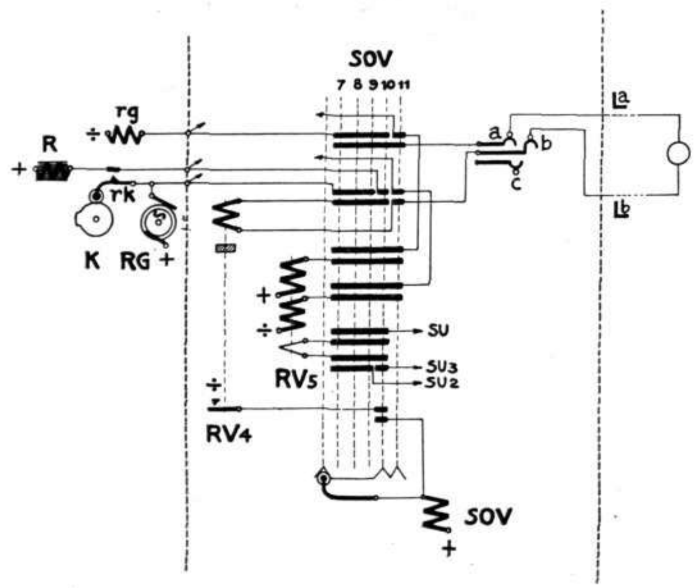
Relays RG_3 and RV_1 energize, breaking the current to the locking magnet *CRG*. As soon as the contact arm has been set to its correct position on the line sought for, the dog of the locking magnet engages a corresponding notch in the contact arm and locks the same, the current for the magnet coupling *MHG* being cut off.

When relay RG_3 is energized, it is held over its contact *a* and the test resistance *r* is shorted. The engaged connector is now blocked against the connecting in of additional group selectors.

When relay RG_3 is energized, its contact *c* closes a circuit through the magnet coupling *SOG*, the sequence switch being advanced from position 3 to position 4. The group selector is now connected to the connector.

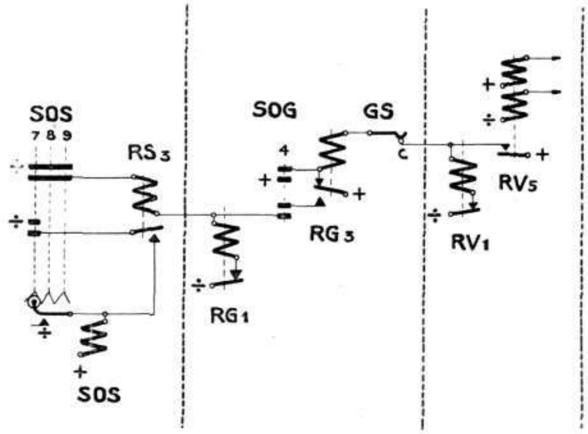
F. *The connector is set to its rotary position.*

The setting of the connector to its rotary position is accomplished in the same manner as has



R 126 Fig. 8. A Ringing Signal is sent out to the Called Number.

been described for the group selector. It is the mechanism Re_6 in the register that now receives the revertive impulses from the connector. When the movement has advanced the number of steps stipulated by the mechanisms Re_2 and Re_3 (i. e. the hundreds and tens figures of the dialled



R 127 Fig. 9. Setting of the Line Finder's Sequence Switch to Speaking Position.

number) the current for the rotary movement of the connector is broken. The controlling switch SOR_2 is reset and connects up the mechanism Re_7 for the receiving of impulses from the connector during the radial setting of the latter.

G. *The connector is set radially.*

The radial setting of the connector is accomplished according to the same principles as its rotary setting.

H. *The register is restored to normal.*

With the radial setting of the connector, the register has accomplished its function and will now be restored to normal so as to be in readiness to receive a new call. The switching process during the restoring of the register can be followed in fig. 6 and is briefly as follows:

With the setting of the connector to its radial position, the controlling switch SOR_2 is advanced from position 6 to position 7. The magnet coupling *SOS* is connected up and the sequence switch of the line finder advances from sixth to seventh position, thereby disconnecting the impulse relay RR_1 of the register, which was previously energized by a circuit over the subscriber's line. Relays RR_1 and RR_2 de-energize. Battery is now connected in to the magnet coupling *MRR* over contacts RR_1—*b* and RR_2—*b*, the sequence switch of the register being restored from position 3 to normal. During this rotary movement of the sequence switch (constituting almost one complete revolution) all the register mechanisms are mechanically restored to their normal positions.

I. *The connector is testing to ascertain whether the called number is disengaged.*

After the setting of the connector to the called number, its sequence switch is advanced from fourth, over fifth, to sixth position. As the fifth position is passed, the called subscriber's line is tested so as to ascertain whether it is disengaged or not, the following circuit being closed (see fig. 7):

15. Positive, RV_1—*a* (this relay is energized), contact in SOV_1, test resistance *r* and test relay RV_3 of the connector, test spring and test wire *c*, cut-off relay *BR* of subscriber's line and negative.

If the line is disengaged, the test relay RV_3 energizes, causing the magnet *SOV* of the sequence switch to be energized in position 6, advancing directly to position 7.

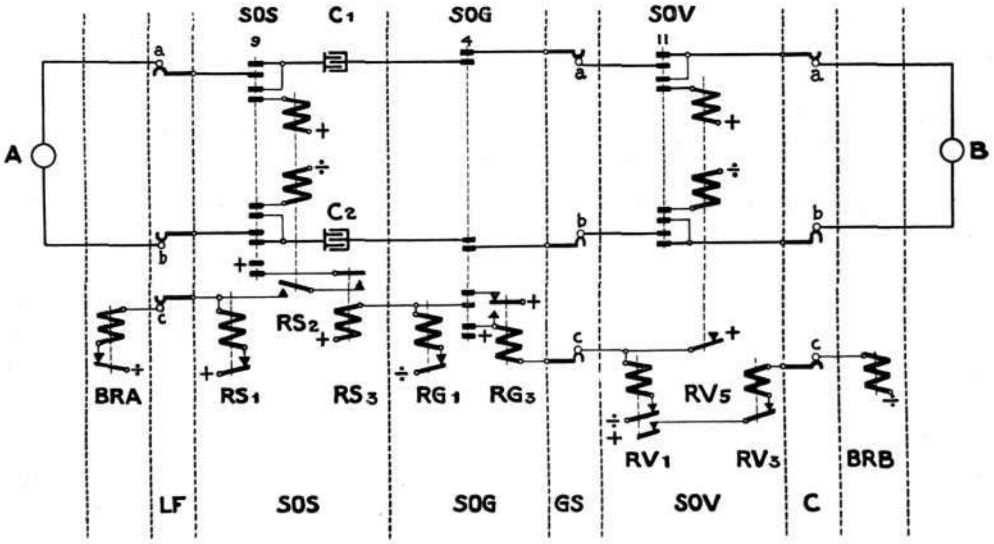
If the line is engaged, the test relay RV_3 does not get sufficient current, and the sequence switch *SOV* will remain in position 6. In this position the busy tone is connected to the tone winding of relay RV_5. The two other windings of this relay receive this tone, induced, and the calling subscriber hears the busy signal.

K. *A ringing signal is sent out to the called number.*

The switching process for the ringing up of the called subscriber can be followed in fig. 8. When, as previously described, the sequence switch *SOV* is advanced from position 6 to position 7, it does not come to rest in this position, but moves right on to position 10, the magnet coupling coil *SOV* receiving current — in positions 7, 8 and 9 — over the contact of the locking device. A first ringing signal is sent out to the called subscriber while the sequence switch is passing positions 7, 8 and 9. At the extreme left of fig. 8 are shown the ringing arrangements, consisting of:

The ringing generator *RG*, one pole of which is connected to earth; the impulse device *K*, consisting of a continually rotating cam-disc which actuates the contact *rk* so that it is alternately closed and opened (duration of closing, $1^1/_2$ sec., duration of breaking, $4^1/_2$ sec.); resistance *R* with high self-induction but with low ohmic resistance; resistance *rg*, which is connected to negative.

The ringing current is closed over the following circuit:



R 128

Fig. 10. Speaking and Holding Circuits.

16. Positive, ringing generator *RG*, contact in *SOV*, relay RV_4, *b*-contact in the connector, subscriber's line, ringer of subscriber's instrument and condensor, subscriber's line, *a*-contact in the connector, contact in *SOV*, resistance *rg* and negative.

Relay RV_4 is so constructed as to be actuated by direct current only — not by alternating current — and is therefore not actuated by the ringing circuit.

In position 10 circuit 16 is altered to the extent that the ringing signal is no longer sent directly out on the line but must first pass over the impulse contact *rk*. The result is that the signal now sent out is intermittent. Besides, resistance *R* is now connected in parallel with the ringing generator.

The intermittent ringing signal continues until the called subscriber answers or until the calling subscriber hangs up his receiver.

When the sequence switch *SOV* is in the ringing positions, a tone is connected to the inside winding of relay RV_5. The two other windings of the relay receive this tone, induced, after which it passes through the instrument of the calling subscriber. Thus the calling subscriber receives a tone indicating that the switching is completed and that the called subscriber is being rung up from the exchange.

L. *The called subscriber answers, thus disconnecting the ringing circuit.*

The moment that the called subscriber lifts his receiver to answer the call, the condenser of the called subscriber's instrument is short-circuited, thus completing the metallic loup. The cut-off relay RV_4 for the ringing signal is hereby energized and its armature is attracted. Negative is connected to the magnet coupling *SOV* over the contact in relay RV_4 and the sequence switch is advanced from position 10 to position 11, disconnecting the ringing signal. In position 11, the called subscriber's current-feed relay RV_5 is connected in and energizes.

We will now investigate the connection the moment before relay RV_5 energizes, for which purpose we will turn to fig. 9. The line finder's sequence switch is standing in position 7. Its relay RS_3 is energized in series with the restoring relay RG_1 of the group selector, this relay being held over its own contact.

When the called subscriber answers and relay RV_5 energizes, the position is changed as follows:

Relay RG_3 is short-circuited over the contact in RV_5 and de-energizes. When relay RG_3 de-energizes, relay RS_3 is short-circuited and also de-energizes, causing the sequence switch to advance from seventh to ninth position, while the magnet coupling *SOS*, in position 7, is actuated over the break contact in relay RS_3. In position 8 the magnet *SOS* is energized over a circuit not shown in fig. 9.

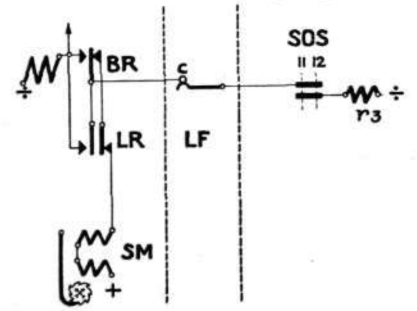


Fig. 11. Registering of Calls on Subscriber's Meter.

A speaking connection is now established between the two subscribers. The speaking and holding circuits during the conversation are shown in fig. 10, where *A* represents the calling and *B* the the called subscriber. The speaking circuit is shown in heavy lines. RS_2 and RV_5 are the current-feed relay and clearing relay respectively for both subscribers, each with a normal resistance of 400+400 ohms. C_1 and C_2 are two condensers of 2 mfd each.

All the relays are shown in the positions they occupy during the conversation. In addition to both the clearing relays the following relays are energized:

The cut-off relays *BRA* and *BRB* of both the subscribers' lines;

The test relays RS_1 and RV_3 for the line finder and the connector respectively, both of which are energized in series with the cut-off relays of the respective subscribers' lines;

The restoring relays RG_1 and RV_1 for the group selectors and connectors respectively.

Relay RG_1 gets positive connection directly over the normal contact in relay RG_3, and relay RV_1 gets positive over the off-normal contact in the current-feed relay RV_5.

Relays RS_3 and RG_3 are short-circuited.

M. *Selectors and sequence switches are restored to normal at the end of the conversation.*

The restoring of selectors and sequence switches to normal takes place when the subscribers, at the end of the conversation, replace their micro-telephones. The switching can be arranged at will so that restoring to normal takes place either after a single clearing signal, i. e. when the calling subscriber hangs up, or after a double clearing signal, i. e. not until both subscribers have replaced their receivers. In the first case, however, the connector will remain in its switching position until the called subscriber has also replaced his receiver, this being necessary to prevent him from making involuntary calls.

In the example here described the restoring does not take place until after a double clearing signal and therefore is dependent in the first place on the two clearing relays RS_2 and RV_5.

The relay RV_5 de-energizes when the called subscriber hangs up his receiver. The short-circuiting of relay RG_3 is discontinued, this relay energizing and being held in series with relay RG_1.

Relay RS_2 de-energizes when the calling subscriber gives a clearing signal by replacing his micro-telephone. The test relay RS_1 of the line finder is now short-circuited and de-energizes, the restoring process starting simultaneously. As RS_1 de-energizes, the magnet coupling for the sequence switch *SOS* of the line finder is connected, causing the sequence switch to be advanced from the speaking position no. 9, passing positions 10, 11 and 12 and not coming to rest until the starting position has been reached. In this position the locking magnet for the radial movement of the line finder is connected, the contact arm of the line finder being restored to normal. The line finder is now restored to normal, as it has no definite starting position for the rotary movement.

When the sequence switch *SOS* has passed position 10, the connection between relays RS_3 and RG_1 is broken and these relays de-energize. When relay RG_1 de-energizes, the group selector together with its sequence switch *SOG* are restored to normal, the connection between relays RG_3 and RV_1 being simultaneously broken. When relay RV_1 de-energizes, the restoring mechanisms for the connector and its sequence switch are connected in.

N. *The call is registered on the calling subscriber's meter.*

When the sequence switch of the line finder passes position 10 — while returning to normal — the holding of the break relay *BRA* is broken. When the sequence switch passes positions 11 and 12, negative is connected to the *c*-line over resistance r_3, causing the subscriber's meter to be actuated as shown in fig. 11. Effective calls only, therefore, are registered, i. e. calls where the calling subscriber has actually received a reply from the called number.

Ineffective calls, where no answer has been received or where the switching, for some reason or other, has been prematurely discontinued, are not registered, the line finder being restored already when the sequence switch is in position 8. In such cases, the connection over the *c*-wire is broken sooner, so that the current to the subscriber's meter over positions 11 and 12 will not actuate the meter. Provision is thus made for the restoring to normal for such calls as are not to be registered, for example calls to the toll operator, for reporting trouble, to the information desk, etc. G. G.

The Automatic Telephone Exchange in Christiansund, Norway.

The full automatic exchange in Christiansund, delivered by L. M. E., has now been in use since a year back. The location of the city on the North Sea, with a background of high mountains, is responsible for an unusually damp and rainy climate. The warm air currents which accompany the Gulf-stream are forced upwards by the mountains and cooled off, causing rain to fall for approximately three hundred days of the year. In addition, the air is exceedingly salty, all of which factors make conditions unusually severe for low tension work. This plant, however, has functioned to the entire satisfaction of the Christiansund Telephone Society.

R 150 Running of Aërial Cable.

Equipment has been installed for an initial capacity of 1500 lines. The system is a 10,000-line system, but a final capacity of only 4000 lines has been planned for.

As the city has a very isolated position, there is no suburban traffic, the only outer connections being with the State toll net. Traffic is very intense, however, as the greater part of the local net consists of business phones. The business interests of the city are entirely centred around the fishing industry, which fact can easily be noticed at the exchange, the greatest concentration of traffic always occuring when the large fishing fleets return home.

Toll traffic between Christiansund and the city of Trondhjem — 150 kilometers distant — is automatically handled during the night in the same manner as has been described in a previous issue for the Hamar system, i. e. a subscriber in Christiansund can make a direct call to the toll operator in Trondhjem and may likewise be called by this toll operator by means of a finger dial. In connection with the rebuilding of the exchange, the outside net has also been modernized with underground cables in the central portion of the city and air cables in the outskirts, the necessary material having been furnished by the L. M. Ericsson cable works at Älvsjö. *D. L.*

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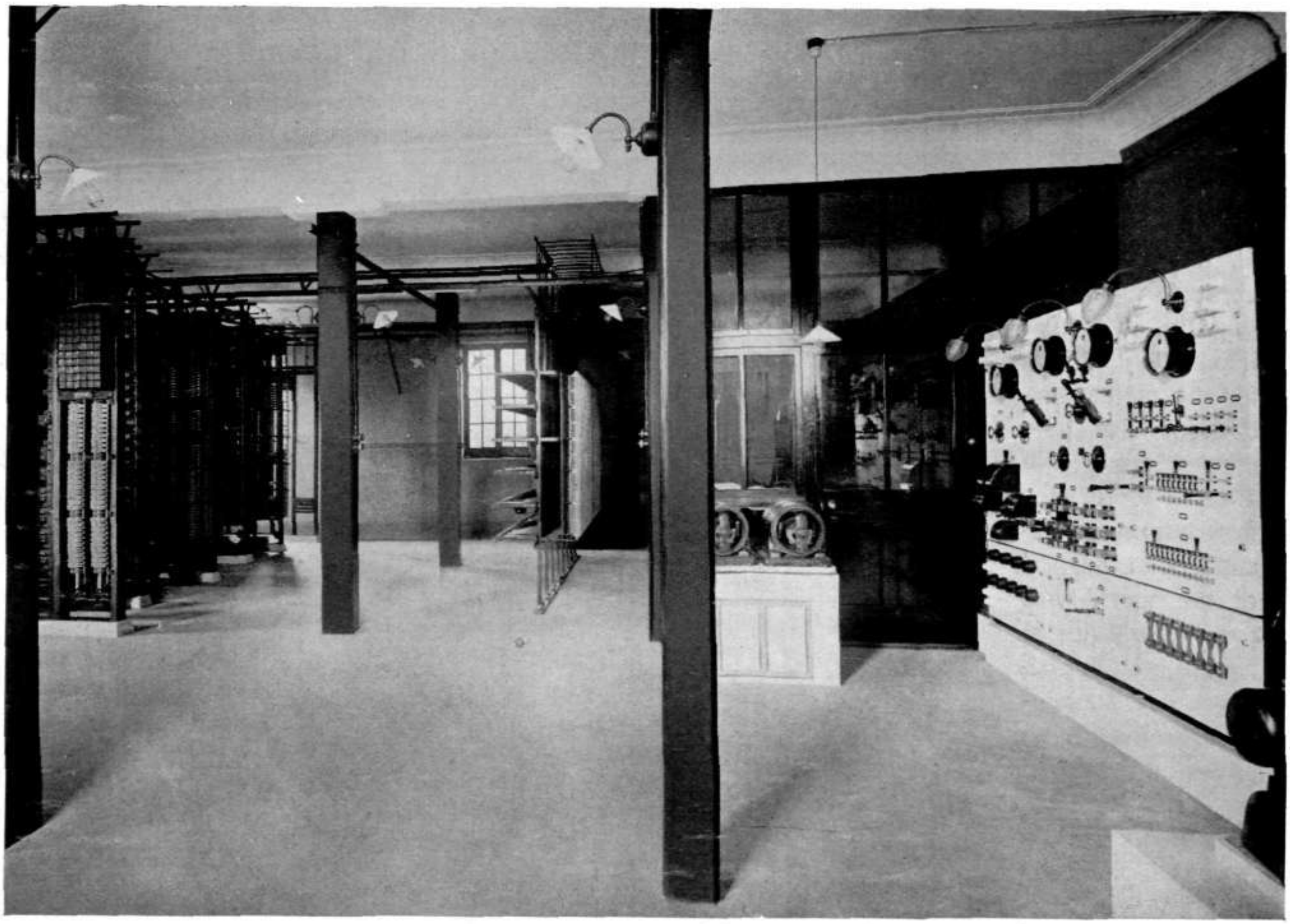

THE SHANGHAI AUTOMATIC EXCHANGE.

ENGLISH EDITION

L. M. Ericsson

THE L. M. ERICSSON REVIEW

ENGLISH EDITION.

JOURNAL OF

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The Shanghai Automatic Exchange.

From a service point of view, the introduction of automatic switching must needs be of special interest in the far East, where the confusion of tongues often makes it extremely difficult for the manual exchanges to give efficient service. In 1922 one of the first automatic exchanges in this part of the world was put into service in Harbin, and in Dairen there is an automatic exchange with provision for a total capacity of 5000 lines. In Tokio, about fifteen telephone exchanges were destroyed by the recent great earthquake, and these are now to be rebuilt and equipped for automatic switching.

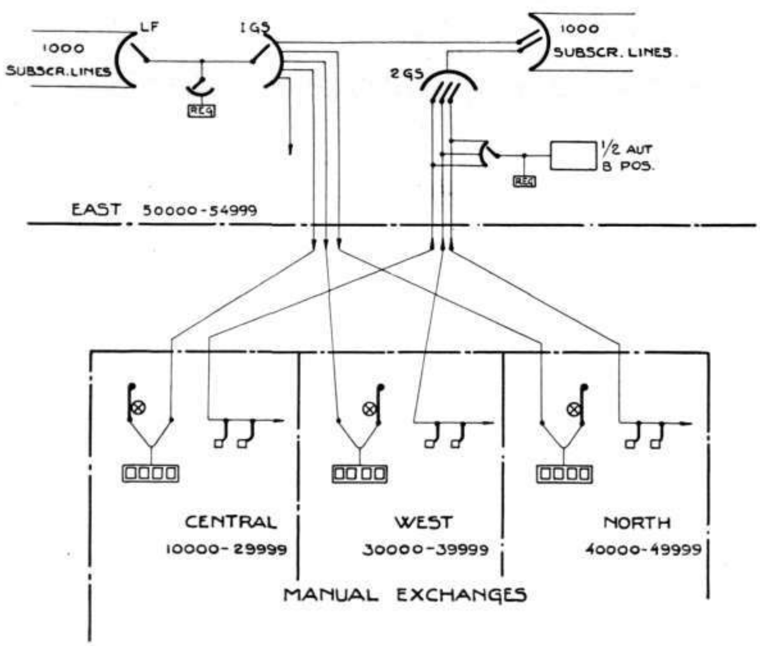

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Fig. 1. Junction Routing Plan, Shanghai East.

The Shanghai Mutual Telephone Company, Ltd., owners of the Shanghai plant, some time ago decided to try out automatic service at one of their exchanges. This decision resulted in the placing of an order with L. M. Ericsson for complete automatic equipment for Shanghai East, and this exchange was opened for service in May of this year. The opening of the exchange resulted in a great congestion of traffic during the first few days, owing to a natural curiosity of the public, their want of practice in the manipulation of the calling dials, and the fact that the new telephone directories, which had to be printed in Chinese in connection with the renumbering of the telephones, were not yet in print. The functioning of the system is entirely satisfactory, however, now that the first curiosity of the public has been stilled and they have become familiar with the new conditions.

The Shanghai plant includes the four exchanges »Central», »West», »North» and »East», of which the first three are still manual exchanges. The automatic system, to which the entire plant is eventually to be rebuilt and in which the »East» exchange constitutes the first stage, is projected for a capacity of 45,000 subscribers' lines, distributed as follows: —

Central,	20,000	lines	numbered	10,000—29,999
West,	10,000	»	»	30,000—39,999
North,	10,000	»	»	40,000—49,999
East,	5000	»	»	50,000—54,999

The first stage in the construction of the »East» exchange includes equipment for 1000 subscribers' lines and arrangements for handling junction traffic with the three manual exchanges.

An explanatory routing plan over the distribution of traffic for the new automatic exchange is shown in fig. 1, the grouping of the selectors together with junction lines to and from the manual exchanges being shown.

The local traffic is carried over line finders *LF*, first group selectors *1 GS* and connectors. The first ten multiple frames in the group selector rack are for the trunk lines to the connectors for 5000 subscribers. As the exchange is equipped at present for only 1000 lines, only frames *1* and *2* are mounted in the rack.

Junction lines run from frames *21*, *22* and *23* in the group selector racks for the first group selectors to the three manual exchanges, Central, West and North. These junction lines terminate in single cords at special B-positions in the

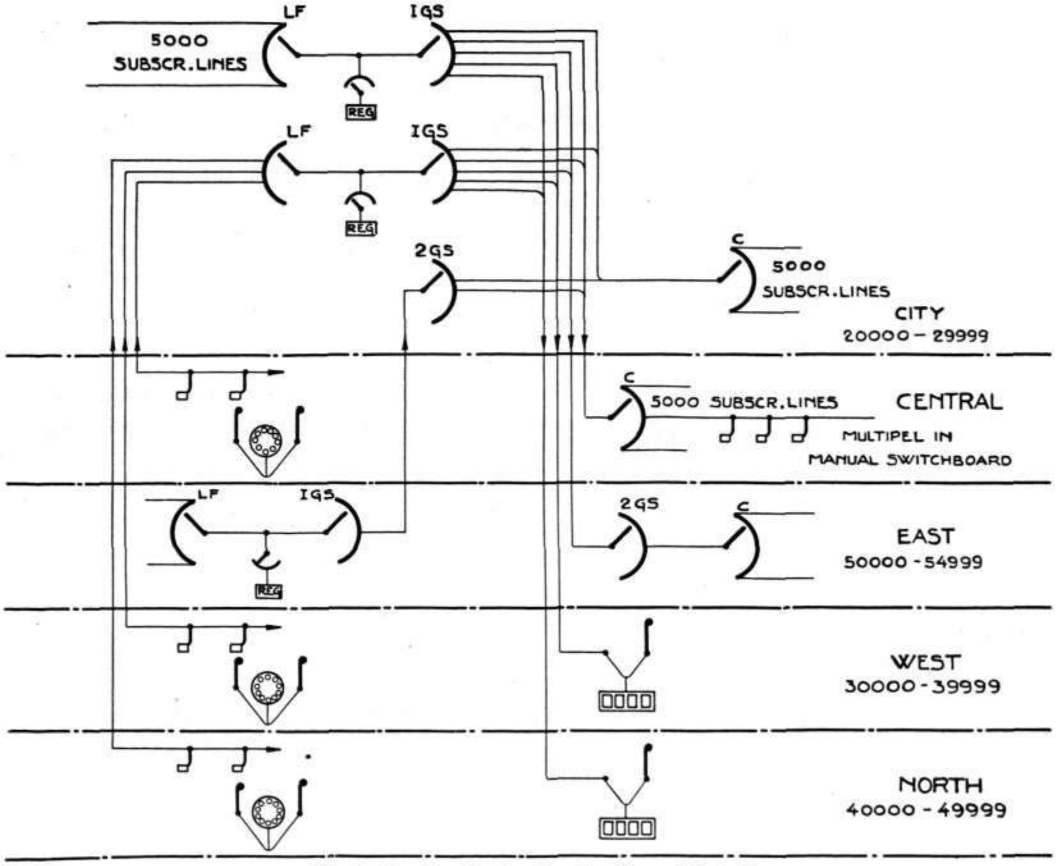

Fig. 2. Junction Routing Plan for City and Central.

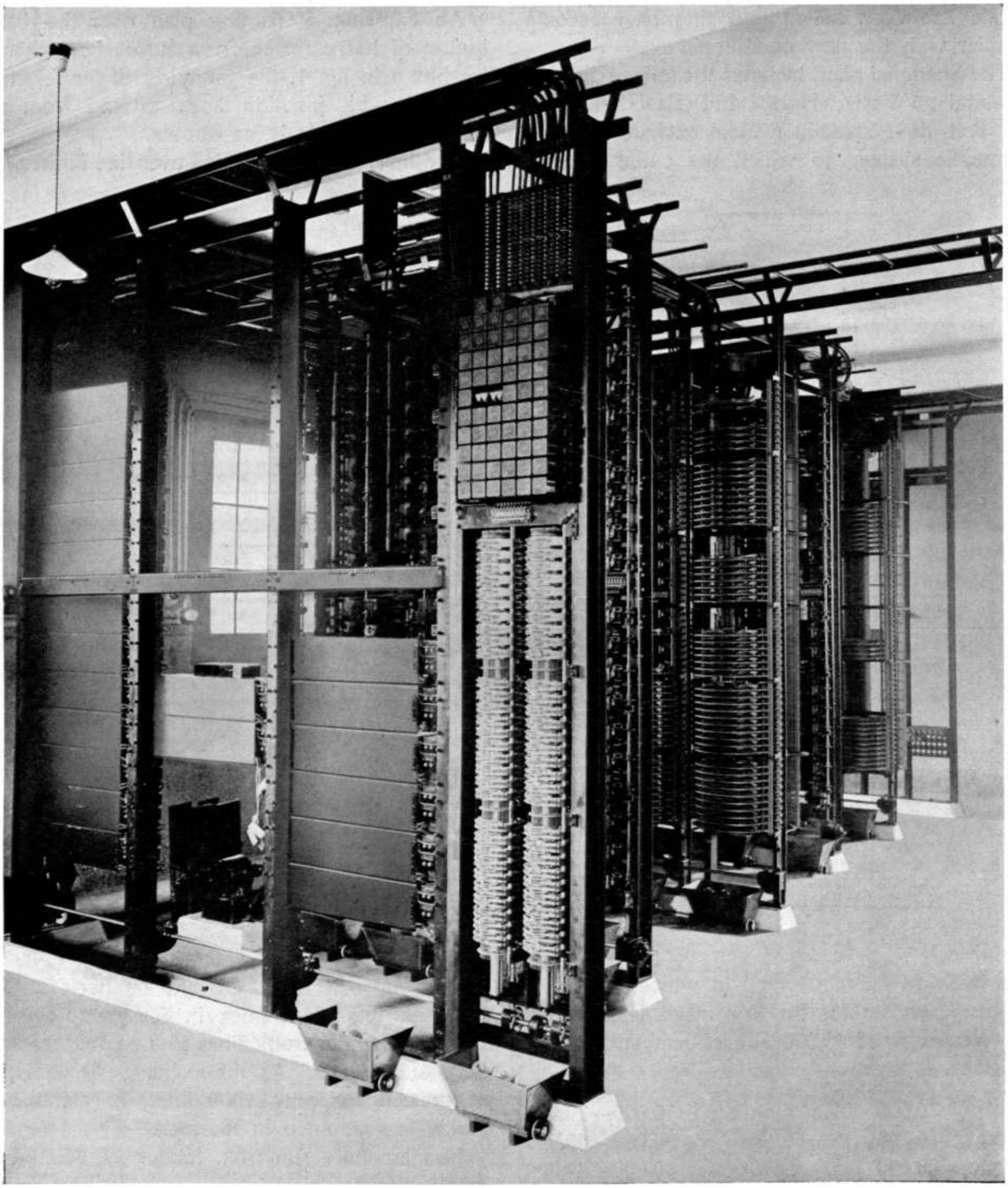

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Fig. 3. The Automatic Equipment at Shanghai East.

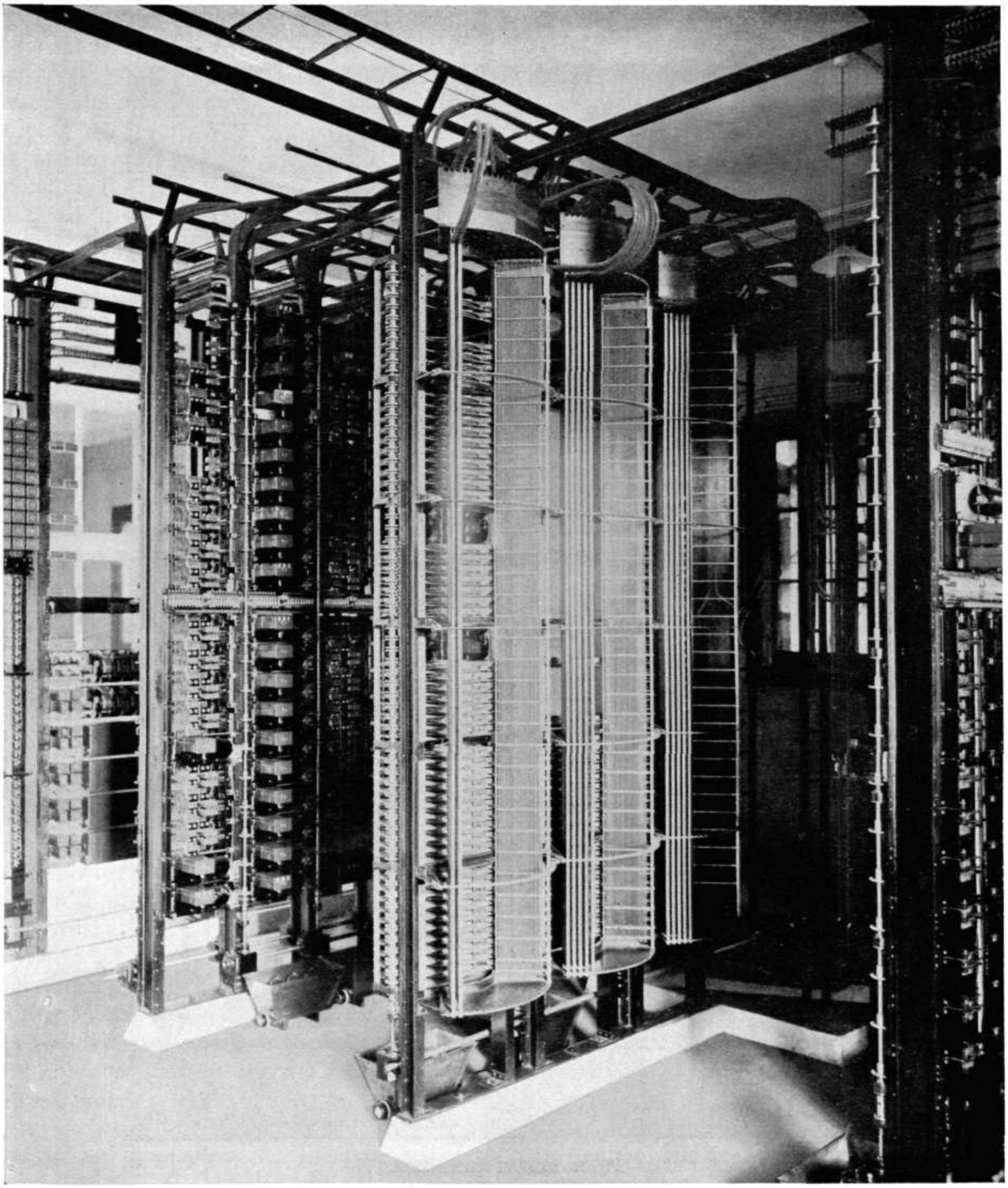

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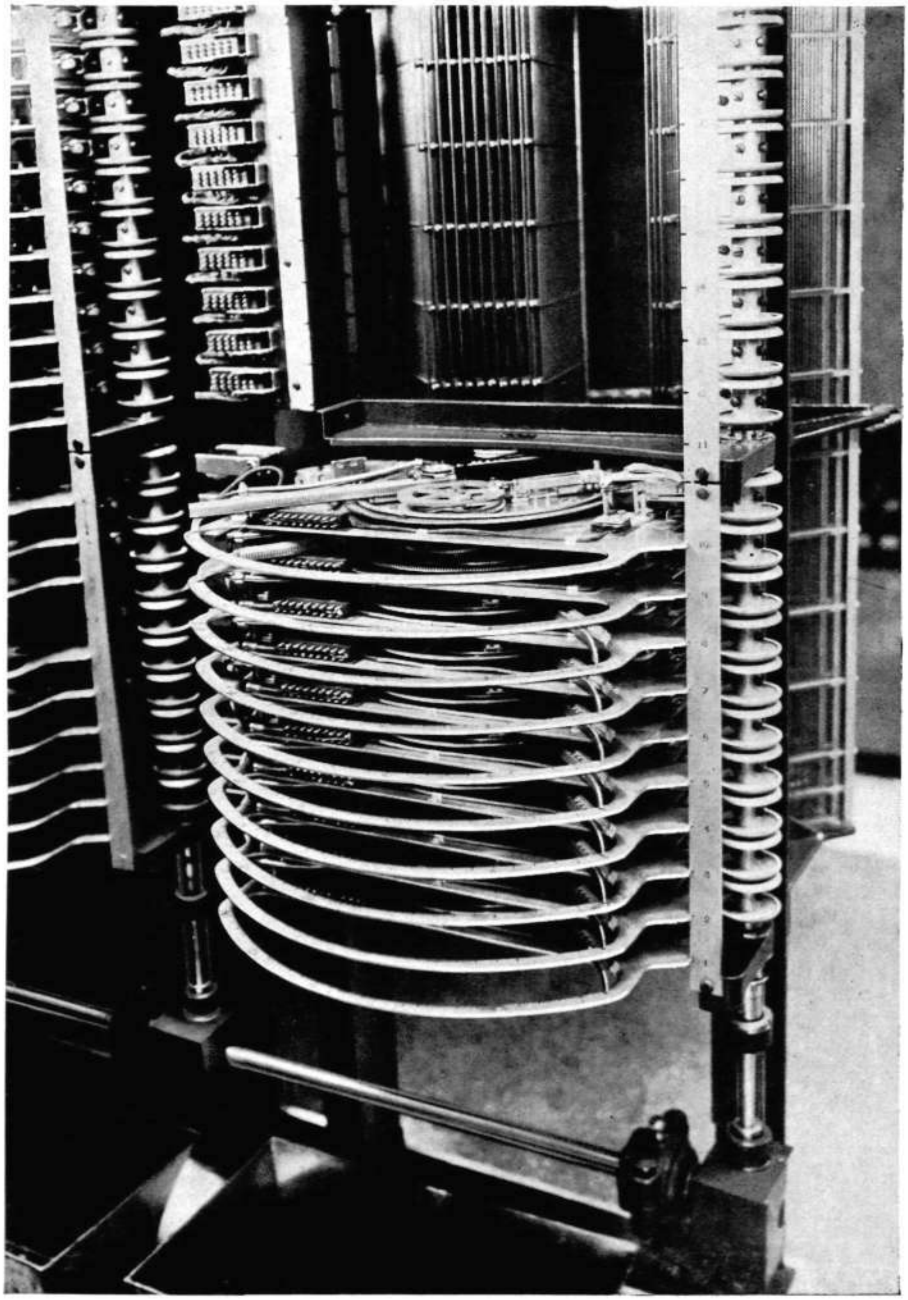
Fig. 4. Shanghai East. Group Selector and Sequence Switch Racks.

respective exchanges, these positions being equipped with call indicators.

All calls from the part of the automatic subscribers are dialled, no matter whether the called subscriber is connected to the automatic exchange or to one of the manual exchanges. For instance, if an automatic subscriber wishes to call number 15789 at Central, all he has to do is to dial the five-digit number in the usual manner. The group selector then seeks out the multiple frame to which the »Central» junction lines are connected. The group selector seeks an idle line

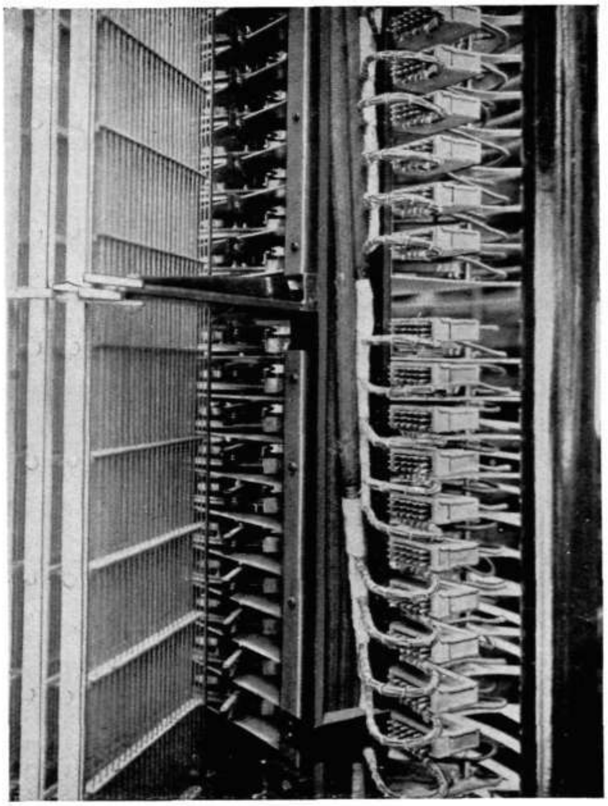


R 160 Fig. 5. Detail of Selector Rack.

and the call is connected to a single cord of a B-position at Central. The calling lamp of this cord glows, and the number dialled by the calling subscriber is simultaneously shown on the operator's call indicator by means of glowing numerals. The operator has now only to introduce the plug of the ringing cord into the multiple jack of the subscriber whose number has been denoted by the call indicator. Testing and ringing the called subscriber is done automatically. If the number is busy, the calling subscriber receives a busy signal; if idle, the ringing signal is heard. Thus the B-operators do not have to speak to the subscribers, their sole duty being to plug in the called number and to disconnect when a ring-off signal is received.

The junction lines from the manual exchanges terminate in second group selectors *2 GS* at the East exchange. Connections are effected by means of B-operators at semi-automatic positions. Traffic over the service lines is established according to the following principle.

When a manual subscriber wishes to be connected to an automatic subscriber on East exchange, he asks the A-operator for the desired number in the usual manner. She then gets in touch with the B-operator at the East exchange over an order wire and repeats the called subscriber's number. At the same moment as she depresses the speaking key, a register finder at East is set in motion, its function being to connect in an idle register and at the same time to automatically find an idle junction line. The B-operator gives the number of the junction line to the A-operator, and when she observes that the A-operator has inserted the plug, this being indicated by the extinguishing of a lamp on the B-position of the junction line, (this lamp having been put in circuit simultaneously with the connecting in of the register) she sets up the called number on her keyboard. The group selector and connector are now set to their respective positions, their movements being controlled by the register of the B-position. The switching units are automatically restored to normal when the line is cleared, no intervention on the part of the B-operator being required.



R 162 Fig. 6. Detail of Selector Rack.

From the fact that tenders have also been invited for the installation of automatic equipment at the main exchange »Shanghai Central», it may be taken as a proof that the introduction of automatic switching in Shanghai is considered a success. As the proposal for the rebuilding of this exchange calls for some arrangements which are rather unusual within the field of telephony, it may be of interest to mention the main features of the same.

The manual exchange Shanghai Central is built according to the magneto system, as also are the West and North exchanges. It is located on the fourth and fifth floors of the building, the cross-connecting frame and the line relays being placed in the lower story and the operating room in the upper. It is estimated that the number of subscribers' lines at Central will be about 9000 by the time the exchange is to be rebuilt. Of this number, 5000 lines will be progressively connected over to the automatic system at the completion of the first stage of reconstruction, the remaining 4000

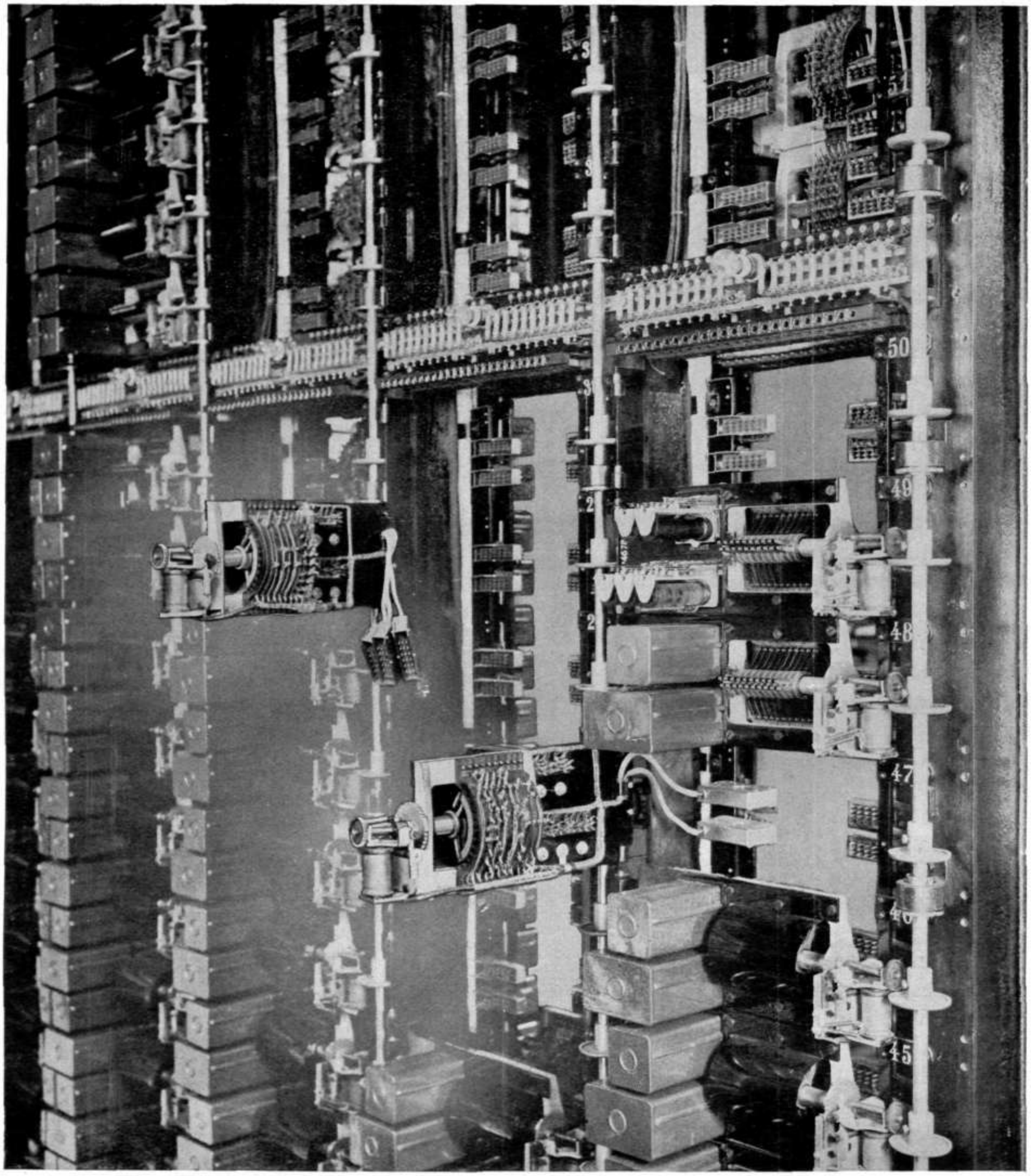


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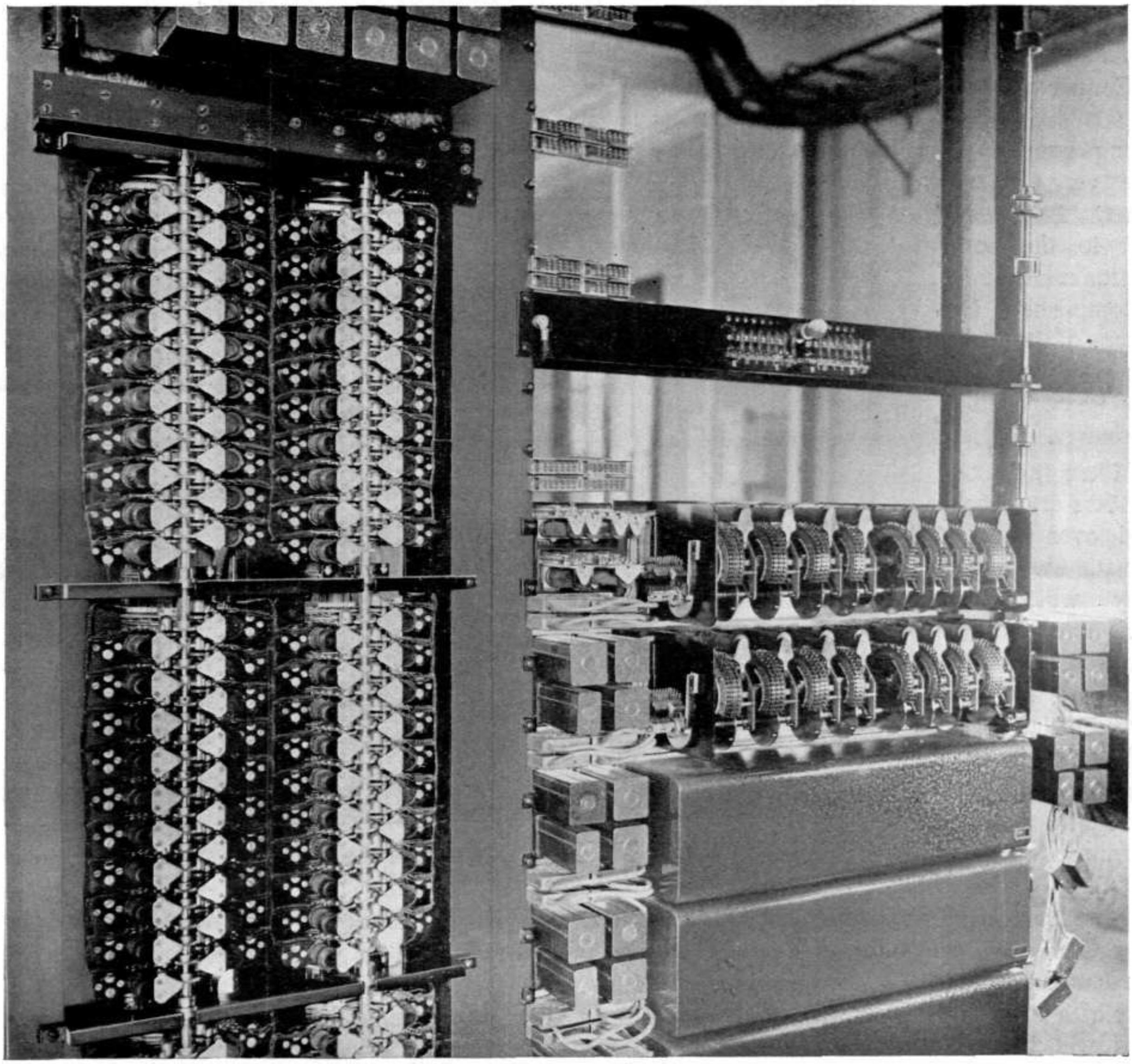
Fig. 7. Detail of Sequence Switch Rack.

still being provided with manual service. The initial automatic equipment is to be placed in the third story, which, when the entire net has been changed over to full automatic working, will contain switching devices for 10,000 lines. Future extensions, up to a maximum of 20,000 lines, will be installed in the room on the fifth floor which now contains the multiple boards.

It is the intention to equip all incoming traffic lines to the manual subscribers — from the new automatic exchange as well as from the West and North exchanges — with automatic service »City», which, together with the manual »Central», will constitute an exchange of 10,000 lines numbered from 20,000 to 29,999.

For the five thousand automatic subscribers



R 158

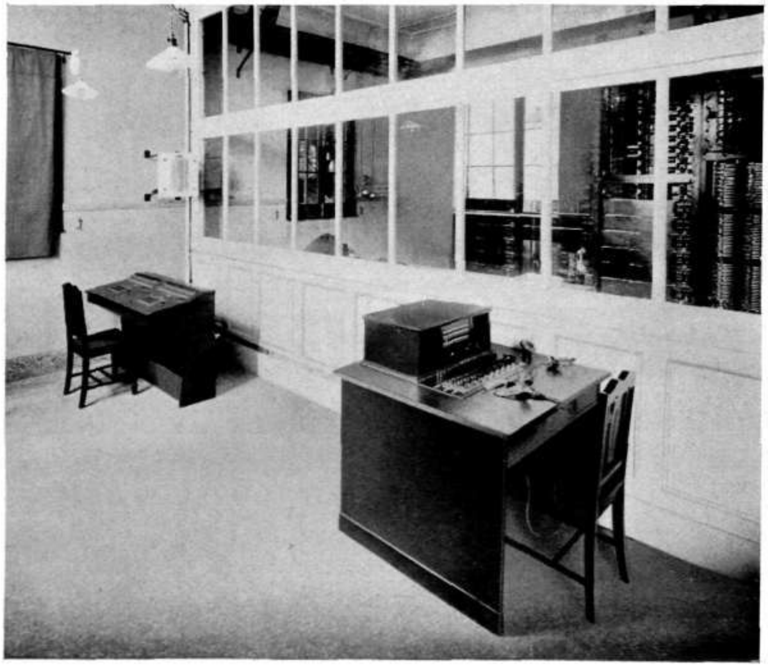
Fig. 8. Shanghai East. Register Finders and Registers.

so as to avoid installing any new B-positions at the manual exchange for the handling of this traffic from the new automatic exchange and so as to provide room for future additions. The grouping of selectors and the routing of junction traffic is schematically shown in fig. 2.

The new automatic exchange will be called will be erected ten racks of line finders — ten five-hundreds groups — and ten racks of first group selectors. The connections of the junction lines to City from Central, West and North, will be the same as for common subscribers' lines, and will require ten racks of line finders and ten racks of group selectors — the same number as for the five thousand automatic subscribers. These racks may be utilised for the connecting in of five thousand new automatic subscribers when the whole net has been changed over to automatic switching and the incoming junctions, therefore, will have been moved over to incoming group selectors *2 GS*.

Connector racks will be erected immediately for 10,000 subscribers' lines, the 9000 manual lines being connected to their multiple banks from the very outset. The branching out to the connector multiple is accomplished by means of the intermediate distributing frame at the exchange.

When the subscribers are changed over to automatic switching they will retain their numbers and therefore also their positions in the connector multiple. The reconnecting will be done in a special intermediate distributing frame and the transferred subscriber will be connected to a line relay for automatic service and will simultaneously receive a connection to the multiple of a line finder rack. As the subscribers' lines will be changed over without regard to their numbering, the multiples in the connector racks — in the beginning, at least — will contain manual and automatic subscribers indiscriminately. For this reason it will be necessary to arrange the scheme, so that the connectors may function regardless as to whether the connections concern automatic or manual subscribers. The A-positions at the manual exchanges will be provided with finger dials for the joint traffic with City and Central.



R 161 Fig. 9. Shanghai East. B-Positions and Information Desk.

The outgoing traffic from City to the West and North exchanges is to be arranged in the same manner as has been described in conjunction with East, and will be led over B-positions furnished with call indicators.

The traffic in both directions between City and East will be led over second group selectors at the respective exchanges.

The junction lines for traffic between East, West and North are not shown in fig. 2. Arrangements for traffic between these exchanges remain unaltered.

Lastly, it may be appropriate to give a few explanations of the illustrations from the East exchange which accompany this article. The illustration on the title page shows a view of the entire switching room. The whole exchange, which is designed for a total capacity of 5000 lines together with switching devices for joint traffic with the other exchanges of this plant, is located in one large room of approximately 36 × 50 feet. To the extreme left of the illustration is shown the automatic equipment. The cross-connecting frame stands in about the centre of the room, and to the extreme right the power board and ringing machines may be seen. The storage batteries are in a separate room with glass wall partitions.

Figs. 3 and 4 show the racks containing the switching apparatus. Figs. 5 and 6 show details of a selector rack. In fig. 6 is shown the method of connecting the cables to the coupling jacks on the selector rack.

Fig. 7 gives a near view of a row of sequence switch panels, two of the sequence switches being swung out.

Fig. 8 shows panels of register finders and registers. Lastly, in fig. 9, are shown the information desk and the semi-automatic B-positions for the incoming traffic from the manual exchanges.

The extremely damp climatic conditions which exist in Shanghai have made it necessary to take unusual precautions in the manufacture and erection of the equipment, to give it the greatest possible power of resistance against moisture. The installation work has been done by the Shanghai Mutual Telephone Company's own staff under the supervision of an erection engineer and an installer from the Ericsson works, Stockholm.

G. G.

Standards for Transmitters and Receivers.

The author of the following article has kindly permitted the L. M. E. Review to re-publish it. It is our opinion that the question of fixing suitable standards for transmitters and receivers is of the greatest importance for the development of international telephone traffic. By inserting telephone amplifiers this traffic has already exceeded the present range allowed for by the authorities.

The problem of finding suitable telephone standards is not yet solved, for the European Telephone Conference in Paris 28/4—3/5 1924 did not state any other particular opinion than that the International Consultative Committee considers it important to have available instruments enabling the measuring of the magnitudes in question.

Foreword.

The Preparatory Committee of the European Telephone Conference has proposed the Solid-Back Transmitter and the Bell Receiver as Standards. It is however herein shown that these instruments do not meet the requirements. Herein is also shown a means of obtaining measuring units and also the necessity of fixing equivalent comparative methods.

The Preparatory Technical Committee of the European Telephone Conference has set forth the following propositions, based upon its discussions regarding the claims of telephone instruments in international practice.

1. The same type of telephone iustrument shall be chosen as a standard in all European Countries.
2. A telephone instrument provided with a solid-back transmitter and a bell receiver shall be used as a standard (subject to modification at a future date).
3. The sound-effect of telephone instruments in Europe may not be less than that of the standard.

In fixing common standards for telephone instruments, the clauses 1 and 3 must be agreed to. The practicability of clause 2, however, is doubtful.

Apart from the question of the solid-back transmitter and bell receiver conforming to their claims as standards, it is doubtful if an effective comparison between the transmitters and the standard can be made. The solid-back transmitter is not extensively used in Europe, the hand-microtelephone being preferred in Scandinavia, Germany and many other European countries, owing to the influence of Swedish technics upon the development of telephony. The use of the H. M. T. with the desk set and also with many other instruments has always turned out satisfactorily. It is therefore improbable that the cumbersome American candle-stick pattern can successfully compete with the H. M. T.-set. The solid-back transmitter cannot be used on a H. M. T., for, apart from its weight, it is too strongly damped for satisfactory working at the varying distances between the mouth of the speaker and the mouthpiece of a H. M. T. Trials made by the German Telegraph Department with the solid-back transmitter have shown that this transmitter does not suit our conditions even if its good character as regards constancy and clearness of speech be appreciated. Consequently, other transmitters, considerably more sensitive, have been designed in countries not using the solid-back. The results obtained by speaking on long telephone lines have shown that these transmitters are as efficient as the American transmitters. The constancy of these types of transmitters has been improved from time to time. They have therefore been extensively used, being both interchangeable and cheap owing to their capsule form.

If it is difficult to compare transmitters of the same or equal construction, the results must be altogether uncertain when the transmitters are of a different mechanical and electrical character. As this is a matter of practical methods one must disregard the complicated testing arrangements at special laboratories. The tests thus made do not give effective results as the distortion and resonance effect play an important rôle, apart from the power generated in the transmitter. Practical speech tests must therefore be made. The vertical sound waves between the mouth of the speaker and the transmitter diaphragm are causing a great influence which cannot be eliminated. These sound waves are, when speaking in our transmitters at a distance of 5—8 cms from the mouthpiece, of quite a different character to those caused by speaking close to the mouthpiece of a solid-back transmitter. It is therefore hardly possible to transmit with equal articulation at different distances from the mouthpiece. These practical reasons show the impossibility of selecting the solid-back transmitter, with its special application as standard for our transmitters, claiming other merits.

It is doubtful whether it is advisable to choose the solid-back transmitter and bell receiver or other similar apparatus as comparative standards. Practical application must be the foremost consideration. If the proposed instruments are to be taken as standards it is clear that they can only be produced through an equivalent and careful manufacture from exactly the same material with the precision necessary for such purpose. All the European Countries would therefore have to take these standards from the same manufacturer. These standards must also at regular intervals be sent to a special laboratory for testing whether they still hold their primary values. This is a laborious procedure. Further, there is still the risk that the tested standards would lose their permanence during transport, with its unavoidable shakings and moisture, without any possibility of controlling this fact on arrival. The tests made against such standards would therefore be defective.

Further, experience has shown that it is doubtful whether carbon transmitters and permanent magnet receivers are sufficiently constant to be used as standards. Carbon is an inconsistently varying material which in a relatively short time loses its primary character on account of the influence of the current. As it is a product of secret manufacture it is hardly possible to fix its quality for using in standards. The magnet steel, which forms the principal part of the receiver, is also subject to variations. The permanence depends upon the composition of the steel and also upon the method of treatment during the manufacture, which also is usually secret. It is difficult to verify the variations of the steel caused by shakings and by influences from other magnets. Thus, neither carbon transmitters nor permanent magnet receivers have the consistent characteristics necessary for effective comparative testing.

It is not the object of this article to propose a certain standard to meet all requirements, but it would, however, be of value to discuss the claims on the measuring units to be chosen. The following points are generally accepted.

1. The standard must be reproducible, i. e. accurate manufacture of standards to drawings and specifications should be possible. (The material employed must be specified exactly.)
2. It must be possible to determine, by equivalent measuring methods, whether the standard possesses the character specified.
3. The standard must be adjustable.
4. Precise methods must be fixed for comparing the transmitters and receivers under test against the standards.

To this the following may be added. It is not so feasible to state a measuring unit for speaking apparatus as, for instance, for length or weight. A reproducible standard should be searched for. In this connection it may be mentioned that there are other less simple units, for instance, the candle-power as the unit of light and the standard cell as a unit for electromotive force. These standards are anywhere exactly reproducible to specification. For comparative tests of speaking apparatus the non-polarised receiver may be taken into consideration. It is sufficiently simple and clear as regards the construction to allow its manufacture without any difficulties. Its active main parts are the diaphragm and the electromagnet system. As these parts are manufactured from laminated iron to eliminate eddycurrents it may be practicable to manufacture the diaphragm and the iron-core of the same quality of iron sheet (not exceeding 0.3 m/m in thickness) in order to have a conformity of these main parts. The thinness of the iron sheet is also a guarantee for its good quality. The stipulated character of the iron may also be easily tested by known measuring methods. As the magnetisation is made with direct current the force may easily be determined. The same is the case with the measuring of other values, for example, the distance between the diaphragm and the pole piece etc. By this method it should be possible to obtain a standard with a predetermined and constant sound-effect. As such apparatus can be used both as a transmitter and as a receiver, a standard for both these instruments is thus obtained, which is a special advantage. Transmitters and receivers built on the condenser principle may also be used as standards, even if their equivalent manufacture is more difficult than the non-polarised receiver. As these instruments, however, cannot be used without employing repeaters, their application is more difficult.

From the foregoing it will be seen that the difficulties of obtaining a standard for speaking apparatus is not insurmountable. The problem of satisfactory comparative testing of apparatus is not so easily solved. The difficulties of comparing speaking apparatus, and more especially transmitters has been pointed out above. Even when using a standard, the comparative results are dependent upon the human element. When telephone sets of quite different character are to be compared in order to decide their quality, a definite measure must be fixed, stating how much the apparatus under test is above or below standard. In this way one can anticipate the results which can be obtained in practice by using a certain type of apparatus. The principle of this measuring unit must first be decided. One method is to make comparative speaking tests over an artificial cable with known characteristics, thereby determining how much of the standard test cable may be switched in or out to obtain the same volume of sound with the apparatus under test and the standard. The actual attenuation of the standard cable switched in or out may be considered a measure of the efficiency of the apparatus in question. This measure may also be obtained in other ways. It is imperative, however, to fix the method of comparing the apparatus under test against the standard. As before mentioned, when speaking into a German transmitter under the same conditions as into a solid-back, the comparison would be quite useless. It must therefore be fixed how the standard and also every other type of transmitter may be used, i. e. the distance between the mouth of the speaker and the mouthpiece. The testing arrangements must be of such a nature that it is possible to maintain a constant speaking distance. Further, the constructive particulars of the different types of apparatus must be carefully specified, i. e. the size of chamber, the form of the mouthpiece etc. It is also essential to work out a special system for speaking into the apparatus. This may be done by fixing a series of syllables containing vowels and consonants in different combinations. When testing it is then determined how many faults have been made during the transmission. These tests must be made by voices of both sexes. When obtaining equivalent results with the apparatus under test and the standard, the difference in attenuation determined under equal circumstances may be a measure of the efficiency of the apparatus.

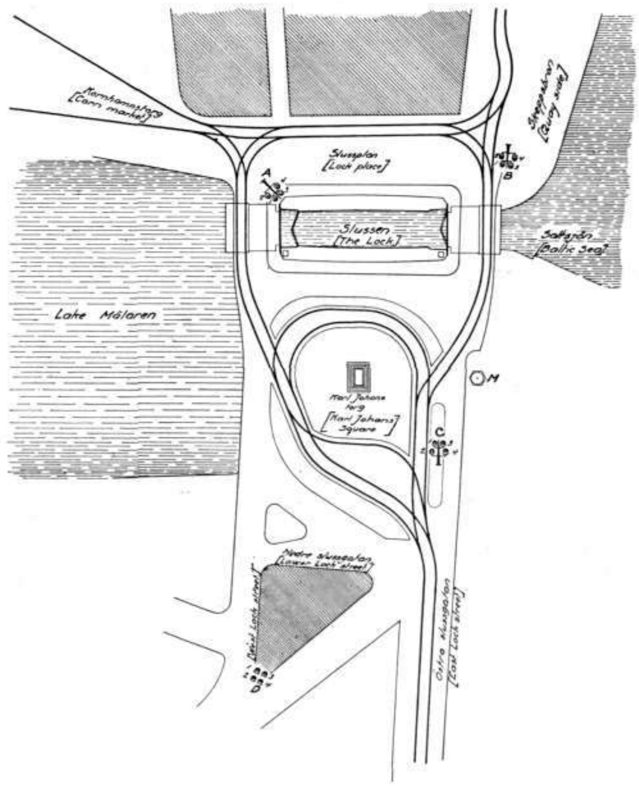
The German Technical Department is at present searching for a standard suitable for telephone instruments. The existing comparative methods will be accomplished in the before mentioned manner. It would be desirable that other telephone authorities made similar tests. The various results obtained could then be discussed at a telephone conference, thereby fixing the unit and the comparative methods.

Karl Hersen.

Oberpostrat und Abteilungsdirigent im Telegraphentechnischen Reichsamt.

Traffic Regulating Signals at the Stockholm Lock.

In 1922, when through traffic between the North and South tramway systems of Stockholm over the lock bridges was established, it became necessary to regulate traffic passing over the bridges, these being occasionally closed to street traffic and opened to sea traffic through the lock. On such occasions the traffic, which is normally handled by both bridges, must be led over only the one, and the tramcars and other vehicles are informed as to which bridge may be passed, signals having been arranged on both sides of the lock for this purpose. They were originally intended for the use of the tramcars, but are equally useful for other vehicles as well.



F 151 Fig. 1. Plan Showing Lock and Vicinity.

Signals have been placed at four different points, as shown on the accompanying plan, on which they are denoted by the letters *A*, *B*, *C* and *D*. Signal *B* serves the traffic from the Quay side, *A* the traffic from the Corn market, and *C* the traffic from East Lock street, these signals being mounted on tramway poles. The signal *D*, which is mounted on the corner building between West Lock street and Lower Lock street, is not for the use of the tramcars, but, unlike the other signals, only for other vehicular traffic going in the direction of the lock.

Each signal is composed of four lanterns placed in two rows, as shown in fig. 2. The two upper lanterns of each group give intermittent green flash-signals and the two lower ones similar red signals. Two of the lanterns are always simultaneously flashing, the other two being dark. The two right hand lanterns denote the bridge which is to the right when approaching the lock from any direction, while the two lanterns to the left denote the left bridge. A green signal means *clear*, and a red means *stop*.

For example, if we advance towards the lock from the Quay side and observe two green flash-signals from the signal group *B* — the only one visible from this point — it means that both of the bridges are open to traffic. A green signal to the left and a red signal to the right but slightly lower indicate that the bridge nearest the Baltic sea may be passed, but that the bridge on the Lake Mälaren side is closed to street traffic, and so forth.

Thus we see that the entire signal system is extremly simple and effective.

The lanterns are furnished with lenses to make the signals sharper, and are also provided with funnel-shaped screens so as to make the signals visible by daylight.

The signals are controlled from a signal tower *M,* placed close to the pavement on East Lock street, east of Carl Johan's square. The upper part of this tower, as may be seen in fig. 2, is lantern-shaped with windows on all sides, so as to give the watchman posted in the tower a clear view over the entire vicinity of the lock. Ringing signals and telephone communication have been installed between the signal tower and the position occupied by the lock operator, enabling the tower watchman and the lock operator to exchange signals before the opening of a lock bridge for sea traffic. The raising of one of these bridges many not take place without the permission of the tower watchman, who, by altering the flash-signal for the bridge to be raised from green to red, first orders the tramcars to pass over the other bridge. When a lock bridge — after having been raised for the passage of boats — is again lowered, for the passage of street traffic, the lock operator informs the tower-man of the fact so that he may forthwith change the stop signals to clear.

R 152 Fig. 2. Traffic Signal Mounted on Tramway Pole.

This altering of the respective signals for the one or the other lock bridge is accomplished by one single manipulation, it being only necessary for the watchman to throw a switch from one position to the other, this switch having one position for »stop» and one for »clear». Two such switches, one for the signals of each bridge, are mounted on an instrument board within the tower. In addition to various devices required for the signalling system, this board is also provided with control lamps for the light signals, by means of which it is possible for the watchman to control these latter.

The flash-signal lights are electric. The flashes are produced by means of a light-flashing device actuated by a 220 volt direct current, as used for the signal lamps. The lighting current for all of the signal lights is led over the contacts of a relay connected to the light-flashing device. The relay contacts are alternately closed and opened by means of the light-flashing device, causing the signal lights to be alternately lit and extinguished about sixty times per minute, the light and dark periods being of equal duration. All of the lamps which glow simultaneously — two in each signal group — flash in unison. Two light-flashing devices with associated relays are installed in the signal tower, one of them being for emergency use.

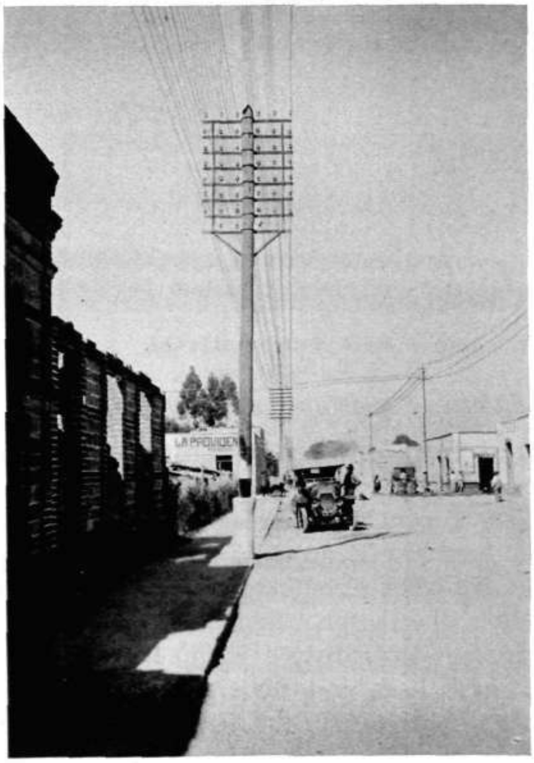
In addition to the telephone communication between the tower watchman and the lock operator, telephone instruments have been mounted on the tramway poles at *A*, *B* and *C*, whereby the tramway employees, if necessary, can communicate with the watchman.

The equipment for this signal plant has been furnished by Allmänna Telefonaktiebolaget L. M. Ericsson through Signalbolaget, the erection of the same having been done by A.-B. Stockholms Spårvägar (The Stockholm Tramways Company.)

E. G. W.

Some Points of View Regarding the Preservation and Maintenance of Wooden Telephone Poles.

The annual consumption of wooden poles for telephone, telegraph and power lines in the whole world is constantly increasing, partly due to the steady growth of new subscribers to public utility enterprises and partly due to the continuous replacement of already existing poles.

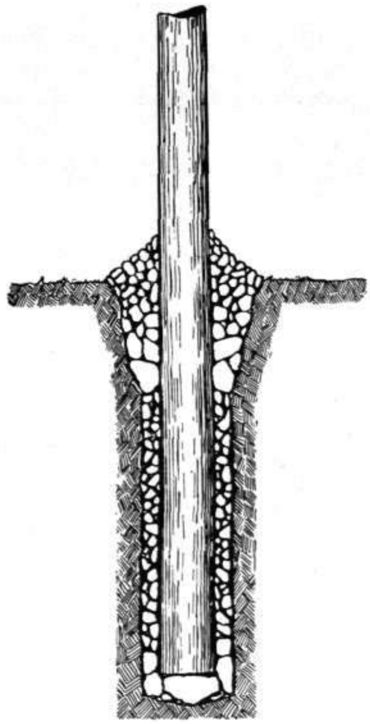


R 169 Fig. 1. 32-foot Telephone Pole with Pole-Support, Mexico D. F.

A. J. Wallis-Tayler, in his book »The Preservation of Wood», makes the statement that 80 to 85 per cent of all wood is lost by decay; the ravages of insects, fires and mechanical destruction account for the balance.

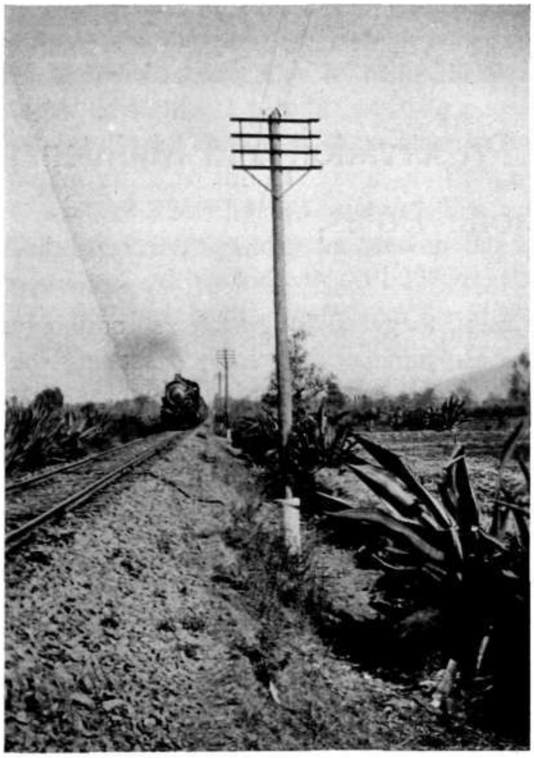
There is a natural desire on the part of all pole users to get as long a life as possible out of the poles purchased, thereby lessening the depreciation rate and bringing the cost of maintenance down to a minimum.

It is of the greatest importance, from a viewpoint of both national and private economy, to increase the length of life of wooden poles, and for this purpose many different methods have been used with more or less success.



R 177 Fig. 2. Pole Drainage According to Swedish Government Telephone Service.

The decay of wood is caused by the growth and activities of fungi at a certain degree of moisture and in the presence of air. If heat is present, the action is accelerated. All wood placed in direct contact with the ground — which always



R 170 Fig. 3. Pole Line in Course of Erection in Mexico.
Note Location of Poles in Ditch.

R 171 Fig. 4. Pole-Support in Use.

contains a considerable amount of moisture — is especially exposed to fungi which, to a great extent, live and thrive in the soil.

Every user of wooden poles will notice that it is at the ground line and immediatly below it, that a pole starts to decay, as it is just there that the three fundamental conditions exist — wood in direct contact with earth, moisture and air — which are necessary for the growth and activities of the fungi.

The minute spores of one of these fungi germinating on a piece of wood send out threads, like cob-web, invisible to the naked eye, which enter by cracks in the sap-wood and soon change the physical and chemical properties of the cells, rendering the wood of a brownish colour and decreasing its strength. Little by little the wood becomes completely decayed.

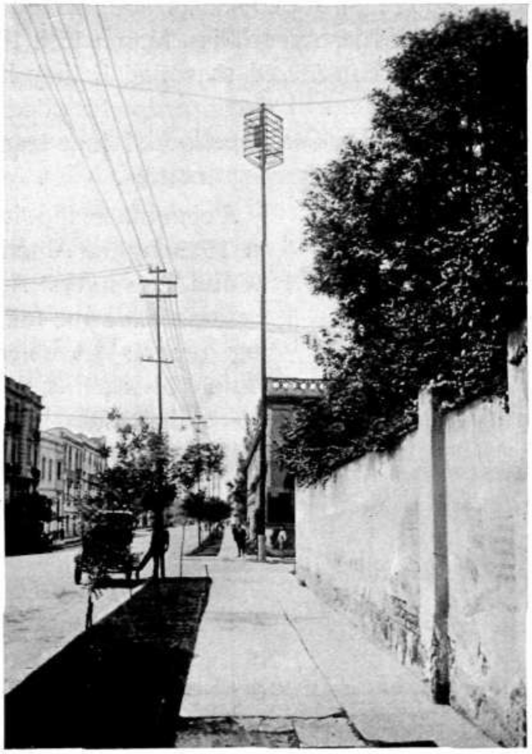
If protected from the action of these fungi, or even if they are present, but lack the conditions necessary for their propagation, wood will last indefinitely.

Conditions of moisture necessary for decay.

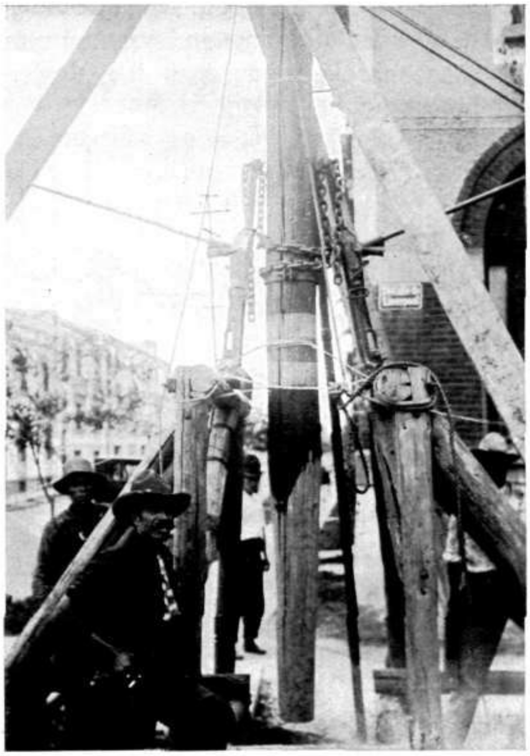
Apart from ordinary circumstances the fungi, in order to thrive, are in an eminent degree dependent on a certain percentage of moisture. We know from experience that timber kept in a perfectly dry place or entirely under water, will keep for ages, the reason being that in the first case its content of moisture is too low, and in the latter case it is too high, to allow the fungi to live. Besides, in the latter case the air is excluded, which still more prevents the existence of fungi.

According to Johan Edén of the Swedish Government Forest Service, in an article published in 1922 in the bulletin »Skogen», the percentage of moisture of wood must not fall below a minimum of 18 % to be suited for the thriving of fungi.

Generally wooden poles above ground contain less moisture than the limit mentioned, and it is only the rainwater that now and then tends to increase it.



R 172 Fig. 5. 78-foot Distribution Pole of Wood With Pole-Support.



R 173 Fig. 6. Setting of Amputated Pole in Pole-Support without Interrupting Service.

Thus, if the portion of the pole above ground generally contains less moisture than is required for the fungi to thrive, such is not the case with that part of the pole encountered at and below the ground line. On account of the moisture always present in the subsoil the pole here absorbs such moisture to a degree that will just suit the growth of fungi, and that will stay nearly constant for a great length of time.

Sap confined in timber that has not been well dried will ferment and cause dry rot. According to V. Petrin — »Mitteilungen über Gegenstände des Artillerie- und Genie-Wesens», 1898 — sap-wood is more liable to be attacked by dry rot than heart-wood; dry wood has been found to offer greater resistance than wet wood; timber from trees felled in winter will better withstand dry rot than that from trees felled in summer. Coniferous woods are much more liable to be attacked by the fungi of dry rot than the woods of foliferous trees.

It is a well-known fact that where wooden beams are hermetically enclosed in brick-work, etc. or where green timber is painted or treated with creosote, etc., the pores of the wood are sealed, preventing the beams from drying in a natural way. The enclosed sap soon begins to ferment and the wood is destroyed very rapidly although its firm outside shell may give it a deceptive appearance of soundness and strength.

Drying of timber.

For this reason, the sap should first be removed as thoroughly as possible by seasoning, before the wood is painted or coated with other protective composition or subjected to any preservative treatment. Seasoning is accomplished by drying the wood in air at natural or higher temperatures, or by first steaming the wood under pressure so as to vaporise the sap, and then removing the latter by means of a vacuum.

Thorough seasoning of large timbers in dry air and at ordinary temperatures may require years. On the other hand, too rapid kiln-drying cracks and weakens the wood. It is questionable, however, whether steaming and vacuum remove the sap as thoroughly as does the slower air drying process.

Preservative treatments of wood.

The desirability of employing some efficient process for the preservation of wood is now universally admitted, and preservative treatments are being made use of to an ever increasing extent.

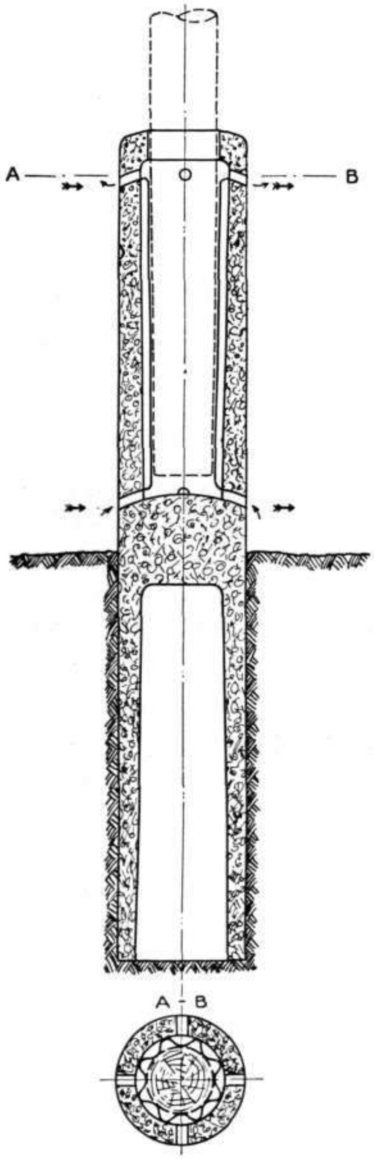
Wood which is to be treated should be of such character as to permit the preservative substance to penetrate at least the sapwood and, if the heartwood cannot be impregnated, it should in itself be resistant to decay.

Timber to be treated should, therefore, be felled in winter, when the sap has ceased to flow, less of it consequently being contained in the wood.

In his book antitled »The Preservation of Wood», page 91, A. J. Wallis-Tayler makes the following statement:

»The wood to be treated should, moreover, be in a proper condition, that is to say, properly seasoned, or at the very least half-seasoned. In the best practice in Europe the wood is not treated until it has been seasoned from six to twelve months. In the United States, however, wood is frequently treated four to six months after cutting, but generally with inferior results».

According to specifications for butt-treatment of cedar poles in open tanks adopted by the Western Red Cedar Association March 15th 1916, poles shall be considered seasoned if they have been properly piled for a period of four seasoning months.



R 178 Fig. 7. Sections Showing Construction of Pole-Support According to the Rost System.

A committee, appointed in 1915 by the American Wood Preservers' Association, made the following report: »A determination of whether wood is sufficiently air-seasoned for efficient treatment may be based on moisture extraction from borings which should show an average of not over 20 per cent moisture in relation to the oven dry weight of wood».

Taking into consideration that green wood dried in an oven still contains a considerable amount of moisture, the author considers the foregoing limit of 20 per cent as being far too high to permit a satisfactory impregnation, as the moisture and sap contained within the timber after any kind of treatment that closes up the pores of the wood, will facilitate dry-rot, shortening the life of the timber as stated.

There are a multitude of preservative treatments of wood, but we will confine ourselves to a brief mention of the most commonly used methods, which are as follows:

Butt-treatment with creosote.

The creosote-oil, in which the pole butts are immersed, is heated to about 65° Centigrade, allowed to cool, heated again etc., alternatively, until a sufficiently deep penetration has been obtained.

The latest development in butt-treatment is the Pentrex method, whereby the poles are punctured for a certain distance above and below the ground line with steel points, the spacing between them being calculated so as to permit a maximum penetration of the preservative oil. According to an article published in »Telephony», Vol. 85, No. 16, page 37, it is claimed that the puncturing theoretically causes the sapwood to lose 8 per cent of its strength. It is the opinion of the author, however, that the loss will be much greater in actual practice. As it is the sapwood of a pole that has to resist the heaviest strain, it is not prudent to impair the original strength of a pole by puncturing at the point where it will experience the heaviest strain and at the same time be exposed to decay.

R 174 Fig. 8. Form and Reinforcement for Pole-Support.

Creosote impregnation under pressure.

There are several processes using heavy creosote, or dead oil of tar, which, in closed vessels, under a pressure of 100 to 180 lbs. per sq. inch and at a temperature of 100° to 130° Centigrade is forced into the fibers of the wood.

The *Bethel* and *Boulton* processes are classified under the so-called full-impregnation methods, while the *Rüping* process is more economical than the two afore-mentioned. A smaller quantity of creosote is required in this process, all superflous oil being removed from the wood cells by vacuum after full-impregnation.

The treatment of poles with creosote under pressure must be done with the utmost care, as otherwise it may prove to be almost valueless. Inferior results are obtained if the timber is not sufficiently dry before being treated and if too high a pressure is applied, in which latter case the wood cells are easily ruptured. If a pole is perfectly dry previous to impregnation, the creosote will penetrate the sapwood to a depth of 1/4" to 1/2" at best, the heart-wood remaining unimpregnated. It is a known fact, that poles become brittle after having been treated with creosote and do not possess the same strength as unimpregnated poles. Also, impregnated poles are exposed to mechanical injury during transportation and when being wedged in the hole at the ground line, the sapwood being easily injured to such an extent, that the unimpregnated wood is exposed, providing points of easy access for the fungi.

Various methods of impregnation. Sulphate of copper treatment.

In this method a 10 per cent solution of sulphate of copper is forced into the butt end of the unseasoned pole under gravity pressure, by means of a specially constructed nozzle. This pressure, acting along the longitudinal axis of the pole, causes the sap and resins to be expelled through the opposite end, the process being carried on until a clear, greenish solution of sulphate of copper drains off through this end of the pole.

Experience shows that poles, impregnated according to this method, will start rotting in the top part after a certain number of years, the probable reason for this being that the sulphate of copper crystals gradually become dissolved by water and sink down in the pole, leaving vacant spaces in the top end of the same, to which the fungi now find easy access, as the preservative resins contained by coniferous woods, for instance, have already been removed from the pole.

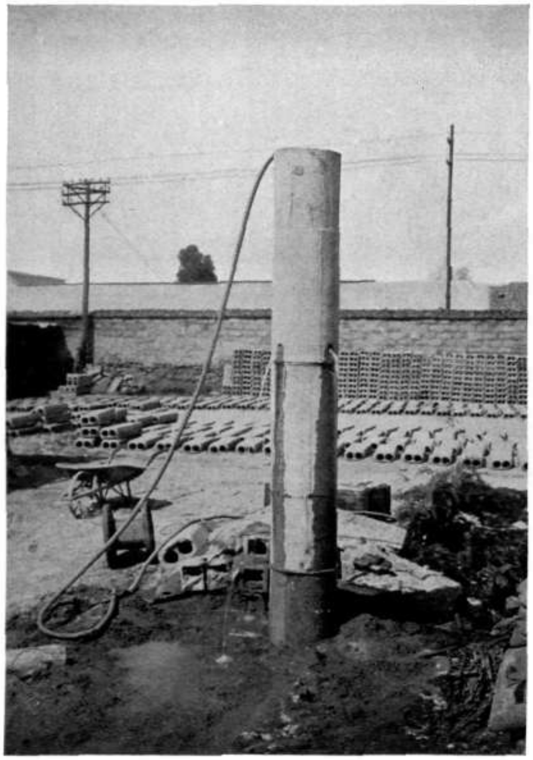
Kyanizing.

In this method, the poles are dipped in a solution of sublimate. The process is both troublesome and expensive.

The Burnett method uses a solution of 2.5 per cent chloride of zink and 97.5 per cent water, which is forced into the pole under pressure.

Saponified creosote method.

This method of impregnation was recently introduced by S. H. Collins, Newcastle-on-Tyne, who, after adding 1/4 per cent of caustic soda to creosote, dilutes this mixture with varying amounts of water, up to as much as 50 per cent. This gives a fairly cheap method of creosote impregnation, making possible a deeper penetration of the fluid into the pores of the wood by merely submerging the parts to be treated in tanks for a shorter or longer time. The brush treatment of poles with this medium is also said to give remarkably good results.



R 175

Fig. 9. View of Pole-Support Showing Lateral Drainage Holes above Solid Partition.

The Furnos spray method.

According to this method the butt of the pole is charred, after which it is sprayed under pressure with light creosote oil by means of a sprayer with specially constructed nozzle, whereby the creosote penetrates the sapwood to some extent and enters into all the cracks and crevices. The pole should be well dried before spraying and as the appliances are portable, the treating of the poles can be done by hand in the field.

Mechanical means of protection.

Owing to the fact that decay always starts at and below the ground line, every attempt has been made to prevent rotting at these points.

The Swedish Government Telephone Service issued the following rules in 1902 for the setting of poles:

»A factor of great importance for the life of the pole is that earth and vegetation shall not come in contact with the same. For this reason small stones shall be heaped about it above the stone wedging just below the ground line, to a point whose height above the ground line is at least equal to the diameter of the pole. The diameter of this stone heap shall be about three times that of the pole.» Fig. 2 shows this arrangement, which helps considerably to protect the pole, as the stones facilitate drainage and — to a certain degree — allow the air to circulate. However, earth and rainwater will soon collect around the lower part of the butt and after some time rotting will set in anyway.

Setting of poles in concrete.

Many patents have been granted for methods intending to protect poles at the ground line, all of which, however, have made the error of hermetically encasing the wood, thereby preventing the escape of moisture still retained in the butt, and instead creating especially favourable conditions for the growth of fungi.

Others attempt to save poles which have rotted below the ground line by casting a collar of concrete around the decayed part, not giving a thought to the fact that the concrete reinforcement will hasten the decay of the already infected wood.

Should it be found necessary to replace a pole of a lead on account of its being too far gone below the ground line, the new pole should never be placed in the same hole or in its immediate proximity, as the fungi will be abundant there and will attack the new pole at once.

Base-support of reinforced concrete.

The writer has made a study of the decay of wooden poles for several years and has found that, as they are always first attacked at or below the ground line, the only way of giving them a long life is not to set them in the ground at all, but to place them above ground and as far from the ground line as possible.

With this fact in mind, he has designed a base-support of reinforced concrete for which patent applications have been filed in most countries.

This base-support, of which vertical and cross-sectional views are shown in fig. 7, has its upper end formed in the shape of a socket for receiving the pole which is to be supported. The base-support can be easily transported for use at any required place and with poles of different types, such as wood or iron.

R 176 Fig. 10. 40-foot Distribution Pole with Pole Support. Mexico D. F.

The principle object of this base support is to provide a perfectly rigid seat for the butt of the pole, the lowest point of which will be situated well above the ground line, at the same time keeping the butt perfectly dry by ventilation on all sides.

These desirable features have been achieved by means of interior vertical ribs or ridges — the cross-sections of which form a sine curve — with air passages interspaced. The bottom of the socket is convex with the highest point in the center. Both the upper and lower extremities of the socket are furnished with sloping side openings or passages, providing a means of communication between the inside of the socket and the outside air. The top of the base-support fits the pole snugly, preventing the ingress of foreign substances such as earth, pebbles, snow, etc. Any rain water which may possibly gain access to the socket through vertical cracks in the wood or through the narrow space between the concrete and the pole at the upper end of the socket (which should exist so as to prevent the wood from coming into direct contact with the concrete) will immediately pass down to the bottom of the socket and drain off through the sloping passages. The butt of the pole is thus always kept dry as air constantly circulates around the same.

According to fig. 7 it will be noticed that there is a solid partition of concrete in the centre of the base support, the upper surface of which is convex, as previously mentioned. The object of this partition is to provide a seal between the pole-socket and the lower, hollow compartment, thereby preventing the passage of moisture from the subsoil to the socket above.

From this description it is obviously possible, by means of these base-supports, to build a pole line through swamps or marshlands or to place a pole in a ditch or directly in water without the slightest inconvenience to the pole, which rests dry and snugly at a safe distance above the water or ground line.

The inside of the socket can be slightly tapered towards its lower end, in which case the pole butt should be trimmed accordingly. This arrangement may be used to advantage when setting green poles which decrease in diameter while drying. They will then automatically adjust themselves to the base-support by simply sliding further down into the socket, if sufficient space has been left at the bottom. Even if the pole should rest directly upon the convex surface of the concrete partition, the air will circulate and water will escape as before.

When there is no wind, air will circulate upwards along the air passages after having been admitted to the socket by the lower side-openings, passing out again through the upper side-openings, as shown by the lighter arrows in fig. 7. If a strong wind prevails, for instance from left to right, the air will be forced through the socket as indicated by the heavy arrows. The lateral holes are sloped slightly downwards, thus preventing rain and snow from entering.

The base-supports may be conveniently manufactured at the yards of any company intending to use the same, and where the concrete can be properly cured — a very important process if satisfactory results are to be obtained. The base-supports are later on transported to any point at which they may be needed, this being easily accomplished on account of their light construction. Moreover, they can be used over and over again, should it be found necessary to change the position of a pole.

If a wooden pole becomes decayed at the ground line, but is otherwise sound, it may be cut off there, trimmed, and set in a base-support without losing its original height.

The following advantages are obtained by using base-supports of the above construction:

1. Direct contact of a wooden pole with the soil is prevented, thus prolonging the life of the pole indefinitely, for it is a well known fact that timber in block-houses, etc., if well cared for, will give unusually long service.
2. The cost of such supports is not prohibitive, even for smaller users of poles, as the first outlay will be amply repaid, in the long run, by reduced cost of maintenance.
3. Their use will facilitate the figuring of depreciation funds for the same kind of wooden poles, soil conditions not being of any consequence, as with poles which are set directly in the ground.
4. The base-supports are easily transported on account of their light construction and will give approximately the same service as poles of solid concrete, these latter being both more expensive to manufacture and more troublesome to transport.
5. The base-support may be used repeatedly and may be moved from one place to another without inconvenience.
6. The use of base-supports will lower the first cost of wooden poles, the length as well as the diameter of the butt being materially reduced.

It is the practice in pole specifications, when poles are to be set directly in the ground, to require poles of a larger diameter than the service actually requires, in order that a certain amount of deterioration by decay shall be allowable before replacement is needed.

7. A pole rotted only below, or slightly above the ground line, can be saved by cutting it off and setting it in a base support, which can be done without disturbing the wires or lessening its height, thus saving both time and labour.
8. The strain on a wooden pole provided with a base-support will be less than for a pole without such a support, for the critical point, in the former case, will be considerably above the ground line. The base-support may naturally be made of any desirable strength at the ground line by varying the amount of reinforcement. Besides, the strength of concrete increases with time, while a wooden pole placed in the ground will, on the contrary, decrease in strength as the years pass by.

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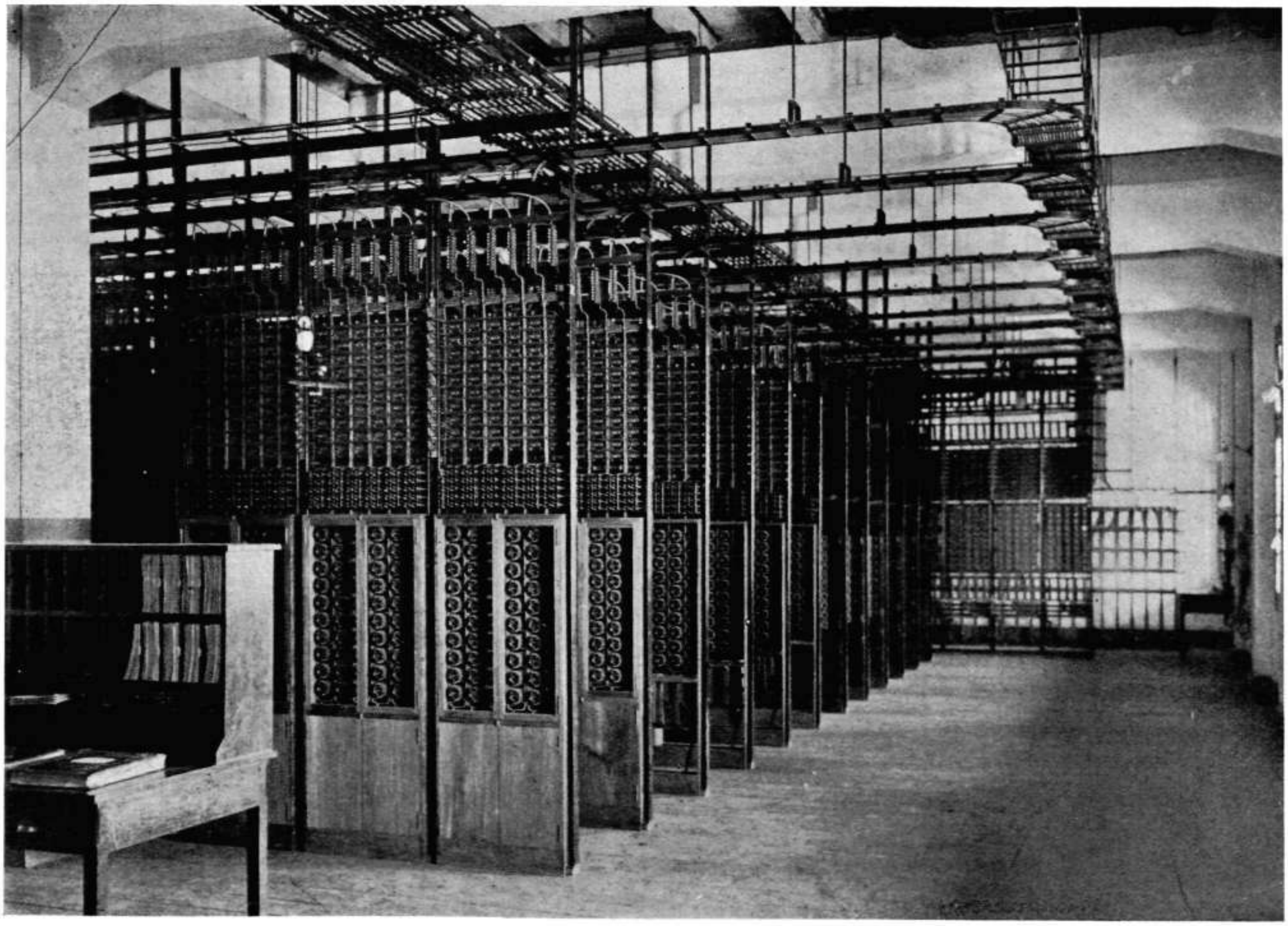

RELAY AND SELECTOR ROOM AT SOEROBAYA NOORD.

ENGLISH EDITION

L. M. Ericsson

THE L. M. ERICSSON REVIEW

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heartily thanks its readers for the deep interest they have taken in this journal and extends to them at this opportune time all good wishes for

A Prosperous New Year.

Stockholm, December 1924.
Hemming Johansson

R 223

R 221

Telephone Conditions in the Dutch East Indies.

The Dutch East Indies are entirely composed of islands and embrace the large and small Sunda islands, the Moluccas and New Guinea, the principle islands and their respective areas being

Java, with Madoera 50,800 sq. miles, Sumatra and neighbouring islands 162,500 sq. miles, Dutch Borneo 213,750 sq. miles, Celebes and neighbouring islands 71,750 sq. miles, Dutch New Guinea 153,400 sq. miles.

All of these islands have a tropical climate, situated, as they are, between 6° N. Lat. and 11° S. Lat., the mean value of the temperature prevailing along the coasts being from 78° to 80° Fahrenheit. The greatest value attained for the maximum temperature is 99° F., its mean value being 89° F. Towards the highlands, a decrease in temperature of about 2° F. for every one hundred yards may be noted. The amount of moisture contained in the atmosphere is exceedingly high, a mean value of 81 % and a mean maximum value of as much as 95 % having been recorded during the rainy season.

R 195 Fig. 1 Trouble Man »On the Job» in Soerabaya.

Before we touch on telephone conditions, I would like to mention a few facts as regards the population.

The Dutch East Indies have a population of about 42 million people, 35 million of which live in Java, the balance being distributed among the remaining islands. In Java, the population has attained a density of 673 inhabitants to the square mile, while for the more distant islands the corresponding figure is as low as 10.

The population is divided into three classes, each with varying obligations and priveleges, i. e.

a. Europeans and others of equal standing (Japanese and Armenians).

b. Asiatic immigrants (Chinese, Arabs and Hindus).

c. Natives (Malayans, Javanese and Sundanese).

These insular possessions are among the richest in the world. Every year large quantities of sugar, tobacco, tea, India rubber, spices, petroleum products, etc. are exported. An extensive export trade being usually followed by a large import trade, we find here cities with flourishing business conditions and, consequently, excellent means of communication. Thus we find some smaller exchanges located in the oil fields of the Koninklijke Petroleum Maatschappij.

In 1923, Java had 274 exchanges with 27,665 subscribers, Sumatra 24 exchanges with 3376 subscribers, while the rest of the islands had altogether 16 exchanges with 1210 subscribers. A tabel covering the larger exchanges is given here below:

R 164 Fig. 2. A Village Exchange in the Interior of Java.

that Java is equipped with a telephone system, which, as regards both organization and equipment, may well be compared with existing nets in both Europe and America. The telephone service in the Dutch East Indies, with few exceptions, lies in the hands of the government, »het Gouvernement van Nederlandsche Oost Indie». The exceptions consist of the Deli telephone plant — comprising part of Sumatra around the city of Medan and operated by Deli Spoorweg Maatschappij (the Deli Railway Co.) — and the exchanges on both the islands Billiton and Banka, known for their tin mines, these exchanges being operated by Billiton Maatschappij. The two latter are of a more local nature, as is the case with

Java.

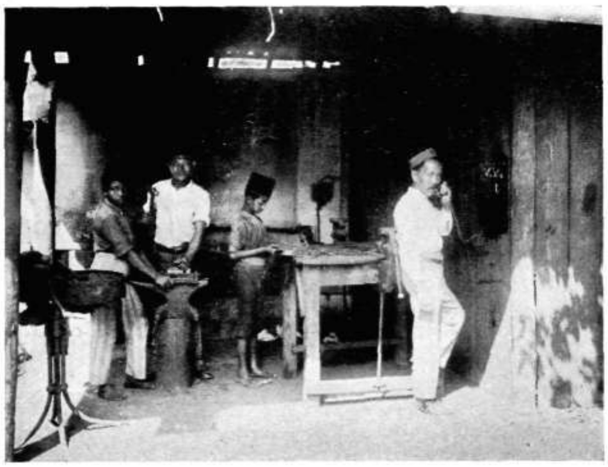
The Batavia net:	Initial equipment, lines	Final equipment, lines	Year delivered	Furnished by
City of Batavia	2160	6500	1912	L. M. E.
Weltevreden ...	6300	6500	1911	L. M. E.
Tandjong Priok	600	1200	1912	L. M. E.
Menteng	1000	2000	1921	L. M. E.
Meester Cornelis	1400	6400	1922	L. M. E.
Bandoeng	4200	6000	1920	L. M. E.
Semarang.........	3000	—	1912	other firm.
Soerabaya:				
»Noord»	4320	8000	1915	L. M. E.
»Zuid»	5040	8000	1915	L. M. E.
Buitenzorg	800	1800	1920	L. M. E.

	Initial equipment, lines	Final equipment, lines	Year delivered	Furnished by
Cheribon	800	1800	1921	L. M. E.
Djokjakarta	600	1200	1911	L. M. E.
Malang	800	1800	1921	L. M. E.
Soerakarta	800	1800	1920	L. M. E.
Sumatra.				
Medan	1280	3200	1918	L. M. E.
Padang	800	1800	1919	L. M. E.
Celebes.				
Macassar	abt. 800	—	1906	L. M. E.

The equipment for the Macassar exchange was first delivered to Soerabaya by L. M. E., but was removed to Macassar in 1916.

will deal more fully with the same in a future article.

The cities of Buitenzorg, Cheribon, Padang, Soerakarta and Malang have L. B. exchanges with double magneto clearing signals, incoming calls being registered by means of visual indicators which are automatically restored to normal upon the insertion of the plug. Both single and double lines often meet in these nets, for which reason transformers are included in the cord circuits. Disturbances from vagrant earth currents, etc., which are always present on single lines to a greater or lesser degree, are thus confined to these lines.



R 193 Fig. 3. A Javanese Smithy.

R 194 Fig. 4. Chinese Carpenter in Soerabaya.

Of these exchanges, Batavia, Weltevreden, Menteng and Tandjong Priok are of the C. B. double cord system; Bandoeng, Meester Cornelis and Medan are of the same system with automatic, periodic ringing; while Soerabaya Noord and Zuid are of the C. B. single cord system with automatic distribution and automatic periodic ringing. A new exchange with an initial capacity of 4200 lines has been ordered for Batavia, to be delivered in 1925. This exchange is also being equipped for automatic distribution of incoming calls and automatic periodic ringing, and provides means for the making of a new call immediately after a double clearing signal. As the system for this exchange contains many features of technical interest, the L. M. E. Review

The smaller exchanges, with few exceptions, are equipped with L. M. E. switchboards of various sizes and types. A very popular type of board is one equipped with drop indicator jacks of a standard model, which is coming into use more and more. Extension of these boards is accomplished by inserting additional strip units.

It is evident, from the foregoing tabel, that telephone service outside of Java is still in its infancy. Also, most of the exchanges on the other islands are merely local, with no toll traffic worth mentioning. During the last years, however, the interconnection of the various exchanges in Sumatra has been taken up, and a complete net of toll lines will in all probability be an accomplished fact on this island within the next few years. The government has also begun to establish communications between the various islands. A cable has been laid between Java and Madoera, preliminary work for the laying of another cable between Sumatra and Java is being carried on, while plans are afoot for the establishing of both wire and wireless telephone communication between Soerabaya on Java and Macassar on Celebes.

In Java, on the other hand, we have a net of toll lines covering the entire island. Generally speaking, it is possible to reach every place of any importance by telephone.

The time when the telephone was considered by the natives to be an article of witchcraft, and must consequently be carefully avoided, is now remote and almost forgotten. Also, the telephone is now used in Java by people of all classes and races. In figs. 3 and 4 we see Tam Toe, a Chinese carpenter, standing in the door of his work shop and talking to Rackmad Alie, a Javanese blacksmith, and in fig. 5 we see the storekeeper Soradji enjoying a little chat over the telephone.

R 196 Fig. 5. Storekeeper in Soerabaya.

As has already been mentioned in the beginning of this article, the Dutch East Indies have a tropical climate. This means that the material used in the manufacture of telephone equipment must be unusually well qualified to resist the harmful influences exercised by the excessive heat and dampness. Insulation, bare metal parts and microphones, especially, are exposed to these destructive influences. L. M. Ericsson have been successful, however, in producing material which is able to satisfy the most rigorous demands even in this respect. Climatic conditions, however, are not the only harmful agencies to be taken into account; tropical insect life is also a cause of constant trouble. The ants, especially, with their usual assiduousness, try to build their nests in the telephone instruments, the spaces between the contact springs being in high favour. All apparatus, therefore, are now made »ant-proof». In fig. 6 we see how ants have tried to build a nest under a keyboard, while in fig. 7 they have attempted the same thing in a selector.

Great difficulties are met with in the erection of aerial lines. Toll lines usually follow mail or railway routes, and are easily accessible. District and subscribers' lines out in the country, however, often follow primitive trails or go right through the jungle. Especially in the highlands, where the roads are often constructed in zig zag fashion so as to reduce the incline, the telephone lines are built in a bee-line along paths cut through the forest, where the linemen have a difficult task in combating the fresh jungle growth.

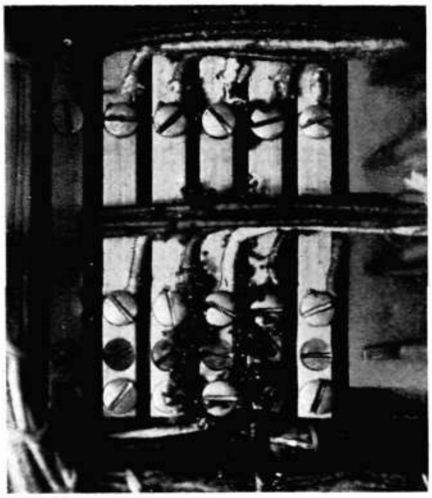
The Soerabaya Exchanges.

Soerabaya is the principle trade centre of Java with a population of 192,000 (1920) inhabitants, 17,000 of which are Europeans and others of equal standing, 26,000 are Asiatics and 149,000 are natives. This city is the main point of export for sugar, and in 1919 37 % of Java's total trade turn-over — amounting to 675 million Gulden — was handled by this port.

The Soerabaya exchanges now have a capacity of 10,000 lines, divided between the two exchanges »Noord» and »Zuid». The large area covered by this city accounts for the fact that decentralisation has been resorted to, although the number of subscribers is comparatively small.

It is customary, in Java, to build houses of only one story for fear of earthquakes, and since most of the houses are surrounded by gardens, we find that a Javanese city covers a much larger area than a European city with an equal number of inhabitants. In Soerabaya, for instance, the distance from the wharves to »Noord» is 2.5 miles, from »Noord» to »Zuid» also 2.5 miles, and from »Zuid» to the southern city limits 3.7 miles.

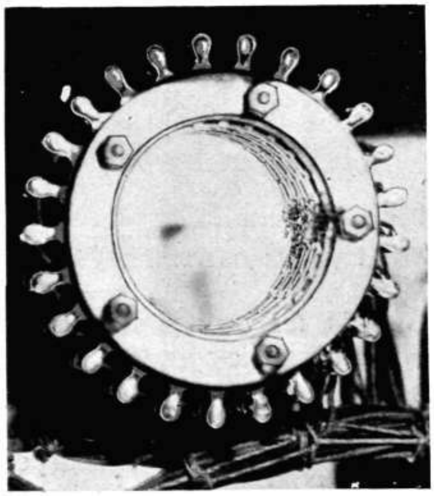
The system carried out in the Soerabaya exchanges is C. B. with automatic distribution. This system having already been described in this journal (Nos. 3 & 4, page 45), I will here confine myself to a mention of the underlying principle of this system and of some special features occuring at these exchanges.



R 191 Fig. 6. A Collection of Ants among the Speaking Line Terminals of a Keyboard in Soerabaya.

Each subscriber's line is furnished with a line relay and a cut-off relay together with an automatic selector with test relay. The selectors are of the L. M. Ericsson step-by-step type with a multiple bank for 25 lines. The contact banks of these selectors are coupled in parallel in groups, each such group being connected to 24 cord circuits. The cords are distributed over the operators positions, as shown in fig. 11, by means of a cord distributing frame shown in fig. 12. In these exchanges the parallel coupling of the contact banks is executed over 60 selectors. The 24 cord circuit conductors for these sixty subscribers are carried through a cable to one side of the cord distributing frame. An additional parallel coupling of such 60-line groups is executed in this frame, thus permitting the final groups to be proportioned to the existing intensity of traffic in each respective case.

The »Noord» exchange gives service to the business and harbour sections of the city, which accounts for the rather high number of calls, amounting to 14 per subscriber and day. At this exchange, only 3 such 60-line groups are coupled in parallel, that is, 180 subscribers are allotted 24 cords between them. These cords are distributed over 12 positions, giving each group of subscribers two cords in each position.



R 192 Fig. 7. Ants in Step-by-step Selector at Soerabaya.

The »Zuid» exchange is situated in the European residencial district. Here the calls are much fewer, averaging 9 per subscriber and day, which permits the use of larger groups. In this case, these groups comprise 240 subscibers' lines.

As shown in fig. 12, the cord distributing frame is also equipped with break jacks, permitting the cord circuits to be tested in the direction of the selectors as well as of the switchboards. Thus it is possible, not only to locate cord trouble but also to test the cord circuit relays, without having to disturb the operator at her position.

Schematically, the system functions in the following manner. When a subscriber removes his microtelephone, the selector belonging to the line

R 209 Fig. 8. Telephone Wires along a Railway in Java.

relay is set in motion and stops when a disengaged cord of an idle operator has been found. This causes the signal lamp of the cord in question to glow and the operator answers by pressing the corresponding key into speaking position.

The system is also provided with a number of blocking devices which function in such manner that

1. an operator does not receive more than one call at the time,

2. the selector connects up with a cord belonging to an idle position,

3. the selectors are not unnecessarilly actuated when all the operators are busy.

Also, a signal is automatically given when the number of operators is insufficient to handle the incoming calls.

Both of these exchanges were equipped for automatic periodic ringing at the time of their extension in 1921. This ringing system functions in the following manner:

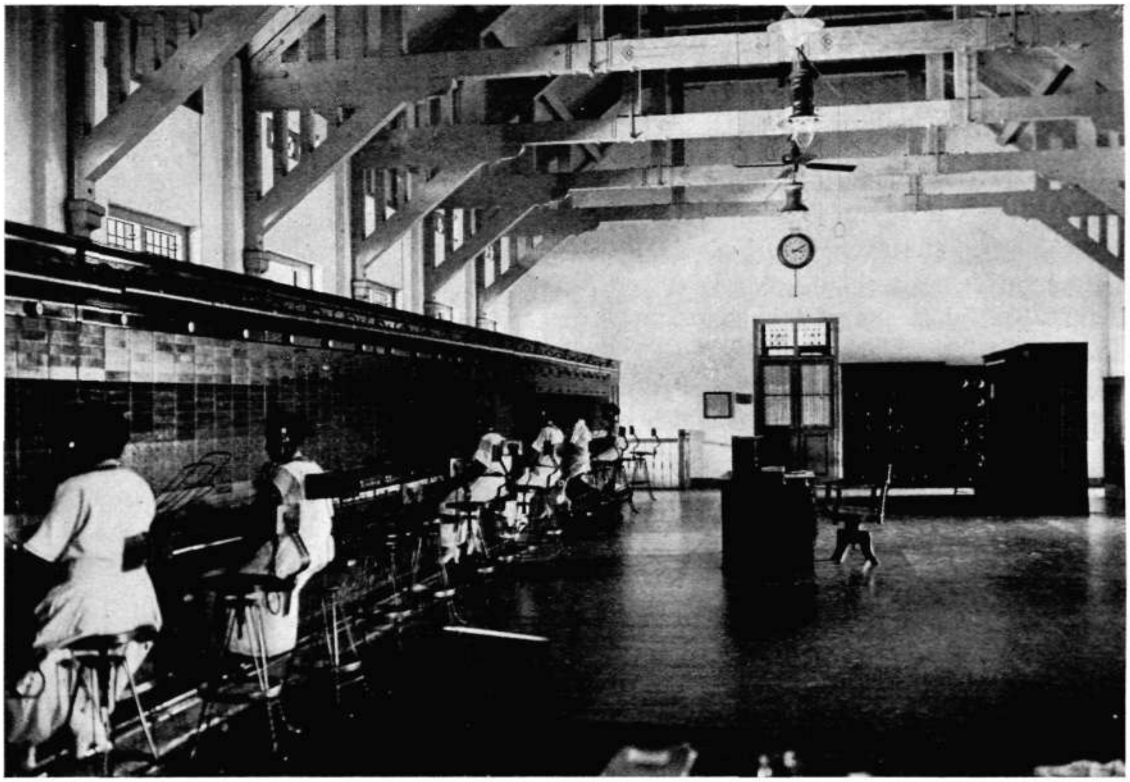
After the operator has plugged into the jack of the desired number, she restores the speaking key to normal, after which a calling signal is automatically sent out in periods of two seconds duration, separated by silent periods of four seconds each. As there is a possibility of a connection being completed at the beginning of a silent period — thereby subjecting the subscriber to an unnecessary delay of a few seconds before the calling signal starts — provisions have been made for the sending out of an extra calling signal, a so-called start-signal, immediately after the plugging in of the desired number, after which the normal ringing periods ensue. As the calling subscriber can hear these automatic signals in the form of a humming tone, it is unnecessary for the operator to »listen in» on the call, her only duty being to break the connection when a double clearing signal is given.

This arrangement permits the operator to concentrate all her attention on incoming calls, the immediate result being that she works faster and that fewer operators are necessary to handle the traffic.

Subscribers' meters are of great importance in Soerabaya, as the subscription rates in Java are

R 185 Fig. 9. The Exchange Building, Soerabaya Zuid.

based on the number of calls. In Soerabaya, a charge is made of 15 Gulden per month for 10 calls per day. Should this limit be exceeded, the subscriber is moved up into another group and is charged a higher rate. It is imperative, under such conditions, that the calls be accurately registered. The meter is actuated when the first calling signal goes out to the called subscriber. As it was considered undesirable to provide a meter for each subscriber, the relay frames were equipped with meter strips, making possible, by a single manipulation, the removal of a meter from one subscribers' line to another. See fig. 13.



R 186 Fig. 10. The Operating Room at Soerabaya Zuid.

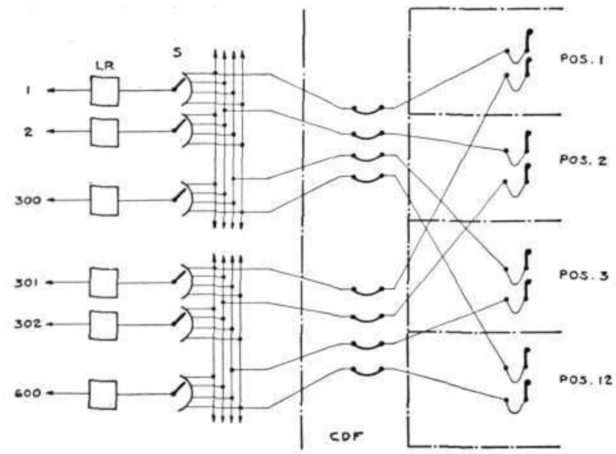
The Soerabaya exchanges have been equipped with automatic distribution for junction traffic since 1923. This traffic is handled in the following manner. After the calling subscriber has asked for the other exchange, the A-operator plugs in a junction line terminating in a selector at the other exchange. This selector then connects up with a disengaged cord in an idle B-position at the called exchange. The B-operator answers and the calling subscriber asks for the desired number. After the B-operator has completed the connection by plugging in the multiple, a calling signal is automatically sent out from the first exchange. When the conversation is finished, the usual double clearing signal is given. This signal is received by the A-operator, who then disconnects, after which the B-operator also receives a clearing signal. This system, therefore, does not necessitate the use of an order wire.

The great advantage with automatic distribution is that it permits the number of operators on duty to vary in conformity with the intensity of traffic at different hours of the day.

It is impossible to profit by these advantages in an economical way if one does not have access to traffic statistics. For this reason devices have been installed and arrangements made to facilitate the keeping of such statistics.

In the exchange superintendent's room, four registering ampere meters are installed, showing respectively:

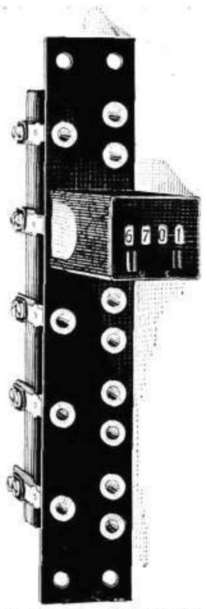
1. The total amount of electric energy consumed.
2. The number of simultaneous conversations.



R 79 Fig. 11. Schematic Diagram showing Cord Distribution.

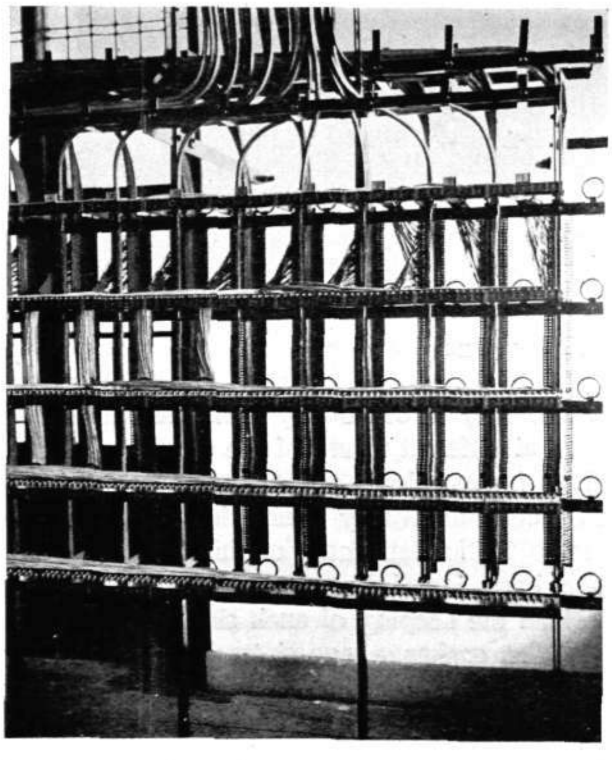
3. The number of simultaneous outgoing junction calls.
4. The blocking of the exchange, i, e. when the operators on duty are simultaneously engaged. It is possible, by means of this instrument, to see when the blockade occured as well as its duration. These four meters are mounted on a marble panel together with lamps which give notice when a blockade occurs on any of the various subscribers' or junction line groups.

In this manner the exchange superintendent can keep posted as to the fluctuations of traffic conditions.

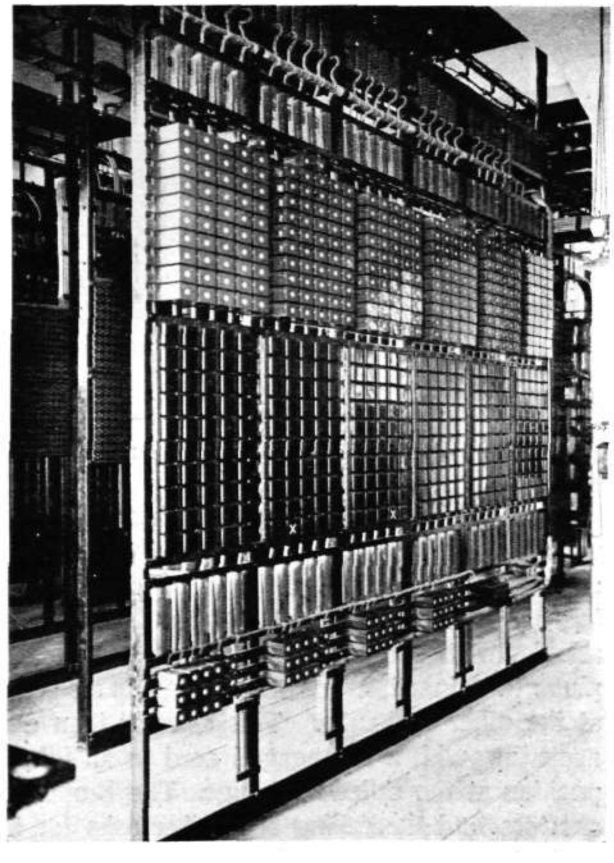


K1 Fig. 13. Meter Strip for Subscribers' Meters.

Two cabinets, the one containing delay time recorders and the other position meters, are mounted in the operating room. Each time recorder is provided with a magnet coupling for starting and stopping the clock-movement, one time recorder and one position meter being provided for each operator's position. These instruments may be connected in various ways for the control of



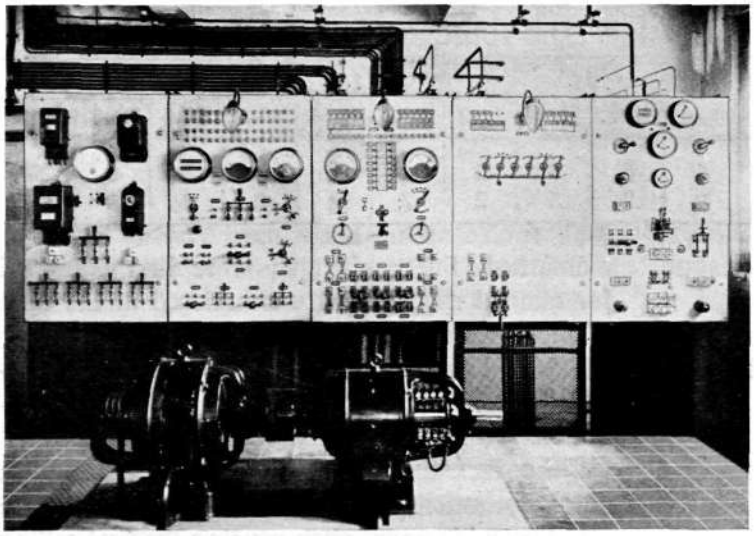
R 189 Fig. 12. Cord Distributing Frame.



R 188 Fig. 14. Relay and Selector Rack for Outgoing Junction Lines at Soerabaya.

the various stages of a switching operation. The following data are obtainable by means of these devices:

1. Average waiting time; the time recorder being set in motion when the calling lamp starts to



R 190 Fig. 15. Power Station at Soerabaya Noord.

glow and stopping when the operator answers. The position meter registers the number of incoming calls at a certain position and during a given time interval, and the average waiting time can then be figured by the aid of these two values.
2. Average time for completing a connection. In this case the clocks and meters are connected to the speaking position of the speaking key.
3. Average time which elapses after the giving of a double clearing signal and until the operator disconnects. In this case the clocks and meters are connected in parallel with the clearing lamps.

A prize system has been introduced in conjunction with these control devices, whereby prizes are awarded to the operators who get the best results. The results hereby obtained are as follows:

1. Average waiting time, 2.25 seconds.
2. Average time for completing connection, 4.17 seconds.
3. From 320 to 480 calls per hour handled by one operator.

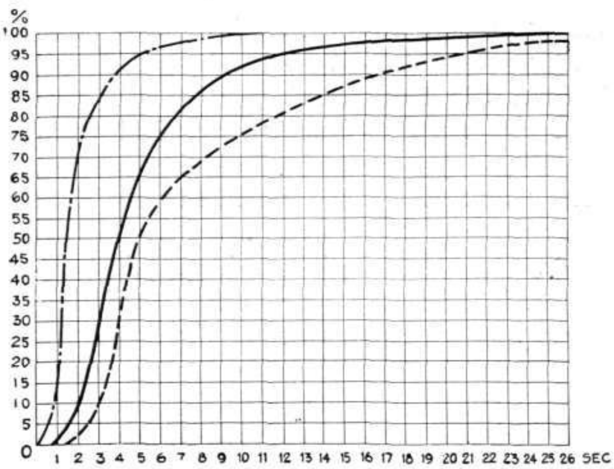
The figures in points 2 and 3 give an average value for effective service of 0.46.

The figures obtained by means of the abovementioned control devices are used for determining the number of operators required at different hours of the day. The following tabels show that but a small number of operators are required for handling the traffic at these exchanges.

The figures here given have been obtained from the oldest sections of these exchanges for the reason that the equipment here is in use to its full capacity.

The Dutch magazine »de Ingenieur» for December 30th, 1922 contains a descriptive article on the Soerabaya exchanges by Mr. Nessel van Lissa, district engineer in the 3rd telephone district of the Dutch East Indies. Mr. N. v. L. was formely superintendent of these two exchanges for a number of years, and we take the liberty of quoting the following from his article:

»At these exchanges, even the subscribers' waiting time — from the moment he removes



R 207 Fig. 16. Delay Curves for the Hague and Soerabaya.

his receiver and until the operator answers — is registered. For the sake of comparison the results are here given in the form of a curve, together with curves plotted by Mr. Neher, giving the waiting time at one automatic exchange and

THE »ZUID» EXCHANGE. 2,880 SUBSCRIBERS.

	Time, a. m.					Time, p. m.							
	7—8	8—9	9—10	10—11	11—12	12—1	1—2	2—3	3—4	4—5	5—6	6—7	7—8
A-operators	4	8	9	9	7	7	6	6	6	6	4	4	4
B-operators	1	3	3	3	3	2	2	2	1	1	1	1	1

THE »NOORD» EXCHANGE. 2,160 SUBSCRIBERS.

	Time, a. m.					Time, p. m.							
	7—8	8—9	9—10	10—11	11—12	12—1	1—2	2—3	3—4	4—5	5—6	6—7	7—8
A-operators	6	8	7	6	6	5	5	4	4	5	6	6	5
B-operators	2	3	3	3	3	3	2	2	2	2	1	1	1

one double cord C. B. exchange in the Hague, as shown in fig. 16.

The dot and dash line represents the waiting time at Soerabaya, the full drawn line at »Haag automat», and the dotted line at the »Haag double cord» exchange.

When comparing these curves, we see at a glance that Soerabaya gives very efficient service. At the old double cord exchange, only 75 % of the calls got an answer within 10 seconds and at the automatic exchange 92 %, while at Soerabaya the corresponding figure is 99 %.

If we take 85 % of the subscribers as an average value, we find that with this figure »Haag double cord» answers in about 14 seconds, »Haag automat» in 7.5 seconds, and Soerabaya in from 2 to 3 seconds.

In this respect, therefore, we find that the Soerabaya system works three times as fast as »Haag automat» and from five to six times as fast as »Haag double cord».

Mr. Nessel also gives a description of the system in extenso, calling special attention to the recently installed automatic ringing. As previously mentioned, the exchanges were first equipped for manual ringing but were altered at the time of their extension. He also states that a saving of 15 % has been made in the number of operators required since automatic ringing was installed. This admittedly high figure is explained by the fact that the houses in the East Indies are very extensive, with the windows always standing wide open, often causing the first calling signal to be lost. With the manual ringing system, the necessary additional signals naturally gave the operator a lot of extra work.

The figures which have been obtained at the Soerabaya exchanges are exceptionally noteworthy. They would be considered good even in a temperate climate, and special value must therefore be attributed them in a tropical climate where manual work seldom reaches the same degree of efficiency.

The result gives evidence of what may be accomplished when a technically inclined administration is entrusted with the operation of a system well suited to existing conditions.

N. S.

The Patent Controversy
Automatic Electric Co. versus L. M. Ericsson, concerning Swedish Patent No. 31511.

As has already been made public by the daily press, the Automatic Electric Company has instituted legal proceedings against Allmänna Telefonaktiebolaget L. M. Ericsson for alleged infringement of the Swedish patent No. 31511, owned by the Automatic Electric Company. The plaintiff bases his claim on the subject matter of a paper by Chief Inspector M. Agrell of theSwedish Telegraph Service in »Technical Communications from the Board of the Royal Telegraph Service» for 1922, page 84, which describes — among other things — certain switching devices supposed to interfere with this patent, and which, according to assertions made by the Automatic Electric Company, have been made use of in telephone exchanges built by Allmänna Telefonaktiebolaget L. M. Ericsson, special reference being made to the automatic telephone exchange »Norra Vasa» in Stockholm and to the telephone plant in Rotterdam.

The controversy refers to full automatic or semi-automatic systems in which certain subscribers, such as business houses with private switchboards (P. B. X.) are connected to the central exchange by means of several lines but, notwithstanding, are furnished with but one directory number. (In semi-automatic systems, the name of the firm is sometimes inserted instead.) The alleged infringement concerns certain devices, by means of which a subscriber, after having called up such a P. B. X. is automatically connected to one of its disengaged lines. According to the patent in question, this last operation shall be performed by the connector (i. e. the last of the series of selectors by means of which a speaking circuit is established) in such manner, that this connector, after having been advanced to the position of the first of the lines in question by means of an impulse-sending device or a register, shall, of its own accord and without any further action on the part of the subscriber, connect up with one of the disengaged lines, passing such as are momentarily engaged. Furthermore, according to the patent, the connector shall be so devised that, when all the lines are busy, it shall automatically advance to an arresting position, in which position the calling subscriber is given a busy signal, indicating that all of the lines are engaged.

The Automatic Electric Co., in its plaint, now claims that it has come to their knowledge that Allmänna Telefonaktiebolaget L. M. Ericsson have utilized the patented invention in the construction of telephone exchanges in, among other places, Stockholm and Rotterdam.

In this respect, however, the Automatic Electric Co. is manifestly misinformed, the true fact being that neither the Norra Vasa exchange nor any other has been equipped with any device of this description. Especially in regard to Norra Vasa exchange, the subscribers connected to the same being residential and of the small shop-keeper class, there is no necessity, even, of installing equipment for such a purpose. Also, in the correspondence which preceded the taking of court action, these existing conditions were made perfectly clear by Allmänna Telefonaktiebolaget L. M. Ericsson as well as by the Board of the Royal Telegraph Service. When, in spite of this, the Automatic Electric Company has seen fit to institute legal proceedings, it is difficult to appreciate what purpose the Automatic Electric Company thereby hopes to attain, for the first thing necessary for the justification of any claim of infringement is that the patented device actually shall have been put into practice. The mere publishing of certain circuit diagrams, for example, as in the article in »Technical Communications from the Board of the Royal Telegraph Service» referred to by the plaintiff, clearly does not constitute any infringement whatsoever.

Apart from the fact that the suit brought by the Automatic Electric Company is devoid of any material grounds as far as the alleged infringement is concerned, these patent proceedings are noteworthy inasmuch as the patent in question must be considered void for want of novelty. The investigations made by Allmänna Telefonaktiebolaget L. M. Ericsson for the purpose of establishing the actual scope of the patent from a legal point of view, have disclosed the fact that the devices which constitute the subject of this patent, in their entirety are anticipad by a paper »History of the Automatic Telephone» by Arthur Bessey Smith and published in the American periodical »Telephony», Vol. 17, No. 9, of February 27th, 1909. In the said paper a description is given, among other things, of an arrangement used in an automatic plant in the city of Dayton for the automatic selection of a disengaged line, the said arrangement coinciding not only in principle but also in details of construction with the switching arrangement covered by the patent. Furthermore, it would seem, from the above paper, that the plant in question has been built by the Automatic Electric Co. themselves, the owners of the Swedish patent. The underlying principle in arrangements of this kind, i. e. the automatic selection of an idle subscriber's line by the connector after having completed the numerical switching operation, however, was known at an even earlier date from other publications. Under such conditions, it is unnecessary to make any comparison between the arrangements covered by the patent and those described by M. Agrell in »Technical Communications from the Board of the Royal Telegraph Service», but may it suffice, in this connection, to verify the fact that the circuit diagrams in question, published by the Board of the Royal Telegraph Service and Allmänna Telefonaktiebolaget L. M. Ericsson, are founded entirely on principles which were public property previous to the seeking of the Swedish patent, and for which the Automatic Electric Company, therefore, are unable to claim patent protection.

For the protection of its own interests, Allmänna Telefonaktiebolaget L. M. Ericsson has seen fit to institute proceeding for the cancellation of the Swedish patent in question, having brought action against the Automatic Electric Company for this purpose. Both of these cases are now being dealt with by the Magistrate's Court of Stockholm.

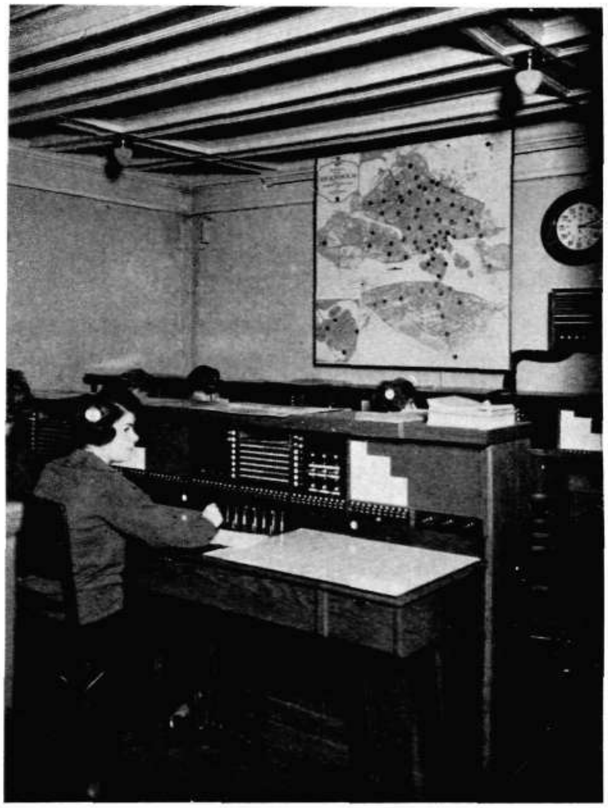
Oscar Grahn.
Patent Attorney.

Ordering Taxicabs by Telephone in Stockholm.

Foreigners who have visited Stockholm seldom fail to speak most enthusiastically about its well organized system for ordering taxicabs by telephone. In fact, it is more than likely that Stockholm was the first city in the world to put an efficient system of this kind into practice. It has now been adopted by the four largest cities in Sweden as well as by a couple of cities in neighbouring countries, in all of which places it is functioning to the complete satisfaction of the public as well as of the taxi owners.

To start with, the cab ordering system was very primitively organized, consisting merely of a few cab owners who clubbed together and subscribed to standard telephone instruments which were set up on poles at the various cab ranks. The public called up these 'phones and ordered the desired vehicles from the cab drivers themselves. This was in the early nineties.

As the number of cabs grew larger and the public became more and more accustomed to ordering them over the telephone, the cab owners became aware that it would be more advantageous to draw all the lines to a private exchange of their own. This exchange was given the privelege of a so-called »name-call» instead of a number, and the public only needed to ask for »Droskstation» — meaning »cab station» — to be connected up with it.



R 203 Fig. 1. Partial View of the Stockholm Taxi Telephone Exchange. Map with Indicator Lamps in the Background.

The advent of taxicabs put much greater demands upon the efficiency of the service, and was followed by one improvement after the other. As we have already mentioned, the public was first permitted to speak with the cab drivers and chauffeurs themselves. This system often gave rise to misunderstandings, unnecessary argumentation causing the lines to be unduly held up, wherefore it was discarded. It now became the duty of the operators at this private exchange to take orders from the public and pass them on to the nearest cab rank. A telephone operator naturally is more accustomed to hear and speak distinctly over the telephone than the general public, and thus it was possible to speed up the service to a marked degree, a given address being rarely misunderstood.

The last big improvement was introduced in 1923, at which time the taxicab telephone exchange was removed to more spacious quarters. In the following we will give a short description of how this system is organized.

There are about seven hundred taxicabs in

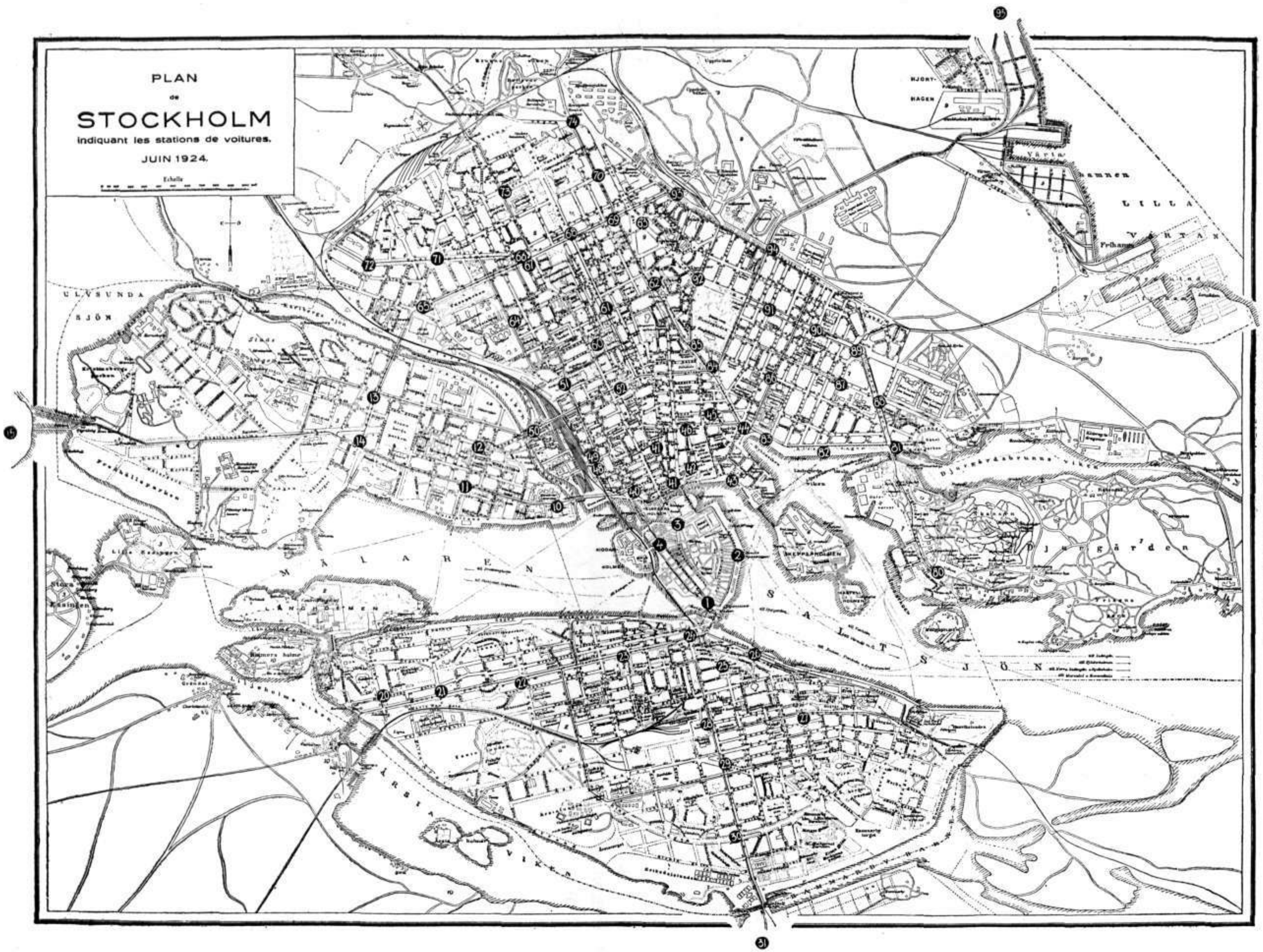
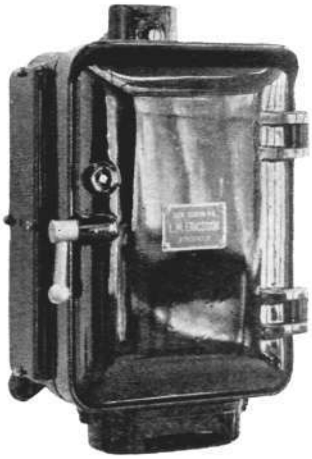


Fig. 2. Map of Stockholm giving Location of Cab Ranks.

Stockholm at the present time, about five hundred of which belong to an economic taxi owners' organization called Stockholms Droskägareförening (The Stockholm Taxi Owners' Association).



R 202
Fig. 3. Cab Rank Telephone Instrument.

As this Association has been granted a certain monopoly by the police authorities and is better organized than the others, we will confine ourselves entirely to a description of its activities. In parenthesis, we can mention the fact that horse cabs have entirely disappeared from the streets of Stockholm since some years back.

All permits to drive taxicabs are issued by the police authorities who also determine the fares and formulate the traffic regulations. The requirements of the traffic are taken into consideration when determining the number of permits, the authorities giving certain directions as to the distribution of taxis in the different sections of the city and as to the necessity of having a sufficient number of taxis in traffic during the night.

The fares as well as the number of permits are calculated so as to ensure the owners a reasonable profit without making conditions burdensome for the public. The exceptionally high standard of both the chauffeurs and the automobiles as well as the fact that taxicabs are extremely popular with the Stockholm public, adequately prove that the organization is a success and that the Taxi Owners' Association does not abuse its monopoly.

Contrary to what is the rule with other organizations, the members of this association are allowed to pick up fares on the streets and to awaite passengers at certain definite parking places or cab ranks. At present, Stockholm has sixty six such cab ranks spread over the whole city. A glance at the map in fig. 2 will clearly show how they are distributed. As may be seen, no Stockholmian need walk very far to reach one of these ranks.

Each cab rank is provided with a specially constructed telephone instrument. These telephones are equipped with three jacks, connected in parallel and so arranged that the insertion of a metal plug in one of these jacks will close a circuit to the taxi telephone exchange and cause a lamp to glow. Every chauffeur is provided with such a plug which he carries about with him, notifying the exchange that he is stopping at his stand by inserting the same into one of the jacks, on condition, however, that not more than two taxis

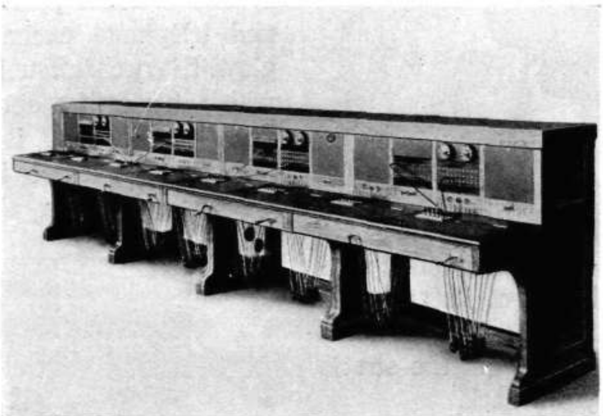
R 202 Fig. 4. Cab Rank with Chauffeur receiving an Order.

are already standing there. The indicator lamp keeps on glowing from the time the first taxi comes in and until the last one goes out, the lamp circuit being broken when the last chauffeur removes his plug. Thus it is always possible for the operators to see if there are any taxis at the various ranks. Fig. 3 shows a cab rank telephone instrument of the most modern type, and in fig. 4 we see such an instrument mounted on a pole.

Equipment of the taxicab telephone exchange.

The Stockholm taxicab exchange is equipped for the present with twenty four positions. In fig. 1 we see the foremost row of switchboards and in the background on the wall a large map of Stockholm. The previously mentioned indicator lamps are mounted on this map, each lamp representing a cab rank. Thus, by a single glance at this map, the operators are able to see at which ranks there are any taxis waiting. The indicator lamps are multipled on each switchboard, so that a trained operator does not have to look at the map to see where there are taxis waiting.

When an operator is speaking with a certain cab rank, the indicator lamp of this rank flickers. For the sake of economy, an arrangement has been installed whereby, when traffic is light, the indicator lamps on the map glow only when a special switch is thrown by the operators. When traffic is heavy the map is always in circuit.



R 204 Fig. 5. A Taxi Telephone Exchange Switchboard, made for Export by L. M. Ericsson.

The process of ordering a taxicab is as follows:

When a subscriber requests »Taxi exchange» a calling lamp glows as usual, an operator connects up and answers: »Taxi exchange». The subscriber then gives his order, for instance: »A taxi, please, to 63 Main Street, Smith». The operator then glances up at the map to see if any taxi is waiting at the nearest cab rank. Should this be the case, she then calls it up and repeats the order to the chauffeur, who, in turn, gives the operator the number of his taxi, after which she tells the waiting subscriber that the taxicab is »coming». The names and addresses of all persons ordering taxis, as well as the numbers of the taxicabs, are written down by the operator. Under normal conditions, an operator is generally capable of handling and keeping records of about 50 orders per hour, although there have been cases when exceptionally fast operators have handled as many as 120 orders per hour during rush periods.

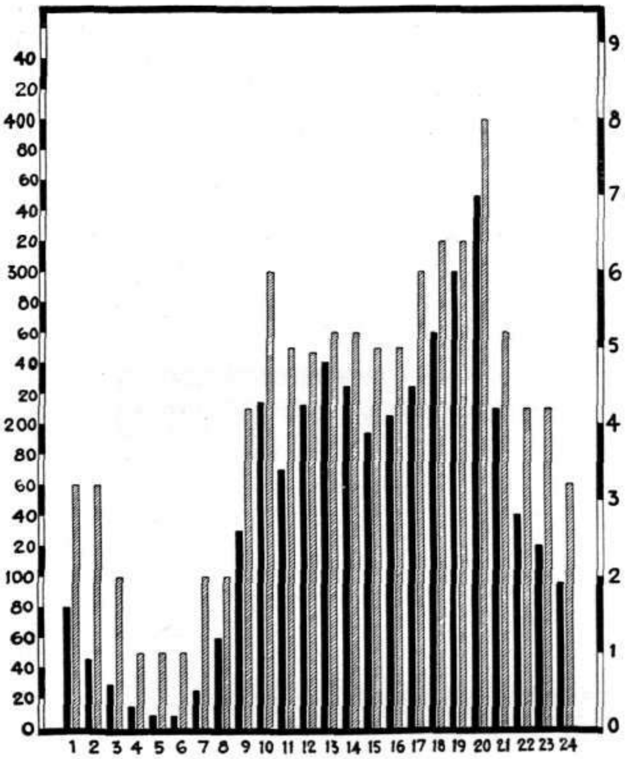
The Traffic.

The traffic at a taxicab exchange fluctuates to a marked degree, depending on a number of varying causes. Some of these are easily anticipated and constantly recurring, being readily estimated by the aid of statistics. The arrival and departure of trains, the opening and closing of the theatres, the closing of the restaurants, important sporting events, etc., all belong to this class. Other causes, such as weather conditions, are more difficult to anticipate and often result in the total upsetting of measures already taken as to the number of operators required for handling the traffic, etc.

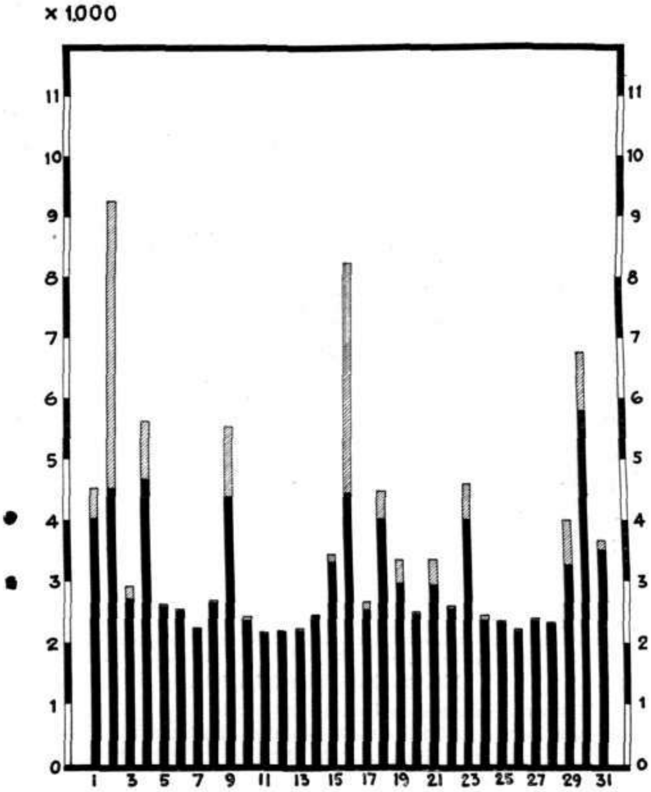
For the rational management of a large taxicab exchange, it is necessary to have a large number of extra operators at ones disposal during rush periods. In Stockholm, this matter has been taken care of by combining the taxi exchange with the number records office of the State Telephones, among whose employees extra operators are recruited when the necessity arises.

The graphs given in figs 6, 7 and 8 show clearly how the traffic in Stockholm fluctuates during different hours of the day as well as during the different months of the year. One plainly sees that a sufficient number of taxicabs have not been available during rush periods. At such times, most of the taxis are engaged on the streets before they have a chance to reach their respective ranks, and the operators are kept busy informing the public that no taxis are available. During 1923, Stockholm's Taxicab Exchange negotiated not less than 1,649,000 taxicab orders.

One often hears foreigners put the question: »But how do you prevent purely mischievous calls?» In fact, it is impossible to prevent such calls, but luckily, they very seldom occur. Statistics show that only three times out of every thousand does it occur that a chauffeur receives an order which proves false on his arrival at the given address. As such fruitless journeys are sometimes caused by the subscriber giving a wrong adress or through a misunderstanding on the part of the operator or the chauffeur, it is safe to say that false orders do not occur in Stockholm, neither is there any reason to believe that they would occur at other places where this system has not yet been tried out.



R 198 Fig. 6. Typical Graph showing Fluctuations of Traffic during Consecutive Hours of the Day.
Black lines indicate number of telephone taxi orders per hour.
Shaded lines indicate average number of operators on duty.
0 to 1 Closing time of restaurants.
8,30 to 10 Arrival of suburban trains and beginning of office hours.
12 to 13 Lunch time.
17 to 18 Close of office hours and departure of suburban trains.
19 to 20 Opening of theatres and cinemas.

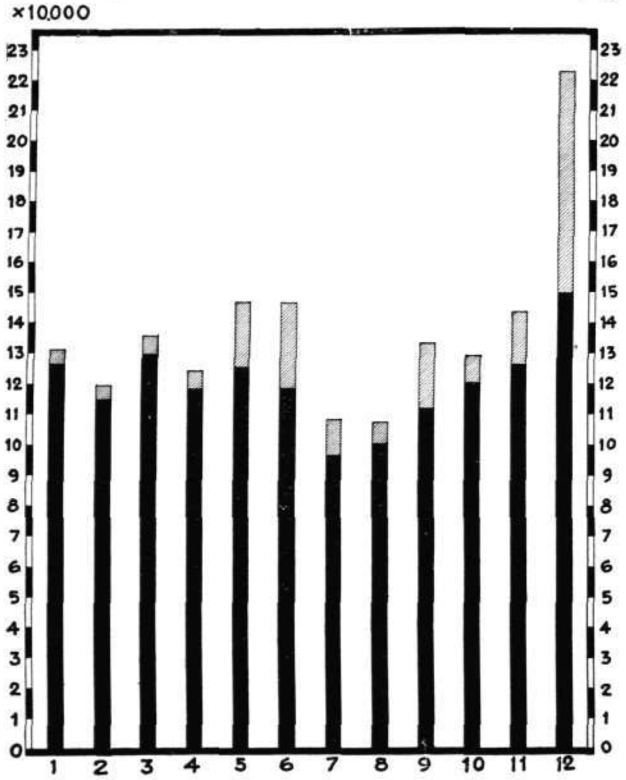


R 199 Fig. 7. Graph showing Fluctuations in Traffic during Consecutive Days of the Month.
Number of telephone taxi orders per day.
Black portion indicates number of orders effectuated.
Shaded portion indicates number of orders not effectuated.
The 2nd, 9th, 16th, 23rd and 30th are Saturdays.

Good results depend in no small degree upon the strict supervision of both operators and chauffeurs. In addition to the controlling devices for the keeping of statistics on waiting time, etc., which are to be found in every modern exchange, the office of this association is furnished with complete controlling equipment. Suspended over the manager's desk is a map of Stockholm, similar to the one at the exchange, mounted with indicator lamps for the cab ranks. The manager, from his own desk, may thus follow all fluctuations of the traffic. There are also arrangements for listening in on the operators, so that the least carelessness or mistake is immediately discovered.

A few expense figures.

The Taxi Owners' Association, like all other subscribers, is required to pay the regular entrance fees and subscription rates for its lines and telephone instruments. It has also to pay the operators' salaries. No rental is charged for the switchboards or the premises, however. The present permanent staff of the taxi telephone exchange consists of a superintendent, an assistant superintendent and eighteen operators. Extra operators are usually obtained from the number records office.



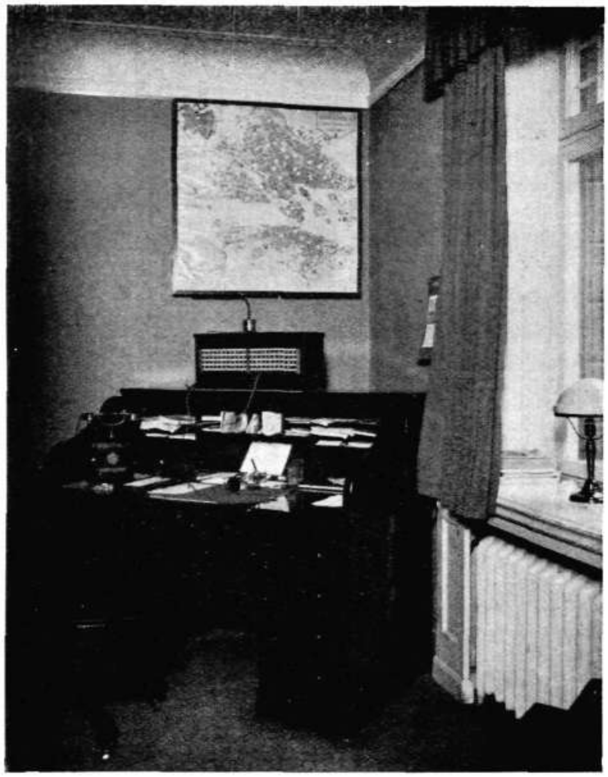
R 200 Fig. 8. Traffic Graph for 1923.
Number of telephone taxi orders per month.
Black portion indicates number of orders effectuated.
Shaded portion indicates number of orders not effectuated.

The expenses for the taxi exchange during the first quarter of 1924 were as follows:

For central exchange lines	2,025	Sw. Crowns
» 66 extension lines @ 10 Cr. ea.	660	» »
» 66 extension telephones @ 10 Cr. ea.	660	» »
	3,345	Sw. Crowns
	3,345	Sw. Crowns
For lines outside the free area	38	» »
Salaries, etc.	15,375	» »
Total	18,758	Sw. Crowns

During the same quarter, 395,000 orders were handled, making the total expense for each order = 0.0475 Sw. Crowns. This expense is negligible in comparison to the profits earned on each run, amounting to approximately 1.70 Sw. Crowns.

A fair conception of the total amount of traffic handled by the association may be gathered from the fact that telephone orders do not account for more than 25 % of this total.



R 205 Fig. 9. Manager's Office, the Stockholm Taxi Owners' Association.
The manager can follow the fluctuations of traffic and control the service *without moving from his writing desk.*

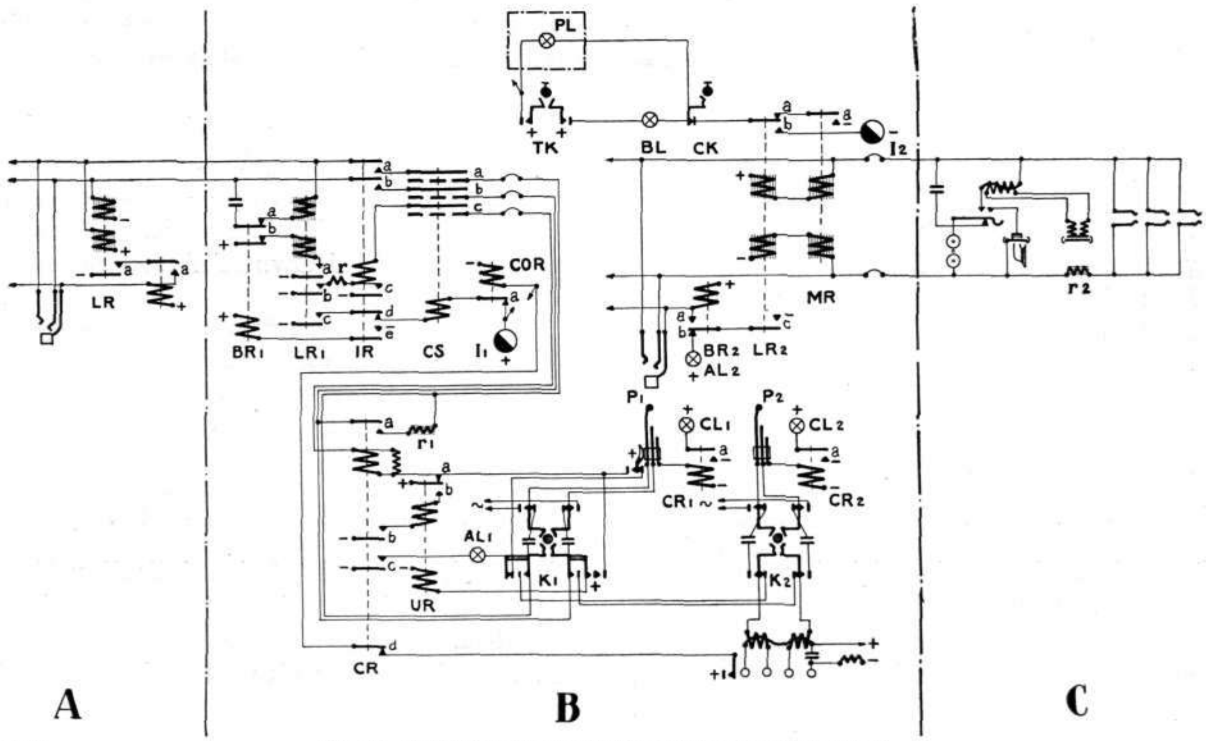
Circuit diagram for a taxi telephone exchange.

Fig. 10 shows a suitable circuit diagram for a taxi telephone exchange with automatic distribution of incoming calls. The automatic distributor is of L. M. Ericsson's construction.

A represents a central C. B. exchange, *B* the taxi exchange, and *C* a cab rank telephone instrument.

The indicator arrangements for the cab rank telephone as well as for the taxi exchange are similar in principle to those of the Royal Telegraph Service at the taxi exchange in Norrköping (Sweden). When a chauffeur inserts his indicator plug into one of the three jacks of the telephone instrument, a corresponding lamp on the map

an indicator plug be negligently left in a jack with no taxi at the cab rank, the indicator lamps may be disconnected by means of the key *CK*. When traffic is light, the indicator lamps are made to glow by means of the key *TK* on the keyboards. The test board is provided with a similar key, with a holding device, for use when traffic is heavy, so that the lamps continue to glow as long as there are any taxis at the respective cab ranks.



R 206

Fig. 10. Typical Circuit Diagram for a Taxi Telephone Exchange.

PL as well as the multipled lamps on the switchboards start to glow. This takes place over the following circuits:

Negative, LR_2, *MR*, one of the line branches, r_2, the jack, the other line branch, *MR*, LR_2 and positive.

MR energizes and closes the following circuit: Negative, *MRa*, LR_2a and *PL* or *BL* resp. to positive over *TK*.

MR is a marginal relay, so balanced with the resistance r_2 and the relay LR_2 that it energizes in series with these without influencing the relay LR_2. Should trouble arise on the line or should

A chauffeur desiring to call the taxi exchange removes the microtelephone, a line relay LR_2 energizing in the usual manner, and the calling lamp AL_2 glows. The indicator lamps simultaneously start flickering, as they now receive an intermittent current over LR_2b. The operator answers by plugging in P_2 and pressing the key K_2 over to the speaking position.

In case a chauffeur — in certain exceptional cases — might wish to call the office of the association or an ambulance for some street accident, etc., it must be possible to connect a cab rank 'phone to the outside net, and this is accomplished by means of a double cord in each position and special central exchange lines.

Incoming central exchange calls are automatically distributed by means of the cord selector *CS.* This is accomplished in the following manner:

The central operator plugs in a disengaged junction line and sends out a ringing current. Relay LR_1 energizes and is held over contact LR_1a, closing the following circuit:

Negative, LR_1c, *IRd, CS, CORa,* I_1 and positive.

IR and *CR* energize, causing the cord selector *CS* to stop rotating and the calling lamp AL_1 to glow. BR_1 energizes, causing LR_1 to de-energize. Line relay *LR* of the central exchange is held over resistance r_1.

The operator answers the call by pressing the key K_1 over to the speaking position, when the calling lamp AL_1 ceases to glow. Relay *UR* energizes and is held over *CRb.*

When the call has reference to a taxi order, the operator writes down the given address and passes the order on to its nearest cab rank. For this purpose, the operator plugs P_2 into the corresponding jack and rings. The key K_2, when in its speaking position, is connected in such manner as to disconnect the calling subscriber while the operator is speaking with the chauffeur. After having informed the subscriber that the ordered taxi is coming, the connection is broken and a clearing signal sent out to the central exchange by restoring the key K_1 to normal.

The cord P_1 comes into use when a central exchange subscriber — for example, the Taxi Owners' Association — wishes to communicate directly with a cab rank.

Most of the information in this article bas been obtained through the ready courtesy of The Royal Swedish Telegraph Service — builders of the Stockholm taxicab telephone exchange — and of The Stockholm Taxi Owners' Association.

B. K.

New Telephone Exchanges in the Orient and China.

Complete equipment for a telephone exchange in Angora, the new Turkish capital, has now been contracted for by the Turkish Post Office, Telegraph and Telephone Administration. This plant, which will have a total capacity of 1,200 lines, the initial equipment being for about half this number, is to be delivered by L. M. Ericsson. The system will be L. B. with magneto ringing and double automatic clearing signals, the switchboards to be equipped with self restoring drop indicators for incoming calls and visual indicators for the clearing signals. The switchboards will be of L. M. Ericsson's latest standardized type, the various parts of the multiple and cord equipment being mounted in strips, thereby greatly facilitating future extension.

This contract has been secured through the offices of The Swedish Oriental Trading Co., of Constantinople, L. M. Ericsson's representatives in the Orient.

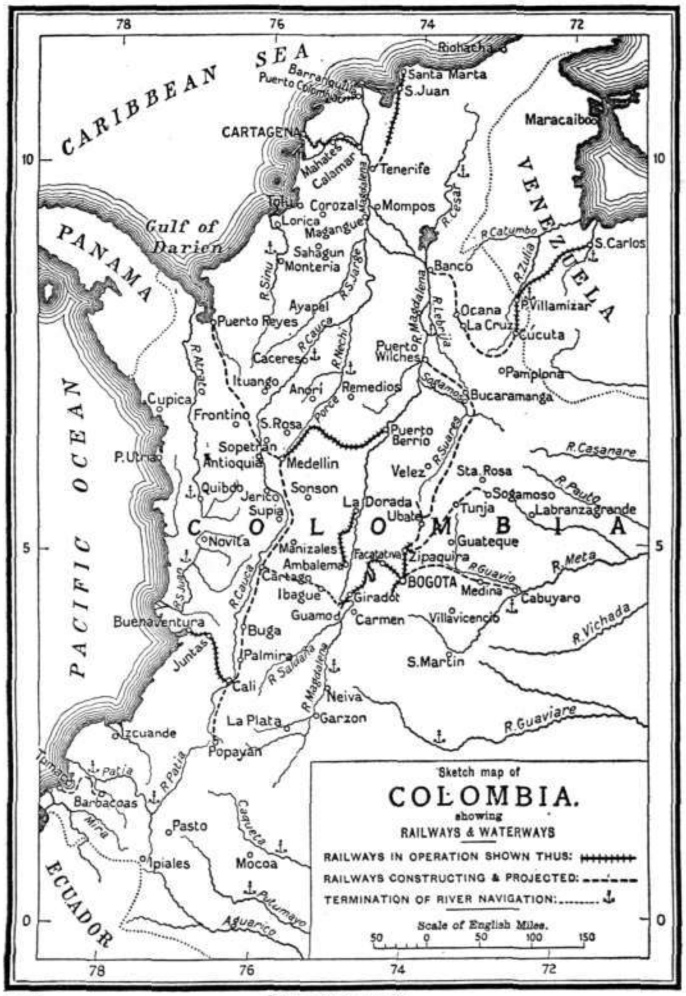
L. M. Ericsson has also secured an order for a plant of exactly the same type for Hang-Chow, capital of the Chinese province of Chekiang. Hang-Chow has a population of about 350,000 inhabitants and is one of the larger cities of China, carrying on an extensive trade in furs and silks. Since the introduction, in 1896, of the »open door» policy, the trade turn-over of this port has been subject to a steady increase and amounts, at the present time, to about twenty million Haikwan Taels per year.

Our representatives in North China, The Ekman Foreign Agencies, Ltd., have negotiated this transaction.

Some Facts about Colombia and Sweden's Participation in the Exhibition at Bogotá 1923.

The Colombian Republic is situated far up in the northern part of South America, its extensive coast lines bordering on both the Atlantic and Pacific Oceans. After the completion of the Panama canal, the vast number of vessels using this waterway pass close to the most important Colombian ports, i. e. Puerta Colombia—Baranquilla and Cartagena on the Caribbean coast, and Buenaventura on the Pacific coast. Due to this fact, Colombia has emerged out of its former isolated position and has been brought into closer contact with the outer world.

The period of development and national prosperity towards which Colombia is undoubtedly advancing, however, may be traced back to several concurring circumstances. First of all, the country has now enjoyed the blessings of peace for more than twenty years after having been subjected to inner strife and unsettled conditions for a period of almost one hundred consecutive years.



R 145

Map of Colombia.

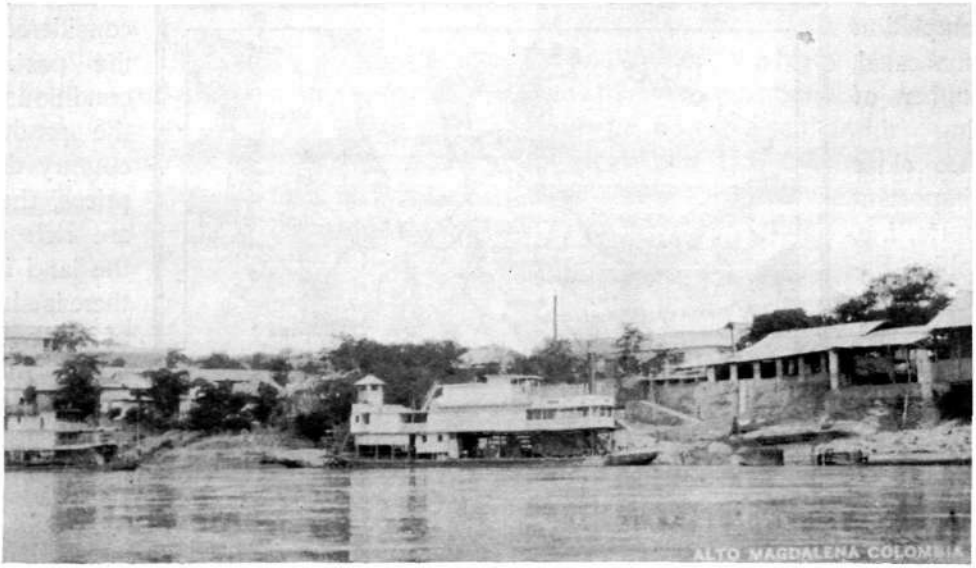
It would seem that the country's present form of government is the one best suited to its needs and that the formerly frequently recurring revolutions are to be considered a thing of the past. Financial conditions are sound, the products of the country demand good prices, the mountains are rich in minerals, the land is fertile, and there is a high standard of intellectual development. All efforts are now being centered on the upbuilding and development of the country.

The technical problems which first require to be solved are those connected with the development of the means of communication.

Colombia has an area almost equal to that of France and Germany combined, its population amounting to approximately 6,000,000 inhabitants.

The inhabitants of South America, especially those of the equatorial countries, who live in the mountainous regions of the Andes, much prefer the highlands to the lowlands, these latter being sparsely populated on account of their torrid climate.

In Colombia, the more thickly populated regions are situated at a comparatively great distance from the sea, their most important means of communication with the outer world being the mighty Magdalena river, whose course runs straight through the country. The southernmost part of the Cauca valley is the most important exception, the port of Buenaventura being reached by means of a railway over the Andes mountains. The Cauca is the largest branch of the



R 148 Scene on the Magdalena River.

Magdalena river. The journey from the coast town of Baranquilla to Bogotá, the capital of the Republic, takes from 12 to 15 days, when there is a sufficient amount of water in the river. Moreover, the Magdalena river has a tendency to overflow large areas of the adjoining country, so that for long stretches only very shallow going boats can navigate its waters, and when the water level drops below normal it is impossible to calculate the time required, as one is subjected to frequent delays on account of groundings, etc. Several millions of inhabitants, as well as about one and a half million sacks of coffee in freight — not to mention numerous other products — are entirely dependent upon these inadequate means of transportation. Here, therefore, is a problem which is in urgent need of a satisfactory solution, but the mountainous character of the country makes railway building very expensive. Loans are expensive and the customs duties constitute the government's main source of income. If conditions happen to be unfavourable, this income is insufficient to meet current expenses. However, the prospects are now brighter owing to the fact that the twenty five million dollar indemnity, which is being paid to Colombia by the United States, has been almost entirely appropriated to the development of the country's communications. This sum is to be paid off successively during a five year period, the first payment having already been made. Meanwhile, investigations covering a project to make the river safely navigable have been carried on, and an air route has been established between Baranquilla and Bogotá by means of hydro-aeroplanes, cutting down the time required for a trip between these points to one and one half days. This means of communication is also being used to advantage for the transportation of mail at a rate somewhat higher than the ordinary one. Fast hydroplanes are also in use on some stretches of the river. It is indeed a strange sight to see these modern means of transportation on the river side by side with the primitive native dugout canoes, the lumbering, wood-burning river boats, propelled by a large paddle wheel at the stern, and the large alligators which are still to be seen — 15 or 20 at the time — lying and sunning themselves in shallow places and along the jungle covered banks of the river. They hardly even let themselves be disturbed by the roar of the motors.

The very latest inventions have at every time been made use of for solving Colombia's transportation problems, this statement being well illustrated by the fact that steamboats were seen on the Magdalena river as early as in 1826 or 1827 by Gosselman, the first Swede to explore these regions. It is also quite natural that the most modern methods should be made use of for overcoming the great distances in such a country, the telegraph and telephone occupying leading positions in this respect. The telegraph service is fairly well developed and is entirely in the hands of the government. According to statistics at my disposal, about four and a half million telegrams — sixty four million words — were dispatched during 1920, for which over $1^1/_3$ million Colombian pesos were received (the nominal value of 1 Col. peso is equal to that of a U. S. dollar). Despite this fact, the service was carried on at a decided loss.

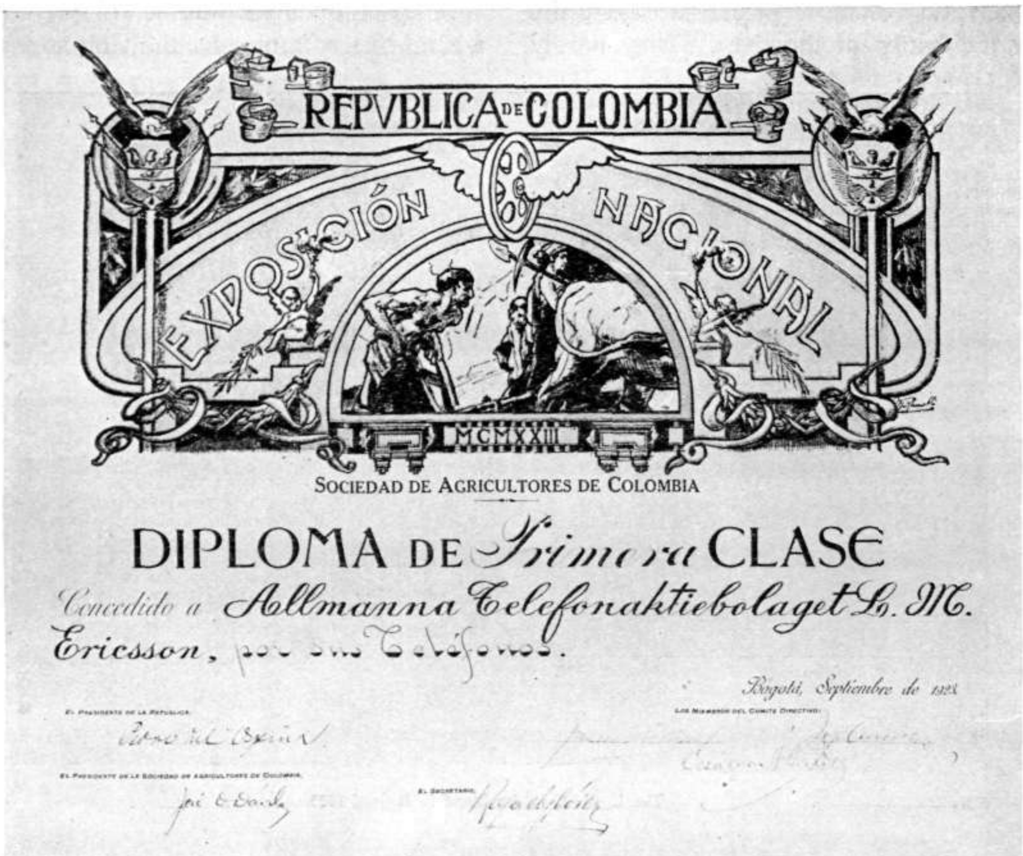
In addition to a number of private lines between houses, farms etc., the Colombian telephone service consists almost entirely of local city nets. One of the first attempts to develop the telephone service within an entire province has just been made in Antioquia, one of the country's most important provinces, inhabited by a numerous, industrious and thrifty population of over one million inhabitants. The city telephone plants are under either municipal or private ownership. In Bogotá, for instance (of about 150,000 inh.), the telephone system is owned by an English company, »The Bogotá Telephone Co. Ltd». Its first concession was granted in 1887, the one now in force dating from 1902 and having been granted for a period of 50 years. Similar

R 147 The L. M. Ericsson Stand in Bogotá 1923.

companies are in existence in all of the more important cities.

The telephone service of Colombia is at present in a state of steady development, and there is no doubt but that it has a great mission to fill in a country whose comunities, even in the comparatively closely populated provinces, often lie at a considerable distance from each other. Furthermore, there is no doubt but that the serious efforts now being made for a rational development of the country and for which all manner of technical resources are being mobilized, will also bring about an unquestionable development of the telephone service.

The national exhibition held in Bogotá last year was a means of expression for the united efforts now being made to develop Colombian industry. La Sociedad de Agricultores, a sort of central agricultural society, were sponsors for the exhibition. In connection with the initiative taken by Swedish interests for the development of communications between this country and Colombia, two prominent members of this society, who took a special interest in Sweden, made the proposal that Sweden take part in the exhibition. For this proposal we are mainly indebted to the interest shown by the executive committee of the exhibition, Messrs. del Corral, Ancizar and Pardo, and to the support given by our highly respected consul don Joaquín Sampér. The proposal was most favourably received in Sweden, and in spite of the existing financial depression a sufficient amount of money was appropriated by the Chamber of Commerce and free transportation was obligingly furnished by the Johnson line, making possible



R 147 Certificat awarded L. M. Ericsson at the Bogotá Exhibition.

a representative exhibit of Swedish industrial products at »La Gran Exposición Nationál en Bogotá 1923». In spite of delays caused by sea damage, necessitating the pressing into service of another vessel, the 89 boxes of exhibits arrived at their destination in ample time to permit the opening of the Swedish section practically on the appointed day. The transportation of these goods through the country was accomplished in record time, thanks to the aid given by our Colombian friends. All the goods were so well packed and so carefully handled during their transportation from the coast to Bogotá, that they did not suffer the slightest damage in spite of seven reloadings.

The Swedish section evoked much well deserved admiration and was very favourably mentioned by the press, L. M. Ericsson's stand, of which a view is here given, being among the foremost in this respect.

Most of us were of the opinion that L. M. Ericsson's »corner» and the excellent quality of the Ericsson products would be kept in especially good memory by the visitors, quality and good workmanship being held in high esteem by the Colombians.

The greater number of visitors came from the surrounding, fairly well populated provinces. The fact that congress was in session during the exhibition, however, brought visitors from among the leading men from all parts of the country. The president of the republic as well as his cabinet inspected our exhibits and evinced a most lively interest for the same.

For these reasons, I sincerely hope that this little exhibition of Swedish products may increase the sale of Ericsson telephones in Colombia and that our Colombian friends, having Ericsson's products in good memory, will find it easier to consider the Swedish telephone when deciding to build telephone plants in their towns and cities or lines between their haciendas. I also trust that they will not hesitate in turning to L. M. Ericsson for their equipment, on account of the confidence which the excellent quality of their products has already inspired.

In this connection, we should not forget all the hospitality and amiability shown Sweden by Colombia, for which reason it is to be hoped that Swedish initiative and capital may partake in the great work now being carried on i. e. the development of the country's material possibilities and great natural resources.

I am convinced that Colombia, with this object in view, would welcome cooperation with our country.

A. Winqvist,
Commercial Attaché.