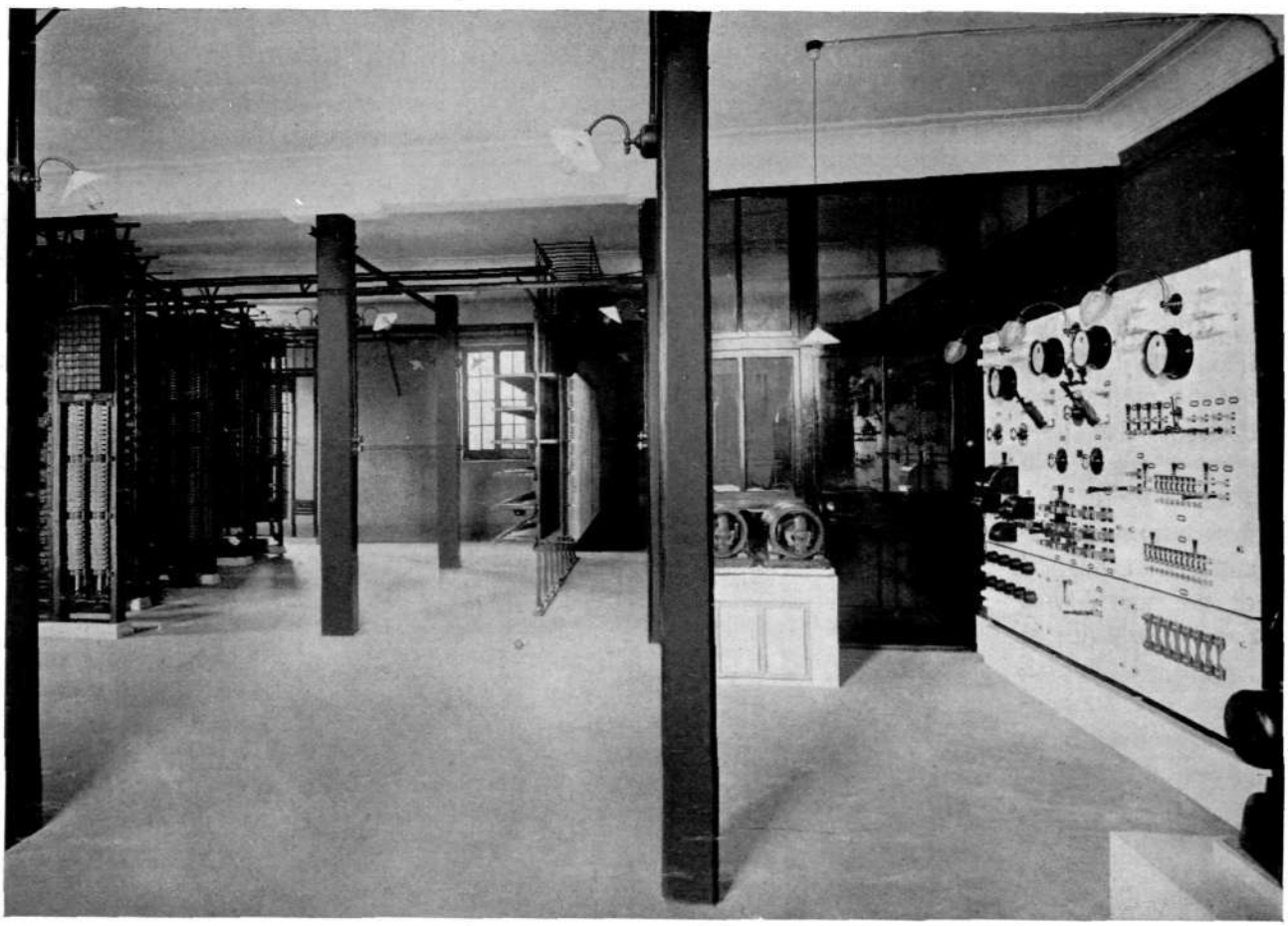
The L. M. Ericsson Review

VOL. 1 SEPTEMBER–OCTOBER 1924 Nos. 9–10.



THE SHANGHAI AUTOMATIC EXCHANGE.

ENGLISH EDITION

L. M. Ericsson

THE L. M. ERICSSON REVIEW

ENGLISH EDITION.

JOURNAL OF

ALLMÄNNA TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM.

HEMMING JOHANSSON, Director.

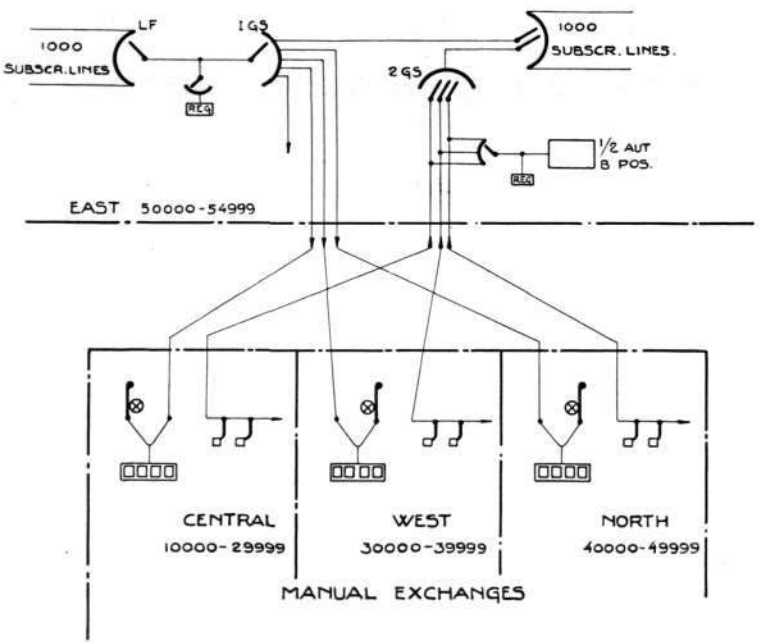
TORSTEN AF GEIJERSTAM, Editor.

Issued monthly. Yearly subscription rate: 7/–

All communications and subscriptions to be forwarded to the Editor.

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.



R 179 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 func-

tioning 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 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*,

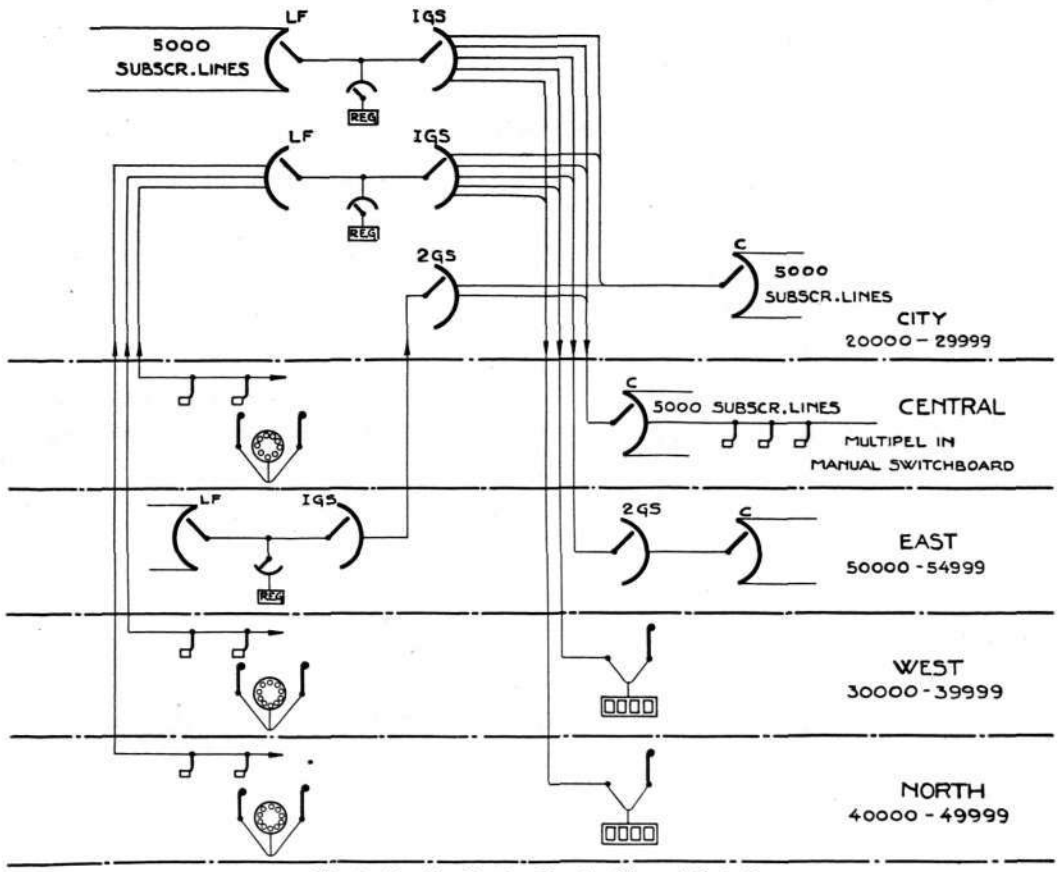


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Fig. 2. Junction Routing Plan for City and Central.

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 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

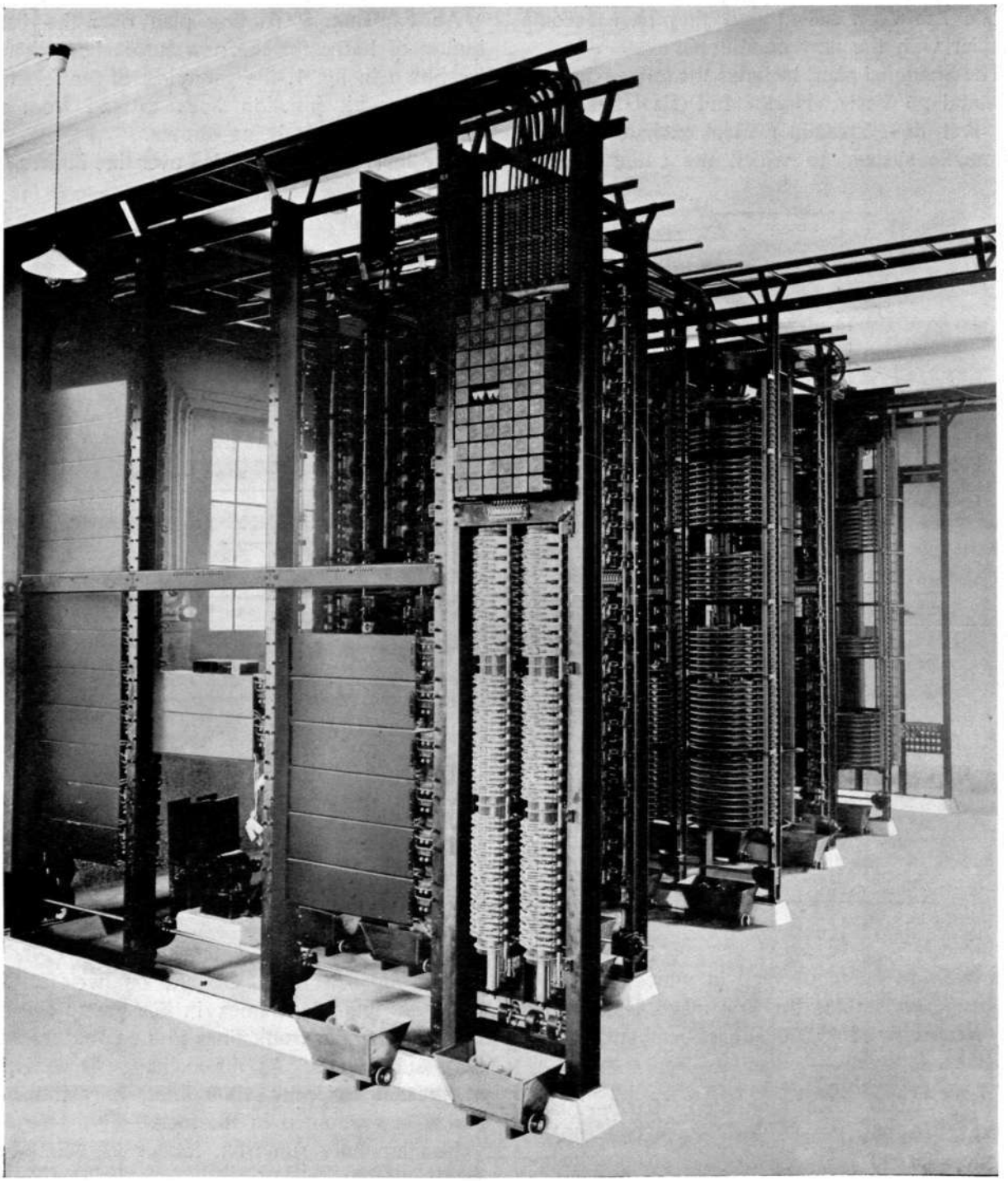

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Fig. 3. The Automatic Equipment at Shanghai East.

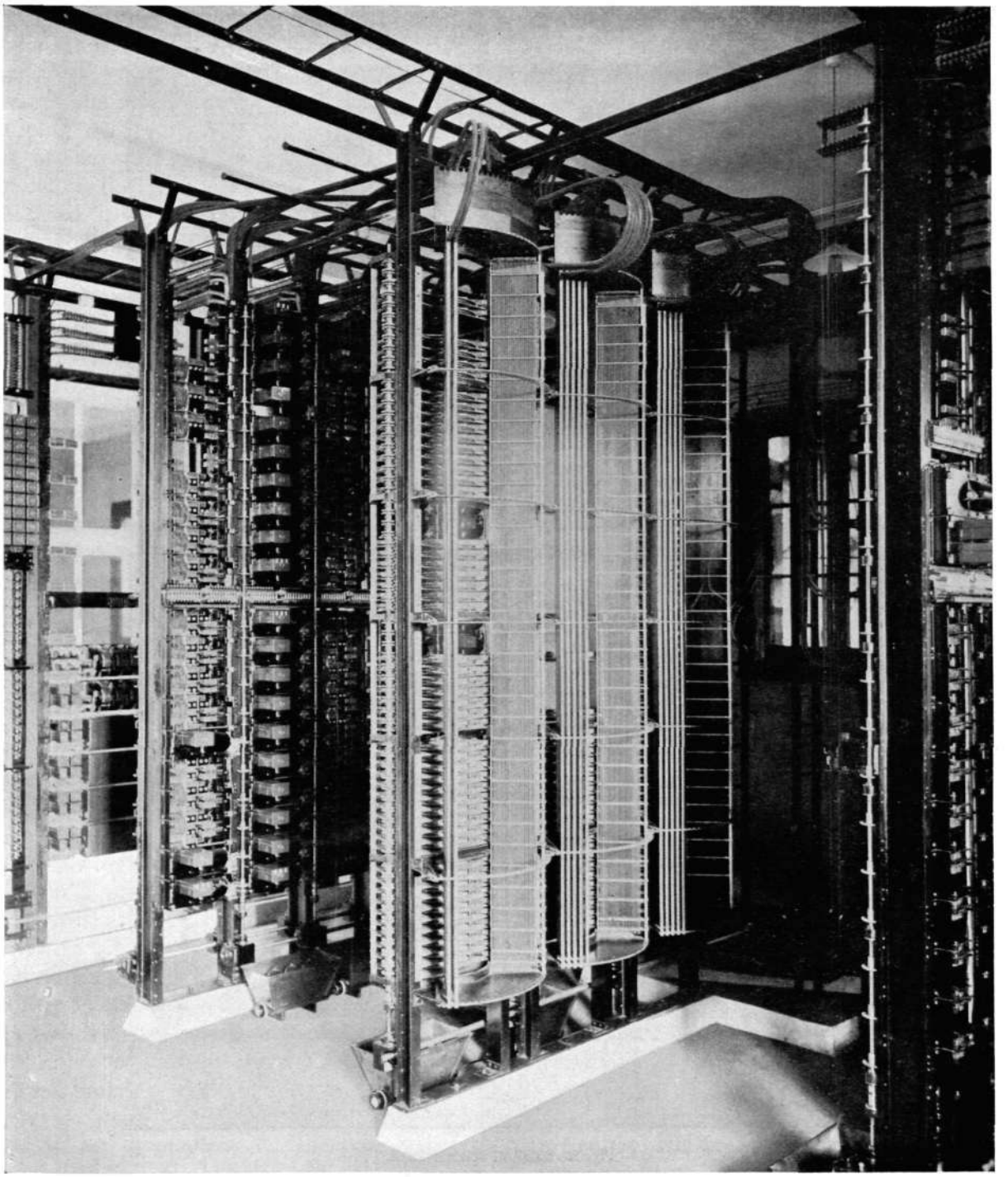

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Fig. 4. Shanghai East. Group Selector and Sequence Switch Racks.

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.

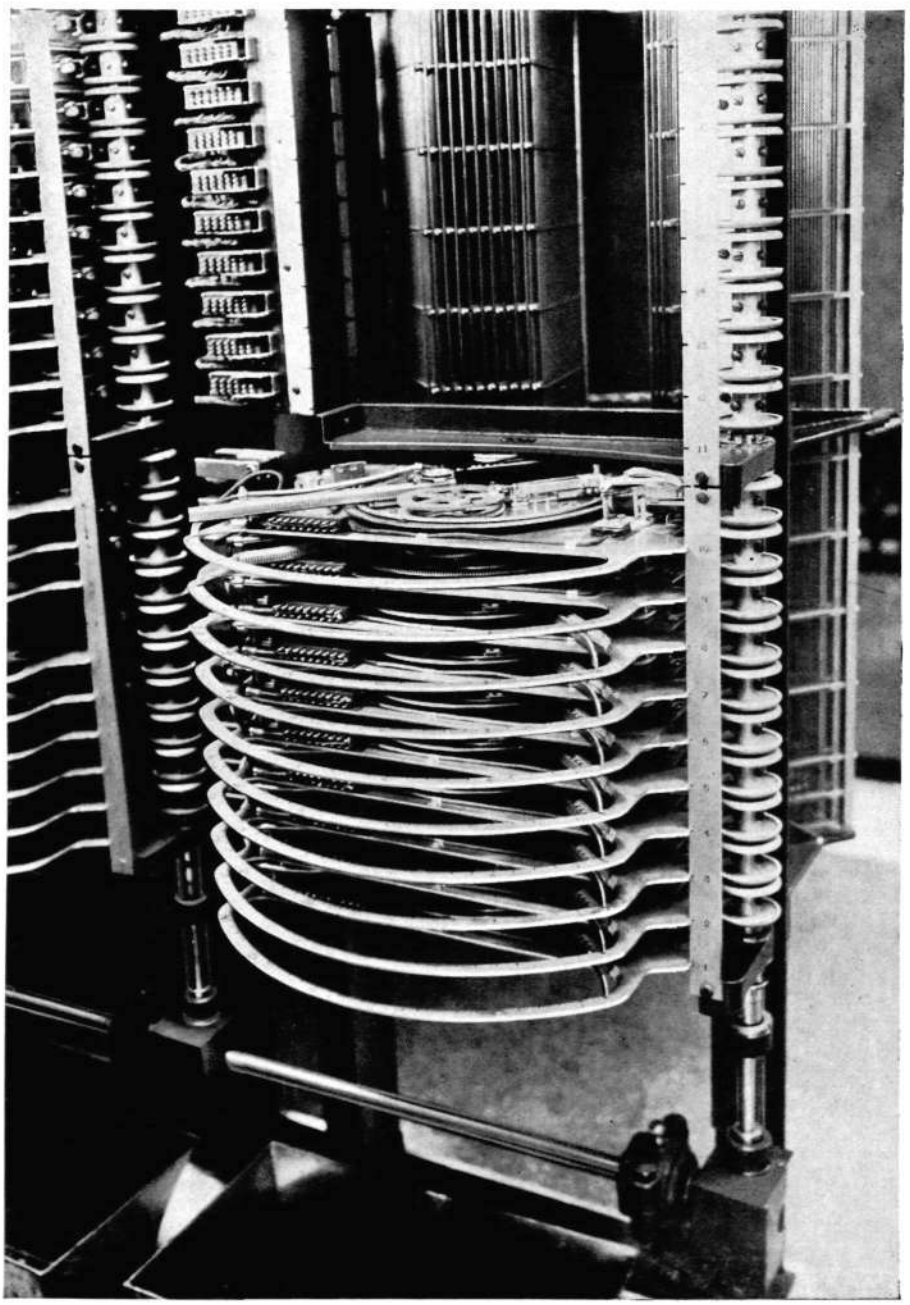

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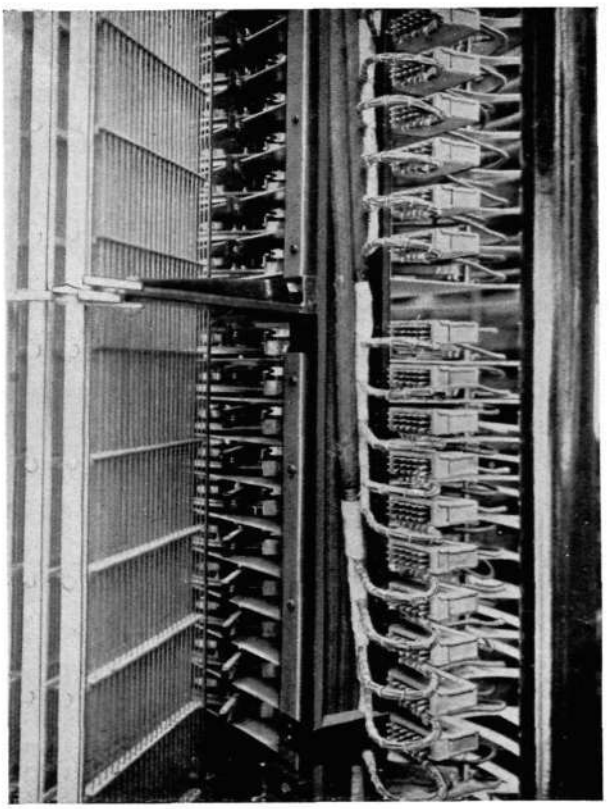
Fig. 5. Detail of Selector Rack.

The group selector then seeks out the multiple frame to which the »Central» junction lines are connected. The group selector seeks an idle line

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

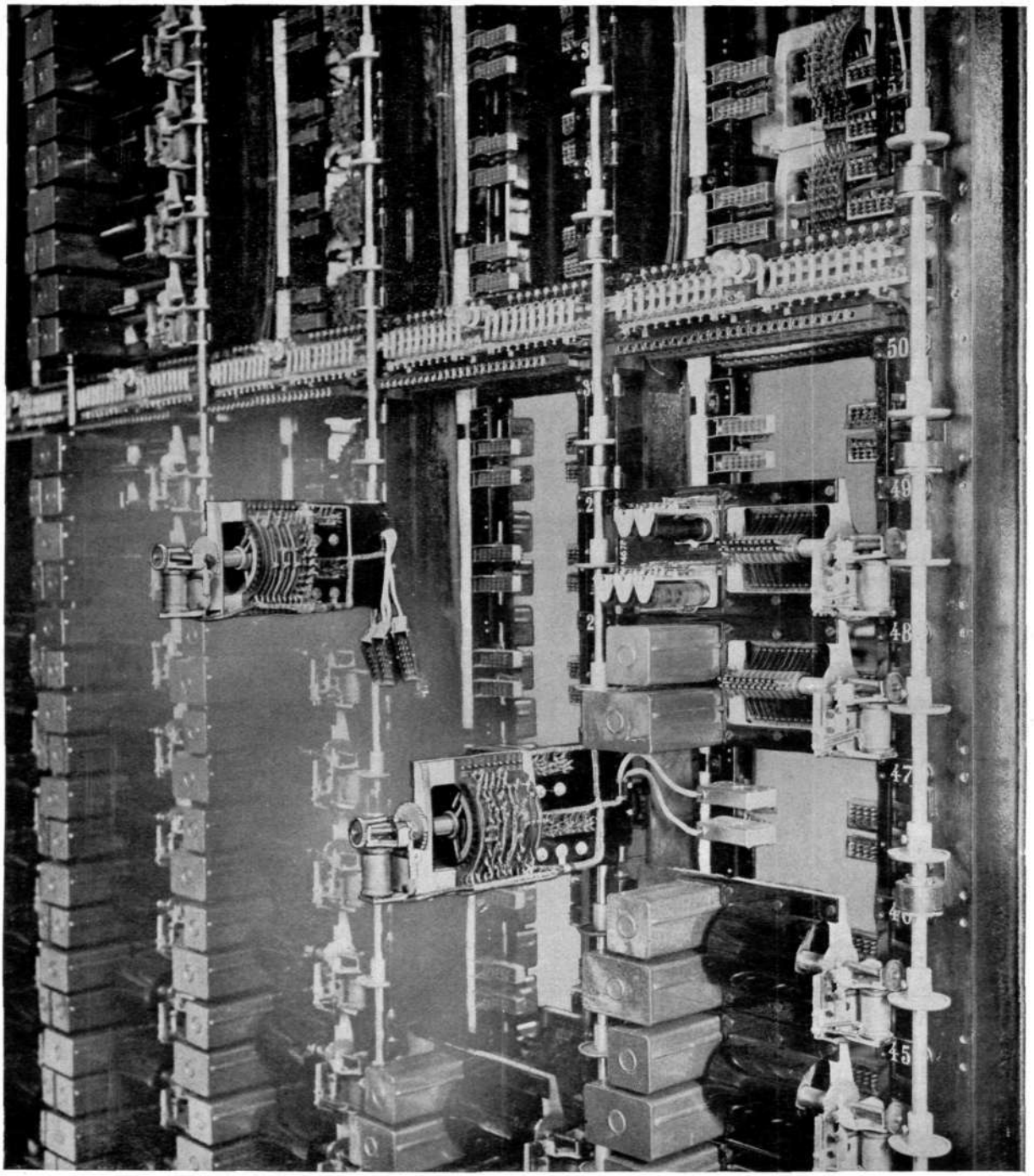


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Fig. 7. Detail of Sequence Switch Rack.

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

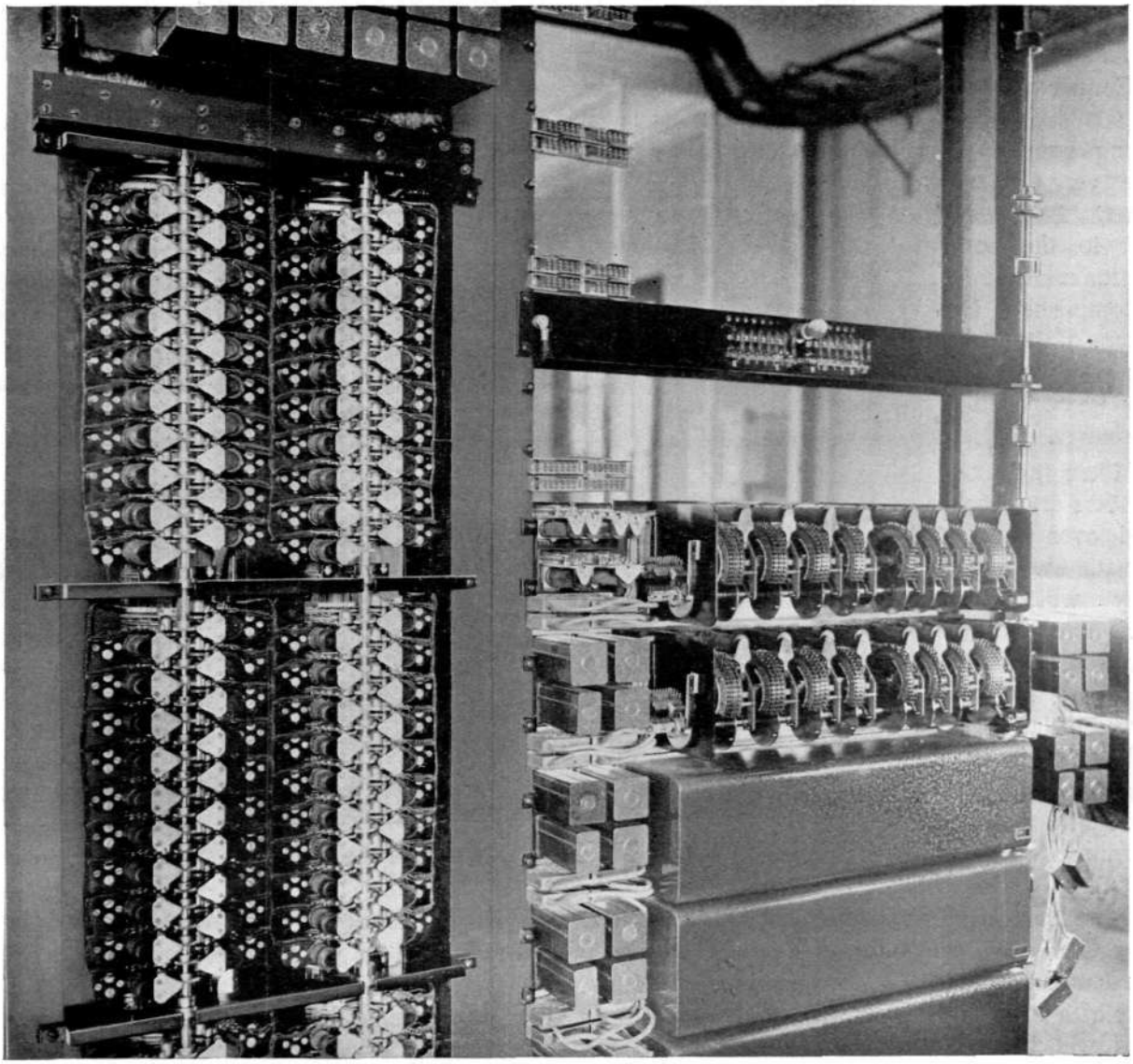

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Fig. 8. Shanghai East. Register Finders and Registers.

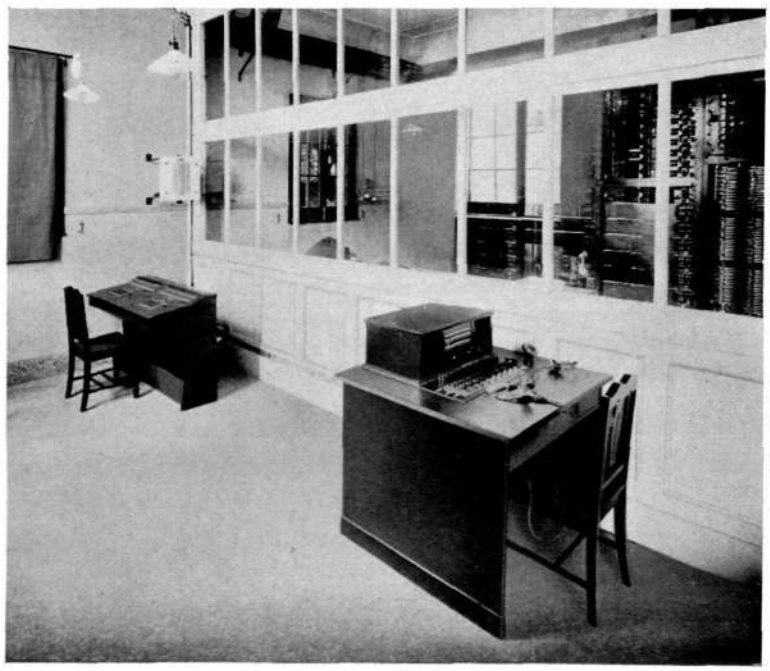
so as to avoid installing any new B-positions at the manual exchange for the handling of this traffic from the new automatic exchange and so as to provide room for future additions. The grouping of selectors and the routing of junction traffic is schematically shown in fig. 2.

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.

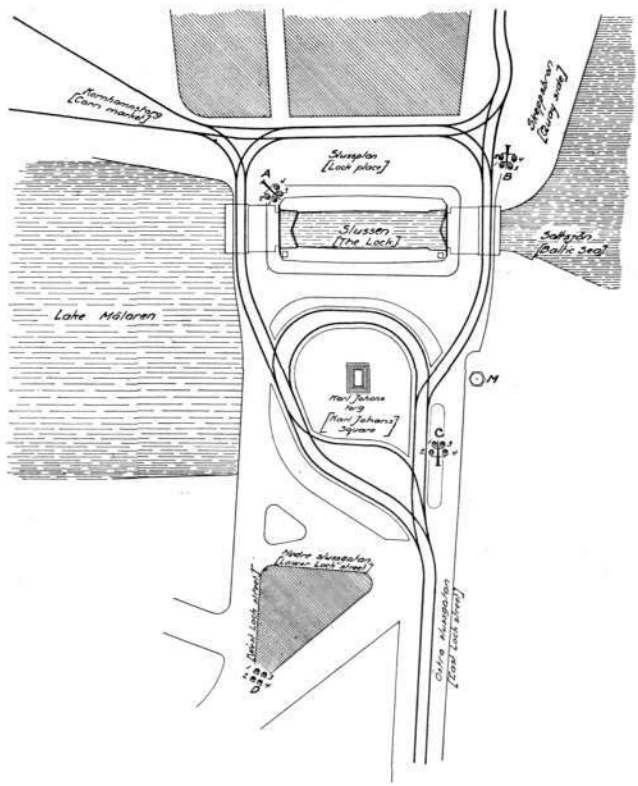
From the foregoing it will be seen that the difficulties of obtaining a standard for speaking apparatus is not insurmountable. The problem of satisfactory comparative testing of apparatus is not so easily solved. The difficulties of comparing speaking apparatus, and more especially transmitters has been 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.

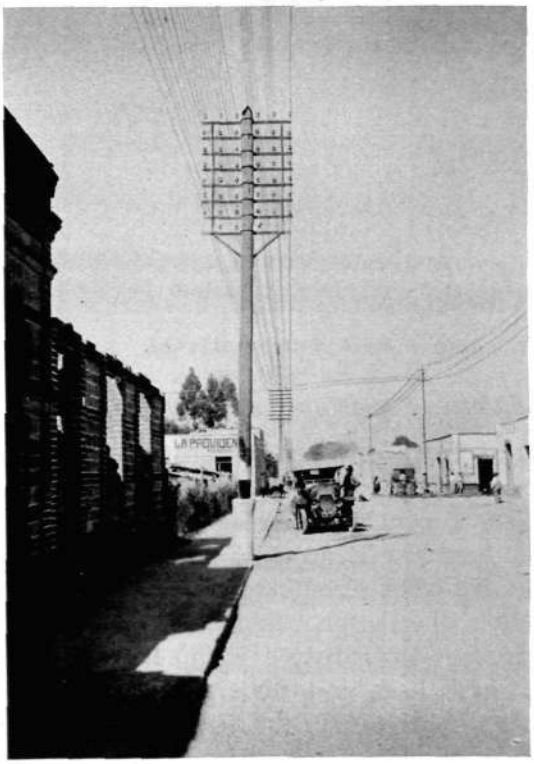
In addition to the telephone communication between the tower watchman and the lock operator, telephone instruments have been mounted on the tramway poles at *A*, *B* and *C*, whereby the tramway employees, if necessary, can communicate with the watchman.

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.

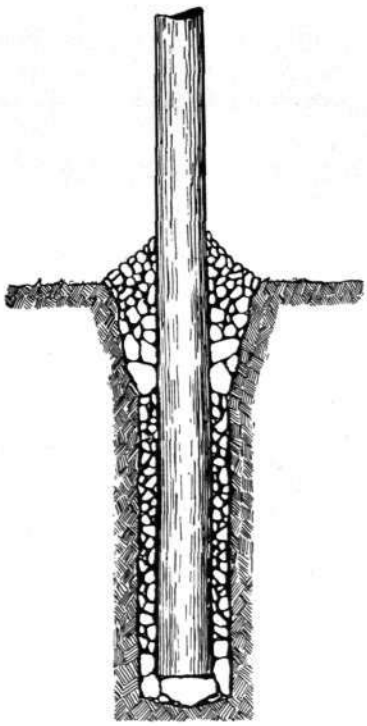


R 169 Fig. 1. 32-foot Telephone Pole with Pole-Support, Mexico D. F.

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.

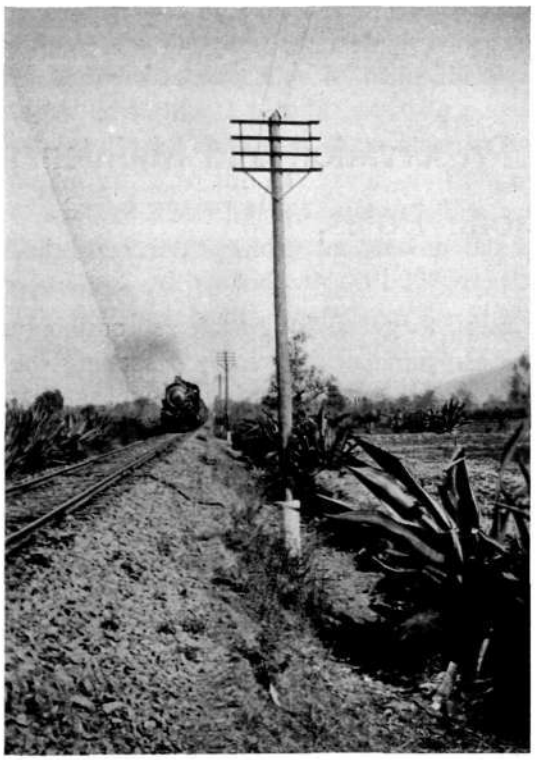
There is a natural desire on the part of all pole users to get as long a life as possible out of the poles purchased, thereby lessening the depreciation rate and bringing the cost of maintenance down to a minimum.

It is of the greatest importance, from a view-point 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.

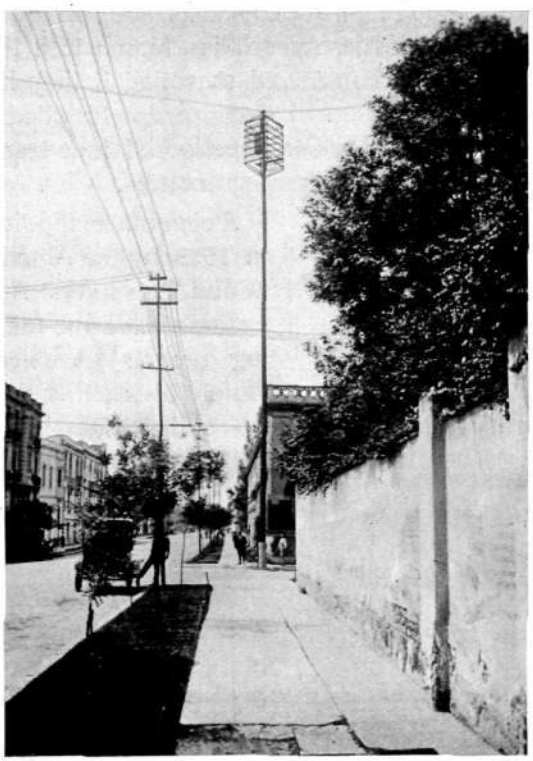
If protected from the action of these fungi, or even if they are present, but lack the conditions necessary for their propagation, wood will last indefinitely.

Conditions of moisture necessary for decay.

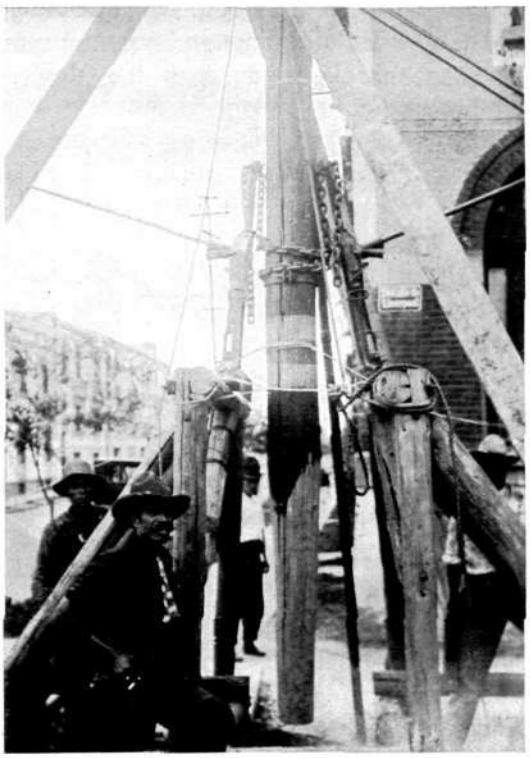
Apart from ordinary circumstances the fungi, in order to thrive, are in an eminent degree dependent on a certain percentage of moisture. We know from experience that timber kept in a perfectly dry place or entirely under water, will keep for ages, the reason being that in the first case its content of 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.

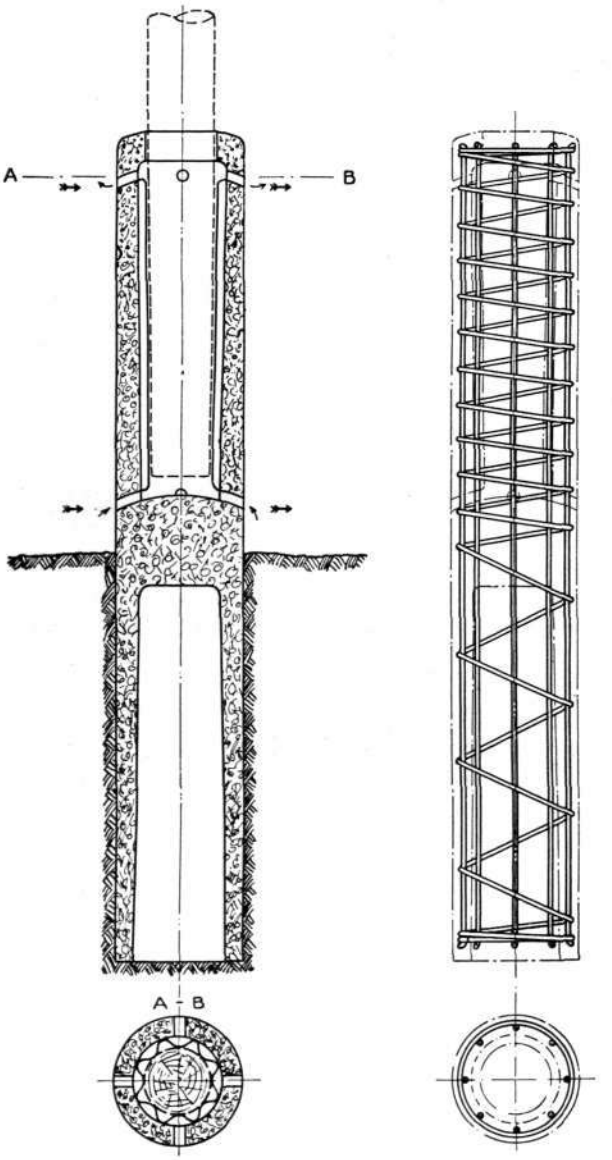
Wood which is to be treated should be of such character as to permit the preservative substance to penetrate at least the sapwood and, if the heartwood cannot be impregnated, it should in itself be resistant to decay.

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.

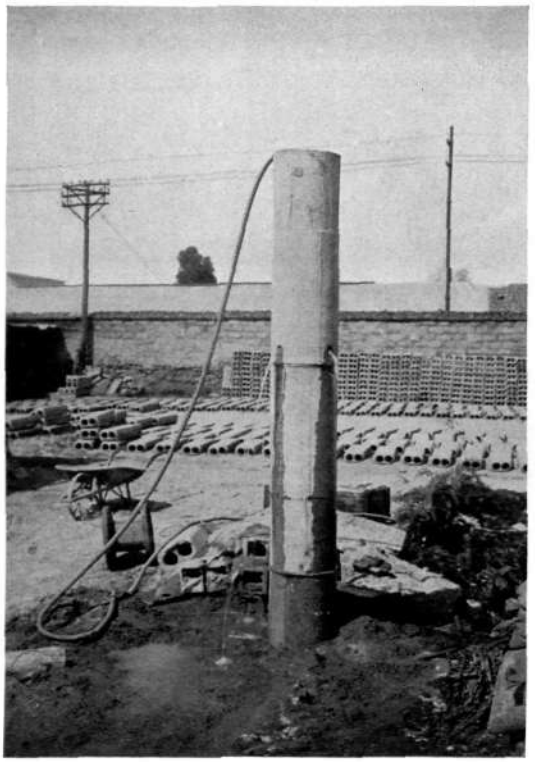
Kyanizing.

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.

Helge Rost
Chief engineer
Empresa de Teléfonos Ericsson S. A.
Mexico D. F.

Printed by Allmänna Telefonaktiebolaget L. M. Ericsson. Stockholm 1924.