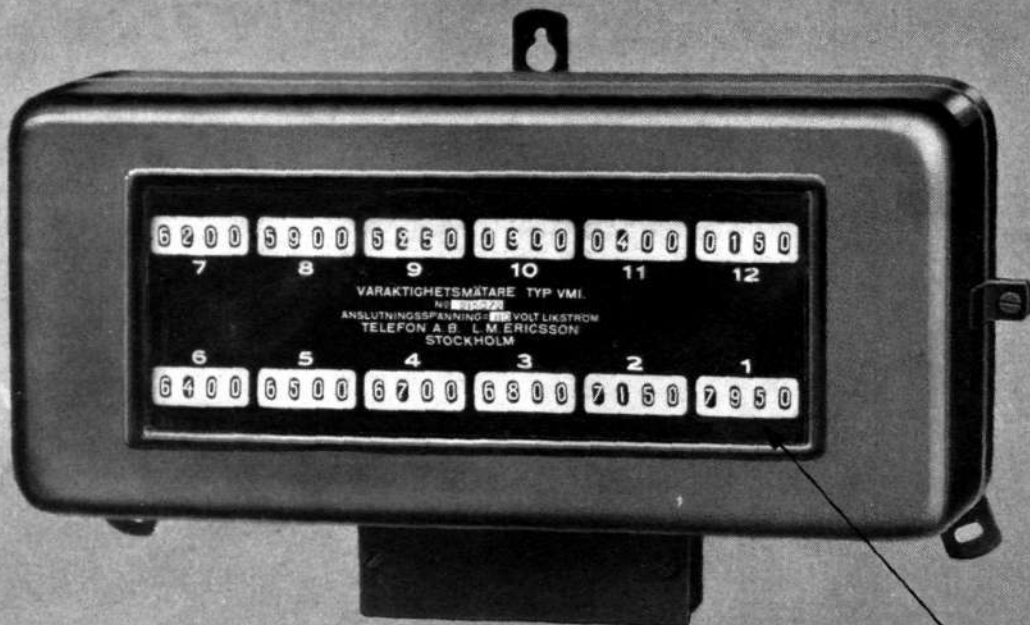


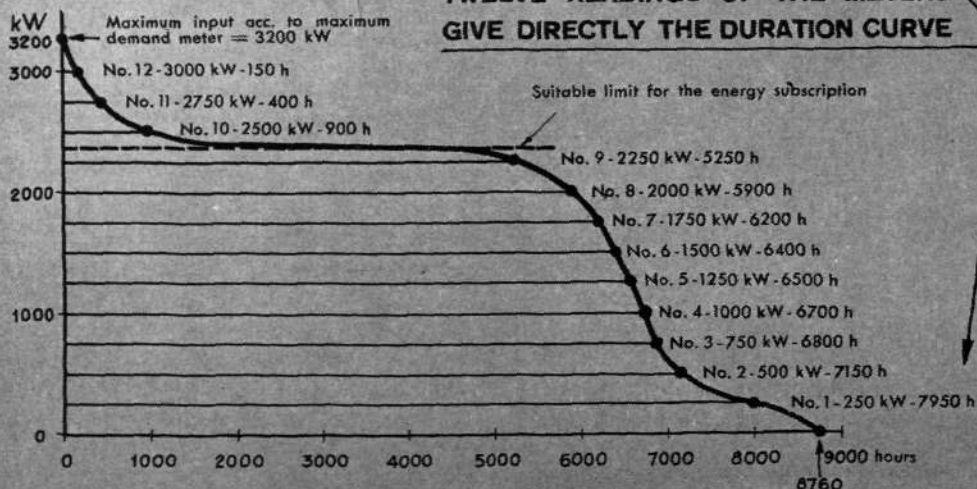


# The L.M. Ericsson Review

1933 Nr. 1



**TWELVE READINGS OF THE METERS  
GIVE DIRECTLY THE DURATION CURVE**



THE ERICSSON DURATION METER ENABLES POWER DISTRIBUTORS AND INDUSTRIAL ENTERPRISES TO CONTROL THEIR POWER SUPPLY AT LOW COST IN ORDER TO OBTAIN THE BEST POSSIBLE ECONOMIC RESULTS



**TELEFONAKTIEBOLAGET L. M. ERICSSON**  
STOCKHOLM

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## Hans Th. Holm

General Manager, Telefonaktiebolaget L. M. Ericsson

# The New Ericsson Telephone

By  
G. GRÖNWALL



Head of Design Department,  
Telefon A.-B. L. M. Ericsson,  
Stockholm.

*A modern design of telephone instruments must meet the needs of the local service as well as the increased requirements brought about by the rapid development of long distance telephony.*

*Further, modern trends in the esthetic design of the instruments must be considered, and all possibilities of simplification and economy in construction must be observed.*

*Taking into account the most exacting requirements of transmission technics, and by utilizing all constructive possibilities of the materials, Ericsson has designed a telephone, which in elegance of appearance as well as in articulation and quality of tone stands up as the best that modern technique can produce.*

The new telephone instruments which are described below are intended for use with automatic and manual central battery systems, and are the results of extensive scientific and constructive research work.

The scientific problems have been worked out with special consideration to international long distance telephony, which has recently made rapid strides and has increased the demands on the telephone instrument's ability to effectively send and receive the spoken word. The new Ericsson telephone instruments are designed to meet all demands in this respect.

They are carefully designed, special attention being paid to the standardizing of the components with which they are built, and also to simplicity in adjusting and maintenance of the instruments in use.

They are of solid construction and mechanically durable and are made from the highest grades

of raw materials which ensures long life in service.

Standardization has been obtained by simple unit construction and the greatest possible limiting of the number of components used, and also by interchangeability. The parts used in the instruments, such as dial, handset with cord and also the internal units, such as ringer, induction coil, key and switches are similar in both table and wall instruments.

A characteristic feature of both types of instruments is the fitting of a mounting plate on which the inner parts are fixed and wired. This chassis is easily detached and replaced; its position being such that both the ringer and switch are easily accessible for inspection and adjustment.

The handset and terminal block cords and the dial cable are connected to the instrument by means of screw terminals. The wiring of the



X 1012 Fig. 1. Table telephone of bakelite, Type DE 702.



X 1013 Fig. 2. Table telephone of bakelite, Type CG 502.



Fig. 3.  
Wall telephone  
of bakelite,  
Type DE 200.

X 1014



Fig. 4.  
Wall telephone  
of bakelite,  
Type CD 1200.

X 1015

inner components is soldered. By reason of these parts having their own solder contacts, necessary changes can be made without disturbing other connections.

The outside parts of the instruments are made of moulded bakelite. This material possesses high insulating qualities, good mechanical strength and resistance to chemical action, and is capable of being easily moulded and retains a bright, hard and durable surface.

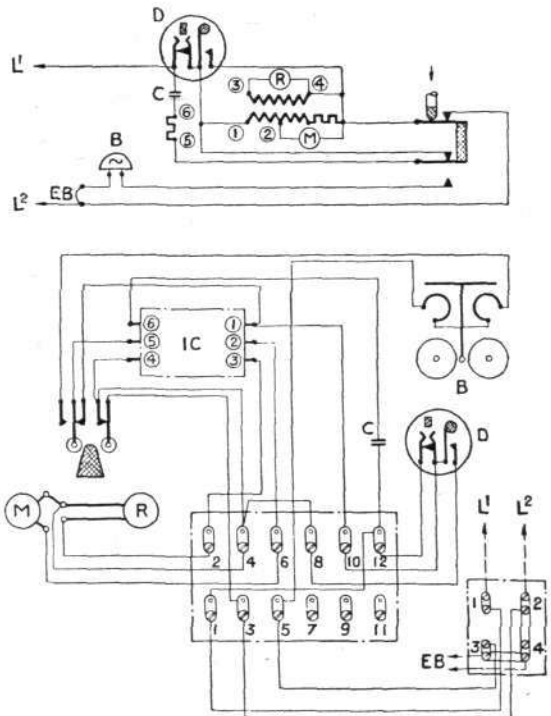
The instruments which are shown in Figs. 1, 2, 3 and 4 are supplied as standard in black. Fig. 1 shows a table instrument with dial. Instruments intended for use on manual CB systems are supplied without the dial which is replaced with a dial blank shown in Fig. 2. Figures 3 and 4 show wall instrument with and without dial.

Thanks to their simple and clear lines and the beautiful appearance and durability of the bakelite the new instruments present an attractive appearance and fit in with both traditional and modern styles of furnishing.

## Circuit.

The upper part of figure 5 shows the circuit diagram which is the same for both wall and table instruments. The under portion shows the wiring diagram of the table instrument. The wall instrument does not possess the terminal block shown on the right; otherwise the circuit is the same as for the table set. On instruments for central battery working the dial *d* is not required, and a metal connection strap joins the terminals 10 and 12. The changing of an instrument from central battery working to automatic system is therefore extremely simple. Anti-side-tone connection is used. During speech the ringer *B* is out of circuit. Whilst dialling, the condenser *C* in series with the resistance 5—6 is connected in parallel with the impulse contact; this is done in order to reduce extra voltages and also to increase the efficiency of the impulsing circuit.

During the dialling the induction coil, transmitter and receiver are short-circuited in order to prevent the impulses being heard in the receiver.



X 1016

Fig. 5. Principle and wiring diagram for table telephone, Type DE 702.

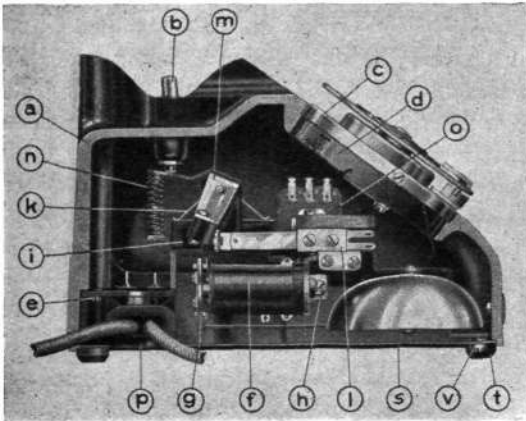
- |                               |           |     |                |
|-------------------------------|-----------|-----|----------------|
| B.                            | ringer    | M.  | microphone     |
| C.                            | condenser | R.  | receiver       |
| D.                            | dial      | EB. | extra bell     |
| L <sub>1</sub> L <sub>2</sub> | line      | IC. | induction coil |

In order to make possible the connecting up of an extra ringer *EB*, if so desired, the table set is provided with a 3-way cord to the terminal block. The extra ringer is connected to the terminals 3 and 4 in the block.

On the wall instruments the extra ringer is connected to the terminals 3 and 5.

The electrical data given below refer to instruments intended for use with Ericsson automatic exchanges for 24 V battery voltage and 400+400 ohm feeding coils.

## Table Telephone DE 702 for Automatic Systems.



X 1017

Fig. 6. Section of table telephone, Type DE 702.

a case	l spring group
c, d dial	b, m, n switch mechanism
f, g bell	o induction coil
i condenser	p terminal strip
k spring for fixing the condenser	s base plate

Figure 6 shows a table set in section, and Figure 7 shows the chassis detached from the case. The table set is composed of the following units

1. Case,
2. Dial,
3. Chassis,
4. Base Plate,
5. Handset with Cord,
6. Terminal Block with Cord.

### 1. Case (Fig. 6 a).

A characteristic feature of the new telephones is that they are made without the traditional switch cradle for carrying the handset. Instead, the case, which is moulded in one piece of bakelite, is shaped so that the handset is carried on the upper portion which is in the form of a cradle. This arrangement has many advantages

over instruments with the usual cradle, such as: reduced dimensions, a smaller number of components, greater stability and a more pleasing appearance. The cradle formed by four projections on the top of the moulded case is shaped to guide the handset into its correct position even if carelessly replaced and is designed to withstand very rough handling.

Fitted in the handset cradle are two plungers *b* sliding independently of each other in brass bushes; each of them operates the switch fitted on the chassis when the handset is placed in position on the instrument.

On the front lower part of the case a rectangular number frame is fitted, which has an opening of approximately 23×8 mm covered with cellulose. The number plate can be mounted and removed from the outside without opening the instrument.

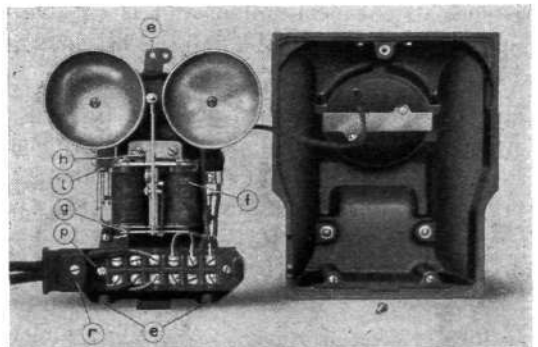
Three threaded metal inserts are moulded in the inside of the case for fixing the chassis.

### 2. Dial (Fig. 6 c).

The dial which is of the Ericsson standard type is recessed on the sloping portion of the case as shown in Figure 6. It is set at the most suitable angle for easy operating.

In order to protect the working parts of the dial as much as possible from the ingress of dust and the influence of the outside atmosphere a protecting case *d* is provided which, with the help of a metal bridge serves to hold the dial in position on the case. The dial connection cable has 3 conductors provided with tags for connecting to the terminals 8, 10 and 12 on the terminal strip.

The dial cable is of the following construction: Each conductor is made up of 7 strands of



X 1018

Fig. 7. Chassis and case for table telephone, Type DE 702.

f, g bell
l spring group
p, r terminal strip

twisted 0.15 mm copper wire insulated with two coverings of silk and a braiding of cotton. Three such conductors are twisted together and protected by a braiding of glazed black cotton yarn.

The dial speed and impulse ratios are as follows:

Make ratio: 40—42 %,

Brake ratio: 6—58 %

of the total impulse.

Speed: 10 impulse per second with a permissible variation of  $\pm 5\%$ .

### 3. Chassis.

Figure 7 shows the chassis detached and placed at the side of the case. In Fig. 6 the chassis is shown fixed in position in the instrument.

The chassis consists of a black enamelled sheet iron on which the parts are fixed and wired. The mounting plate is fixed on the instrument by 3 screws fitting in inserts moulded in the bakelite case. Figure 7 shows the three inserts and the holes in the mounting plate for the clamping screws.

The following parts are assembled on the mounting plate:

#### Ringer.

The polarized ringer is of entirely new construction. In spite of the reduced size in comparison with the older types it has been possible, by the choice of suitable materials and dimensions to produce a ringer with a high efficiency and sensitivity and also a long life.

The permanent magnets are made from steel with a high cobalt content.

The two electromagnets *f* have cores of low-remnance iron on which the bobbins carrying the windings are moulded in bakelite.

Each bobbin is provided with 2 tags moulded in the cheeks to which the outer ends of the windings are connected. Each coil has a winding of 500 ohm  $\pm 5\%$  resistance making the total resistance of the ringer 1000 ohm.

The bearings of the armature *g* which carries the hammer stem are constructed so that friction is reduced to a minimum and wear is negligible.

The two bell gongs are made from special brass sheet and have different tones in order to attract attention more readily and are nickel plated. The ringer is adjusted so that the hammer stem at rest does not lean dead against either of the gongs but due to the spring in the hammer stem the hammer strikes the gongs alternately on the receipt of an incoming signal and

in this way a clear tone is obtained. The fixing holes in the gongs are slightly eccentric so that the positions of the gongs in respect to the hammer can be adjusted without alteration to the armature gap. Adjustment can, if desired, be made to the armature by loosening the screw *h* and altering the air gap.

The ringer is constructed so that a biasing spring can easily be fitted, if necessary. In an installation where instruments are connected up in parallel the biasing spring prevents the ringer in the instruments not being called from tinkling when dialling is going on the instruments with which it is coupled in parallel.

#### Condenser (i in Fig. 6).

The capacity of the condenser is  $1 \mu F$  with a permissible variation of  $\pm 10\%$ . Despite its small dimensions,  $50 \times 43 \times 12$  mm, this new condenser complies with the same demands concerning insulation and break down voltage as the older and larger types.

The condenser is held on the mounting plate by two positioning clips and a spring located by the spindle of the operating arm of the switch.

#### Switch.

The switch consists of a group of springs and an operating arm *l* and *m*, Figs. 6 and 7. The spring group which contains 5 contact springs is mounted on a separate plate and forms a unit fixed to the mounting plate by 2 screws. The contact springs are insulated from one another and from the plate by means of bakelite spacers. The operating arm *m* fits in two lugs bent up from the mounting plate and is provided with a wedge of bakelite which is forced between rollers on two springs in the spring group when the handset is placed in position; the plungers *b* operate the arm and in this manner switching is made.

When the handset is lifted, the wedge, by reason of its form and with the aid of a spiral spring *n* slides out of the spring group, and both plungers *b* are lifted by the operating arm.

#### Induction Coil (o in Fig. 6).

The induction coil has a closed iron core consisting of laminations of high permeability iron.

The bobbin has cheeks of bakelite in which six soldering tags are inserted for the connecting up of the ends of the various windings.

The induction coil as shown in Fig. 5 has 3 windings, namely:

Line Winding	1—2
Balance „	2—4
Receiver „	3—4

The resistance 5—6 is an outer bifilar non-inductive winding.

#### Terminal Strip (p in Figs. 6 and 7).

The terminal strip is a bakelite moulding with 12 connection terminals numbered 1—12 having screw connections on one side and soldering tags on the other. As previously mentioned all interior connections are soldered, whereas the handset, terminal block and dial connections terminate on screws. The terminal strip has a bell mouthed entrance for the handset and terminal block cords, which are securely held by a wedge shaped clamping bridge *r*, made of bakelite, screwed to the strip.

The interior wiring is carried out in 0.6 mm enamelled copper wire insulated by a double covering of silk and a single covering of cotton impregnated with bees wax.

#### 4. Base Plate (s, Fig. 6).

The base plate, which is made of black enamelled sheet iron, is fixed to the instrument by means of a bent-up edge on the chassis and a single captive screw *v*.

The base plate has perforations opposite the bell gongs and is fitted with four rubber studs *t* which form the feet of the instrument.

By loosening the screw *v* the base plate can be detached and the interior of the instrument inspected.

#### 5. Handset with Cord.

The new handset is shown in section in figure 8, and figure 9 shows separately the various units of which it is composed.

The handle *a*, earpiece *b*, clamping ring *c* and the mouthpiece *d* as well as the terminal block *e* are moulded in bakelite. No metal parts are exposed; consequently the handset is completely insulated. The total length of the handset, 232 mm, as well as the distance between the transmitter and receiver, and also the shape of the mouthpiece, are designed with the object of obtaining the best results in transmission. A characteristic of the design is that the diaphragms of the receiver and transmitter lie in parallel planes giving the most suitable position of the transmitter during conversation.

The outer form has been designed with a view to mechanical strength and an attractive appearance to harmonize with the whole instrument.

The section of the handle is triangular with rounded corners, which shape has been found to be the most comfortable to hold. The ends are shaped to hold the transmitter *g*, the receiver *f* and also the terminal block *e*.

Two metal wires with terminals are moulded in the handle and serve as conductors between the transmitter and the receiver. At the transmitter end a male threaded metal ring *h* is moulded in the bakelite on which the bakelite ring *c* is screwed. The earpiece *b* which is shaped to fit comfortably against the ear has a female thread for clamping with the receiver inset.

The transmitter mouthpiece *d* serves partly as a sound collector and partly for clamping the transmitter inset with the assistance of the ring *c*. The mouthpiece is fixed by means of a notch fitting in a catch on the metal ring *h*.

The terminal block is in certain respects one of the new handset telephone's foremost improvements compared with previous models. This block serves partly as a central connection point for the whole handset, and partly to protect the transmitter against damp and outside noises that might enter through the cord inlet.

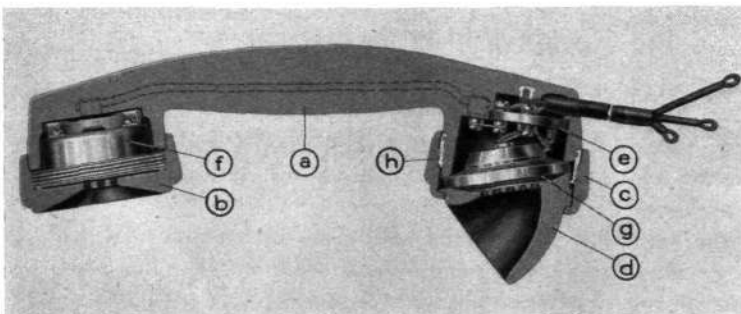
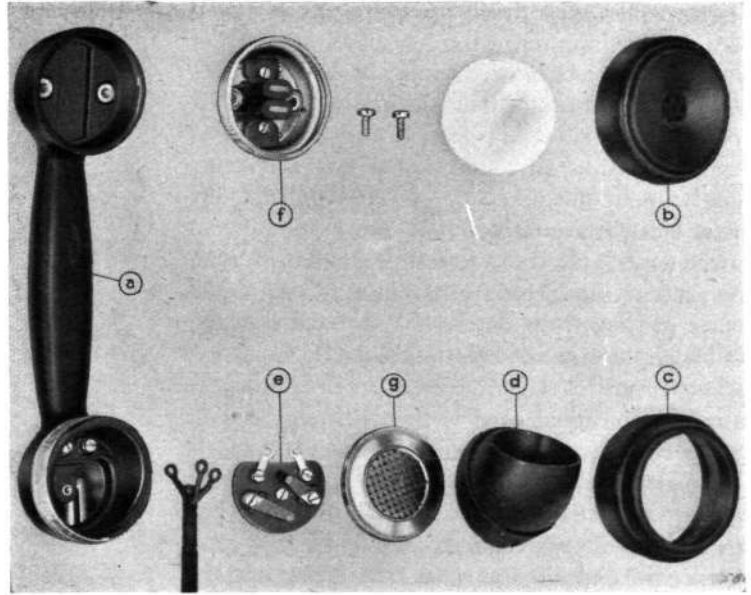


Fig. 8. Section of handset.

- a: handle
- b: earpiece
- c: ring
- d: mouthpiece
- e: terminal block
- f: inset receiver
- g: inset transmitter

Fig. 9. Handset, disassembled.

- a: handle
- b: earpiece
- c: ring
- d: mouthpiece
- e: terminal block
- f: inset receiver
- g: inset transmitter



X 5003

The connecting of the cord, thanks to the terminal block, is a very simple operation as it can be made before the block is fixed in the transmitter receptacle. After the cord is connected, the terminal block is placed in position and fixed by a single screw fitting in a brass bush inserted in the bakelite moulding and in this way the cord hole is sealed.

The connections between the terminals in the block and the conductors to the receiver moulded in the handle are made by two connection straps.

Two contact springs are mounted on the terminal block and connect up the poles of the transmitter inset.

The transmitter is of the inset type and is clamped in position by the ring *c*.

The receiver is fitted in a pressed brass inset case of strong construction.

The receiver has a single powerful magnet of high cobalt content steel identical in size with the magnet in the ringer. The magnet is placed on the exterior of the inset and is held against the pole pieces by two clamps.

The receiver is of the bipolar type, the pole shoes being made of low-remance iron. The receiver coil bobbins are moulded in bakelite.

The connection of the receiver to the conductors moulded in the handle is made over two metallic surface pressing against each other. It might be pointed out that *no* contacts in the new instrument are made over screw threads only.

The receiver is held in position by two screws

fitting in the terminals of the conductors from the transmitter.

The receiver diaphragm is made from special alloy steel. It is clamped to the receiver inset by the earpiece.

The space between the pole pieces and the diaphragm is adjusted by grinding, and consequently no packing ring is required.

The handset cord has three conductors and has a free length of 1.25 metres. The ends are looped and held by contact screws in the terminal blocks in the instrument and the handset.

In order to relieve the conductors of mechanical stresses at the connection points, a strain loop is fastened by means of the terminal block clamping screw at the handset end, and the previously mentioned clamping wedge clamps the cord on the instrument terminal strip.

The cord is of the following construction:

Each of the three conductors consists of  $3 \times 6$  copper tinsel insulated with two coverings of artificial silk impregnated with black compound and braided with mercerized cotton yarn. The 3 conductors are stranded and braided over-all with a coarse black cotton yarn.

## 6. Terminal Block & Cord.

The terminal block shown in Figs. 10 and 11 consists of 2 parts, the base and the cover. The base is made of bakelite with moulded-in terminals.

All connections including both the terminal cord and the incoming wires are made on the front side of the block whereby the bare conductors are protected from the dampness of the wall. This arrangement allows inspection and a change of terminal cord as all connection screws are accessible without the necessity of removing the terminal block from the wall.

The base is fixed to the wall by a single screw. To prevent the block from rotating, small steel spikes project from the back and drive into the wall when the fixing screw is tightened.

The cover is made of black enamelled sheet iron. The terminal cord is fitted through a hole in the cover which consequently cannot be lost.

The cover is fixed to the base by a snap spring.

The terminal cord is of exactly the same appearance and construction as the handset telephone cord and has the same free length of 1.25 metres.

## Dimensions and Weight.

The dimensions of the table telephone are: —

Height without handset	129	mm
Width	»	» 151 »
Depth	»	» 178 »

The weight of the complete instrument including the handset and terminal block is approximately 2.5 kg.

## Table Telephone CG 502 for Manual CB Systems.

In this instrument no dial is fitted, its place being taken by a dial blank which is fixed to the case in the same manner as the dial and is

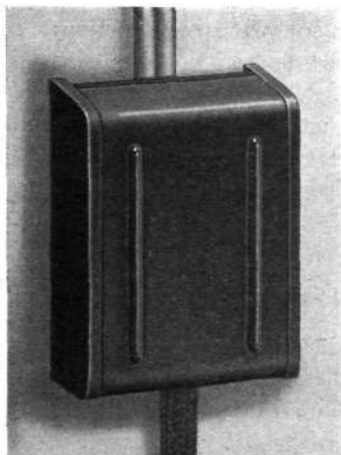


Fig. 10. Block terminal for table telephone, Type DE 702 and CG 502.

Base of bakelite, cover of black enamelled sheet iron.

X 3001

ERICSSON REVIEW

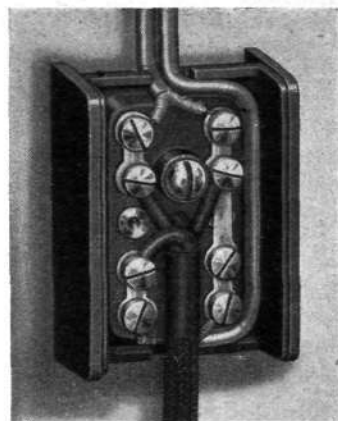


Fig. 11. Block terminal with the cover removed.

All connections are made on the front of the base, which is fixed to the wall with one screw only.

X 3002

very easy to remove should the instrument be changed over to automatic working.

The total weight of the telephone CG 502 is approximately 2.3 kg.

## Wall Telephone DE 200 for Automatic Systems.

The constructive problems that present themselves in the designing of a wall set are on many points quite different from those for a table set which is not fixed and can be moved about to the liking of the user. The wall instrument is stationary and probably at times fixed in a very inaccessible position.

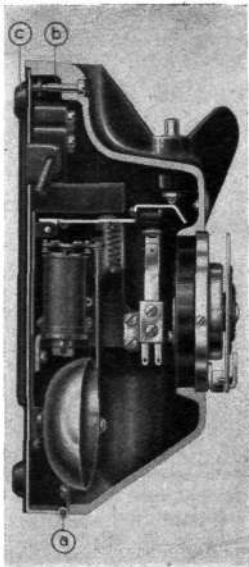
It must be designed and made so that the connection of the incoming lines and the inspection and maintenance can be carried out without removing the instrument from its place on the wall. Further, it is desirable that all necessary work and repairs can be carried out from the front of the instrument, as mouldings and panels often project from walls and stand in the way of approaching the instrument from the side.

The new design of wall set fulfils all demands that could reasonably be expected in this direction.

Figs. 3 and 4 show the exterior of the wall set, Fig. 12 shows the instrument in section from the side and on Fig. 13 it is shown with the case lowered to display how the interior fittings are easily accessible.

The instrument is made up of the following parts

1. Case.
2. Dial.
3. Base Plate.
4. Chassis.
5. Handset with Cord.



**Fig. 12. Section of wall telephone, Type DE 200.**

- a: hinge.
- b: screw for fixing the case to the baseplate.
- c: circular impressions, pierced to take screws for fixing the instrument to the wall

X 9001

### 1. Case.

The handset cradle is formed on exactly the same lines as on the table set and the two plungers operating the switch are found also on the wall instrument.

The number frame is placed over the dial.

The bottom edge of the case is hinged to the base plate. The case is fixed to the base plate in its normal position by a captive screw (*b* in Fig. 12). By loosening this screw the case can be lowered downwards and takes up the position flush against the wall as shown in Fig. 13.

### 2. Dial.

The dial and the method of fastening it in position are the same as in the table set. The connection cable between the dial and the terminal strip is held by a clamp on the base plate whereby it is prevented from coming in contact with the ringer.

### 3. Base Plate.

The base plate on which the whole of the instrument is carried is made of black enamelled sheet iron and has a central pressed strengthening rib. Three circular impressions are raised on the back of the base plate and pierced to take the clamping screws with which the instrument is fixed to the wall. These impressions are of such depth that the edge of the body is kept about 5 mm from the surface of the wall.

The bottom edge of the base plate is bent forward at nearly a right angle and forms part of the hinge on which the body swings. This bent

portion is provided with perforations for the ringer.

At the top of the instrument are two wire holes for the incoming line wires and the leads to an extension bell.

### 4. Chassis.

The mounting plate which carries the wiring and the interior fittings including the terminal strip, thus forming a detachable unit, is somewhat different from the corresponding plate in the table set. The chassis is held in position on the base plate by 3 screws that are fitted from the front.

The ringer, condenser, switch spring group and induction coil are identical with those on the table instrument. The terminal strip is practically the same as on the table set, the difference being that the bell mouthed cord hole is altered slightly in shape, the wall set having no block terminal cord.

### Dimensions and Weight.

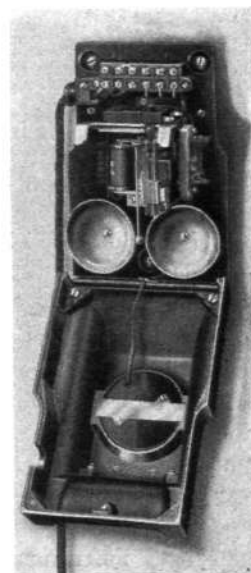
The dimensions of the new wall instrument are:

Height .....	217 mm
Width without handset ..	151 »
Depth .....	106 »

The complete weight including handset is approximately 2.5 kg.

### Wall Telephone CD 1200 for Manual CB Systems.

In this instrument the dial is replaced by a dial blank with the same appearance and method of fastening as on the table telephone CG 502. This telephone CD 1200 has a weight of approx. 2.3 kg.



**Fig. 13. Wall telephone, Type DE 200, opened for inspection.**

All parts are easily accessible from the front for inspection and adjustment. A single captive screw fixes the case to the baseplate, which is screwed on to the wall.

X 9002

# Indicating Plant for Stock Exchange Quotations

By  
E. SCHEWELOV

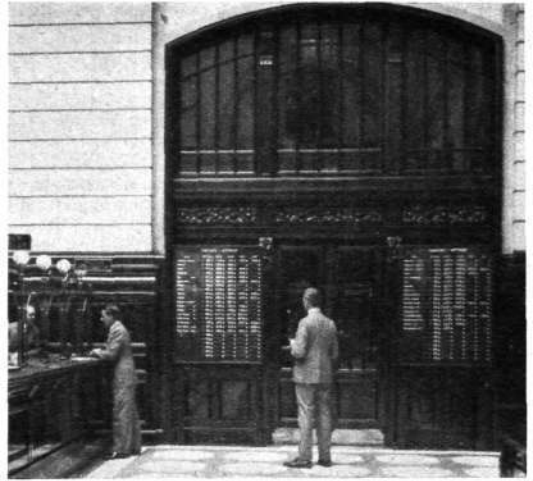


Technical Department,  
Telefon A.-B. L. M. Ericsson,  
Stockholm.

*The quotations of the Stockholm Stock Exchange are transmitted during the transactions by telephone to the brokers' offices, where they are posted for the information of the public, generally by means of hand-written lists. Ericsson has devised a system for Svenska Handelsbanken in Stockholm, by means of which the quotations from the Stock Exchange are listed electrically on panels accessible to the public, immediately after they have been reported to the Stock Exchange Department of the bank.*

In the head office of Aktiebolaget Svenska Handelsbanken, Stockholm, an installation for the listing of Stock Exchange quotations by means of electrically driven machinery has recently been put in service. The plant, which has been designed and installed by Telefonaktiebolaget L. M. Ericsson, is presumably quite unique and may therefore deserve a detailed description, the more as the underlying principles are certainly applicable to other installations for similar purposes.

In solving the constructional problems, it has, of course, been necessary to take into consideration the organisation and business methods of the Stockholm Stock Exchange, which are in many respects different from those of other stock exchanges. On most of the leading stock exchanges the official quotations are not fixed



X 1024  
Fig. 1. Interior view of the main hall in the head office of Svenska Handelsbanken.

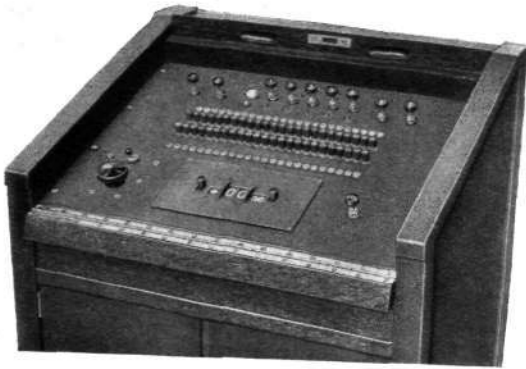
The two indicator panels belonging to the quotation indicating plant are seen to the left and right of the door.

till business is over; the prices actually paid during exchange hours are compiled and a representative quotation is fixed in some way or other, e. g. by computing the arithmetic mean of the various prices. The Stockholm Stock Exchange, however, fixes the official quotations by a kind of auction, the »roup», which takes place at the beginning of the day's business before the open market proceedings. In normal times, the »roup» is repeated in the afternoon, but at present only one »roup» takes place a day. As is the case on several important exchanges the public is not admitted to the Stockholm Stock Ex-



X 1025  
Fig. 2. Pair of panels installed in the stock department of the bank.

These panels differ only slightly from the panels mounted in the main hall (see above).



X 1026

Fig. 3. Central switchboard.

The 5 push-buttons at the top in the middle are used for disconnecting the panels which are not to be altered. The headings of the panels are changed by means of these push-buttons to the left and right. The groups of each 24 push-buttons with the corresponding signal lamps in the middle represent the 48 different stocks figured in the panels. The dial to the left selects the vertical columns in the panels. The figure drum for the adjustment of the differences in the quotation is seen at the bottom in the middle.

change, and all business is handled through brokers, especially the banks; for this reason the official quotations must be brought to the knowledge of the interested public as soon as possible, preferably already during exchange hours. To this end the banks exhibit hand-written exchange lists in their windows; for no kind of »ticker» is used in Sweden. The new plant is simply an electrically operated exchange list, which is, however, far superior to both the ticker and the hand-written lists on account of its quick working, its accuracy and its ingenious design and construction.

In the main hall of the bank a pair of indicator panels has been suspended, and the new quotations are listed on them as the »roup» proceeds. The installation is controlled from a switchboard in the stock department of the bank; there the quotations are received from the Exchange by telephone. Another identical pair of panels is installed in the stock department. Only two pair of panels have been installed so far, but the central switchboard is designed so as to allow the connection of a larger number.

As the price fluctuations on the Stockholm Stock Exchange are usually quite small relatively to the quotations, the system has been designed for the setting of differences only; at first sight it would seem more natural, first to change all figures in the panels to zero and thereafter to set up the new quotations.

The quotations are always expressed either in whole Kronor, or in whole Kronor and 50 Öre. For this reason the device for setting the Öre columns has only the alternatives »00» and »50».

For each stock listed on the Exchange, the following quotations must be shown on the panels: »Bid», »Asked», »Highest», »Lowest» and »Difference», i. e. the difference between the new »Bid» quotation and the previous one. At present only one »roup» is made a day, but the plant is designed for a second »roup» as well. Usually, not all stocks are dealt in every day and so a special screen is provided to cover the corresponding quotations.

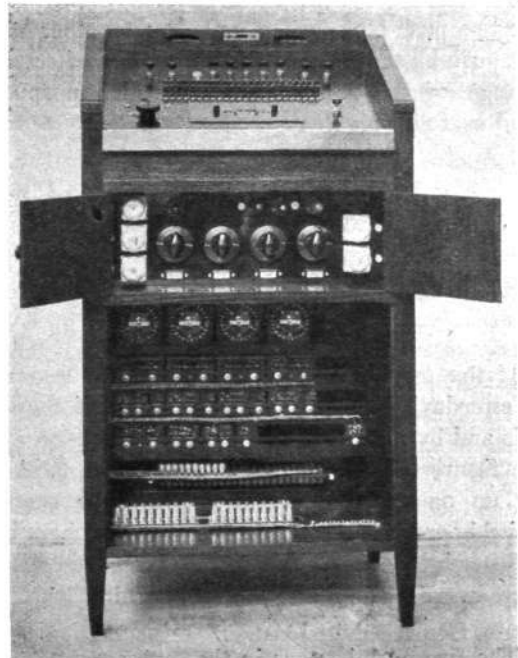
## The Apparatus.

The installation consists of a central switchboard and a number of indicator panels connected to it. The general layout of the system is shown in the diagram on Fig. 5.

The indicator panels are arranged in pairs, and each panel is intended for 24 different stocks, thus both panels have space for a number of stocks not exceeding 48.

From the central switchboard the quotations are sent out to the different panels which are connected in parallel; the changes of figures are checked in the central switchboard for each set of panels individually.

When the plant is not in operation, i. e. before the first or between the first and the second »roup», no current must be on. Before commen-



X 1027

Fig. 4. The central switchboard uncovered.



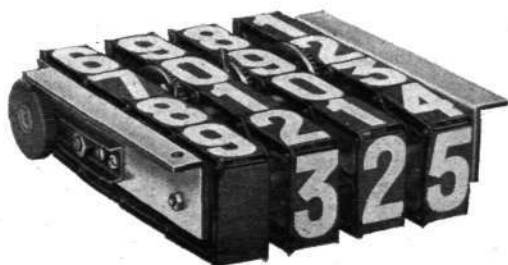
panels. As mentioned before, the panels are arranged in pairs. The second panel of each set is connected to the central switchboard as a direct continuation of the first, so that in the central switchboard the buttons 25—48 correspond to the stocks figured on the second panel. Above the first, and below the second row of push-buttons there are signal lamps, the lenses of which are marked with the same figures as the corresponding buttons. These lamps control the setting up of the quotations on the panels and will not light up before the corresponding horizontal line of all the panels connected has been set correctly.

The dial to the left selects the desired vertical columns on the panels (see diagram Fig. 5).

As pointed out before, the figures in the »difference» columns indicate the difference between the preceding and the new »Bid» quotation. In order to show whether these figures represent gain or loss, a device indicating »+» or »—» is installed in all the panels.

The corresponding operations in the central switchboard are effected by means of a switch placed above the dial. For control purposes signal lamps are provided on each side of the switch; their lenses are marked »+» and »—» respectively. One of these lamps must always light as soon as the central switchboard is being set for the »difference» column.

The mechanism for transmitting the differences in quotations to the panels is installed at the bottom of the desk plate. As mentioned above, these differences are usually small and the setting device therefore consists of figure drums for setting the last two figures of each quotation and a switch for setting 50 or 00 Öre. If the difference amounts to more than Kronor 99: 50, the change is effected in two steps. In front of the figure drum there is a switch, the position of which determines if the amount set up is to be added or deducted from the previous quotation.



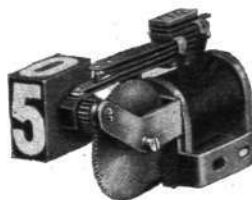
X 1029  
**Fig. 7. Figure mechanism**  
 with four figures, for the quotation columns of the panels.



X 1030  
**Fig. 8. Figure mechanism**  
 with three figures, for the difference columns.

### Panels.

Certain details concerning the installation and appearance of the panels have already been mentioned. In order to protect the panels against dust and damage, they are mounted in a casing with a glass pane on the front side. From Fig. 6 it will be seen, that the names of the stocks quoted appear in the column to the extreme left, followed by the columns for »Difference», »Bid», »Asked», »Highest» and »Lowest». The columns are controlled by individual switches operated by means of corresponding devices in the central switchboard in the same way as the horizontal positions.



X 1031  
**Fig. 9. Figure mechanism.**  
 This mechanism indicates only 0 or 5 (00 or 50 öre).

### Figure Mechanisms.

As already mentioned, the prices are quoted in whole Kronor and 50 Öre. As shown by Fig. 7 and 8, the panels have mechanisms for setting whole Kronor; the setting in this case is wholly mechanical while »50» and »00» Öre are set by means of direct step-by-step operated mechanisms (Fig. 9). Each panel is provided with an electrical motor for driving the figure mechanism, the motor being connected to a vertical shaft (Fig. 10). By means of a magnetic clutch, this motor operates the driving shaft of the figure mechanism. In order to control the changes in each panel, a back-impulse contact is arranged to send to the central switchboard impulses corresponding to the number of steps effected by the connected figure mechanisms. The change of 50 or 00 Öre is checked electrically direct from the central switchboard.

If any security is not quoted during a »roup», the corresponding figures will be screened on the panels. In the set of panels mounted close by the central switchboard (Fig. 2), the screens have openings through which the previous quotations can be seen. On all other panels the screens are made of an opaque material. The »Difference» column has no screens, but there are special devices for marking »+» or »-», which are controlled direct from the central switchboard in the same manner as the mechanisms for raising the screens.

The whole series of different operations effected in connection with the quotation on the exchange is as follows. In the morning, all panels should show the latest quotations of the preceding day. The headings of all panels are to be changed into

**»Yesterday's 2nd (or 1st) roup».**

This is effected by means of the above-mentioned push-button »G» in the central switchboard after the current has been connected to the plant. Before beginning the setting of the quotations in connection with the first roup, the aforesaid headings are changed into:

**»To-day's 1st roup  
above lit lamp».**

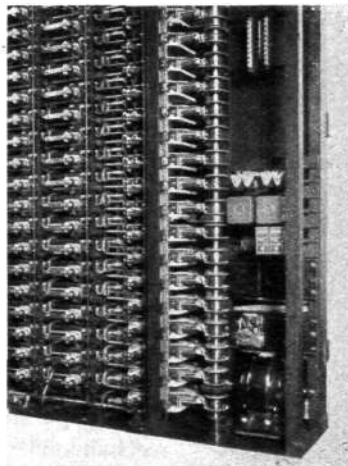
The change is effected by pressing the push-button switch »I» and by throwing the switch which controls the lamps in the panels into the

position corresponding to the panels connected (position »1» or »2»). While the quotations are being set, a lamp is lit beside the name of the stock, the quotations of which is being altered. The new quotations are set in the same sequence as they are listed on the panels, i. e. the push-buttons in the central switchboard are operated in numerical order. To change a figure, the difference between the new quotation and the preceding one is set up in the central switchboard (Fig. 3); the pushbutton »STK» is then pressed down and released. The white signal lamp to the left on the desk will then go out, but will light up again as soon as the corresponding changes have been correctly effected in all panels.

If, however, the quotation has not been altered in conformity with the new quotation set up in the central switchboard, a red lamp will light, showing in which of the panels the trouble is to be found.

The necessary operations in passing from the first panel to the second have already been mentioned in the description of the different parts of the installation. The setting of the quotations after the second roup is made in the manner described above.

After completion of all changes in connection with a roup all current is disconnected, so that no current is used during the interval between two roups.



X 3003

**Fig. 10.**

**Back view of a quotation panel.**  
The motor drives the shafts of the figure mechanisms by means of the vertical shaft, when the magnetic clutch is operated.

# Ericsson's Selective Calling Telephone System

By

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## Synopsis.

The main requirements for a selective calling telephone system for railway working are:

- reliability** in operation,
- simplicity** in construction and working,
- flexibility** in intercommunication with other telephone systems.

A general examination of these requirements shows that a system should, to fulfil these conditions, be made as a **non secret parallel system with decentralized switching.**

On systems with decentralized switching the main problem is the question of impulsing and operating the selectors on the subscribers own line. In general one of the following methods has been used:

The power supply for working the selectors has been available at every instrument; the system can then be worked with two conductors and no earth.

With the power supply centralized to a point on the line, one can use either direct current impulsing over both special lines and earth return or another third conductor, or also use both alternating and direct current thereby the impulses from the dial are DC impulses and the working impulses to the selectors AC impulses. The Ericsson System uses only direct current and operates on two conductors without earth return. This has been attained by using different current directions for both kinds of impulses, both impulses being consequently on the same line in a loop circuit but with different directions. Firstly on the instrument itself the impulses are separated by means of small electrical valves, as copper oxide rectifiers. One finds in this way that the normal voltage on the line can be as low as for example 24 V. Only during the impulsing is the pressure increased to a value necessary to operate the various selectors on the line. The **selector** used

## for Railways.

on the system is of the two-magnet type, that is to say it is provided with a **step-by-step** magnet which operates with the line impulses and thereby feeds forward a toothed wheel, and also a **locking magnet** which, whilst the stepmagnet is working, is attracted and actuates a pawl fitting in the toothed wheel; when the impulsing stops and the current ceases to flow through both magnets the wheel is returned to its original position by a coil spring. By special mechanical construction the selector is given a capacity of 19 numbers.

The telephone instruments are especially simple and resemble in the main normal instruments for automatic working. The special selecting equipment consists of only the selector itself and the previously mentioned rectifiers. The trembler bell is provided with a thermic delayed action in order not to give ringing signals of short duration whilst selection operation is being carried out.

The selecting apparatus is normally made in the form of a table instrument with the associated selecting equipment mounted in a small case fixed to the wall, and serves as a terminal fitting.

**The Line Equipment** is made up of normal relays, switches, condensers and rectifiers. For a single section the equipment consists of six relays but in a general case with an arbitrary number of sections nine relays are required and a 12-step-switch. The whole is built in a dust tight sloping case, the necessary leads being connected to a moulded bakelite block.

**The capacity** of the system for each section is: 8 outgoing lines — numbered 1 to 8 — and 19 instruments numbered 92—90 and 01—00.

**Intercommunication** with local exchanges is very simple to arrange especially with those of the CB type including automatic exchanges. As an example a combination line between the selective calling system and an Ericsson's automatic exchange type OL 35 can be given.

In small and medium railwaystations a **simplified local exchange** has been designed capable of interworking with the selective calling system. This local exchange is designed for one simultaneous call and is of the non-secret type.

Its capacity is 8 outgoing lines and 9 instruments.

**The Power Installation** for the section groups can be made very simple when the power distribution operates in AC current. Only a small 24 V battery with charging rectifiers is required. The higher voltage for impulsing is obtained from a special rectifier or from a radio high tension battery. The current consumption is 0,22 A per line equipment during calling periods.

## Definitions.

A selective line is understood to be a telephone line along the whole length of which are distributed telephone instruments connected in parallel, usually called *parallel system*. *Series systems* are also in existence but are used to a much lesser extent. All the telephone instruments are equipped with a switching arrangement which all operate at the same time. Depending on the position of these switches only one instrument is connected at a time and in this way selective calling is obtained.

If the switching arrangements are made so that only the caller and the called subscribers instruments are connected, the system is named *secret*. In cases where the calling only is selective the system is called *non-secret*.

Selective calling systems are divided into two main types depending on the method of operation. The systems with *centralized* switching are manually supervised at some point on the line from which the operation of the selector switch occurs, generally by code impulsing. Systems with *decentralized* control, on the other hand, have no manual supervision and allow of selection from all instruments connected to the system. This is usually done by means of a dial. There are even systems of this kind having code impulsing.

## What Are the Principal Demands on a Selective Calling System for Railways?

The requirements that ought to be provided by a selective calling system for railways can be placed under the following headings:

*Reliability,*

*Simplicity* in construction and operation and

*Flexibility* or ease in working in with other telephone systems such as local exchanges.

As far as reliability is concerned the general rule holds good that simplicity in construction and operation are conditions that must be carried into effect in order to obtain a good working result. This is not altogether for the reason that a simple piece of mechanism can in general be made to function with more certainty than a complicated one, but for the further reason that the clearing of faults can be made much quicker and by less skilled labour. This condition is a very weighty one, especially in railway telephony, where the equipment in question is often spread over long stretches of line.

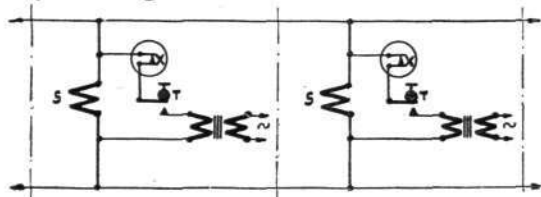
The long lines in this particular case give rise to special wishes concerning traffic possibilities. It is necessary to divide up the line in suitable lengths to handle the traffic, each length being in itself an independent unit but still possessing the traffic possibilities of working in both directions.

As far as secret and non-secret working is concerned from a railway service point of view, safety is the most important. Under all conditions one should be able to make a desired call, even if whilst connection is being made an engaged line is encountered. If a secret system is used the instruments can be arranged in such a way that in cases of emergency one can force oneself in on ones own section by means of breaking a seal or something similar, but in cases where any other section is engaged one cannot put a call through to that section. In a non-secret system in similar circumstances, connection can be made with the engaged section and a request made that the conversation is terminated, after which normal working can continue. The more sections through which a call must be connected the greater the possibility of an engaged section being encountered.

Interworking with other telephone systems should be possible in a simple and satisfactory manner. This refers especially to intercommunication with automatic exchanges as for example in the larger railway stations. In this case the traffic between both systems should be fully automatic in both directions as otherwise a large proportion of the advantages of automatic working are lost.

The Ericsson Selective Calling Telephone System for railways is herewith described. This system has been designed to fulfil as far as possible the conditions stated above and can therefore be put forward with every confidence as a *non-secret parallel system with decentralized switching*.

## Impulsing on the Selective Lines.



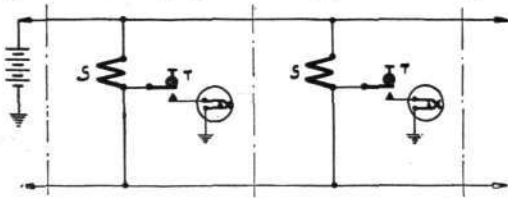
X 1032 Fig. 1. Decentralized switching with local AC supply.

The problem, which above everything sets its stamp upon the design of a system of decentral-

ized switching is the impulsing from the dial and the consequent operating of the selectors on the line to which the instrument dialling is connected. The principles in general use are the following:

With a primary operating current available at every instrument one gets the simplest system, which is shown schematically in Fig. 1.

The motive supply, which, as can readily be appreciated, is usually alternating current, is obtained from a transformer contained in each instruments, which is connected up to the mains. When the selectors are to be operated, the AC current is connected through the dial break contacts to the line by means of a push button. The whole of the selectors which are coupled in parallel operate by this alternating current and step, as the dial effects series of breaks in this current, as many steps as breaks contained in the series of impulses. As can be seen this system requires a double metallic circuit without any earth. In a single section only no central apparatus is required.

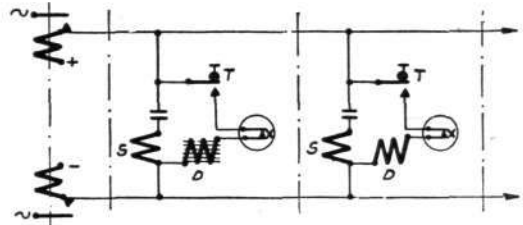


X 1033 Fig. 2. Decentralized switching with central DC supply.

If it is desired to work with a supply source available at only one position on the line the simplest course to take is to use the system shown in Fig. 2. There is constant voltage above earth on one line. All the selectors are connected in parallel between the two lines and whilst impulsing the other line is earthed through the dial. The system has amongst other things the disadvantages that the line whilst not in use is under pressure, which to enable a number of selectors to operate at a time must be at least 100 V.

In general therefore two separate sources of supply are used for calling and impulsing from the dial on the one hand and for the issuing impulses for the selectors on the other. In order to do this it is necessary to have separate circuits for the dial and the issuing impulses which can be brought about by using an earth connection or also by using two different kinds of current as for example 50 cycles alternating current for impulse sending to the selectors and direct current for the dial impulses.

According to Fig. 3 both the signals are worked in loop over the line. The selectors are connected

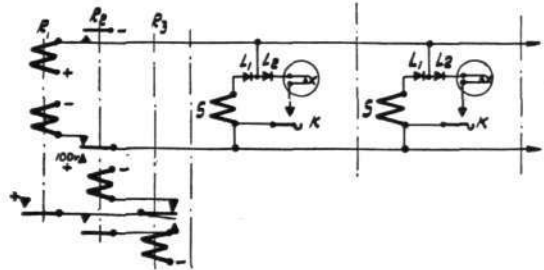


X 1034 Fig. 3. Decentralized switching. Primary impulsing in loop with central DC supply. Secondary impulsing in loop with central AC supply.

in series with the condensers and the dials with retardation coils. The object of this is to get the dial and the selector to work together on one line at the same time without disturbing one another, by separating the alternating and direct current, so that all DC current goes through the dial and all AC current through the selectors. When it was found to be difficult to carry into effect the separation of the direct and alternating currents the system was modified in such a way, that the dial DC impulses and the selectors AC impulses did not occur on the line at the same time. This has been brought about by providing the central station equipment with a translator which first receives the DC impulses and after these are finished sends out corresponding AC impulses.

It is of especial importance in electrified railways that earth connection is not used for impulse sending. During the short circuiting of a power line using overhead conductors an excess voltage to earth can occur in the range of 1 000—2 000 V. Even under normal conditions voltages arise which could completely destroy the possibilities of impulsing on a system working with earth return. In order to avoid complications with the translation in the central equipment it is desirable to be able to cut off the selectors during the time the dials are being operated.

The selective system to be described now gives the solution of this problem, Fig. 4.



X 1035 Fig. 4. Decentralized switching. Primary impulsing in loop with central DC supply. Secondary impulsing in loop with central AC supply. Ericsson system.

The selector and the dial are connected in parallel with one another. Besides this, each one is connected to its own non-return electric valve, that is to say a half-wave rectifier, as for example a copper oxide dry rectifier, which has the opposite polarity to the line.

The selectors with their rectifiers are permanently connected to the line. The polarity is arranged so that a call is not made at the central equipment, that is to say the relay  $R_1$  is not attracted by the current passing through the rectifiers  $L_1$ . If a hand microtelephone is now lifted, a contact is closed in the cradle switch so that the line is connected to the dial and the other rectifier  $L_2$ . This rectifier has little resistance at the polarity of the line and for this reason the relay  $R_1$  in the central equipment is attracted. Relay  $R_1$  connects the relay  $R_2$ , which in its turn operates relay  $R_3$ ; this relay is held energised over its own contacts and disconnects relay  $R_2$  which falls after having been attracted for a short while. On relay  $R_2$  are contacts which change the polarity of the line. With reversed line polarity the rectifier  $L_1$  has a low resistance and the rectifier  $L_2$  a high resistance. A current thus flows through the selectors  $S$  as long as the relays  $R_2$  remain attracted and all the selectors on their own lines move forward one step. In certain cases it may be convenient to use the first step on all selectors on the line to give the engaged signal. It should be observed that relay  $R_1$  is not disconnected by  $R_2$ .  $R_1$  is retained by current through the one half of the winding as long as  $R_2$  is attracted.

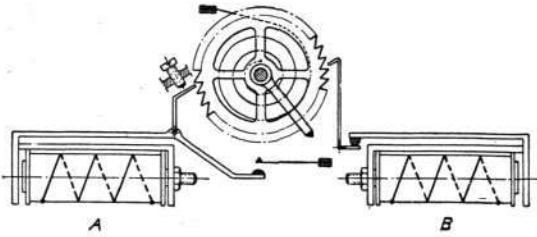
During impulsing from the dial the short circuit over the rectifier  $L_2$  is broken at the beginning of every impulse causing the relay  $R_1$  and in consequence even the relay  $R_3$  to release. At the end of every impulse when the line is again connected to the rectifier  $L_2$  the impulse relay  $R_1$  is again attracted so that the previously described operation of relays  $R_2$  and  $R_3$  is repeated. After each connection of the line to the rectifier  $L_2$  and the impulse contacts of the dial, the relay  $R_2$  becomes attracted for a short while and thereby reverses the polarity of the line. In every time this is repeated all the selectors on the line step forward one step. In this way any desired instrument on ones own line can be directly selected by the dial. Calls coming from another line offer no great difficulties when the selectors can be operated exclusively from the exchange equipment.

The method of impulsing herewith described allows one to have different pressures in both directions. Normally the voltage on the line is 24 V which is sufficient to attain the desired operation of the impulse relay. The polarity changing impulses which operate the selectors could on the other hand be of higher voltage. The amount of voltage is decided by the number of selectors and the resistance of the line. In general one can say that approximately 100 V is sufficient. It should be noted that the high tension current supply that these impulses require need not be of any great capacity. It is only a question of delivering a series of current kicks of some 10 milliseconds duration at a current of some 10 mA. One can therefore, for this purpose, use a radio battery or a small rectifier which is connected direct into the mains. The connecting of the relays  $R_1$ ,  $R_2$  and  $R_3$  is in a somewhat modified form known in automatic telephony as »Impulse Correction Circuit» and is used to correct the incoming impulses in the impulse repeater, so that these, when sent out again, are of the correct ratio, irrespective of whether they were previously so. Besides that the relays produce the desired polarity changes, they allow further for an impulse correction which shows to advantage on traffic from one section to another and makes possible, at least in principle, unlimited impulse repeating.

## Selectors.

The selector system is built up in the previously described impulsing method. In certain details the erection is dependent on the design of selectors that are used. The details about to be described are based on the use of a selector of the two-magnet type, Fig. 5.

This selector is equipped with two electromagnets of which the one works an armature connected to a pawl which on the closing of the armature moves a notched wheel with contact arms one step. The other magnet operates a locking pawl which with the closing of the armature racks the notched wheel in a backward direction. When both the armatures lie in the forward position the notched wheel is returned to its normal position by a coil spring similar to a clock balance spring. At a certain determined position of the notched wheel a contact is closed, when the racking magnet armature lifts a contact spring against the moving contact arms. The number of steps from the home position to the position of the



X 1036 **Fig. 5. Circuit diagram of two-magnet selector.**  
 In practice the two magnets are mounted beside each other. The selector is of the same size as a two-coil relay. The step-by-step magnet (A) is connected across the line and energized by the line equipment. The locking magnet (B) receives current from the local battery when the step-by-step magnet works.

notched wheel at which the closing of the contacts takes place gives the number of the telephone set to which the selector in question belongs. On telephone apparatus specially designed for railway working the selectors are furnished with two contact arms, one to give the individual number of the telephone instrument and the other to give a general call number for all the instruments.

On other systems using this type of selector the normal working is with negative impulses, that is to say the selectors are constantly energised and, when the interruptions occur, the notched wheel steps forward to the desired position in which it is kept until the current breaks. The system described herewith works with positive impulses, that is to say short current impulses that step forward the selector to the desired position. In order to use this selector in connection with the latter system it is necessary in some way to mark the end of the series of impulses, so that the ringing signal is sent out to the correct instrument.

The marking of the last impulse in an impulse series has been arranged so that the last impulse produced by the moving dial does not give out the final impulse issued to the selectors. From the central equipment a further impulse is sent out after these originated at the dial, at such an interval from these that it acts as the last impulse in a series of normal impulses. This impulse is made longer than the others. A bell that does not ring for currents of short duration such as normal impulses is by this means made to function and operates until the last impulse ceases after a few seconds duration of the ringing signal. How this extra-impulse is produced is shown in the following description of the central equipment.

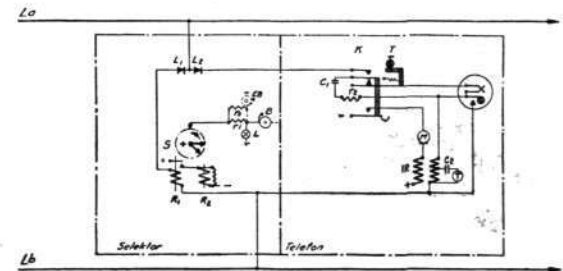
After an impulse series is completed the selector returns to its home position. It follows that if no special steps are taken, each section can only make a maximum of 10 outgoing con-

nections consisting of those to instruments or to other sections. The number could be increased by enlarging the capacity of the dial, which would be unpractical. One can, by simple means, make the selector stop at a certain determined position after the completion of a series of impulses and from this resting position as a starting point, continue with repeated impulsing. At a desired position, for example after as many impulses to correspond with the last digit on the dial the notched wheel can quite simply be locked by mechanical means so that it does not return to its home position.

On further impulses the selector steps from this position and is returned after the completion of the impulsing to its home position by the usual means. In such a way a capacity of 19 positions with two digit numbers is obtained. In the same way, naturally, further reading positions could be obtained, but they would have no practical value as more connections per section are not likely to occur.

## Telephone Instruments.

If we now go over to the actual performance of the system we shall find that contrary to what is the usual case in selective telephony the simple principles correspond to an equally simple fulfillment of detail. The telephone instrument, the equipment of which, upon the whole, agrees with the normal instrument used for automatic telephony, is made according to figure 6. The equipment is as follows:



X 1037 **Fig. 6. Circuit diagram of selector telephone instrument.**

The instrument contains the equipment of a normal automatic telephone, plus the selector and the two rectifiers. The trembler bell is fitted with a thermic damping device.

Hand Microtelephone *M* and *T*.

Induction Coil with anti-side tone winding *IR*.

Dial.

Switch Hook *K*.

Press Button *T* with locking and release of switch hook.

### Trembler Bell *B*.

Damping arrangement for Bell consisting of a glow lamp and a resistance  $L$  and  $r$ .

Selector  $S$  with two electro magnets  $R_1$  and  $R_2$ .

Rectifiers  $L_1$  and  $L_2$ .

Condenser  $C_1$  and resistance  $r_2$  for impulse sparking protection.

Condenser  $C_2$  to stop the direct current through the telephone.

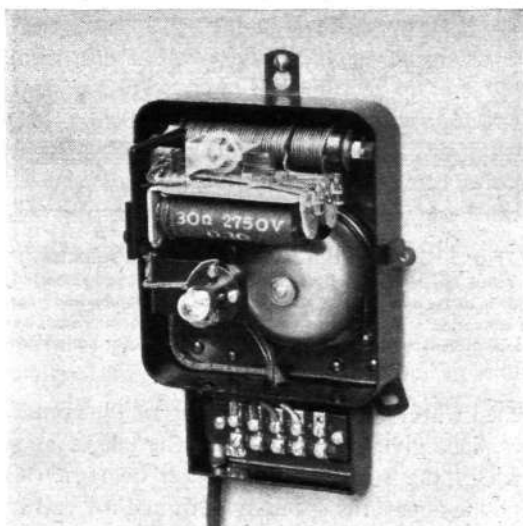
The fact that direct current only is used makes it possible to allow the outgoing impulses to operate the selectors directly without the use of the usual auxiliary relays as in common practice.

The working of the apparatus can be grasped without difficulty from the schematic diagram. The only details that are perhaps not quite normal are the push button  $B$  and the delayed operation arrangement of the bell. With the use of the selector design described, visible means of indicating that a subscriber's line is engaged cannot be carried out in a simple manner. Instead, one must determine if the line is free by listening. In the meantime it is possible that a hand microtelephone of an instrument may be lifted at the same moment as dialling is occurring at another point on the line. The impulsing is spoilt, in this case, if special precautions are not taken. To prevent trouble of this kind the press button  $T$  is introduced. When the hand microtelephone is lifted connection is made with the line, but in series with the condenser  $C_1$  and the resistance  $r_2$ . It can be observed that the capacity connected to the line in this manner does not affect the impulsing



X 1038 Fig. 7. Telephone instrument with selector equipment case.

The instrument is normally constructed as a table telephone with the selector equipment mounted in a dust-tight sheet iron case, which serves also as a terminal fitting. The glow lamp is mounted behind a window in the case and lifts up when a signal comes in.



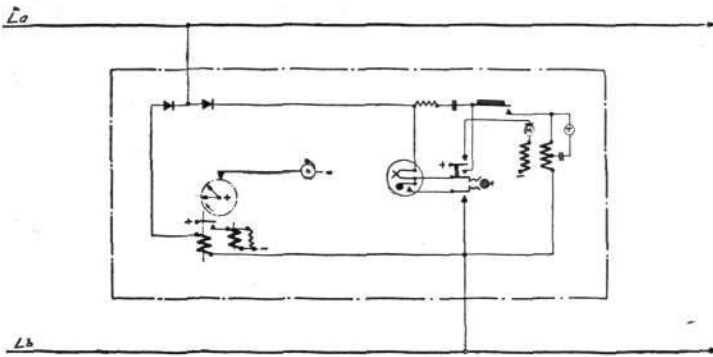
X 1039 Fig. 8. Selector equipment case, opened.

because of the rectifier connected in series which compensates the reverse periods which otherwise would occur. With this arrangement it is possible to impulse even if, say 10 instruments, are connected in at once.

When the press button  $T$  is depressed the condenser is short circuited and the line is closed electrically through the instrument so that a signal is given. The condenser  $C_1$  and resistance  $r_2$  serve during impulsing as a protection against excess voltages arising from dialling.

The trembler bell is provided with a delaying arrangement consisting of a series coupled resistance and a parallel coupled glow lamp. The lamp is of the metal filament type and is of low resistance when cold. Until the lamp has time to warm up the bell is heavily shunted which prevails it ringing when the contact arm on the selector passes over the ringing positions. When the contact arm stays for a longer period in the ringing position the lamp warms up and the bell rings.

The mechanical design and construction of the equipment is in general carried out in such a way that the selector, rectifier and bell are fitted in a special selector equipment case-which also acts as a terminal point for the telephone instrument, which is of the usual table type as shown in Fig. 7 and 8. This is especially advantageous in the event of having several selector lines at the same point as it is then possible to communicate over all the lines with only one instrument. For every selector line a similar selector equipment case is provided. The equipment is connected to a desired line by a suitably arranged push button. By fitting the glow lamp in a position on the case where



X.5005

Fig. 9. Selector telephone, portable type.

it can easily be seen a visible indication is obtained as to the line from which the signal comes.

In certain cases as for example during inspection and repairs and other work along the line a portable selective calling telephone instrument according to figure 9 is suitable for use. Such an instrument can be carried on trains and in cases of necessity be used by the train staff to get into telephone communication with any desired station.

The circuit for this instrument is as near as possible the same as that for the fixed instrument shown in Fig. 6. The whole instrument is built with a case similar to those used for field telephones.

The modifications made depend chiefly on the fact that with portable telephones contacts corresponding to those used on normal switch hooks are not found to be suitable. This depends only to a certain extent on the mechanical difficulties of such contacts in this case. On portable instruments it is much easier than on fixed ones for the hand microtelephone to be left off or fall off the switch hook under normal working conditions. As a loop on the line holds the selector system fixed or out of operation, failure to replace the hand microtelephone blocks the whole line for impulsing. In this case therefore it has been decided to replace the most important function of the switch hook by a press key fitted in the hand microtelephone.

The working of the instrument is as follows: when the instrument is used, the contact  $T_1$  on the press key is closed and, by listening, it can be ascertained in the usual way if the line is at liberty. The locking key  $T_2$  is then depressed. By this means the previously described condenser  $C_1$  and resistance  $r$  are short circuited. At the same time the current is connected to the transmitter and the dials short circuiting contact. The letter is made to prevent any accidental movement of the dial giving a signal on the line.

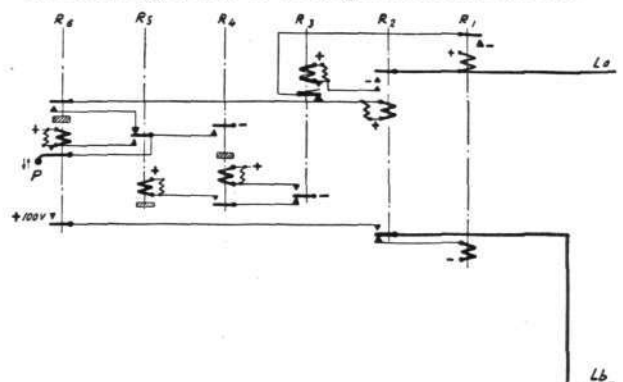
For the sake of simplicity delayed action arrangement for the trembler bell is left out. Every time the selector moves past the ringing position the bell gives a short tinkle. As such portable telephones are not used in large quantities per section high numbers can be chosen for these instruments and by this means the tinkling of the trembler bell is reduced to a minimum.

## Line Equipment.

In the simplest cases with only one section the line equipment consists of a set of six relays as shown in Fig. 10. The line equipment is placed in the middle of the line so that the impulsing is carried out over the least possible line resistance.

The relays  $R_1$ ,  $R_2$  and  $R_3$  are the previously mentioned impulse and correction relays. In addition to these are 3 more relays  $R_4$ ,  $R_5$  and  $R_6$ . The purpose of these is to send out the extra impulse, following the impulses from the dial, the length of which gives the ringing signal. As soon as the line is engaged the relay  $R_4$  is attracted. During impulsing  $R_5$  and  $R_6$  are attracted. After the impulsing  $R_5$  releases immediately and  $R_6$ , which is provided with a pendulum contact, keeps its armature attracted till the pendulum has ceased to vibrate which occurs after 4 to 5 seconds. During this time the relay  $R_2$  is connected again through the relays  $R_5$  and  $R_6$  and is attracted and sends out the long ringing signal over the line.

By suitable regulating the operating time of the relay  $R_5$  it can be arranged that this last im-



X.5006

Fig. 10. Line equipment for single section.

The line equipment consists of six relays;  $R_1$ — $R_3$  are the impulse and correcting relays, while  $R_4$ — $R_6$  are intended for sending the long-signal impulse.

pulse occurs at an interval from the last normal impulse equal to the impulse period of the whole group.

In the case of several sections the line equipment is naturally more complicated than in the simple case with only one section, see figure 11. The number of relays is increased from 6 to 9. Besides this, 12-stepping switches are used, 3 condensers of 2, 2 and  $1 \mu F$  respectively and also the rectifiers  $L_1$ ,  $L_2$  and  $L_3$ . The buzzer is common for all the lines in one junction point.

The main duties of the 12-stepping switch is to connect the sections together when communication between them is required.

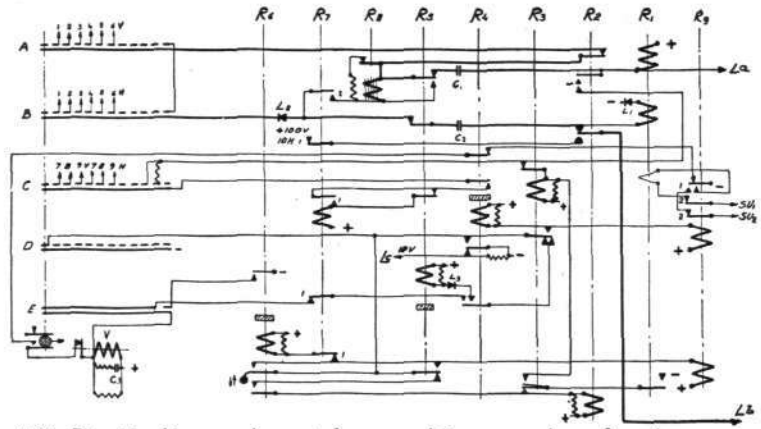
The speech goes over A and B-lines from which the positions corresponding to the directing numbers to other stations are connected to their respective sections. On the C-line, the engaged signal is connected so that when an engaged section is encountered speech can be carried on but dialling is prevented until the called section is at liberty again. This is of great importance in the case of several sections because it makes possible a rapid step-by-step connection of the desired number even if, whilst connecting up, an engaged length of line is encountered.

The relays  $R_1$  to  $R_6$  have the same functions to perform as in the simple case of a single section. The new relays are used chiefly to make possible intercommunication to other sections.

The relay  $R_7$  is a two-step relay and at the first step it disconnects the outgoing impulses to its own section. The second step is only completed if the section required is free, in which case the relay obtains current from the C line and the break contact of  $R_4$  on the required section. In the second step the loop to the next section is closed through the rectifier  $L_2$  and relay  $R_8$ .  $R_8$  is connected in parallel with a resistance which, after the signal, is cut off by the relay itself so that the impedance of the bridge connected between the speech lines does not become too small.

The relay  $R_9$  connects up the buzzer to the section immediately a call commences. The buzzer tone is disconnected as soon as the dialling starts.

In the case where a line is divided into many adjacent sections, each one is furnished with a line equipment at each end as shown in figure 14. Therefore when a call is made the impulse relays



X5007 Fig. 11. Line equipment for an arbitrary number of sections. The equipment consists of nine relays and one selector, which latter effects the connexions when another section is being called.

of both line equipments are attracted and work in parallel during impulsing. In order to prevent, as far as possible, reaction between the two impulse relays and also to diminish the damaging influence of any voltage differences between the batteries at the ends of the sections, the rectifier  $L_1$  is connected in series with one winding of the impulse relay. Without this rectifier the result would be that the impulse relay with the weaker magnetisation would be fast in operation and the one with the stronger would be slow.

Different battery voltages at both ends would have precisely the same result. The rectifier which prevents reverse current in the impulse relay causes the impulse relays to operate as if they were connected each to separate lines.

The rectifier  $L_2$  corresponds to the one with the same designation in the selector apparatus. The calls in other sections are made through this rectifier. But for this the high voltage surges of current for the operating of the section would be short circuited and consequently the work of the selectors would be made difficult.

The task of the rectifier  $L_3$  is to make it possible for the relay  $R_8$  and the selector to be driven from the same impulse contact.

In addition to the particulars given above the following details of the circuit should be pointed out.

The relay  $R_4$  cannot be pulled up except when the selector stands in its home position. This arrangement is made so that if a new call is made on the section so soon after another call that the selector whilst restoring, has not had time to reach the home position, the restoring would be stopped by the new call if the relay  $R_4$  was not

prevented from being pulled up before the selector reached its home position.

According to the above the line equipment is made in such a way that a long ringing impulse is added to the impulses of the dial. It is not desirable that this ringing impulse should be a long one in case the figure dialled is a directional figure which marks the traffic to another section. In this case it is desirable that the connecting up of the section be performed as quickly as possible. Therefore the long final impulse is clipped short in this case as soon as the relay  $R_7$  is attracted.

As shown above the capacity of the section is 19 numbers. The maximum number of positions that the selector in the line equipment can search out is 9. For the reason given below this number is reduced to 8. As previously described the line equipment is designed so that when a directing figure is encountered, the final impulse to the selectors is shortened. There is consequently nothing to prevent a selector being placed on just that directing figure, since the trembler bell has not time to operate. In order to use this for increasing the capacity of the selector system, the line equipment is designed in the following way.

The impulses from relay  $R_3$  to the selector are carried over a line in the selector multiple in all positions except the last. In this last position the selector receives instead current from a contact on the relay  $R_6$ . All the telephones are given two digit numbers. After the first digit, 9 or 0, the selector stands in the 9th or 10th position and has gone past the 8th directional position for the connecting up to other sections.

In these two positions the negative from  $R_2$  is connected through the selector C-line to relay  $R_7$  which consequently operates and cuts short the otherwise long extra-impulse. Since the relay  $R_2$  has released,  $R_7$  is released also. After the second digit in the number is sent out the final impulse is not shortened. When the impulsing for the second digit begins the selectors are in different positions. If 0 is the first digit the notched wheel is locked fast in its existing position, whilst with a 9 as first figure the selector falls back to its home position. The 12 step selector meanwhile operates the same in both cases. With the impulsing for the second figure the selector moves as usual until the last position is attained after 2 respective single steps. In this last position it immediately obtains current from relay  $R_6$ , hence the armature of the selector is attracted and remains actuated until the relay  $R_6$  is released. As

the selector is indirectly driven it does not operate until the magnet is deenergised and in this way moves to its home position again after which, consequently, a fresh call can be made and a new ringing signal received. Two or more different subscribers can be called one after the other without the necessity of the calling subscriber replacing his hand microtelephone between each call.

In this way the following capacity per section is obtained:

Number of directions from the section: 8.

Number of telephone instruments on the section: 18 (19).

Directing numbers: 1—8.

Telephone numbers: 92—90, 01—09(00).

As a general call number the 00 is used.

Should a still greater capacity be required, the following method may be used. All selectors connected to a section are divided into groups, which are designed in different ways with respect to the device for the addition of the impulse series. A group stops in the position attained, if 0 is the first digit, whilst all the other selectors fall back to their home position, starting from this anew, when the second digit is dialled. Another group will work similarly, if 9 is the first digit, another group if 8 is taken first etc. Thus, only a certain number of selectors will have reached a new starting position after the first digit. When a long impulse is sent from the line equipment after the second digit, the bell will ring in the apparatus, the selector of which makes contact in the position selected. As the position of contact must be at a distance of at least 12 steps from the home position, the numbers available will not be ten for each first digit, but will decrease as the first digit diminishes.

The number series will be

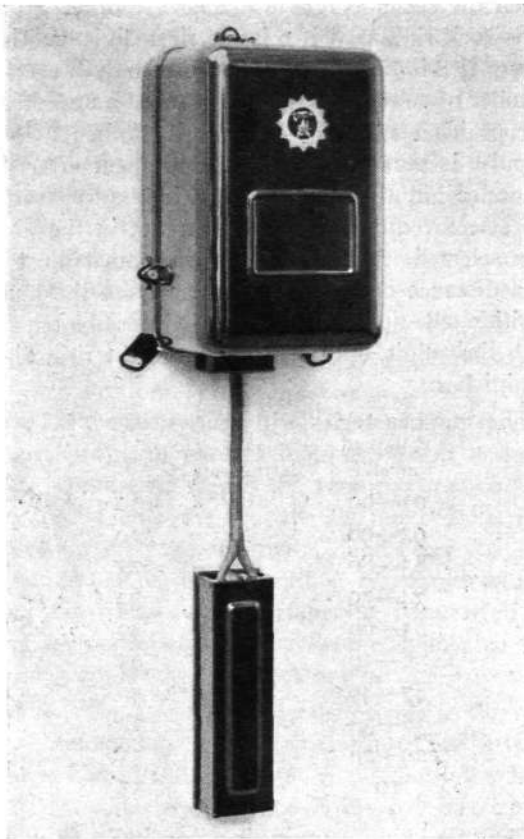
Telephone number	Number of instruments	Total
01—00	10	10
92—90	9	19
83—80	8	27
74—70	7	34
65—60	6	40
56—50	5	45
47—40	4	49
38—30	3	52
29—20	2	54
10	1	55

The maximum capacity is accordingly 55 numbers, if no directing numbers are required. As the low figures increase the capacity only very

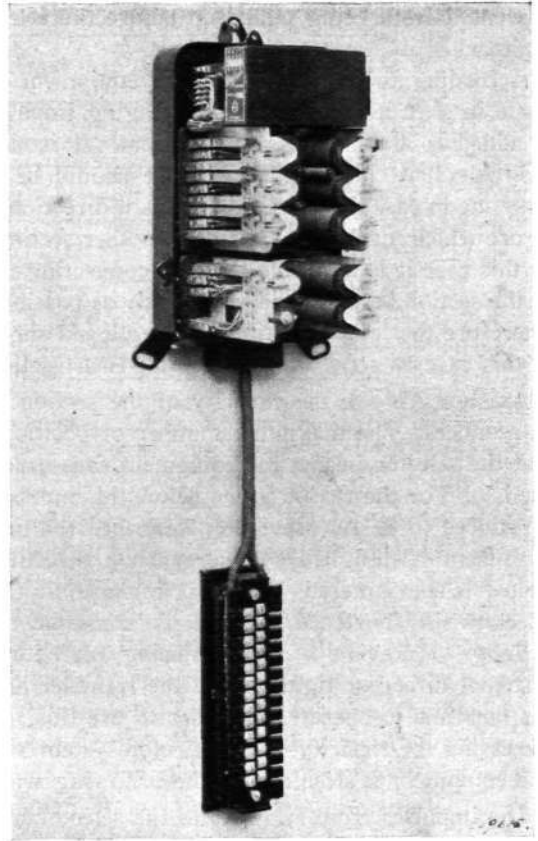
little, they may suitably be used as directing numbers. If 1—4 are used for this purpose, the remaining capacity will still be 45 numbers, which ought to be more than sufficient for all practical cases.

The line equipment is built up mechanically as shown in figures 12 and 13. All relays and selectors are enclosed in a dust tight sloping case from which all the necessary connections are taken to a separate terminal strip of bakelite. On this strip are to be found the terminals for connecting up the selector line, battery and buzzer etc. and also the terminals for interconnecting to other sections.

Because of this standardization it is possible to increase an existing selector installation by fitting further line equipments and connecting up these to the already existing lines. This connecting up is so simple to carry out that it can be done whilst the whole installation is in use.



X1040  
Fig. 12. Exterior of the line equipment.  
The equipment is mounted in a dust-tight sheet iron cover.



X1041 Fig. 13. Interior of the line equipment.  
The connexions are effected on a terminal strip of moulded bakelite.

## Intercommunication with Local Systems.

In larger stations in railway systems there are often local exchanges for the internal telephone traffic in and around the station. It is naturally desirable that intercommunication between the selector system and this local installation be arranged.

As the system here described works with only one loop and direct current, it is a relatively simple matter to arrange connecting lines to all kinds of CB exchanges. For LB systems the usual difficulties present themselves regarding the ringing-off signal.

As an example figure 14 shows a junction line for two-way traffic between an automatic exchange Type OL 35 and the selective calling system.

The traffic to the local exchange is the simplest to arrange. For this purpose no kind of special equipment is required. A call in the local system occurs in the same way as a call in another section. From the A- and B-lines are connected the

positions corresponding to the directive number given to the local exchange to the line connections for an ordinary line. On the local system the call is made in the same way as from an ordinary telephone instrument. As soon as buzzer tone is received the dialling can commence. If both the outgoing and incoming traffic goes over the *same* line on the OL exchange, a marking of disengaged lines must be introduced, which is done in the usual way over the C-line in the line equipment selector.

The outgoing traffic is more troublesome to arrange. The connecting line as shown in figure 14 is arranged so that no encroachment on the local system itself is necessary.

The coupling-in to the selector lines occurs immediately after the ringing signal is sent out from the switch on that subscribers line to which the junction line group is connected. Because of this the alternating current relay  $R_1$  is attracted.  $R_1$  connects up current to the relay  $R_3$  which connects  $R_4$  and also puts positive on the B-line. At this point the ringing is tripped so that  $R_1$  releases and connects-in the impulse relay  $R_5$ . After  $R_5$  is attracted  $R_3$  is held energised over a contact on this relay.

The local system is now in communication with the selector system. A call on the latter is carried out immediately after the relay  $R_7$  is attracted, which occurs when disengaged marking through LC is received.

During impulsing the relay  $R_5$  operates in parallel with the impulse relay in the cord line of the local exchange in the same way as normally used for the main lines of this type of system. During impulsing the lines are separated by the slow acting relay  $R_6$ .

It is absolutely essential, when the selective calling system is used on electrified railways, that it is fully insulated from earth. This is also the case in the event of cables being used. As the battery used on the local system is usually earthed one must introduce a separate battery for selector installations. On the junction line as shown Fig. 14 there are circuits belonging to both systems, thus the methods of connecting up both batteries have been shown.

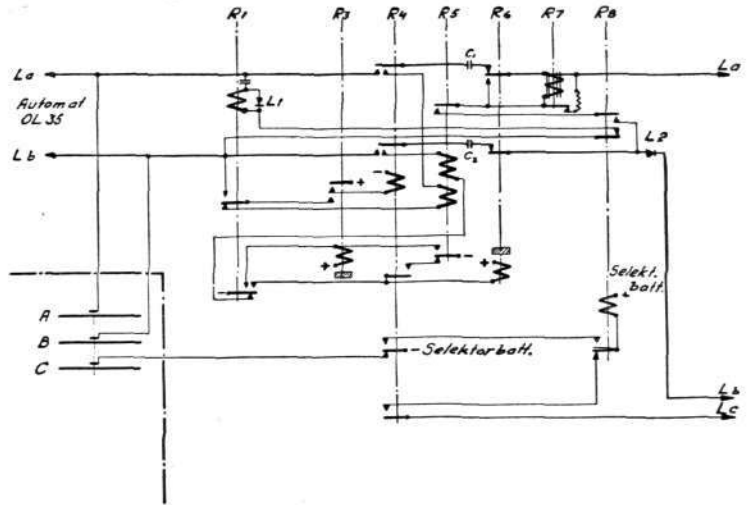


Fig. 14. Junction line between the selective calling system and an automatic exchange.

The junction line is intended for automatic traffic in both directions and requires no alteration whatever in the exchange or the selective calling system.

It should be observed that the rectifier  $L_2$  which has the same function as in the other circuits must be placed on the outgoing line itself and not only in the bridge (relay  $R_7$ ). This is because the telephone instruments on the local system are not protected against the heavy discharges of the condensers  $C_1$  and  $C_2$  which occur at the conclusion of each impulse series. The rectifier  $L_2$  appreciably reduces the violence of these discharges so that they do not produce un-supportable acoustic shocks at the telephone.

## Simplified Local Exchange.

In those cases where the local traffic inside a railway station is not considered sufficient to require a local exchange of the normal type but where the number of desired telephone instruments from an economic and traffic point of view is too high to be suitable for a normal selective calling system, a simplified local exchange has been designed to meet the case. This is shown in Fig. 15 and the instruments used in Fig. 16.

The capacity of the local exchange is 8 outgoing lines and 9 local instruments. These instruments work in exactly the same way as the normal selector instruments and differ from these chiefly through having no selector. Only one conversation can be carried on at a time and the call is not secret.

The system can therefore be compared to a compact section from which the telephone lines

radiate. Each instrument is connected to the switching equipment by a double line.

All of the instruments are connected in parallel to the impulse relay and remain so during impulsing. Because of this it follows that normal CB instruments cannot be used, as the impulse relay will not operate with so many bells and condensers in parallel. The ringing is therefore obtained in another way. The instruments are equipped with direct current trembler bells connected in series with half-wave rectifiers in the same manner as the selectors in the selector instruments. The ringing signal is now made in such a way that after the impulsing is complete the polarity of the called line is reversed for a few seconds. During this time the trembler bell obtains current from the switch section, whilst the other lines are cut out. Immediately after the ringing signal is sent out, the selector returns to the home position and the desired number can be called again.

Only in the case of a directing figure being used does the selector stop in the fixed position and connect in the local switch to the required section. The system is arranged that a call is only made if the required section is at liberty. Should the section be engaged it is only possible to come into speech communication with the section.

As soon as the section is disengaged the call is connected up and buzzer tone indicates in the usual way that dialling can commence.

The equipment of the local system consists of 9 relays, a 12-stepping switch and also 3 condensers and a rectifier.

The method of working is as follows:

On a call being made the impulse relay  $R_3$  is attracted. If the selector is in its home position the relay  $R_4$  is then attracted and remains so until the call is rung off. Simultaneously with  $R_4$ ,  $R_2$  is attracted the first step with which buzzer tone is sent out to the calling instrument, which indicates that dialling can begin. During impulsing  $R_5$  and  $R_2$  are attracted and operate the final step so that buzzer tone is cut off. If the dialled figure is a direction figure to another section,  $R_8$  is attracted in the usual way and gives a signal in the required section if it is disengaged. The con-

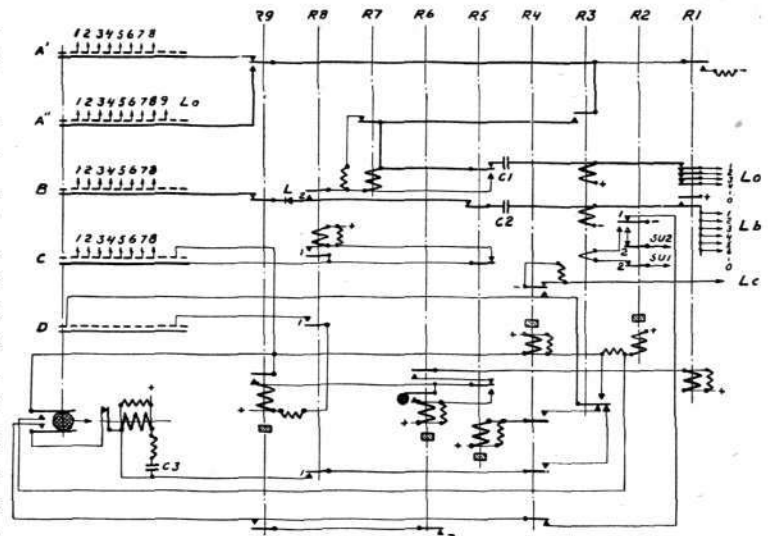


Fig. 15. Simplified local exchange.

A', B, C directing numbers, A'' instrument numbers. The capacity of the exchange is 9 instrument numbers and 8 outgoing directions for the traffic with the selective calling system. The construction of the exchange is the same as that of the line equipment, Fig. 12 and 13.

nection occurs over A', B and C-lines. If it is desired to ring up one of the local systems own instruments, 0 is first dialled. After this  $R_0$  is attracted and is held energised over its own contacts. The relay  $R_0$  connects up the local system selector for local traffic. The A-wire is connected up to the A''-line of the selector switch to which the A-wire of the local line is connected, and the B-wires connection with the B-line is cut off. When  $R_0$  is attracted the selector switch is driven immediately to its home position through the self driving contact. When the next figure is dialled,  $R_5$  and  $R_6$  are both attracted. Then  $R_5$  releases when the impulsing is completed but  $R_6$  is held attracted for a few seconds more by the pendulum contact and connects the current to the relay  $R_1$  which cuts off all the lines connected in parallel and through the selectors position on the A''-line reverses the line polarity on the required local line, so that the bell in the instrument rings. After the ringing signal is sent out the selector returns to its home position, after which any local instrument can be called again.

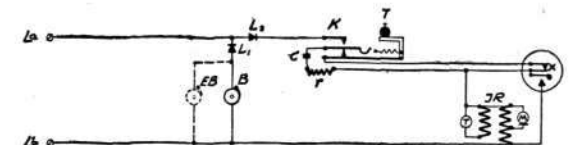


Fig. 16. Telephone instrument for simplified local exchange.

The instrument is designed as a CB set, but the magneto bell is exchanged against a trembler bell in series with a rectifier. The bell rings when the polarity of the line is reversed.

A call between a selector line instrument and a local instrument, according to the above, operates on both the selector and the local systems.

For instruments commonly used for such traffic the best type is that known as a double line instrument which by means of a push button can switch over from local to selector working. With this exception the telephone instruments agree with the ordinary local instruments.

## Sectionizing of Selector Lines.

It is the traffic conditions themselves that within the limits of the system decide how the division of the selector lines should take place. The Ericsson Selective Calling System is very flexible in this respect and from a point of view of sections can be divided up in practically any way desired. Figures 17, 18 and 19 show several examples of this.

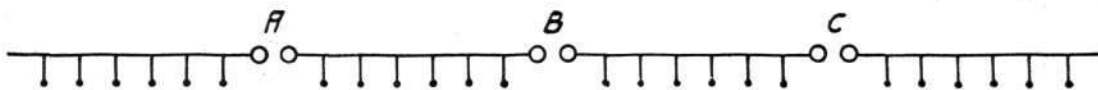
Figure 17 shows the basic principles governing the dividing up of the sections. A long line is divided into a series of short stretches which are connected together like the links of a chain. The division should in general be carried out so that as many calls as possible are kept within one

section. For example the directional figures for traffic to another section could be 1 in one direction and 2 in the other.

Figure 18 shows a more complicated system. At the section points A and C, a single and a double brand section are introduced respectively, whilst at the point B a local switching system as previously described is connected in.

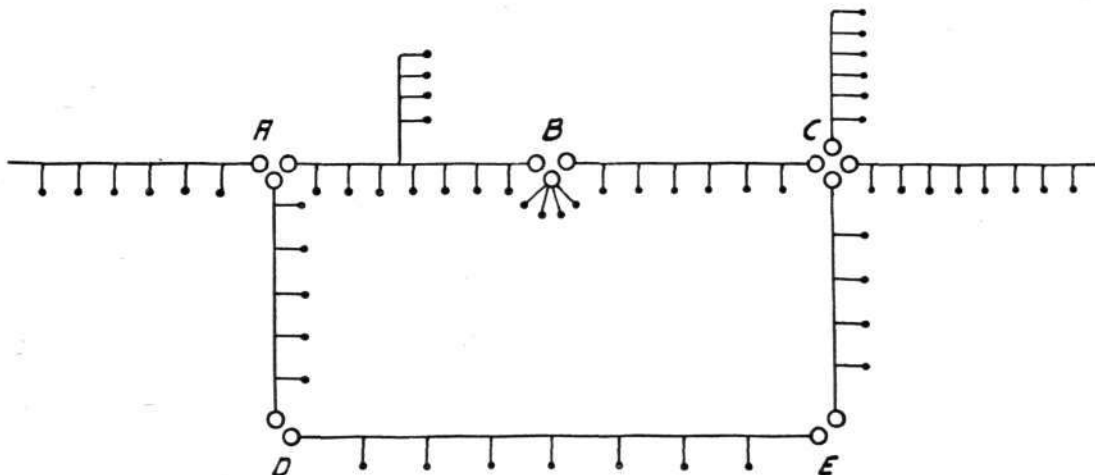
The sections in reality do not require to be carried out as direct connection lines between the sectionized points. If necessary each section can be provided with branches as is shown for example in the section between A and B. A selector installation in accordance with this skeleton scheme requires several directional figures to operate it. As an example, 5 different directional figures are required for the traffic from the section between B and C.

In larger selector installations with heavy traffic one connection possibility is often insufficient. One can then have two or even several similarly equipped sections in parallel. As this may prove to be relatively expensive it is often quite sufficient to pick out certain instruments in the system and connect them to a separate main station line, an example of which is shown in Figure 19.



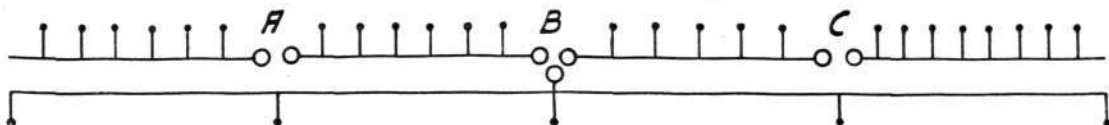
X 7003

Fig. 17. Sectionizing of a long line.  
Directing figures for traffic in one direction 1, in the other 2.



X 7004

Fig. 18. Sectionizing of a more complicated railway line.  
Maximum number of directing numbers: 5 from each section.



X 7005

Fig. 19. Sectionized line with parallel, not sectionized, main station line.

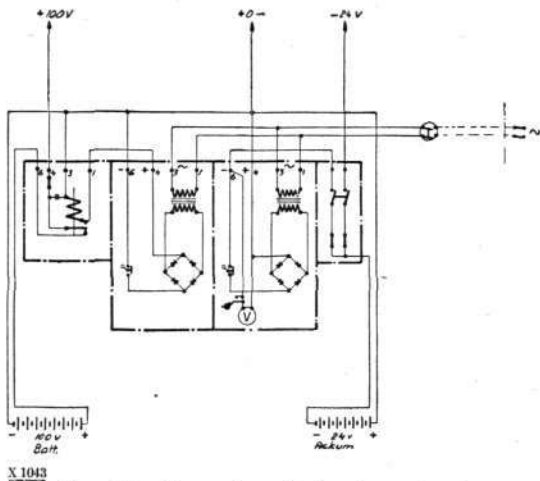


Fig. 20. Power installation for selective calling system.

The examples given could be multiplied and are only intended to give an insight into the possibilities of the system. How the sections in reality should be designed and carried out can only be decided as the cases arise and depends entirely on local conditions and requirements.

## Power Installation for Selective Calling System.

At every sectionized point, 24 V direct current is required to operate the relays and switches, which is obtained from a suitable accumulator that can be of low capacity because of the small current consumption. For each line equipment the current consumption during speech is 0.22 A and 0.6 A on an average during impulsing. For a call of approximately 2 minutes in length, the consumption is therefore 0.01 Ah for line equipment.

Dependent on the line resistance and the number of selectors a higher voltage is required for operating the selector switches. In general it can be taken 100 V is sufficient. This higher voltage can be obtained by the use of radio anode batteries of the dry cell type or from a rectifier which gives the required current direct. In the last case it is advisable to have a radio battery in reserve.

It should be observed that this higher voltage should not be connected at more than one point in the section. From this it follows that this higher voltage need not be available at the terminal point of each section but is actually only required at every other point.

In the same way a reduction of buzzer connections to the sections can be made. In this case also the connection should occur at only one point per section or otherwise variations in the tone could occur as one cannot maintain exactly the same tone from all the buzzer generators.

To avoid disturbances from power lines the battery should be insulated from the earth and this condition should also be maintained whilst the battery is being charged. In the case of a direct current system, where the charging is done through a resistance, two batteries should be used which can be alternatively charged and discharged.

On the other hand when alternating current is used the charging can be done whilst the system is working. A power installation for manual operation on alternating current is shown in Figure 20. The equipment consists of two standard rectifiers, a circuit breaker with fuses for the battery and also a change-over relay which switches over the high tension rectifier and the 100 V reserve battery.

Figure 21 shows a general arrangement of a complete section with a power installation of this type.

A power installation of this kind can be made fully automatic by fitting a controlling arrangement for battery charging of Ericsson's standard manufacture.

In those cases where the higher voltage is not required at the section points in question, the rectifier and the change-over relay are naturally left out of the equipment.

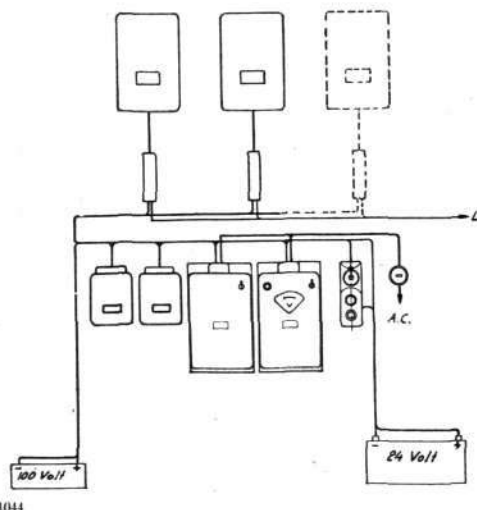
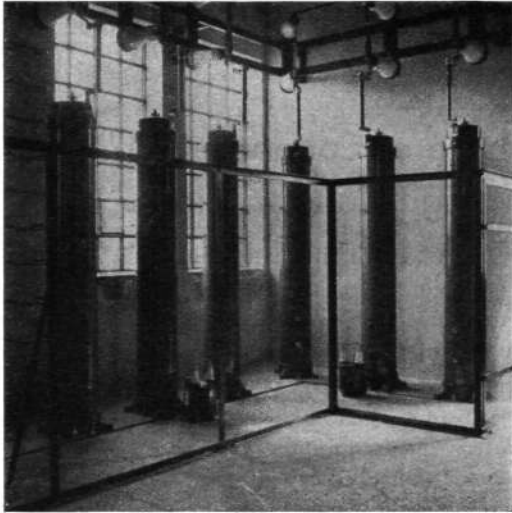


Fig. 21. Erection plan for a section equipment; line equipment and power plant.

# Condensers for Protection against Atmospheric Excess Voltages



X 1061 Condensers for excess voltage protection at the Royal Board of Waterfalls, Gothenburg.

By R. LUNDHOLM, D. Sc. Tech.,  
Royal Board of Waterfalls,  
Stockholm.

*The author examines briefly the nature of atmospheric excess voltages, and the demands on an efficient protection against them.*

*The calculation of condenser protectors on high and low tension lines is exemplified. The author stresses that condensers, apart from their function as excess voltage protection, may also be used for improvement of the power factor and as voltage transformers, which is considerably less expensive than current methods at high operating voltages.*

## The Nature of Atmospheric Excess Voltages.

The researches carried out on atmospheric electricity during the last few years, especially by means of Dr. Norinder's cathode ray oscillograph have considerably extended our knowledge of the nature of excess voltages thus rendering possible a much more accurate calculation and design of the protecting devices than was possible only some years ago.

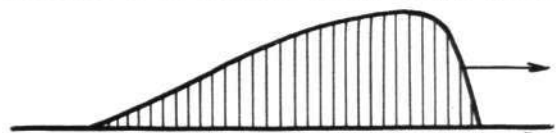
As is well known, excess voltages appear on aerial lines as transient waves, which progress along the line with about the same velocity as that of light. The shape of such transient waves varies considerably but according to measurements made with cathode ray oscillographs, the most dangerous type of waves has a more or less triangular shape, approximately as shown in Fig. 1.

The front of the wave is comparatively steep, so that within a distance varying generally from some hundred meters to some kilometers, the voltage rises to its peak value. The declination on the back of the wave is in the average much smaller, and the total length of the wave may amount to several kilometers. During the migration of the wave along the line, its amplitude is gradually damped. Apart from leakage losses, the charge remains unchanged and the

length of the wave increases therefore as the amplitude decreases. For this reason, waves of relatively small amplitude have in the average a greater length than those of great amplitude. The charge of a wave on a well insulated line may amount to a considerable value. The charge exceeds, however, seldom a few percents of a Coulomb. The diagram in Fig. 2 shows the amplitude of a wave on a normal aerial line with a charge of 0.03 Coulomb, as a function of the duration and the length of the wave respectively. The crosses in the diagram indicate excess voltage waves actually observed. From the diagram it may be inferred, that the charge of a wave exceeds 0.03 Coulomb only in exceptional cases and that we may therefore consider any part of a system as sufficiently protected, if the lightning arrester cuts down the amplitude of such a wave to a safe value.

## The Condenser for Excess Voltage Protection.

In principle it has long been known that a condenser is an excellent excess voltage protec-



X 1057

Fig. 1.

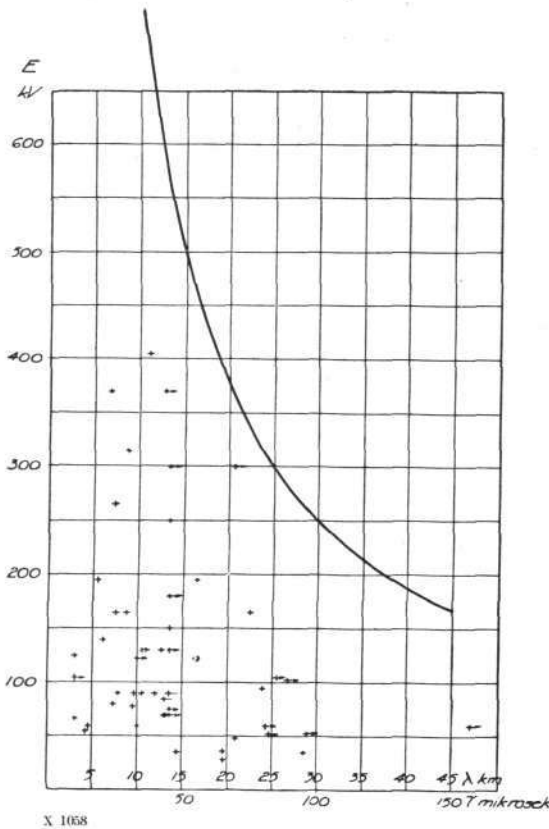


Fig. 2. Maximum voltage and duration of measured waves arriving at a terminal station (before voltage doubling due to reflection at the line terminals).

→ The arrows in the diagram indicate that the duration is not exactly known, but in all cases greater than the value indicated by the abscissa.

tion. The difficulties in the manufacture of condensers having now been overcome, Sievert's Cable Works feel sure that they are supplying a long felt need by starting the manufacture of a series of condensers intended for excess voltage protection; the following gives more detailed information about condenser protection of this type.

Lightning arresters of any kind are intended to protect some vital part of a plant, as for instance a transformer station with switch gear on a high tension line, a motor on a low tension line etc., while it is not considered economical to provide separate excess voltage protection on the lines at least as far as high tension lines are concerned.

The main purpose of excess voltage protection is to *reduce the amplitude* of an excess voltage wave to a safe value. Nowadays, the same importance is not attached to the *smoothing out of the front of the wave*; it must, however, be noted that one great advantage of the condenser is that it will also be able to round off the front of

the wave and damp all high frequency oscillations in the tension more effectively than any other kind of protecting devices. If it is designed to meet the first mentioned requirement, the second point will automatically be gained.

## Design of Condenser Protection on High Tension Lines.

A wave arriving at a terminal will be doubled by reflexion; for this reason there is, especially at the terminals, a great risk of flashover in case no excess voltage protection has been provided. If a condenser is connected at the terminal between one phase and earth, the excess voltage will be considerably reduced. Fig. 3 shows the extent to which the reduction is effected as a function of the capacity of the condenser, if we suppose that the shape of the arriving transient wave is triangular.

In the calculations below the following symbols will be used:

$E$  = amplitude in kV of the most dangerous transient wave arriving.

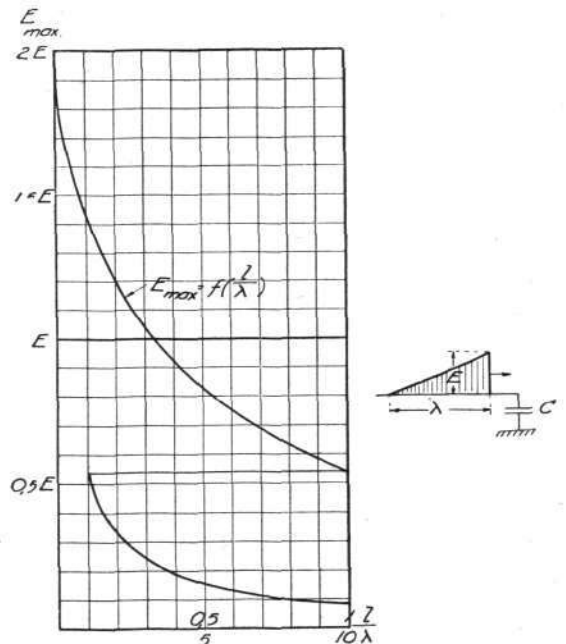


Fig. 3. Condenser as excess voltage protection in a terminal station.

Symbols:

$E$  = amplitude of the arriving voltage wave.

$\lambda$  = length of the wave in km.

$C$  = capacity of the condenser in microfarads/phase.

$E_1 = \sim 125 \cdot C =$  length of a line of the same capacity as the condenser.

$E_{max}$  = maximum excess voltage in the protected station. The wave resistance of the line is supposed to be 500 Ohm.

- $E_l$  = amplitude in kV of the flash-over voltage of the line.  
 $E_s$  = amplitude in kV of the flash-over voltage of the protected switch gear.  
 $E_{max}$  = Maximum permissible amplitude value in kV of the excess voltage at the station.  
 $\lambda$  = Length in km of the most dangerous wave of excess voltage.  
 $l$  = Length in km of a part of the line having the same capacity as the condenser.  
 $C$  = Capacity of the condenser in  $\mu F$ .

The amplitude  $E$  of the wave arriving at the station is limited, and determined by the insulation of the line. From the diagram in Fig. 2 the greatest probable length of a wave of the amplitude  $E$  will be found.  $E_{max}$  is determined by the insulation of the switch gear. From the diagram in Fig. 3 will be found the lowest admissible value of  $\frac{l}{\lambda}$  corresponding to the proportion  $\frac{E_{max}}{E}$  and if  $\lambda$  is known, the value of  $l$ .

The aforesaid will be suitably illustrated by the following example:

A 77 kV line with suspension insulators has an excess voltage on the line of

$$E_l = 600 \text{ kV amplitude value.}$$

The switch gear to be protected is arranged in a building and has a flash-over voltage on the supporting insulators (the point of lowest insulation) of  $E_s = 300$  kV.

It is supposed that the wave is added to the normal phase voltage. Consequently the highest permissible value of amplitude of the excess voltage will amount to

$$\begin{aligned}
 E_{max} &= E_l - \text{phase voltage} = \\
 &= 300 - \frac{77}{\sqrt{3}} \cdot \sqrt{2} = 300 - 63 = 237 \text{ kV,}
 \end{aligned}$$

and the highest possible value  $E$  may assume is  $E = E_l - \text{phase voltage} = 600 - 63 = 537$  kV.

$$E_{max} = \frac{237}{537} = 0.44.$$

From diagram Fig. 3 will be found

$$\frac{l}{\lambda} = 1.4$$

According to Fig. 2 the greatest probable duration of a wave of an amplitude of 537 kV is estimated to be about 45 microseconds, corresponding to a wave length of  $\lambda =$  about 13.5 km.

$$l = 1.4 \cdot 13.5 = 18.9 \text{ km.}$$

The condenser cut-out should consequently have a capacity per phase corresponding to an aerial line of about 18.9 km. or about

$$0.8 \cdot 10^{-2} \cdot 18.9 = 0.15 \mu F / \text{phase.}$$

In this manner the required capacity of a condenser protection has been calculated for different operating voltages, when assuming an approximately normal proportion between the insulation of the line and that of the station. The calculation results are assembled in the table below. If larger equipments are concerned, it is advisable to make special calculations in accordance with the principles indicated above.

Concerning lines erected on wooden poles where the insulator brackets or cross arms are not connected to earth, it must be taken into consideration that the wooden pole itself increases considerably the insulation to earth. In such case it is advisable to calculate with  $E = 10^6$  kV, and, according to Fig. 2 with a corresponding higher duration of the wave of 24 microseconds or

$$\lambda = 7.5 \text{ km.}$$

So far as an intermediate station is concerned, a considerably lower capacity of the condenser protecting device will be sufficient, e. g. one half down to one third of the value calculated as above.

## Condenser Protection on Low Tension Aerial Lines.

Concerning the design of condenser protection on a low tension line, there are no rigid rules to follow for the calculation. The American measurements on high tension lines have produced fairly complete statistical data on excess voltage waves at their arrival at a station, i. e. after having passed a longer or shorter section of the line; during this passage both leakage (on account of corona phenomena or the like) and damping (due to resistance in the line) occur. Such a »normal» wave having a length of some ten km cannot be contained in a low tension line of relatively short length and the whole line will instead be more or less uniformly charged while excess voltage arises. In such cases, the total capacity of the network ought, in order to be effective, to be sufficient to store the whole quantity of electricity charged in the line. The problem will therefore be to calculate the quantity of this charge. It is known that the charge of a lightning is very considerable ranging about some ten Coulomb. A direct lightning flash is, however, rather rare in low tension lines, the line will more often be damaged by excess voltage. Even on high tension lines, where lightning

flashes occur much more frequently, the quantities of electricity in a transient wave are of far lower range (about 0.03 Coulomb) than the quantity of electricity in a lightning. In practice we are on the safe side if, when low tension lines are concerned, we reckon with the same charge as for waves in high tension lines.

A line of 220 V with a voltage to earth of 130 V may be taken as an example. The test voltage for low tension apparatus amounts to 1 000 V alternating current corresponding to about 1 400 V amplitude value. For safety we calculate with only 1 000 V amplitude value. The capacity required for the line amounts consequently to

$$\text{about } \frac{0.03}{1\,000} = 30 \cdot 10^{-6} \text{ Farad/phase.}$$

At service voltage and 50 cycles, this capacity corresponds to a three-phase condenser output of 0.48 kVA, which is quite moderate.

A condenser of this kind will, especially if it is divided in several smaller batteries, of e. g. 10  $\mu F$  per phase, protect the whole low tension line on account of the latter's small extension; it will not only protect the instruments in the proximity of the batteries, but also the low tension lines themselves, which is quite contrary to the condensers on high tension lines, the protecting capacity of which extends only some kilometers along the line.

In accordance with this principle, the capacities of the low tension line cut-out condensers have been calculated, and reproduced in the table on page 35.

In the table suitable values are also given for the capacities of condensers on intermediate voltage lines, which values have been chosen in such way that a smooth transition occurs between the values for low tension and high tension lines.

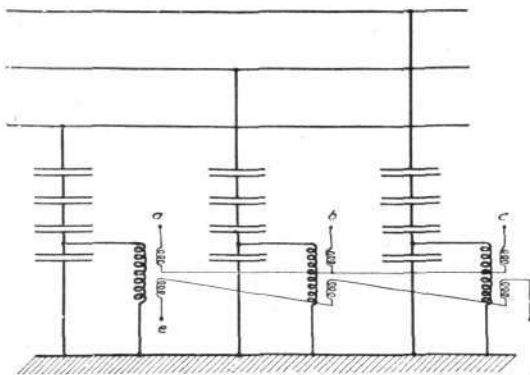


Fig. 4.

X 1060

## Combined Power Factor Correction and Excess Voltage Protection.

When considering the purchase of a condenser for improvement of the power factor, the question arises, whether it might not be advantageous to design the condenser in such manner that it may also serve as excess voltage protection. For that purpose it is only necessary to connect the condensers in star with neutral directly connected to earth. The condenser will be more expensive only in case it should be intended for very low operating voltages; the additional price is, however, very reasonable with regard to the protection against excess voltage. As much higher capacities than those given in the table are very often employed for power factor correction, the obtained protection against excess voltage will be very effective.

## Condensers Used as Voltage Transformer for High Operating Voltages.

For high operating voltages each condenser element is built up of several cells connected in series. It is therefore quite natural to design the condenser as a capacitive potentiometer by arranging on the element a special tapping on the cell nearest to earth. Between this connection and the earth is placed an intermediate voltage transformer. In this way, voltage transformation is obtained for measuring purposes, for relays etc. This arrangement will, especially, when very high operating voltages are used, be considerably cheaper than voltage transformers of the usual type. Furthermore, the condenser will also be useful as a phase advancer. The high tension condenser may thus at the same time be employed for three important purposes, viz. as excess voltage protection, voltage transformer and phase advancer.

The Sievert condenser, type BCB, for an operating voltage of 40 kV and above, may be fitted with a special tapping for connection to an intermediate voltage transformer in accordance with the above. The intermediate voltage transformer is executed with two secondary windings. For three-phase arrangement, the connection is effected according to Fig. 4, one set of the secondary windings being connected in star in order to make possible

the measurement of the main voltage, and the other set being connected in open delta in order to make possible the measurement of the tension of the system to earth.

### Test Voltages etc.

As the condensers are intended to protect other parts of the system, they must be more resistant than the rest of the plant with respect to insula-

tion. In the table below are given the test voltages of the Sievert excess voltage protecting condensers. Generally speaking, condensers have a very high resistance against excess voltages of short duration, and surpass in these respects all other kinds of apparatus.

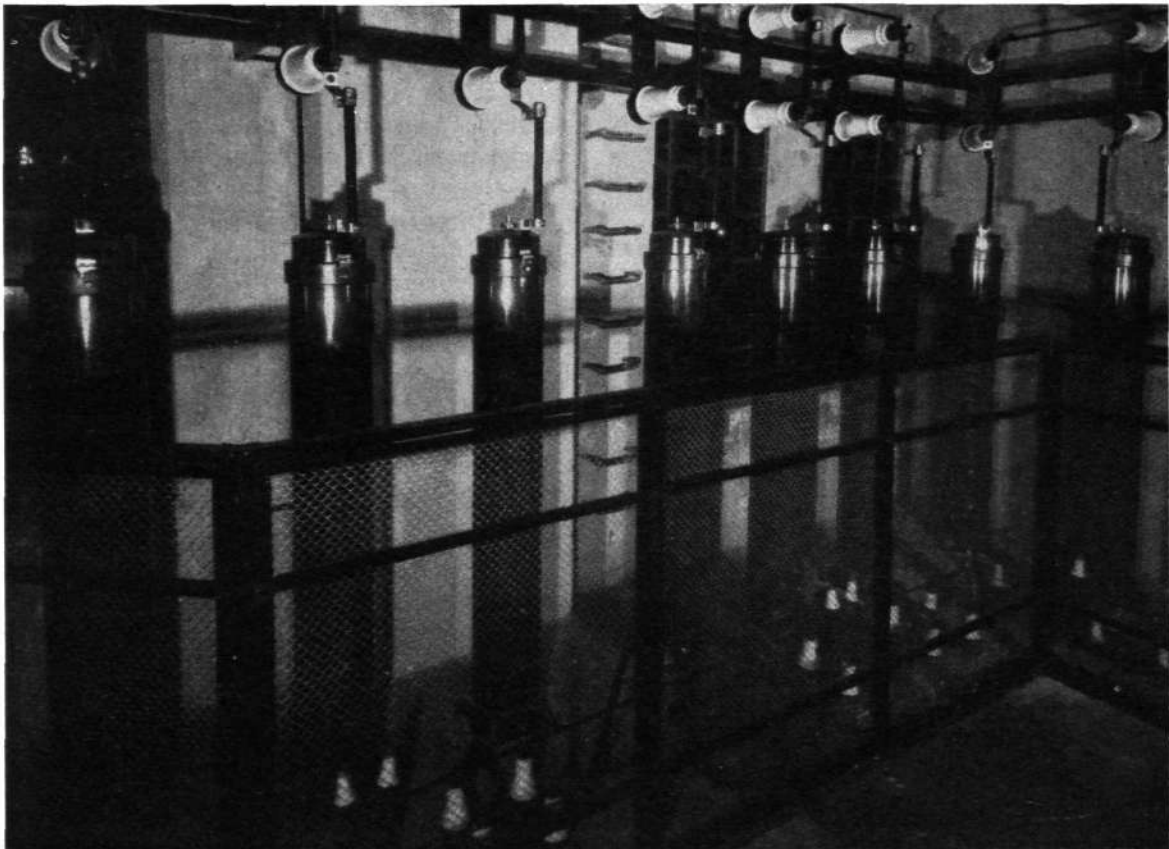
The condensers will stand direct discharge (without intermediate resistance) at the D. C. voltages indicated below.

### Three-phase Condenser for Excess Voltage Protection.

Operating voltage V	$\mu\text{F}/\text{phase}$	kVA 3-phase	Coulomb $\times 10^3$ per phase at operating voltage	Test voltage D. C. 5 min. kV	Test voltage A. C. 50 cycles 1 min. kV	T y p e	Number per phase
380	11.0 <sup>1</sup>	0.90	3.4	5	2.5	ECPW-0	1
500	11.0 <sup>1</sup>	0.90	4.5	5	2.5	ECPW-0	1
3 300	1.50 <sup>2</sup>	6.00	4.7	25	7.5	ECPW-0	1
6 600	0.75 <sup>2</sup>	12.00	4.55	50	15	ECPW-I	1
11 000	0.50 <sup>2</sup>	18.00	4.20	80	22	ECPW-II	1
22 000	0.25 <sup>2</sup>	37.5	4.50	140	35	RCP-300/IV	1
33 000	0.22 <sup>2</sup>	75.0	5.90	220	50	RCP-300/IV	2
44 000	0.16 <sup>2</sup>	75.0	5.75	260	60	RCP-300/IV	2
55 000	0.15 <sup>2</sup>	75.0	5.85	300	75	RCP-300/IV	2
66 000	0.144 <sup>2</sup>	162.0	7.75	330	85	BCB-300/VII	3
77 000	0.125 <sup>2</sup>	192.0	7.85	360	95	BCB-300/VI	4
110 000	0.105 <sup>2</sup>	330.0	9.40	430	130	BCB-300/VII	6

<sup>1</sup> The figures indicate the total capacity output required on the line.

<sup>2</sup> The figures indicate the capacity output required in each protected station.



X 7008. Fig. 5. Condensers for excess voltage protection at the Royal Board of Waterfalls, Gothenburg.



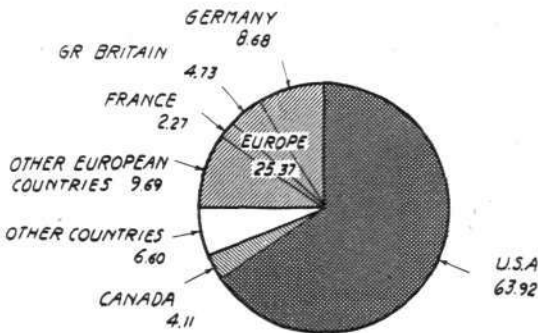
Director of the Stockholm Telephone System

# World Telephone Statistics

On the basis of international telephone statistics, the telephone development of various countries during the 10-years period 1921—1931 is discussed. The author treats several important problems, such as the influence of Government or private operation on the increase in the number of subscribers.

Distribution of the world's telephones, in %.

1st JANUARY 1921



X 10453

Fig. 1.

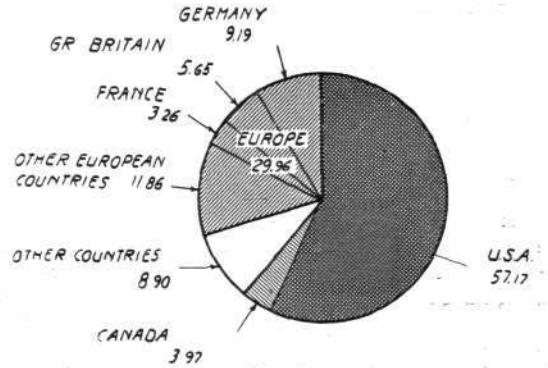
A publication that is always eagerly expected by people interested in the telephone industry is the American Telephone & Telegraph Company's Worlds Statistics of the extension and use of the telephone. The latest available publication at the moment shows the position on January 1st, 1931.

It may be of interest to make a general survey of its main contents and at the same time to make a comparison with the conditions existing 10 years earlier, on January 1st 1921. In certain cases the annual changes during this 10-years period are given.

The percentage figures given in fig. 1 and 2 show how the telephones in the world are distributed.

As can be seen, the United States of America, the foremost telephone country in the world both as to early development and number of telephones, show a falling percentage figure. The conditions in Canada are exactly the same, as this country had a large number of telephones already in 1921. The development was to be expected as the greatest possibilities of development lie in the rest of the world. The United States has lost 6.75 percent during the 10 years period and Canada 0.14 percent, whilst Europe has increased by 4.59 and all other countries together by 2.30 percent. The distribution of the worlds

Distribution of the world's telephones, in %.  
1st JANUARY 1931



X 10463

Fig. 2.

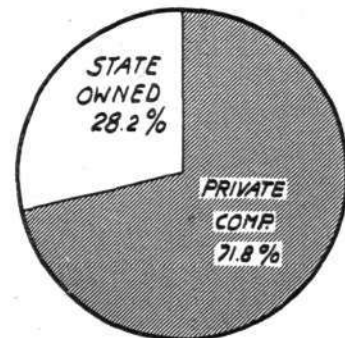
telephones between Government systems and private companies at the beginning and the end of the 10 years period is shown in the figures 3—4.

The Government telephones which on the 1st January 1931 comprised 32.9 % of the telephone total have increased by 4.7 %.

This natural development is explained partly by the fact that Government operated enterprises are much more numerous and partly because

Distribution between Government and private operation, in %.

1st JANUARY 1921



X 10473

Fig. 3.

Distribution between Government and private operation,  
in %.  
1st JANUARY 1931

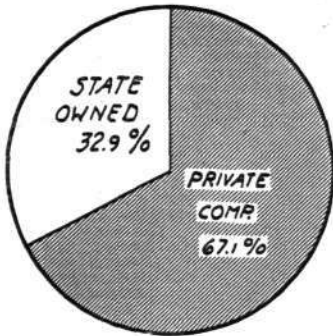


Fig. 4.

these enterprises, which dominate in Europe, have at the present time the greatest possibilities of development.

The table on pages 40—41 gives the total number of telephones and the number per 100 inhabitants in the different countries at the beginning and the end of the 10-years period; it also shows the increase, both absolute and in percent, during that period.

### Europe.

Europe taken as a whole registers an increase of 5 299 616 telephones, or 100.2 percent. This is an average of somewhat more than half a million instruments per year. The telephone density (number of telephones per 100 inhabitants) has hereby not increased more than from 1.2 to 2.0 %.

The Government owned telephones show an increase of 4 444 570 or 90.2 %, whereas the privately owned have increased by 859 046 corresponding to 173.6 %. How this growth is distributed over the different countries is shown in the diagram, fig. 5.

Among countries with Government operated telephones, Germany, owning approximately one third of the telephones in Europe, shows the largest increase with 1 439 000 telephones. As a good second comes Great Britain with over one million, and next comes France with 680 thousand instruments. The greatest percentage increase in these three countries occurred in France with 143.7 % whilst Great Britain has an increase of 102.5 % and Germany 79.5 %. Among the remaining countries with Government owned telephones, Belgium shows the greatest growth both in total number of telephones and percentage in-

crease with 229 766 instruments and 365.5 %. Next in the list comes the U.S.S.R. with 177 586 and 88.8 % followed by Sweden with 148 262 and 38.2 %.

Among countries with privately operated telephone service Italy and Spain, who both in 1921 had partly Government telephone service and who during the 10 years under review went over to exclusive private control, have increased by 267 015 and 152 382 telephones or with 232.2 and 217.7 % respectively.

With regard to the total number of telephones at the beginning and end of the 10 years period, Germany, Great Britain, France and Sweden have held their position 1 to 4. Italy has made a big jump from the 11th to the 5th position whereas Denmark which held this position dropped to the 7th, being passed by the U.S.S.R. Holland, Switzerland and Austria have each climbed one rung of the ladder and stand 8th, 9th and 11th position respectively. Norway has dropped from No. 9 to No. 14 in order.

Poland has held its position, Belgium has jumped 5 steps from No. 15 to No. 10 and Spain from 14 to 12.

The diagram fig. 6 shows the telephone density in a number of European countries. For the sake of comparison the United States and Canada are included, as these countries possess the greatest telephone density in the world.

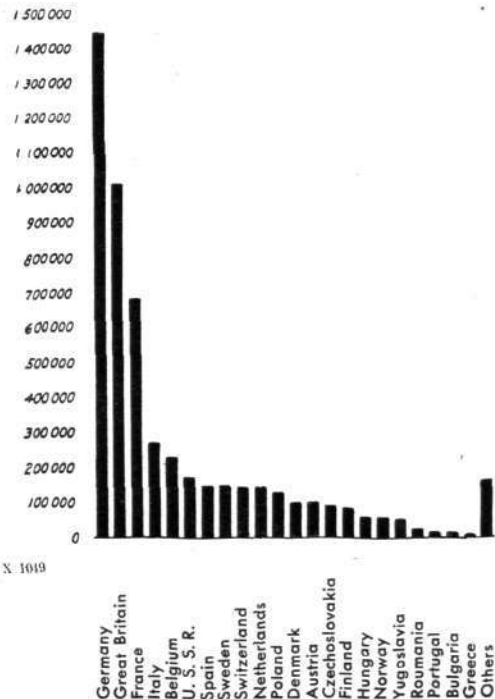


Fig. 5.

The telephone density has during the 10-years period increased:

in Canada	.....	from	9.8	to	14.0	or by	4.2	telephones per	100 inhabitants
» United States	.....	»	12.4	»	16.4	»	»	»	»
» Switzerland	.....	»	3.8	»	7.3	»	»	»	»
» Belgium	.....	»	0.8	»	3.6	»	»	»	»
» Great Britain	.....	»	2.1	»	4.3	»	»	»	»
» Denmark	.....	»	7.7	»	9.9	»	»	»	»
» Finland	.....	»	1.3	»	3.5	»	»	»	»
» Sweden	.....	»	6.6	»	8.7	»	»	»	»
» Germany	.....	»	3.0	»	5.0	»	»	»	»
» Norway	.....	»	5.0	»	6.7	»	»	»	»
» Holland	.....	»	2.4	»	3.9	»	»	»	»
» France	.....	»	1.4	»	2.8	»	»	»	»
» Austria	.....	»	2.2	»	3.4	»	»	»	»

## Increase in the Number of Telephones in Europe during the 10-years Period 1/1 1921-1/1 1931.

Number of telephones per 100 inhabitants in various countries.

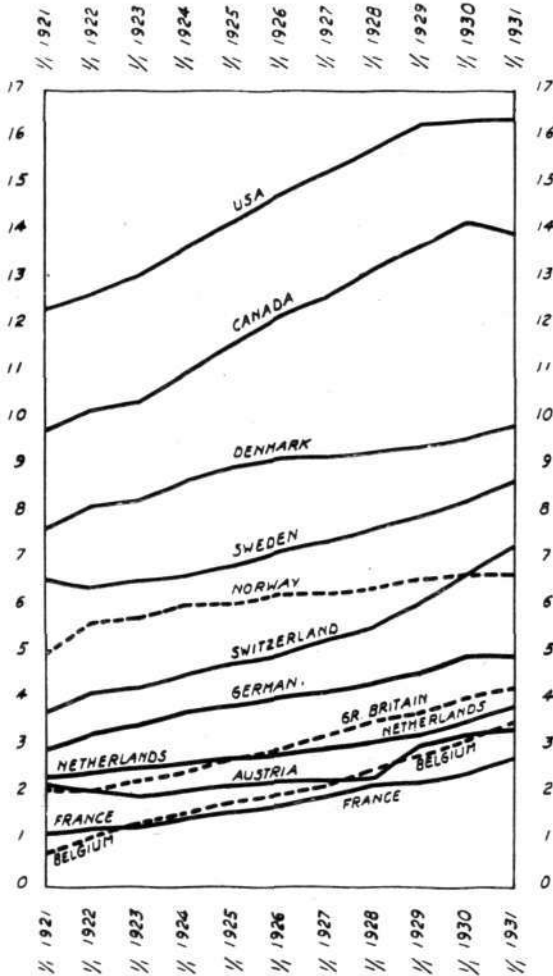


Fig. 6.

X 10503

Switzerland has shown the biggest increase in Europe in relation to the number of inhabitants and during 1930 passed Norway. This was undoubtedly the result of a determined propaganda for the increase in the use of the telephone.

The increases of 2 and 2.2 % in Germany and Great Britain are worthy of note as they are the result of direct increases of 1 439 000 and 1 010 900 telephones respectively.

Sweden in 1922 suffered a set-back in the number of telephones by reason of the cancelling of several ten thousand telephones by subscribers who had previously had two telephones of different networks in Stockholm, and who now needed only one when the private and Government enterprises were merged.

As shown by the curve, growth in the United States was stationary in the year 1930. In the same year Canada shows a decline. This can be put down principally to the economic depression which was an even greater influence in this direction in the year 1931. According to the American Telephone & Telegraph Company's report, the number of telephones in the United States declined in the year 1931 by 292 000 instruments which is about 2 %. The first six months of 1932 have brought about a net reduction of not less than 785 000 instruments. The number of telephones in the U. S. A. is 6 % less than the highest figure reached hitherto, in 1930.

The telephone density in Europe, which seems very slight in comparison with the United States is only 2.0 against 16.4 telephones per 100 inhabitants in the last mentioned country. When the economic crisis abates, and trading conditions start to improve it is quite possible that the telephone development in Europe will be on a very large scale.

Number of telephones per 100 inhabitants in the principal cities of Europe.

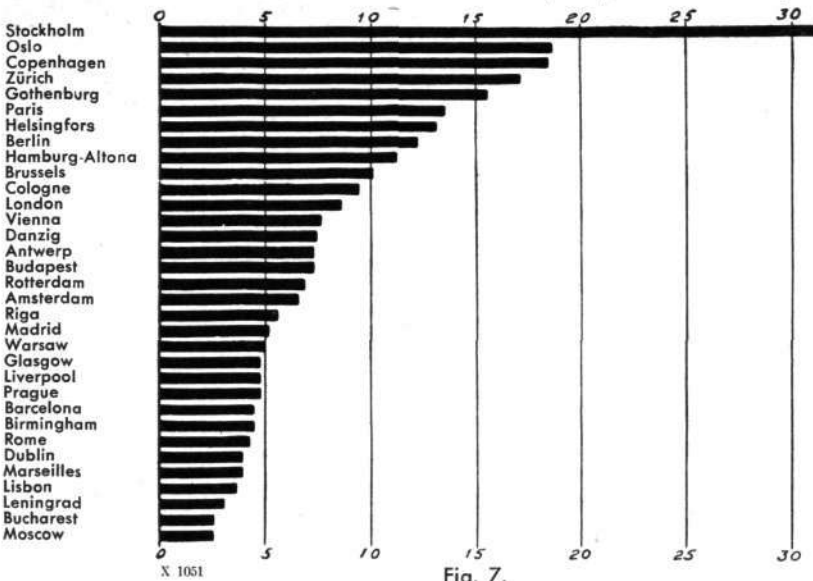


Fig. 7.

The telephone position on January 1st 1931 in the large cities of Europe is shown in the diagram, fig. 7.

The number of telephone conversations, local and long distance, per inhabitant, is shown by the diagram, fig. 8.

### North America.

In North America the number of telephones during the 10-years period has increased by 7 534 000 or 52.6 %; consequently the average increase per year is 753 400 against 530 000 in Europe. The telephone density has increased from 9.8 to 13.0.

Private enterprise is here predominant and the increase for this group is 7 464 444 telephones, and as will be seen, represents practically the whole increase. The United States, and Canada are practically responsible for the whole of new

figures. Mexico and Cuba have during the period increased by only 47 275 and 34 100 telephones, 105.6 and 99.2 % respectively. Cuba shows a decline during 1930 of 8 341 telephones. The growth in the United States previously pointed out came to a standstill in 1930, and during the same year the number of telephones in Canada showed a slight decline. In telephone density the United States holds the world's record with 16.4 followed by Canada with 14.0 telephones per 100 inhabitants. In the other parts of North America the telephone density is very low.

The telephone position in some of the North American cities on 1st January 1931 is shown in the diagram, fig. 9. The telephone density is considerably larger than in Europe, and the only city in Europe that can be compared in this direction with American cities is Stockholm, which as regards telephone density lies between Denver and Los Angeles with 31.2 telephones per 100 inhabitants.

The American uses the telephone to a far greater degree than the European. Whilst the countries that make the most frequent use of the telephone in Europe are Sweden and Denmark, with 152.2 and 132.1 telephone calls per head during 1930, the corresponding figure for U.S.A. are 226.0 and 264.8 for Canada.

### South America.

The number of telephones on the southern continent has increased during the 10-years period by 332 875, which is 116.0 % or an average increase of 33 200 per year. The telephone density has only increased from 0.4 to 0.7. Private companies are here predominant and the increase is entirely due to their efforts.

The greatest increases are shown by Argentina,

Telephone calls per inhabitant in 1930.

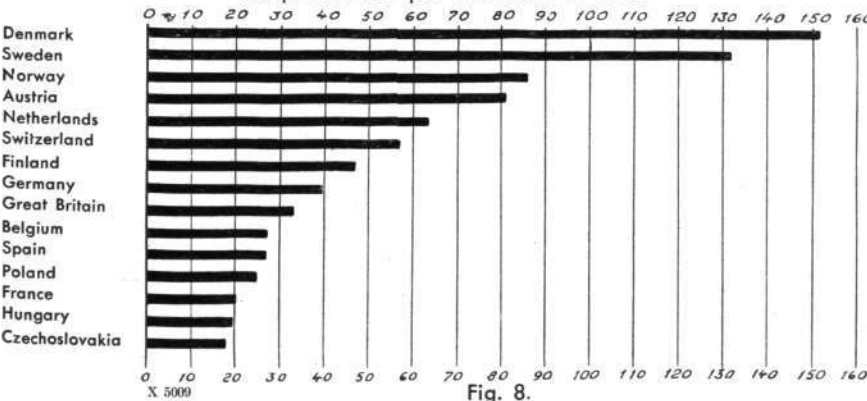


Fig. 8.

Number of telephones, and telephone density, on Jan. 1st, 1921 and Jan. 1st, 1931.

	January 1, 1921				January 1, 1931				Increase 1921—1931	
	Number of Telephones				Number of Telephones				Number	%
	Government	Private	Total	Per 100 Inhabitants	Government	Private	Total	Per 100 Inhabitants		
	1	2	3	4	5	6	7	8	9	10
<i>Europe:</i>										
Germany .....	1 809 574	—	1 809 574	3.0	3 248 854	—	3 248 854	5.0	1 439 280	79.5
Great Britain .....	985 964	—	985 964	2.1	1 996 897	—	1 996 897	4.3	1 010 933	102.5
France .....	473 212	—	473 212	1.2	1 153 560	—	1 153 560	2.8	680 348	143.7
Sweden .....	386 341	1 789	388 130	6.6	534 722	1 670	536 392	8.7	148 262	38.2
Denmark .....	7 230	245 091	252 321	7.7	13 593	340 722	354 315	9.9	101 994	40.4
U. S. S. R. ....	200 000	—	200 000	0.2	377 586	—	377 586	0.2	177 586	88.8
Netherlands .....	160 733	1 200	161 933	2.4	306 554	—	306 554	3.9	144 621	89.3
Switzerland .....	152 336	—	152 336	3.8	297 930	—	297 930	7.3	145 594	95.6
Norway .....	73 372	62 000	135 372	5.0	115 164	77 400	192 564	6.7	57 192	42.2
Austria .....	133 480	—	133 480	2.2	233 912	—	233 912	3.4	100 432	75.2
Italy .....	79 934	35 043	114 977	0.3	—	381 992	381 992	0.9	267 015	232.2
Czechoslovakia .....	77 195	—	77 195	0.6	143 028	17 451	164 479	1.1	87 284	113.1
Poland .....	47 450	25 000	72 450	0.3	108 683	90 696	199 379	0.6	126 929	175.2
Spain .....	5 000	65 000	70 000	0.3	—	222 382	222 382	1.0	152 382	217.7
Belgium .....	62 867	—	62 867	0.8	292 633	—	292 633	3.6	229 766	365.5
Hungary .....	57 009	—	57 009	0.7	115 273	—	115 273	1.3	58 264	102.2
Finland .....	—	45 000	45 000	1.3	1 642	126 500	128 142	3.5	83 142	184.8
Roumania .....	24 701	—	24 701	0.1	—	49 809	49 809	0.3	25 108	101.6
Yugoslavia .....	16 439	—	16 439	0.1	70 000	—	70 000	0.5	53 561	325.8
Portugal .....	1 800	13 621	15 421	0.2	7 803	28 963	36 766	0.6	21 345	138.4
Bulgaria .....	5 000	—	5 000	0.1	19 000	—	19 000	0.3	14 000	280.0
Greece .....	4 700	—	4 700	0.1	12 800	—	12 800	0.2	8 100	172.3
Irish Free State .....	—	—	—	—	30 601	—	30 601	1.0	30 601	—
Latvia .....	—	—	—	—	51 530	—	51 530	2.7	51 530	—
Others .....	30 365	1 160	31 525	0.2	99 507	16 365	115 872	1.4	84 347	267.5
Total	4 794 702	494 904	5 289 606	1.2	9 235 272	1 353 950	10 589 222	2.0	5 299 616	100.2
<i>North America:</i>										
United States .....	—	13 329 379	13 329 379	12.4	—	20 201 576	20 201 576	16.4	6 872 197	34.0
Canada .....	181 930	674 336	856 266	9.8	241 309	1 161 552	1 402 861	14.0	856 266	63.8
Mexico .....	1 860	42 924	44 784	0.3	1 427	90 632	92 059	0.6	47 275	105.6
Central America .....	6 337	9 613	15 950	0.3	11 893	13 376	25 269	0.4	9 319	58.4

<i>West India:</i>											
Cuba.....	464	33 912	34 376	1.1	485	67 991	68 476	1.8	34 100	99.2	
Porto Rico.....	555	7 415	7 970	0.6	602	11 776	12 378	0.8	4 408	55.3	
Other West-Indian Countries .....	2 958	7 180	10 138	0.2	8 222	13 531	21 753	0.3	11 615	114.6	
» North American Countries .....	40	3 160	3 200	0.8	100	11 829	11 929	3.3	8 729	272.8	
Total	194 144	14 107 919	14 302 063	9.8	264 038	21 572 263	21 836 301	13.0	7 534 238	52.6	
<i>South America:</i>											
Argentina .....	—	116 553	116 553	1.3	—	303 000	303 000	2.6	186 447	160.0	
Brazil .....	1 247	83 844	85 091	0.3	674	162 000	162 674	0.4	77 583	91.2	
Chile.....	—	29 867	29 867	0.8	—	48 687	48 687	1.1	18 820	63.0	
Uruguay .....	—	22 381	22 381	1.5	—	29 356	29 356	1.6	6 975	31.2	
Venezuela .....	663	8 233	8 896	0.3	591	20 931	21 522	0.7	12 626	141.9	
Peru .....	2	8 550	8 552	0.2	—	13 745	13 745	0.2	5 193	60.7	
Columbia.....	—	6 843	6 843	0.1	2 500	26 888	29 388	0.3	22 545	329.5	
Equador .....	1 425	2 521	3 946	0.2	1 500	2 700	4 200	0.2	254	6.4	
Bolivia .....	—	2 517	2 517	0.1	—	2 333	2 333	0.1	184	7.3	
Paraguay .....	138	268	406	0.04	185	1 905	2 090	0.2	1 684	414.8	
Others .....	1 898	—	1 898	0.4	2 830	—	2 830	0.5	932	49.1	
Total	5 373	281 577	286 950	0.4	8 280	611 545	619 825	0.7	332 875	116.0	
<i>Asia:</i>											
British India .....	13 000	21 268	34 268	0.01	22 000	35 000	57 000	0.02	22 732	66.3	
China .....	52 500	21 960	74 460	0.02	84 000	69 000	153 000	0.03	68 540	105.5	
Japan .....	330 597	—	330 597	0.60	913 157	—	913 157	1.4	582 560	176.2	
Others .....	49 473	4 847	54 320	0.04	108 881	17 502	126 383	0.1	72 063	132.7	
Total	445 570	48 075	493 645	0.1	1 128 038	121 502	1 249 540	0.1	755 895	153.1	
<i>Africa:</i>											
Egypt .....	22 280	—	22 280	0.2	46 000	—	46 000	0.2	23 720	106.5	
South Africa .....	51 402	—	51 402	0.7	112 900	—	112 900	1.4	61 498	119.6	
Others .....	27 076	1 448	28 524	0.02	86 871	1 320	88 191	0.1	59 667	209.2	
Total	100 758	1 448	102 206	0.1	245 771	1 320	247 091	0.2	144 885	141.7	
<i>Oceania:</i>											
Australia .....	224 000	—	224 000	4.3	520 169	—	520 169	8.1	296 169	132.2	
Dutch East Indies .....	33 225	1 279	34 504	0.1	49 447	4 598	54 045	0.1	19 541	56.6	
Hawaii .....	—	14 376	14 376	5.6	—	25 104	25 104	6.6	10 728	74.6	
New Zealand.....	88 439	—	88 439	7.0	164 739	—	164 739	10.2	76 300	86.2	
Philippines .....	1 955	10 496	12 451	0.1	6 000	20 017	26 017	0.2	13 566	108.9	
Others .....	2 073	237	2 310	0.1	3 638	776	4 414	0.2	2 104	91.1	
Total	349 692	26 388	376 080	0.6	743 993	50 495	794 488	1.0	418 408	111.3	
World Total .....	5 890 239	14 960 311	20 850 550	1.2	11 625 392	23 711 075	35 336 467	1.8	14 485 917	69.5	

Brazil and Colombia with respectively 186 447, 77 583 and 22 545 telephones. Argentine in itself is responsible for more than half the increase in South America. In spite of this, the telephone density in the Argentine is not higher than 2.6. Of the larger cities Buenos Aires has 6.6 and Rio de Janeiro 2.9 telephones per 100 inhabitants.

### Asia.

The increase in the number of telephones in service in Asia is 755 895 or 153.1 %. The major portion of this increase is in Japan with 582 560 telephones, and despite this very considerable step up in number of telephones the density has not risen more than from 0.6 to 1.4. The telephone density for the whole of Asia is the same for the 10-years period, 0.1 telephones per 100 inhabitants. The telephone service in Asia is practically all state owned as only 121 500 telephones, or approximately 10 % of 1 249 500 telephones, belong to private companies. Among the larger cities, Tokio has 4.4, Kyoto 4.2 and Osaka 4.1 telephones per 100 inhabitants, whilst Shanghai and Hongkong have respectively 3.0 and 3.4 telephones per 100 inhabitants.

### Africa.

Africa is the continent that has the lowest number of telephones, the figure being only 249 000 at the end of 1930.

The Union of South Africa is at the head with 112 900 telephones, a telephone density of 1.4 and an increase during the 10 years under review of 61 498 instruments or 119.6 %. The telephone density in Africa during the 10-years period has increased from 0.1 to 0.2.

### Oceania.

The number of telephones at the end of the year 1930 was 794 488, and the increase since

1921 418,408 subscribers or 111.3 %. Australia is foremost with 520 169 telephones and an increase of 296 169 or 132.2 %. New Zealand follows with 164 739 telephones and an increase of 76 300, corresponding to 86.2 %.

The telephone density is in certain districts remarkably high, i. e. in

New Zealand .....	10.2
Australia .....	8.1
Hawaii .....	6.6
telephones per 100 inhabitants.	

The Oceanian telephone service is principally state owned; only 50 495 telephones, or not more than 6 % of the total number are under private control.

The large towns have the following number of telephones per 100 inhabitants:

Honolulu .....	12.4
Auckland .....	10.5
Adelaide .....	9.4
Melbourne .....	9.4
Sydney .....	9.1
Brisbane .....	7.9
Manila .....	4.5

As can be seen, the telephone density is many times greater than in many European towns. Even the frequency of telephone calls is high. New Zealand has in this respect 208.3 and Australia 71.1 calls per head.

The development of the telephone in the whole world from the 1/1 1921 to the 1/1 1931 shows an increase of 14 485 917 telephones, corresponding to about 70 percent of the number of telephones in 1921. In spite of this appreciable increase, the telephone density has not risen more than from 1.2 to 1.8 instruments per 100 inhabitants.

The A. T. T.'s telephone statistics concerning the frequency of telephone calls unfortunately do not differentiate between local and trunk calls. If such were the case some remarkably interesting figures would be disclosed which with certainty would show the large increase in interurban traffic in Europe—with regard to the international telephone traffic during the last half of the ten-years period—and these figures would certainly show the effect of the different tariff charges between countries on the number of calls made.

Number of telephones per 100 inhabitants in the principal cities of North America the 1/1 1931.

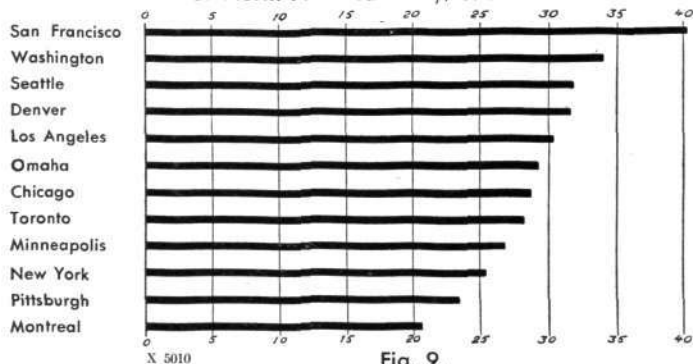


Fig. 9.

# The Direct Current Track Circuits on the Electrified Lines of the Swedish State Railways

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The first electrification scheme of the Swedish State Railways was completed in the year 1914 on a line of 123 km between Kiruna and Vassijaure on the Iron Ore Railways in northern Sweden. The electrification was extended few years later to cover the 304 km line between Kiruna and Luleå, making the whole of the ore traffic electrically propelled.

The power used is single phase alternating

drop arouses in the rails two mutually opposed EMF:s.

If the voltage drop in the two rails is different, which is always the case, if one of the rails is insulated at both ends so that the other rail alone acts as return conductor for the propulsion current, a foreign current is impressed on the track circuit and consideration must be given to this fact when designing the track circuit.

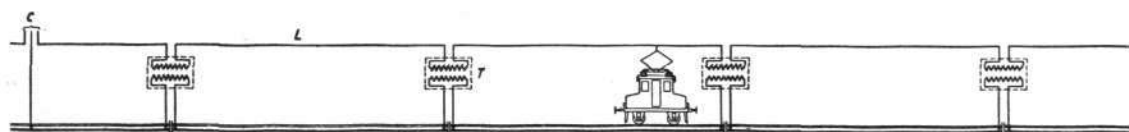


Fig. 1 a. C = from the substation; L = trolley-wire; T = booster transformer.

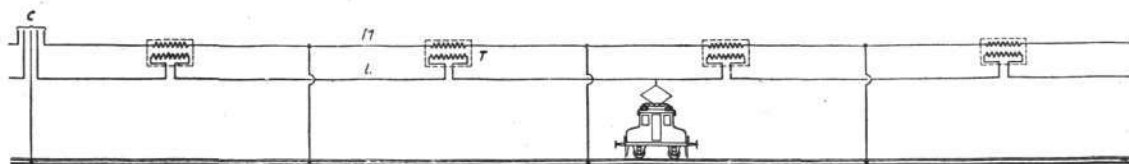


Fig. 1 b. M = return conductor.

current of 15 cycles with a line voltage of 16 000 V. The return current from the locomotive to the transformer substations which are placed 40 km apart, flows through the rails.

In order to reduce the inductance on adjacent telegraph and telephone lines booster transformers are provided, the secondary windings of which are connected in series with the rails, the primary winding being connected in the trolley line (Fig. 1 a). The windings have the same number of turns so that the current in the trolley-line and in the return rail will be the same.

The current in the rails causes a voltage drop along the track depending on the volume of the return current and the resistance of the rails. In a closed track circuit consisting of two parallel rails as outgoing and return conductors, this voltage

At the time of carrying out the electrification of the Iron Ore Railway, no other track circuits than the insulated rails in lengths of only about 20 metres existed on this line. These are used in Interlocking Systems in conjunction with lock-magnets on point levers as shown in Fig. 2 a or in conjunction with stick relays and route locking magnets on signal levers, the connection being carried out according to Fig. 2 b. The leads from the relay and the source of supply being connected to the track at practically the same point on the return rail, no disturbing voltage differences through the propulsion current in the rails were likely to occur, nor has any disturbance of this kind been experienced with the arrangement shown in Fig. 2.

Fig. 3 shows another arrangement with short

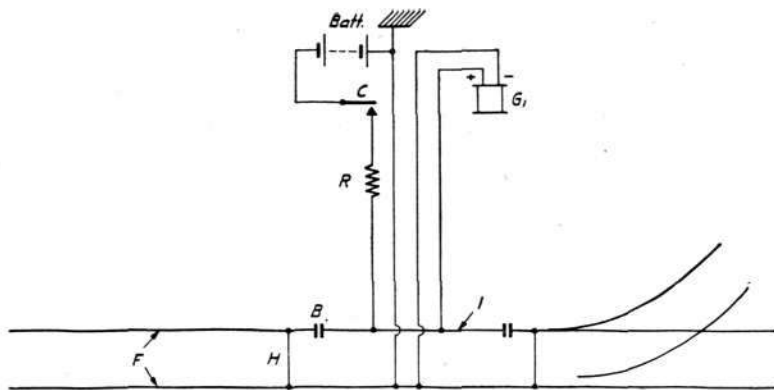


Fig. 2 a.

- B = insulated point;
- C<sub>1</sub> = latch contact;
- F = rails;
- G<sub>1</sub> = point block relay;
- H = cross bonding;
- I = insulated rail;
- R = resistance.

X 5011

insulated rails, which on this railway line was brought into use for signalling the approach of trains at highway level crossings. The armatures of two combined relays *a* and *b* are mechanically interlocked so that the armature that first drops prevents the opening of the front contacts of the other armature. The arrangement is such that the interlocking does not release until both relay armatures have again been operated. The contacts on the armature of relay *a* (see Fig. 3) break therefore when a train passes in the direction *a* to *b*, and the contacts on relay *b* when a train passes in the direction *b* to *a*. A line circuit controlled by a front contact of relay is operated by trains that go in the direction *a* to *b* but is not affected by trains travelling in the opposite direction. No disturbing influence of the propulsion current on the relays can be observed with the arrangement described, evidently dependent on the fact that the rail conductors are too short for any voltage differences worth mentioning to occur.

The track circuit problem presented no real difficulties until the beginning of the electrification scheme of the 450 km line of State Railways between Stockholm and Gothenburg which was

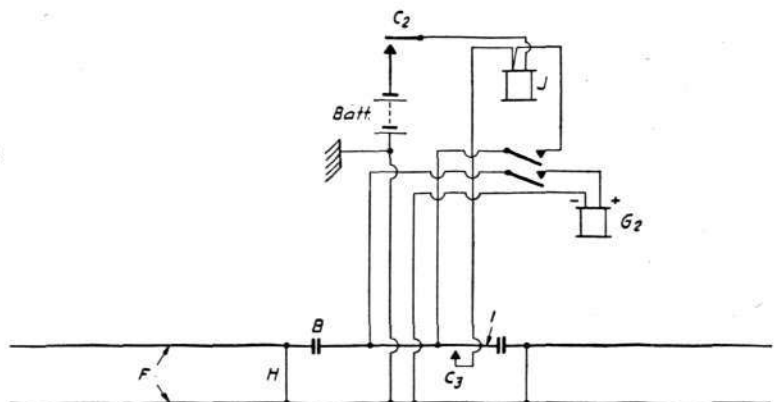
commenced in the year 1923 and was finished 2 years afterwards. On this line there were not only a number of short insulated rails of the same type as on the Iron Ore Railway, but also a large number of long track circuits, most of which were used for automatic signalling at road level crossings. These track circuits, which were provided with direct current relays fed from primary batteries, had in general a length of about 1 000 meters and could not without alteration be used in connection with electric traction because of the potential differences occurring on these lengths of rail attaining values high enough to disturb the functioning of the relays.

These track circuits were scattered along the line and generally at long distances from the stations, therefore the altering of the same to alternating current supply with frequency selective track relays of common type would have necessitated not only a replacing of the relays but even special equipment for generating and transmitting power for the feeding of the track circuits. It was therefore necessary from an economical point of view to find another solution.

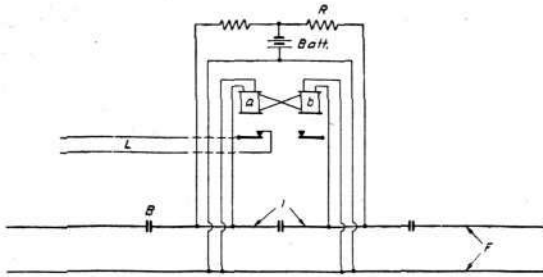
The new electrification scheme was carried out with certain alterations concerning the arrange-

Fig. 2 b.

- C<sub>2</sub> = contact on the signal lever;
- C<sub>3</sub> = rail contact;
- G<sub>2</sub> = route locking relay;
- J = stick relay.



X 5012



X 1052

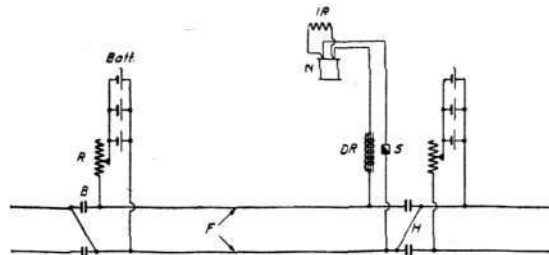
Fig. 3. L = line circuit.

ment for the power supply. A special insulated conductor for the return of the propulsion current was fixed on the line poles parallel with the trolley line (Fig. 16). Booster transformers were still used, but with their secondary windings connected in series with the return conductor instead of the rails.

The return conductor was connected to the rails by special leads placed approximately half way between the booster transformers.

The return path from the locomotive is via the nearest of the above mentioned leads to the return conductor and then through this to the power station. The current passes therefore only over a distance of the rails, the maximum length of which thus being half the distance between two booster transformers (see Fig. 1 b). As only one or two locomotives can be on the track between two booster transformers at a time, the current in the rails is limited and the voltage-drop has a comparatively low maximum value. With 100 A current, a distance of 3 000 meters between drain transformers and 0.20 ohm impedance per 1 000 meters in a single rail, a voltage drop of 30 V occurs. This figure gives the voltage differences encountered in track circuits under normal conditions. A practical test with trains or with artificial loads connected between the trolley line and the rails demonstrate that this potential-drop can with every certainty be considered as a maximum.

Because of these relatively favourable condi-



X 1053 Fig. 4. DR = damping resistance; IR = non-inductive resistance; N = track relay; S = fuse.

tions the thought occurred to try to retain the existing direct current line circuits and repel or divert the disturbing alternating current from the track relays by the device shown in Fig. 4.

Under steam working both rails were insulated, but with electrical propulsion only one of the rails could be kept insulated because the other rail must serve as a return conductor for the traction current.

To prevent leakage from one track circuit to the other, due to defective insulated points, steps shown in Fig. 4 were taken to lead over the return conductor from one rail to the other. Heavy cross bondings were provided at the ends of each track section for this purpose. If breakdown occurs in an insulated point between two rail conductors the cross bond will short circuit the rails in one of the track circuits thus making the fault apparent.

In series with the existing track relays which have a coil resistance of 4 ohm and approximately 0.1 A working current and were made according to the American Railway Associations specification a choking coil was inserted which at  $16\frac{2}{3}$  cycles alternating current had a reactance of 450 à 500 ohm with voltages up to 200 V, but for direct current only 3 ohm resistance. Because of the insertion of this choke, the direct current voltage at the relay end must be raised from 0.4 to 0.7 V.

The relay coils were found to have a natural impedance of about 60 ohm at  $16\frac{2}{3}$  cycles. The armature started to vibrate at an AC pressure of only 2 V corresponding to something above 0.30 A alternating current through the relay, should this, at the same time, have flowing through it a direct current corresponding to the release value of the relay. In order to produce the mentioned volume of current with the choke connected in series with the relay, an AC voltage of about 15 V is necessary.

Because the potential difference in the rails could exceed 15 V it was necessary to reduce the sensibility of the system to alternating current. This was attained by connecting in parallel with the relay coil a non-inductive resistance of approximately 30 ohm. Owing to this resistance, the consumption of direct-current at the relay terminals was increased by 20 %, so that the working current became 0.12 instead of 0.10 amps.

The necessary increase of voltage between rails at the relay end to compensate for this shunt resistance was only from 0.70 to 0.76 volts.

With alternating current, on the other hand, due to the shunt resistance, the impedance between the relay terminals was lowered from 60 ohm to about 16 ohm, so that an AC current of 0.12 amps instead of 0.03 amps was necessary to operate the relay. With the choke in series, a pressure of about 50 to 60 V would be necessary between rails instead of 15 V. This was considered to give absolute safety as higher voltages than 30 V were not encountered.

In order to prevent the breakdown of choking coils by momentary high voltages whereby a dangerous condition could occur, a heavy insulation was provided between turns as well as between the windings and the core. A factory test of 6 000 V was specified. The choking resistances was completely immersed in an oil filled iron box provided with substantial porcelain insulators for terminals.

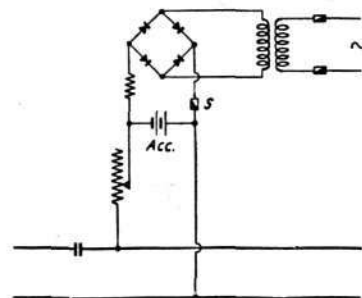
In order to protect the relay and the choking resistance from exceptional voltages in the return rail due to short circuit currents, which are always of short duration, and therefore in themselves not dangerous from a point of view of safety, fuses were put in the relay leads. Normal 1 A fuses were used at first. As in practice these were not found to have a mechanical strength, they were replaced with combined safety devices of the type often used for three phase induction motors consisting of a 6 A fuse and a thermic relay which operates when a load of 1 A is lasting for a few seconds.

As power supply for the type of track circuit shown in Fig. 4 a battery is used consisting of 6 caustic-soda cells with type Edison electrodes connected in series multiple  $2 \times 3$ . By using caustic soda cells type Le Carbone, which gives a higher potential, the number of cells can be reduced to 3 connected in  $1 \times 3$ . In certain cases where higher battery voltages are required six such cells have been used connected in  $2 \times 3$ .

The capacity of the battery for both types of cells is 1 500 Ah, which is sufficient for about 6 months working; battery renewals are therefore only necessary twice a year.

The series resistance at the battery is designed with a view to withstand the current which will pass through it on account of the voltage drop caused by the propulsion current. Fuses are therefore not put in at the battery end as it has been found that the cells will stand up to this current also.

In several cases where alternating current supply has been available the primary cells have been replaced by accumulators under trickle charging from metal rectifiers (Fig. 5). The accumulators act as reserve in case of accidental failure of the AC supply but in addition assists to deflect the propulsion current from the rectifier preventing the rectifier from being overloaded by the foreign current. The rectifier alone without a battery is not considered advisable for the reason that the propulsion current in the track circuit could be changed into pulsating current that cannot be kept from the relay by the series choking coils.



X 1054

Fig. 5.

The number of track circuits of this category in use on the Stockholm—Gothenburg lines is about 140 quite a number of which have been in use for several years. The experience with them has been very favourable and has caused no apprehensions with regard to safety. In connection with the electrification now on hand on the lines Stockholm—Malmö, Falköping—Näs-sjö and Mjölby—Örebro, a further number of about 300 track circuits will shortly be equipped with the arrangement shown in Fig. 4. The favourable experience gained on the Gothenburg line gave rise to the arrangement shown in Fig. 4 being introduced on a number of track circuits on the Iron Ore Railway, although the voltage differences with the return system in use there was found to be greater than in the Gothenburg line. As the secondary windings of a booster transformer could not be connected in series with a track circuit (see Fig. 1 a) it was found necessary on the Iron Ore Railway to divide those track circuits in which an insulated point for a booster transformer was situated into two, one on each side of the booster transformer, and to repeat the track relays with a common line relay as shown schematically in Fig. 6. To avoid a line

relay, by allowing the contacts of one track relay to break the current from track battery of the other track circuit, was not suitable as in this case the propulsion current would pass through the relay contacts and injure them. Even with the working conditions existing on the Iron Ore Railway the arrangement shown in Fig. 4 has proved sufficient to prevent disturbances from the traction current.

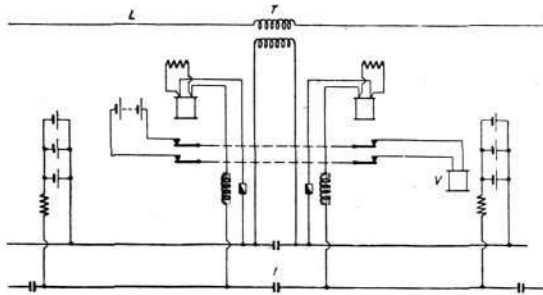


Fig. 6. V = line relay.

In order to examine the shunt value of a track circuit as shown in Fig. 4 we assume that the track relay has a working voltage of 4 V and a release voltage of 0.12 V. We assume a track circuit length of 1 000 meters, a DC resistance of 0.11 ohm per kilometer of track and also a ballast resistance of 5 ohm per kilometer of track under the worst conditions.

In an unoccupied track circuit there is required at the relay end

$$e = 0.40 + (3 + 1) \times 0.120 = 0.88 \text{ V.}$$

$$i = 0.120 \text{ A,}$$

and at the battery end:

$$p = 0.88 + 0.12 \times 0.11 + \frac{0.90}{5} \times \frac{0.11}{2} = 0.90 \text{ V.}$$

$$u = 0.12 + \frac{0.90}{5} = 0.300 \text{ A.}$$

With 1.30 V battery voltage the necessary limiting resistance

$$= \frac{1.30 - 0.90}{0.300} = 1.33 \text{ ohm.}$$

With the release current passing through the track relay the voltage and current at the battery end will be:

$$p_1 = 0.90 \times \frac{0.12}{0.40} = 0.27 \text{ V.}$$

$$u_1 = 0.300 \times \frac{0.12}{0.40} = 0.09 \text{ A.}$$

For reducing the pressure from 1.30 V at the battery to 0.27 V at the track there will be required

$$\frac{1.30 - 0.27}{1.33} = 0.78 \text{ A.}$$

In order to increase the current from 0.09 A to 0.78 A a shunt between the rails is required at the battery end of

$$\frac{p_1}{0.69} = \frac{0.27}{0.69} = 0.4 \text{ ohm,}$$

this being the shunt value at which the track circuit functions.

To determine the rate of immunity of the relay to alternating current tests have been carried out with the aid of the laboratory track circuit shown in Fig. 7.

*M* is a potentiometer consisting of an ohmic resistance and a sliding contact ring connected to the accumulator. By moving the contact ring, the pressure between the rails  $S_1$  and  $S_2$  can be adjusted to any value between zero and maximum battery voltage. In series with the rail  $S_1$  is inserted the secondary winding of a transformer connected to a  $16\frac{2}{3}$  cycles alternator *G*, the voltage of which can be regulated within wide ranges by alternating the excitation. The voltage produced by the generator in the secondary of the transformer corresponds to the voltage drop caused in an actual track circuit by the propulsion current.

Between the rails  $S_1$  and  $S_2$  a relay *R* is connected provided with a 20 ohm shunt and a non-inductive resistance *D* of the type previously described. In the rail  $S_2$  a moving coil ammeter *A* is connected and between the rails a voltmeter *V*.

A 220 V lamp *M* is connected over the front contact of the relay.

The following tests are carried out.

*Test No. 1.* The contact ring is set so that the relay operates whereupon the voltage is slowly reduced till the lamp *L* goes out. The ammeter indicates then the release current of the relay.

The alternator *G* is started and the voltage regulated till the relay armature begins to vibrate and the front contacts make, so that the lamp glows. The voltage is then read on the voltmeter which shows the disturbing alternating voltage

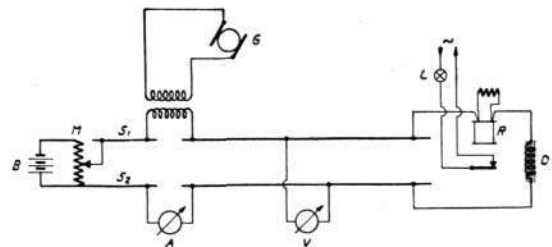


Fig. 7.

required to operate the relay with the release current still passing through it.

*Test No. 2.* Whilst the alternator is at rest the contact ring of the resistance is set in such a position that the relay armature is attracted, i. e., the ammeter indicates the working current of the relay increased by the leakage through the 20 ohm relay shunt.

The alternator is then started and the voltage regulated till the voltmeter shows approximately the disturbing voltage read in test No. 1.

The contact ring on the resistance is then moved towards the zero position until the lamp *L* dies out completely; the alternator is then stopped and the ammeter read off. This shows the release value of the relay when the propulsion current is passing at the same time through the relay windings. The test is repeated with different voltages between the rails and the release values taken.

The tests 1 and 2 were carried out with relays of different designs and the results are given below:

A. Relay with 4 front and back contacts and the following current data with a 20 ohm shunt:

Working current 0.100 A  
Releasing » 0.050 A

With test No. 1 disturbing pressure of 50 V was obtained and with test No. 2 a release current which varies from 0.035 to 0.040 A during the tests using a disturbing pressure from 60 down to 15 V.

B. Relay as above, but with only 2 back contacts and the following data with a shunt of 20 ohm.

Working current 0.100 A  
Releasing » 0.050 A

Test No. 1 showed a disturbing pressure of 72 V and test No. 2 a release current of 0.045 A during tests with disturbing pressures from 72 to 15 V.

C. Relay of the same type with 4 front and back contacts but with large contact gaps and the following data with a shunt of 20 ohm:

Working current 0.130 A  
Releasing » 0.050 A

With test No. 1 no disturbance occurs at 140 V (the maximum voltage of the alternator) and the

release current in test No. 2 varied from 0.040 to 0.050 A at a disturbing voltage between 100 and 20 V.

D. Relay with 4 front and back contacts with small contact gaps and flexible back contact fingers and the following data with 20 ohm shunt:

Working current 0.110 A  
Releasing » 0.035 A

Test No. 1 showed disturbance at 55 V and test No. 2 a release current which kept at a nearly constant figure of 0.035 A between 55 and 20 V.

From the tests made it is found that the amount of the disturbing voltage that can be allowed between the rails at the relay end without the functioning of the relay being upset, is to a considerable extent dependent on the design of the relay. The contact gap seems, according to the tests, to have a bearing on the sensitivity for alternating current, probably dependent on the bigger movement of the armature whereby the vibration is made more difficult. Further an increase in the number of back contacts makes the relay more sensitive to AC disturbances, evidently depending on the rebound against the back contacts which must be the more powerful, when a greater number of contacts are to cooperate.

Test No. 2 shows that the application of alternating voltage of the same value as the disturbing voltage according to test No. 1 generally causes a decrease of the releasing current, but this seems to keep within reasonable limits. The decrease in question appears to be least with relays with large contact gaps and few or flexible back contact fingers.

For the State Railway installations, relays have been used which are chosen for direct current operation without any consideration to the existence of disturbing alternating currents.

From the tests carried out with different relay types it was found that a more marked immunity to alternating current can be obtained with the arrangement shown in figure 4 by the choice of specially suitable relays for the purpose. Amongst other things an articulated finger design as now used on many modern direct current relays might offer certain advantage on account of the flexibility of the contacts which prevents rebounding and diminishes the tendency of the armature to vibrate under AC load.

# The Subscriber's Multiple and Other Multiples in the Ericsson Automatic Telephone System.

By  
**SIGURD JOHANSSON**

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*(This article is reprinted with the permission of "The Technical Reports of the Royal Board of Telegraphs".)*

The multiple is one of the most important parts of a telephone system. The efforts of many telephone men have been directed towards the designing of a good and cheap multiple. Which, then, are the demands on a good multiple?

## I. Design.

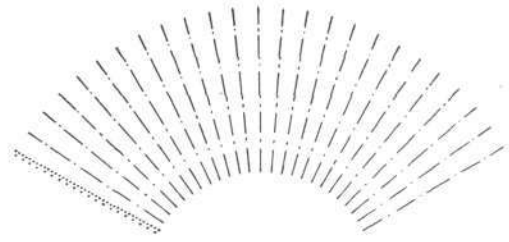
- a) The contacts must be reliable.
- b) For that reason, precision work is necessary.
- c) The number of soldering points must be kept as low as possible, as they constitute sources of faults.
- d) The construction must be strong and sturdy.
- e) The wear should not be so considerable as to make necessary the replacement of the multiple during the lifetime of the exchange.
- f) The space required for a given capacity must be as small as possible.
- g) cost of maintenance should also be the least possible.

## II. Cost of manufacturing.

- a) The number of soldering points must be low in order to keep down cost of installation.
- b) The multiple should contain the least possible weight of material.
- c) The raw materials should be cheap.
- d) The manufacture should as far as possible be carried out with the aid of machines.

## III. Installation.

- a) The multiple should be easy to handle without damage.



X 1062

Fig. 1.

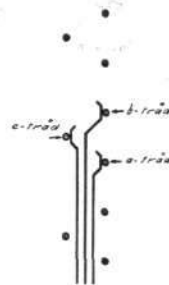
b) The installation should not offer such difficulties as to in the work of erection.

All these demands are met by the type of multiple used in the Ericsson automatic telephone system. As is well known, this multiple is built up in the following way: 25 multiple frames, each containing 20 subscribers — or trunklines — are assembled together so as to form a fan, as shown in Fig. 1. Hence, the wiper shaft belonging to a selector is able to reach  $25 \times 20 = 500$  lines. There are 3 wires, a, b and c, for each line, as shown in Fig. 2. The wires, which are blank, are made of manganese bronze, and the contact springs of German silver.

Each rack being as a rule made for 60 selectors, placed on top of each other at intervals of 35 mm, the number of solderings for each rack will be  $500 \times 3 = 1500$ , as each wire is soldered to one end only of the wires. Had the multiple been designed in such a way that contact banks or springs had been used instead of the long, straight, blank wires, a number of  $60 \times 1500 = 90000$  solderings per rack of 60 selectors would have been necessary.

From this example it will be evident, that considerable savings are made in the soldering work and, that at the same time the number of sources of faults has been considerably reduced.

When this multiple was first proposed, it was received in the same way as so many other valuable inventions, i. e., nobody believed in it. Cross-



X1063

Fig. 2.

talk would occur between the parallel wires, for which reason quad construction as on aerial lines must be undertaken. It was feared that the wires would oxidize. Spiders would build their webs between the wires, etc. But none of all these apprehensions came true.

From this short description it will be clear precisely how most of the above mentioned demands on a good multiple have been met in the Ericsson automatic telephone system. For this reason I will confine myself to give a few data concerning telephone exchanges in service, in order to show that such requirements as I a), c) and g) are also met. Experience is the only certain way of learning something about the *reliability of the contact making, wear and maintenance cost.*

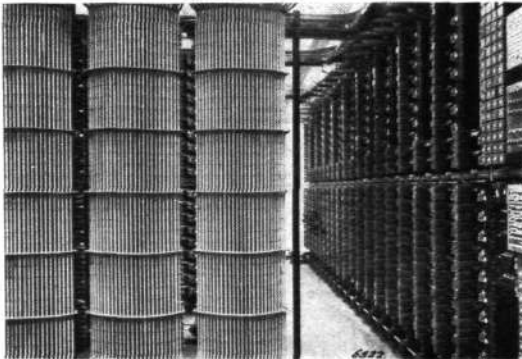
To begin with the last point, maintenance cost, I want to state, that during the period of 9 years that the Norra Vasa Exchange in Stockholm has been in service, the cost of maintenance for all the multiples of this construction erected in the exchange has been practically nil. No cleaning whatever has been undertaken. The multiple frames have been removed only occasionally, perhaps only once a year, the reason being, as a rule, that a screw or some other thing has in some way happened to fall between the wires.

Up to this day no traces of wear are visible on the wires. The path of the contact springs is of course clearly marked, but this means only that the thin film of oxide is worn off. The wear

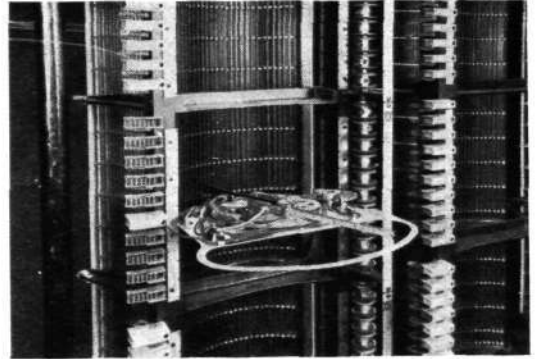
accordingly amounts to only some hundredths of a millimetre, and has no practical importance whatever.

Concerning the most important point, the *reliability of the contacts* it is obvious that good contacts are of considerable importance in a multiple. On account of the great number of contact points contained in a multiple, the *total number of faults* will already at a low percentage of faults, be comparatively large, which in its turn increases the cost of maintenance. On the Norra Vasa Exchange, with a capacity of 10 000 subscribers lines, there are more than 2 million contact points in the multiples. As the total of the remaining contact points—in relays and sequence switches—is only 1 million, the multiples contain  $\frac{2}{3}$  of the total number of contacts in the exchange. In the 9 years during which the Norra Vasa Exchange has been in service, not a single fault on account of oxide or grease has, however, occurred in these contacts.

As no periodical cleaning of the multiples has been effected, as only sporadic faults have been located to the multiple frames, and as not a single fault in the contacts has occurred, one may say that the maintenance cost for multiples of this construction in the Norra Vasa Exchange has been practically nil during 9 years of service. This is a remarkable result, which largely explains the reliability in service of the system, and the secret of its rapid success.



X 1034



X 1065

In connexion with the article above, we publish two detail views of the multiple in the Norra Vasa Exchange. The picture to the left shows the multiple frames assembled so as to form a fan; to the right is shown a selector in operating position in front of the multiple.

# Design and Use of Brush Switches



By C. KIHl and  
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*The extensive use of the switch for telephony and radio purposes has brought forward innumerable different designs based on various principles.*

*The essential demands on a good switch are: low resistance of the current-carrying parts, especially of the contact surfaces, which must also be resistant against wear; smooth and even motion; distinct indication of the contact positions; high leakage resistance between current-carrying parts; the design must allow of easy cleaning and adjustment as well as the interchangeability of the components.*

*Svenska Radioaktiebolaget, in collaboration with Telefonaktiebolaget L. M. Ericsson, has designed a brush switch fulfilling all those requirements, and possessing appreciable advantages in many other respects as well.*

The switch is one of the parts most frequently used in telephony and wireless. This is why innumerable different designs of switches, based on more or less distinct principles, have gradually been developed.

With respect to the mechanical design only, one will find nearly as many different types as there are manufacturers.

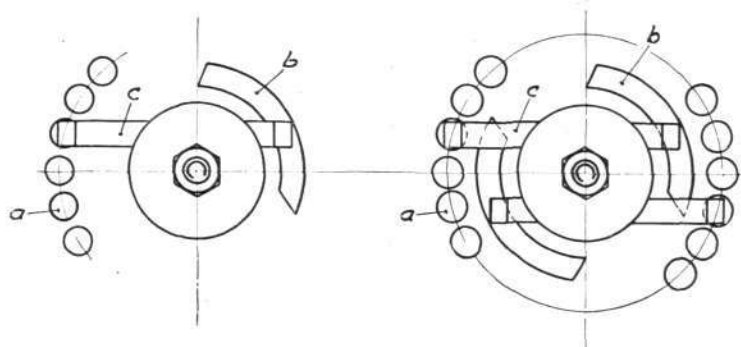
Since Svenska Radioaktiebolaget undertook the manufacture of telephone repeater and carrier frequency equipments, the problem of designing a satisfactory switch has been extremely pressing.

In these kinds of equipments, switches are used for all kinds of purposes, as for regulating filament currents and tensions, for connect-

ing and disconnecting condensers, coils and resistances, and, first of all, for step-by-step connection of artificial lines. The switch most frequently used in this connection is the step-by-step, or brush switch.

The purpose of this article is to describe a type of brush switch, which has been designed by Svenska Radioaktiebolaget in cooperation with Telefonaktiebolaget L. M. Ericsson as a result of extensive tests and experiments. We will, however, confine our attention to the final design, without entering into details of the previous experimental work.

A satisfactory switch must meet among others the following requirements: the current-carrying parts as well as the contact surfaces should present the least possible electrical resistance, and at the same time possess a great resistance against wear. The motion of the switch should be smooth and even; the different contact positions should be

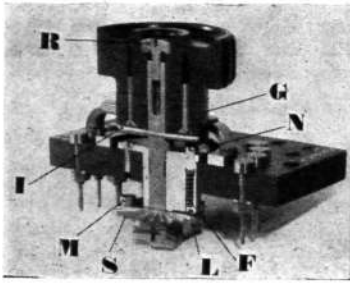


Single brush.

Fig. 1.

Double brush.

a = contact stud b = contact segment c = contact brush



X 3004

Fig. 2.

easily distinguishable by means of a suitable arrangement. The contact surfaces should be accessible for cleaning, and the various parts of the switch should be manufactured in such a way and with such accuracy, that they may be exchanged without special adjustment. Finally, the leakage resistance between the current-carrying parts must be as high as possible.

With respect to the mechanical design proper, the switch consists of the following parts:

- Contact studs and contact segments,
- Contact brush,
- Ratchet device,
- Various parts, as shaft, bearing, brush-holder, click-wheel, knob, and screws for assembling these parts.

The contact studs and segments are determined as to their number—the latter also as to their design—by the purpose for which the switch is intended; we will discuss this point further when treating the various uses of the switch.

The contact-brush is single or double, depending on whether the switch is intended for use on one or two rows of studs, as, e. g., the symmetrical and unsymmetrical connection of artificial lines etc. (Fig. 1).

The design of the ratchet device is determined by the number of contact positions of the switch.

Fig. 2 shows in section a switch of our construction.

In a decade resistance set, where the resistances to be connected or disconnected very often amount to a fraction of an ohm only, it is of course very important that the con-

tact resistances between the brush and the studs should be as low as possible. One does not, however, demand a very great accuracy from a decade resistance set with small resistance values, but the importance of the contact resistances should nevertheless not be overlooked.

In order to reduce the contact resistances to a minimum, the contact surface between the brush and the studs should be the greatest possible. However, this is not always feasible to the desired extent, as the space available for the switch is in general none to ample. The contact resistance depends, however, to a very great extent on the material used for the brushes, contact studs and segments. By choosing appropriate materials, it has been possible to reduce this resistance to a very low value, at the same time avoiding impracticably large contact surfaces.

In the choice of suitable materials for the different parts, one must take into consideration the wear of the brush and the contacts, which should be as low as possible. After many experiments and long-time tests, the following materials were adopted:

For the contact brush: aluminium bronze.

For the contact studs and segments: hard-drawn brass.

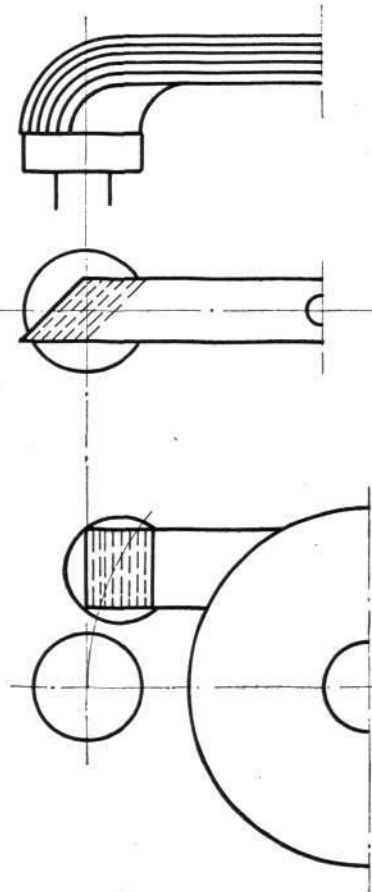
In this connection we may mention that the tests have shown the most appropriate material for the contact studs and segments to be hard-rolled sheet-brass, provided that the brush is running with the grain.<sup>1</sup> This has proved most suitable with respect both to contact resistance and wear, but cannot be used on account of the considerably higher costs of manufacture.

We may mention that the total resistance of recently manufactured switches amount to about 0.002 ohms, for clean contacts including two contact resistances as well as the resistance of the contact studs, segments and brush.

Without special precautions the contact brush, which consists of several metal springs, would very soon make grooves in the studs and segments, no matter which material is used. To avoid this, the brush may be fixed in an oblique position, and will thus slide on the studs at an angle with their pitch radius (Fig. 3).

Another method, which gives the same results has been developed for our switch. The brush is placed eccentrically with reference to the centre of the switch (Fig. 4).

This method has proved to offer some very important advantages over the former. Among other things, the springs are easier to manufacture, as they may be made by bending metal strips of standard sizes. Further, the insulation of the brushes from each other and from the shaft of the switch is very much simplified.



X 3005

Fig. 3 and 4.

<sup>1</sup> Acc. to tests carried out by Mr. Aste, engineer at the Nynäshamn works of the Royal Board of Swedish Telegraphs.

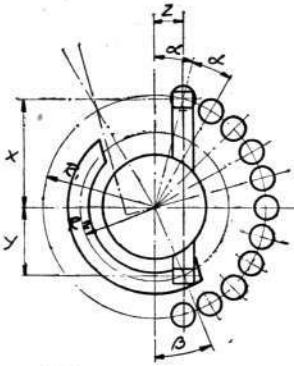


Fig. 5.

The correct geometrical position of the brush in relation to the centre of the shaft and the length of the brush for a given radius of the contact row is calculated in the following manner:

The radius  $R_1$  may be arbitrarily selected. The pitch is chosen so that the contact studs will not be too far apart but should enable the brush to slide easily from one stud to the next; at the same time, the division should be such that, when the brush is in a contact position, its centre line passes two studs (Fig. 5).

The distance  $Z$  is the above mentioned excentricity of the brush with reference to the centre line of the shaft.

From Fig. 5 we have  $Z = R_1 \sin \alpha$

The angle  $\beta$  is made equal to  $1.5 \alpha$

The radius  $R_2$  of the contact segment is then 
$$\frac{Z}{\sin \beta}$$

The dimensions  $x$  and  $y$  of the brush are easily calculated as

$$x = R_1 \cos \alpha$$

$$y = R_2 \cos \beta$$

In this connection, it should be observed that the contact segments are always divided by the centre line of the brush (Fig. 5).

These are the main geometrical principles of the design of the switch, although certain special switches may be designed in a somewhat different manner.

A smooth movement of the switch has been obtained, as mentioned above, by means of the excentric position of the brushes. The great-

est accuracy must, however, be observed during the process of manufacture, e. g., in drilling the shaft-hole, to avoid a bevel drilling which, on account of increased contact-pressure, would make the switch move stiffly at some points of its course. As a further security against stiff and uneven movement, the supporting surface of the brush in its holder has been reduced as far as possible in order to ensure the greatest possible freedom of movement — the brush may float in the holder.

The different contact positions of the switch are indicated by means of a ratchet device. This device must be so designed as to cause the positions of contact to be distinctly indicated and so that the brush cannot stop in an intermediate position between two contact studs. The material for the various parts of the ratchet device must further be chosen so as to avoid a deterioration of the position-indication on account of wear. The fig. 2 shows the design of the ratchet device used.

The click-wheel  $S$  is made of bronze. Its top part is provided with radially milled channels, corresponding in number to the contact positions. The angle between these channels must be equal to the angle between the contact studs of the switch (in general  $15^\circ$ ). The channels are milled in such a way that no plane surface should exist between them. A steel ball  $L$ , operated by a coil-spring  $F$ , the pressure of which is regulated from the top of the switch by means of a screw  $N$ , catches in these channels. The combination of the different parts may be seen from the figure. In this design the ratchet device has proved to be very reliable and sturdy, and further provides excellent indication of the contact position.

The lower side of the click-wheel has been shaped into a locking device by means of which the wheel may be secured to the shaft in the desired position. From Fig. 2 it is seen that the above mentioned steel ball must catch into one of the channels in the click-wheel when the contact brush is exactly above a contact stud. The

locking of the click-wheel at first offered various difficulties as it was originally done by means of radially placed common set-screws. These, however, produced small marks on the shaft, which prevented the small displacements needed when adjusting the click-wheel in the right position in relation to the positions of contact. This difficulty may be avoided by a simple and ingenious device which facilitates an efficient locking of the click-wheel without damaging the shaft. Fig. 6 shows the arrangement of this device, which is seen from fig. 2 although not quite so distinctly.

The inferior part of the above mentioned click-wheel  $S$  is shaped into a socket, containing the locking device, which consists of two steel jaws  $a$  and  $b$ ; when fastening the screw  $c$ , these jaws are tightened on to the shaft, thus ensuring a very efficient locking without leaving any marks.

As shown in Fig. 2, the bearings for the switch shaft, the holder for the steel ball with its spring and the regulating screw have been assembled into a single unit. By this arrangement, we have realized the advantage, that no external influence can possibly upset the adjustment of the bearing in relation to the ratchet-device. The unit thus assembled, the shaft-socket, is cast in bronze. The screws marked  $M$  in Fig. 2 are in-

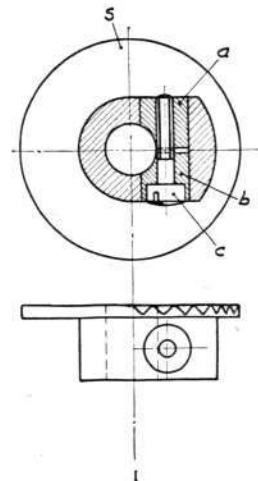
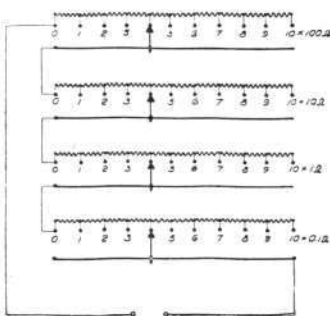


Fig. 6.



X 3008  
Fig. 7. Resistance and capacity bridge, MKM 232.

tended as a stop for the switch at the end positions, for which purpose, the shaft-socket has been shaped in a suitable way. The above-mentioned requirements for the interchangeability of the various parts is perfectly fulfilled in our construction, subject to accurate manufacture. Provided that narrow tolerances of between 0,01 and 0,05 mm are observed, one part may simply be transferred from one switch to another. Such interchangeability may often prove necessary, as when, e. g., a brush in an installation or apparatus in service is broken. Any spare brush or one taken from another switch, should immediately fit in the broken brush's place. The exchange of a brush is a very simple matter: the screw *R* (Fig. 2) in the knob is loosened; the knob, the brush holder and the brush, which compose a single unit, are removed and replaced with the corresponding part from, e. g., another switch. The position of the brush is fixed by means of a lock-pin *J*, which goes through the shaft and fits into a channel in the brush-holder *G*. The knob, brush-holder, and brush are

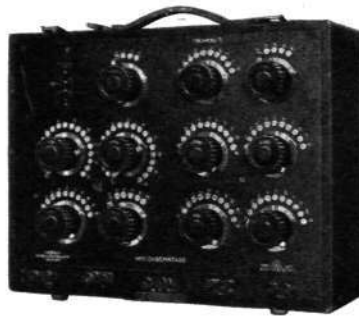


X 3009  
Fig. 8.

screwed together and may be individually exchanged.

On account of the ease, with which the knob as well as the brushes may be removed from the switch, the advantage of an easy accessibility to the contact surface for cleaning is also obtained.

The leakage resistance between the various current-carrying parts of the switch should be the highest possible. The switches being often used for connecting and disconnecting resistances amounting to several megohms, the resistance of the insulating material between the current-carrying parts should be great in comparison with the operated resistances. After many tests, a ma-



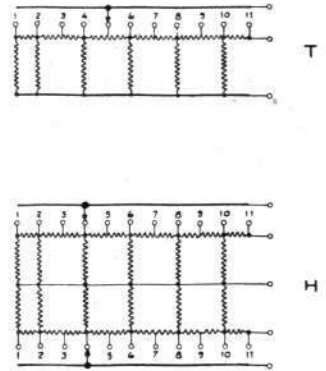
X 3019  
Fig. 9. Impedance bridge IM 1130.

terial fulfilling this requirement for the mounting plate as well as for the brush-holder has been found.

Between the contact studs there accumulates, however, a metallic dust ground off the brush and the contacts; for this reason, in specially troublesome cases, grooves must be taken out between the contact studs (v. *S* in Fig. 11) in order to increase the leakage resistance by means of a longer leakage path.

### Different Uses.

Among the various uses of the single contact brush switch may be mentioned the resistance and capacity bridge MKM 232 (Fig. 7), which



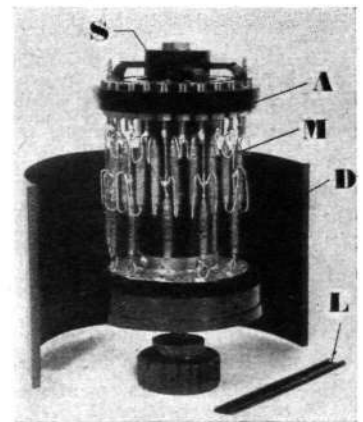
X 3010  
Fig. 10.

contains a decade resistance variable between 0 and 1111 ohms divided into 4 switches. These switches effect the connection and disconnection of  $10 \times 100$ ,  $10 \times 10$ ,  $10 \times 1$  and  $10 \times 0,1$  ohm respectively, as seen from the diagram (Fig. 8) below.

The single brush switch is used in the same connection as above for the operation of resistances as well as inductances in several other instruments, e. g., the impedance bridge IM 1130 (Fig. 9).

The switch may also be used with advantage for the step-by-step connection of artificial lines. For T-connected resistances, a single brush is used, for H-connected resistances a double brush is necessary (Fig. 10).

Fig. 11 shows how the switch is assembled together with the resistances in one unit. The frame *A* for



X 3011  
Fig. 11.

this unit is moulded in bakelite. To fulfill the requirement for a high leakage resistance, the leakage path between the contact studs has been increased by means of moulded grooves *S*. The resistances *M* composing the artificial line are connected to the corresponding contact studs. To protect the unit against dust and damage, it is provided with a cover *D* which is secured by means of a simple locking device *L*. The same frame is used for *H* as well as T-connected resistances; the only difference is that in the latter case only one half of the frame and one brush are used. By certain devices in the design of the contact studs, segments and brushes, it is possible

to adapt the switch to many different functions. It would take too much space to describe all these special designs, and we will confine our description to one of them only, viz. the switch used in the decade condenser DK 431. This switch effects a step-by-step increase or reduction of a capacity as results from Fig. 12, by comparison between the parts designated by the same letters in the diagram and on the switch. By choosing the condensers composing each decade in sizes of, e. g., 1, 2, 2 and 5  $\mu$ F, connecting together certain contact studs and adjusting the length of the various contact segments, it is possible to vary the capacity between 0 and 10  $\mu$ F. Be-

sides, the brush-holder of this switch is made of metal, so that both contact brushes are electrically connected to each other as well as to the shaft. One pole *B* is connected to the shaft through a coil-spring. From the diagram (Fig. 12) it is seen that, when no condenser is connected between *A* and *B*, the contact brush *e* is in zero position. In the position 1, the 1  $\mu$ F condenser is connected, and when the brush is advanced to the positions 2..... 10, the capacity will increase from 2..... 10  $\mu$ F.

Other designs of brush switches and their use have been described in previous issues of the Ericsson Review, to which we refer.

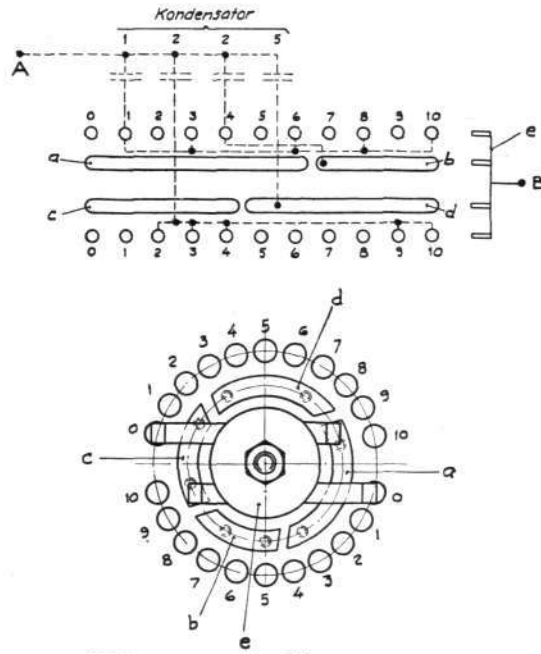


Fig. 12.

X 5014

# Standardization of Electric Cooking and Heating Appliances

By AKSEL KVAM,  
engineer, A/S Elektrisk Bureau, Oslo.

*Elektrisk Bureau in Oslo has during several years devoted extensive and successful work to the design of modern electrothermic appliances. With the permission of the firm we reprint from their journal Elektroposten the following article, wherein the advantages for the manufacturers as well as the consumers of a standardization of the hot-plates are discussed.*

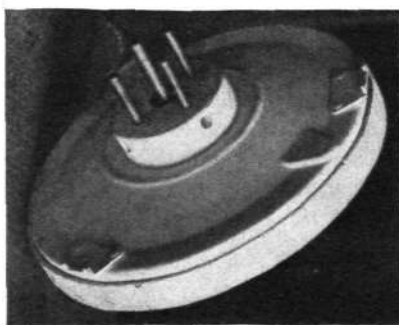


Fig. 1.

Intense efforts have been made in the last years by means of lectures, newspaper articles etc., to bring the public to realize the economic importance of using electric heating and cooking to the greatest possible extent.

Two items are of special importance when endeavouring to make the use of electricity more popular with the consumers.

Firstly, the rates of current must be low; the apparatus must further be, not only reliable and convenient, but also inexpensive, so that the public may see the advantage of the electrification of their kitchens. If we look back on the development of the last ten years, one will be agreeably surprised to notice the progress made by manufacturers in the construction of really reliable cooking appliances.

There is, however, ample scope for improvements. Technical progress never stops, and the task of the engineer of the future will be to reduce still further the prices of our electric cooking appliances by improvements in their construction. Another important fact, which is too often overlooked by designers is that even the best cooking apparatus is liable to be damaged on account of faulty treatment or hidden defects in the materials. In that case, it is of course important that the repairs can be effected as quickly as possible and at minimum cost.

The main point is, therefore: if e. g., electric kitchen ranges are to be introduced in all kitchens, a standardization according to international rules of the most expensive and vital parts of the range must be carried out. At the same time, all parts liable to damage in service, must be easily interchangeable and replaceable even by inexperienced people.

The most important parts, and at the same time those mostly exposed to damage, are without doubt the hot plates. It is therefore natural that the experts should have worked out standards for these parts in first place. The fundamental work in this respect was carried out some years ago by »Deutsche Industrie Normen» (DIN) and gave the following results:

1. The diameter of the plates must be in strict accordance with the dimensions prescribed by DIN, and should not be determined arbitrarily. The standard diameters are: 30, 22, 18, 14.5 and 11 cm.

2. At the bottom the plates must be provided with fixed contact pins, that fit in a corresponding horizontal socket in the same manner as a common triple-pole plug.

3. The center pin should form a neutral contact, so as to connect automatically the body of the plate to earth when it is fixed in position.

4. The external dimension of the plate, as e. g., the diameter of the pins and the distances between them must conform strictly to DIN standards.

Let us now discuss the advantages of this standardization from the consumer's point of view.

1. The standardization will simplify the manufacture of the plates, as the manufacturer will need to keep only a limited number of different diameters in stock. This reduced number of types will make possible production in series, the costs will come down, and the production process as a whole will be rationalized. A natural consequence will be a reduction of the selling price of the electric range.

2. Even the most perfect hotplate may be put out of service on account of rough handling or hidden defects in the materials.

A plate manufactured according to the standards may easily be taken out even by an unexperienced person and sent to the nearest fitter to be exchanged against a new standard plate, which may in its turn be replaced in the range by the cook herself.

The cost to the customer will further be reduced to a minimum, as there is no need to call in a fitter, who very often is not familiar with the construction of the range, and accordingly has to find out with much trouble how the plate should be disconnected. The time used by the fitter as well as his transport

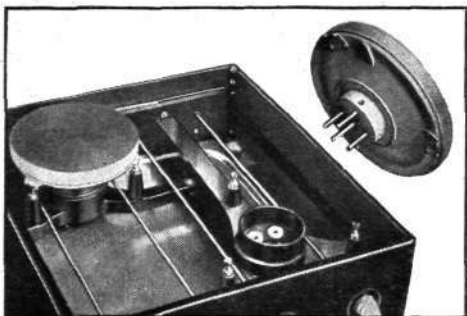


Fig. 2.

costs must of course be paid by the customer. The repair bill for non-standard plates will very often run into such considerable sums, that the use of electricity may be undeservedly discredited with the customers.

3. The standardization of the plates once carried through, it is obvious that the manufacturers of kitchen utensils will adjust the dimensions to those of the standard plates. In order to attain the shortest possible cooking time on electric plates, care should be taken that the diameter of the vessel is the same as that of the plate.

It is evident that a standardization in these domains will contribute considerably to make electric ranges still more popular than they are today. Why should not a hot-plate be manufactured on the same principles as an electric bulb? Would it not be considered absurd to be compelled to send for a fitter each time a bulb must be replaced, or to be obliged to use only bulbs of a certain make to make them fit into the socket?

The standardization of hot-plates is unfortunately still in its infancy. This important question has, to my knowledge, not yet been noticed in America. In Europe, the system has been introduced, among others, by the Swiss firms Therma and Salvis, and by Elektrisk Bureau in Norway, which have applied the system to their new »Rex» kitchen ranges, types G and H. The public has found these standard hot-plates of Alo-Rex' make very satisfactory. The plates are durable, easily cleaned and show a very short cooking time.

The contact socket, where the con-

tact pins of the plates are fixed, is floating, which ensures a very reliable electric contact.

The contact pins as well as the corresponding contact springs are of such ample dimensions that even a high power hot-plate may be used for many years without the slightest traces

of burns showing on the pins. The development of technics cannot stop, and it is to be hoped that before long other manufacturers also will discover the advantages of standard size plates.

Another step will then have been taken to realize a better exploitation of our white coals — and to introduce electric cooking in every home.

## The Ericsson Automatic Fire Alarm System Saves Millions

In less than a month's time two fires that threatened to cause huge losses, have been stopped in time thanks to the Ericsson fire alarm system. The matter has aroused considerable interest in the Swedish press, and we may be content to quote an article from one of the leading dailies of Stockholm.

»Fire calls fire brigade.

Automatic fire alarm.

Millions saved in the Svanström building.

Fire broke out Tuesday evening in a store-room at Herkulesgatan 11. The address will be familiar to our readers: it was in the store-rooms of the Svanström Co. in this house that the big fire raged some years ago, when books, paper etc. of over 4 million Swedish Kronor worth were destroyed. This time, the loss consisted in a burned crate containing paper, and a scorched ceiling, to a total value of Kronor 25. The fire originated in



X 5013

The fire of the Svanström building in June 1929. A repetition of this fire was averted thanks to the Ericsson Automatic Fire Alarm System.

the crate — it appears that somebody had left his pipe there and forgotten it — but it was checked within a few minutes.

The fire might have cost several millions this time too, if it had not been for special circumstances, which deserve to be told in detail.

The store-room in question has no windows; nobody could have noticed the fire and called the fire brigade. Had the fire had time to spread, one or two stories of the house would certainly have been ravaged by the flames, said the officer in command of the fire brigade.

How, then, was the fire discovered? Well, that is just the point of the story, *the fire itself called the fire brigade*. In the new building, which was erected after the last big fire, an automatic alarm system invented by Mr. Ekman and built by the Ericsson company, was installed. Thermostats that function at a certain temperature automatically send an alarm signal to the fire brigade of district; they are mounted in the ceilings. In the present case, the system functioned with the accuracy

that has made Swedish system famous, and there is no doubt that the installation saved millions.

In this connection, it may be mentioned that the Ericsson automatic fire alarm has proved to be extremely reliable on several previous occasions. Among other things, a threatening fire was stopped some years ago behind the scene of Södra Teatern, while the play was going on.

The system is installed in the theatres of Stockholm as well as in many shops and warehouses, and has proved to meet in all respects the demands on an efficient fire alarm system.»

The second case happened only some weeks ago. We quote another paper:

»A fire that could easily have had serious effects, but was stopped in the nick of time, broke out Tuesday night at the Cable Works in Älvsjö. Just before five o'clock in the morning, the watchman noticed some smoke, and, fetching a chemical extinguisher, proceeded to look for the fire. Even before he had time to find it, the fire brigade had already

been warned by the automatic fire alarm system installed in the building by Ericsson, and was already on its way. When they arrived a moment later, the premises were already filled with smoke to such an extent, that it proved necessary to use gas masks in order to enter the threatened building. It was ascertained that the fire had originated on account of spontaneous ignition of oil-saturated cotton rags in a waste box. This was entirely on fire, and a delay of some minutes only would have led to a catastrophe; the cable works would have suffered considerable damage to buildings, machinery and materials, not to mention appreciable losses on account of delayed deliveries.

Thanks to the automatic fire alarm, everything turned out so well, that nothing was damaged; the company has not even deemed it necessary to claim anything on their insurance. Keeping the recent fire in the Svanström building in mind, we may safely say that for the second time in a very short period the alarm system has prevented the loss of millions of Kronor.»

# Big Success of Bakelite Telephones

*The new Ericsson bakelite telephone, which is described in detail in another section of this issue, has already won vast recognition from all quarters where it has been examined and its excellent technical and electrical qualities ascertained.*

## The Prince of Wales Buys Ericsson Telephones.

During their visit to Sweden in October, the Prince of Wales and Prince George desired acquaint themselves with the telephone system in the world's leading telephone city, and accordingly inspected the exchange Stockholm—South. After the demonstration of the Ericsson automatic system, the new bakelite telephone was shown. The Prince found it so attractive, that he at once ordered four sets. The sets exhibited were of the *de luxe* design; especially the white telephone with gold plated dial made for the King of Afghanistan won the approval of the Prince, who ordered one white, one green, and two red sets.

During their visit, the Princes were accompanied by Crown Prince Gustaf Adolf of Sweden, who also liked the new Ericsson model so much that he expressed his desire to have a similar telephone set installed in his study in the Royal Castle in Stockholm.

## The Swedish Telegraphs Select the Ericsson Model.

After exhaustive tests and investigations the Swedish Telegraphs have approved the Ericsson bakelite telephone and booked a first order for 12 000 sets.



X 1066 Table telephone of *de luxe* design.  
Ordered by the Prince of Wales and the King of Afghanistan.

## Norway.

The new set has already been widely used in Norway. But then, the final design of the set is the result of a Swedish-Norwegian cooperation — it was the engineers of Telefonaktiebolaget L. M. Ericsson and Elektrisk Bureau in collaboration that built the new model.

The following towns in Norway have already been equipped with the bakelite telephone:

Haugesund,  
Egersund,  
Kristiansand.

The following towns will have it shortly

Fredriksstad,  
Selbak,  
Arendal,  
Moss.

## Iceland.

In connexion with the change to automatic traffic of the Ericsson system, the towns of Reykjavik and Hafnarfjörður have been equipped with bakelite telephones. See further article below.

## The Netherlands.

We take the liberty to quote from an article in the journal of the Dutch Telephone and Telegraph Engineers. »*The new Ericsson telephone.*

In our issues of december 1929 and februar 1930, some new types of telephone sets were mentioned. We cannot possibly be complete in this respect and introduce each new model. Our survey would, however, be extremely incomplete, if we did not give our attention to the new Ericsson set. Besides, we are pleased to introduce it for several other reasons. Our very old relations with the Ericsson firm would in themselves suffice to justify it, and the new model, furthermore, well deserves a description.

When the modern style of telephones came on the market some years ago we at first felt bewildered: they were so unfamiliar, so different. But, sooner than we should have expected, we had reconciled ourselves with the new style; we found our faithful acquaintances old fashioned, even misproportioned. At first sight of the new Ericsson

set, we still hesitated a little, but this did not last; we soon began to admire its beauty.

-----  
The whole apparatus is thorough in construction, and shows the well-known Ericsson dependability. We wish the firm much success.»

## Italy.

The telephone manufacturing company Fatme in Rome, connected with the Ericsson group, will shortly take up the manufacture of bakelite telephones.

## Finland.

In Finland, the Ericsson telephone is already introduced in Ekenäs and Jyväskylä, and will be installed in Tammerfors before the end of the year.

## Yugoslavia.

*The Ericsson telephone wins a competition.*

During the first half of 1932, the Yugoslavian Post Office arranged a competition in order to determine which was the best telephone instrument. The new Ericsson bakelite set came out a winner; 13 manufacturers took part in the competition.

The choice between the different makes was based on extensive tests and comparisons, the properties of the competing telephones being rated according to schedules fixed beforehand.

The properties to be examined and compared, as well as their relative weight in the final score had been previously determined by fixing a *coefficient of importance* for each property. A determined maximum number of points had also been fixed for each of the properties to be compared, and accordingly for the total score.

After the comparative tests the number of points attained was multiplied with the coefficients of importance of the respective properties, and the price of the sets was divided by their total score. In this manner was obtained a *price per*

*unit of value*, which was decided the final order of excellence.

As already mentioned, the Ericsson telephone ranked first and attained 215 of 230 theoretically possible points. The Ericsson set got the maximum score for several of the properties examined, i. e., it was considered in this respect to realize the ideal. The most important of these properties were: general appearance, the design of the microphone, the commutator, the dial, the contacts, the internal mounting, the cord, and the mechanical construction of the various parts of the set.

## Spain.

San Sebastián, capital of the province of Guipuzcoa, is automatized with the Ericsson system. The Municipality, which owns and operates the installation, has now adopted the new bakelite model.

## Czechoslovakia.

The Böhmsche Escompte-Bank und Credit-Anstalt in Prague is

moving in to a new building, which for modern comfort will rank first in Prague, and is certainly one of the most impressive in Europe. Special care has been given to the electrical installations and the Ericsson bakelite set will be a standard feature of the equipment.

## Mexico.

Empresa de Teléfonos Ericsson, the leading telephone company in Mexico, that operates more than half the telephones of the country, will gradually introduce the new telephone sets in their plants.

## Afghanistan.

The State Telephone Administration has bought a shipment of bakelite telephones. We have already mentioned the white *de luxe* set intended for the King of Afghanistan.

## Siam.

The State of Siam's Telephone Administration has also ordered a shipment of the new types.

# Automatic Exchanges in Finland

## Demonstration of Wholly Automatic Intercommunication between Automatic Exchanges of Different Systems.



X 3012

Fig. 1.

The automatic exchange in Ekenäs is installed in a new building erected for the purpose.

The first automatic exchanges of the Ericsson 500-line system in Finland were taken into service towards the end of 1931 and during 1932. On December 6th, 1931, the automatic exchange in Lovisa was opened, on January 30th, 1932, the exchange in Ekenäs and on August 20th the ex-

change in Fredrikshamn. All these exchanges have a capacity of 500 lines. To the Lovisa exchange is connected an automatic sub-station erected in the village of Köpbacka, 4 km from Lovisa (Fig. 2). This latter is of the Ericsson multiple relay automatic system with 40 line selectors, with a capacity of 80 lines, and works without supervision. The traffic between the sub-station and the exchange is handled entirely automatically over two-wire junction lines. All subscriber numbers contain four figures.

The traffic with the manual exchanges connected to Ekenäs, Lovisa and Fredrikshamn is handled without an operator in the automatic



x 3013

Fig. 2.

The telephone station in Köpbacka.

The exchange is erected in the low annex.

exchanges, the rural lines being connected to the automatic system, and the exchanges in the rural stations being equipped with dials.

In day-time the long-distance traffic is handled at the manual long-distance switchboards in the exchanges. By night, however, the traffic is handled by the long distance operators at the other end of the long-distance lines, i. e., in Helsingfors, Åbo, Viborg etc.

The automatic exchange in Ekenäs, which is erected in a new building (Fig. 1) was demonstrated on

February 19th, 1932 to a great number of visitors, representing the Municipality of Ekenäs, the Ministry of Communication, the Post and Telegraph Administration, various private telephone companies and the press. After the automatic exchange proper, *automatic intercommunication* was demonstrated between subscribers connected to the Ekenäs exchange and subscribers connected to the Helsingfors and Riihimäki exchanges, which are of the Siemens system and connected to Ekenäs by long distance aerial lines of 114 and 191 km length. The purpose of this demonstration was to show, in the presence of a representative and competent audience that automatic intercommunication is possible between exchanges of the Ericsson and Siemens automatic systems, which had previously been contested in the press and otherwise in Finland. When it had been shown how the connection between subscriber's telephones on the one hand in Ekenäs, and in Helsingfors and Riihimäki on the other is effected direct by means of the dials of the respective telephones, those present were allowed to connect themselves to any

subscriber in Helsingfors, an opportunity which was used by the reporters to report on the demonstration to their papers in the Finnish capital. On January 7th, 1933, still another automatic exchange of the Ericsson system was opened in Finland, viz. in *Jyväskylä*, for a capacity of 900 lines.

In connexion with the inauguration of the *Jyväskylä* exchange, automatic intercommunication was arranged between *Jyväskylä* on the one hand and Riihimäki and Ekenäs on the other. In this latter case, the intercommunication was thus carried out between two exchanges of the Ericsson system. The long distance line was not less than 500 km in length. If a long distance call comes in for a subscriber, when a local call is on, an automatic long distance disconnection of the local call is effected, simultaneously giving busy signal to the disconnected subscriber.

Telefonaktiebolaget L. M. Ericsson has for the moment under construction another automatic exchange for one of the most important towns of Finland, Tammerfors; this exchange will be opened for service toward the end of 1933.

## Elektrisk Bureau Builds Ericsson Automatic Exchanges for Iceland and Norway

Five Exchanges of the Ericsson System Opened in December.

It is certainly no common thing, that five great automatic exchanges delivered by the same firm are opened for service during the same month. This feat has, however, been accomplished by Elektrisk Bureau in Oslo, as the new automatic exchanges in Reykjavik and Hafnarfjörður in Iceland, and Haugesund, Kristiansand and Egersund in Norway were put in service last December. All these exchanges are built by Elektrisk Bureau and are of the Ericsson automatic system; as several automatic exchanges for other Norwegian towns are now under construction in the factory of the firm, it may be said without exaggeration that the Ericsson exchanges



Mr. Hliddal, Director of Telegraphs.  
Head of the Telephone Administration of Iceland.

built by Elektrisk Bureau have stood up very successfully against the keenest competition.

### Reykjavik and Hafnarfjörður.

Iceland and automatic telephony — this juxtaposition will probably puzzle many people accustomed to associate very different ideas with the island of the Sagas in the North Atlantic —. This, however, is quite wrong, for contemporary Iceland is a very modern-minded and progressive country, and its inhabitants rank among the most highly cultivated people of our time.

The step towards complete moder-



Reykjavik.<sup>1</sup>

nization of the telephone system that has now been taken has been carefully prepared. The Reykjavik telephone system was modernized as late as in 1922, and it should be pointed out that the equipment was bought from Elektrisk Bureau on this occasion as well as when the telephone was first introduced in Iceland in 1906. The final capacity of the station delivered in 1922 was 2 400 lines. Due to the rapid increase in the number of subscribers,

it proved advantageous however to replace the existing LB plant, after less than 10 years, with a modern automatic exchange of 9 000 lines' final capacity. Elektrisk Bureau and the Ericsson system won the very keen competition with the world's leading telephone firms.

that each call *within* Reykjavik or Hafnarfjörður is counted as 1, while a call *between* the towns is counted as 6. Calls between Reykjavik and Hafnarfjörður may not last more than 5 minutes. When this period has lapsed, the conversation is automatically interrupted.

Bakelite telephone instruments of the new model have been delivered by Elektrisk Bureau for installation in both towns.



X 3014 Interior of the new automatic exchange in Reykjavik.



X 3015

The new building, which contains the Reykjavik exchange. The broadcasting station is installed in the same house.

Hafnarfjörður is a much smaller town than Reykjavik, situated at a distance of about 10 km from this latter. The final capacity of this new exchange is 900 lines. Both towns are connected by cable.

The method of handling the traffic between the towns is of particular interest; for it is carried out quite automatically. The metering of the calls is arranged in such way

## Kristiansand, Hauge- sund, Egesund.

The operating companies in all three towns have been in business for about 50 years.

The oldest one is *Kristiansand og Omegns Telefonaktieselskab*, which opened its first exchange in 1883.



X 3016 The telephone exchange in Hauge-sund.

The new automatic exchange has been built for a final capacity of 5 000 lines. An especially remarkable fact is that the company was able to reduce its rates appreciably in connection with the automatization — the reduction amounting to  $33\frac{1}{3}\%$  for private subscribers — a proof as good as any of the economical advantages of automatic service.

*Haugesunds Telefonselskab* started its activities in 1888 with a 50 lines' exchange of Elektrisk Bureau's make. The automatic exchange may be extended up to 5 000 lines and has been installed in a building built specially for this purpose.

*A/S Egersunds Telefonselskab* started in 1885. In 1896, the company had 45 subscribers — the in-



X 1067

Aerial view of Kristiansand.

stallation then consisted of a manual exchange of 100 lines and a long distance exchange of 5 lines. The installation was increased with 50 numbers in 1900 and with 250 numbers in 1914, after which time the development continued apace. The

newly opened automatic exchange is intended for a total of 1 000 subscribers.

The three Norwegian towns, as well as both the Icelandic towns, are equipped with bakelite sets of the new type.

## Ericsson Technics

With the beginning of 1933 Telefonaktiebolaget L. M. Ericsson has started the publication of a series of papers, under the name of *Ericsson Technics*. Each issue will contain only one article, and they will appear in free sequence.

The purpose of this new publication has been to create a separate organ for the purely scientific material published up till now in the *Ericsson Review*; the series will give a representative picture of the scientific work carried out in the Ericsson group, chiefly by the Research and Development Department.

Each paper will be issued in one language only, as a rule in English, although French may be used for certain treatises.

When the first 1933 issue of the *Ericsson* appears three issues of *Ericsson Technics* have already been published. In each issue of the *Review* we will give a synopsis of the contents of the papers published; these may be ordered from the *Ericsson Review*, Editors Office.

**Ericsson Technics 1933. No. 1.**  
*H. Pleijel: Théorie générale des circuits composés.*

This paper deals with the general theory of a line constituted by an

arbitrary number of quadripoles or lines connected in sequence. The general case, where individual lines are interconnected by means of impedances or where transversal impedances are inserted at the junction points of two lines has been included. Each line is characterized by the reflection factors at its terminals, and by its complex attenuation. Further, the transition factor from one line to another for a current wave must be taken into consideration.

General formulæ are deduced and

proved, concerning the effective attenuation of a composite line, the impedance for the incoming current when assuming an arbitrary arrangement at the receiving end, the characteristics, the equivalent impedance of the composite line, the ratio between the total outgoing current and the total incoming current, as well as the attenuation factor of a composite line.

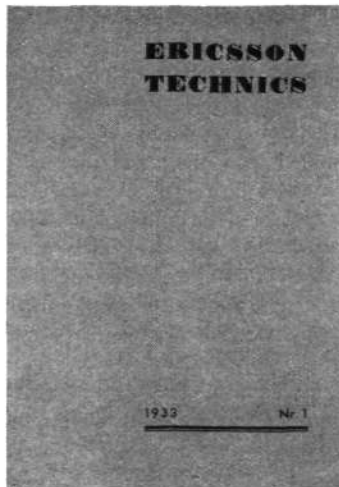
**Ericsson Technics 1933. No. 2.**  
*S. Ekelöf. On the Calculation of Relay Windings.*

The problem treated is to find under different conditions the appropriate windings for a relay with round core.

In § 1 are deduced the fundamental formulæ for the calculation of the resistance and number of turns of a winding.

§ 2 treats the problem to calculate a winding with a maximum number of ampere-turns, when the other data of the circuit are given. It then also considers the inverse question to find a winding with a given number of ampere-turns, working on maximum external resistance.

§ 3 solves the problem to find a



X 3017

winding with given number of ampere-turns, when the external resistance is zero.

In § 4 the question treated is to find a winding with given resistance and maximum number of turns.

§ 5, finally, is devoted to relays with two windings.

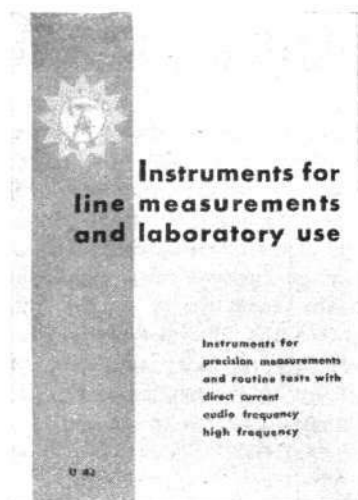
The table on page 22 contains in a form, suitable for practical calculation, the results of §§ 1—3, applied to a certain make of enamelled copper wire. The use of the table will be understood from examples.

**Ericsson Technics 1933. No. 3.**  
*H. Sterky. Power Factor and Inductance of Coils with Windings Connected in Parallel.*

It is a well known fact, that in order to reduce eddy current losses at high frequencies in the copper wire, inductance coils must be wound with thin wires. To obtain a specified inductance with a low power factor such coils are often wound with many wires connected in parallel. In this article a mathematical deduction of the formulæ for the resulting power factor and

inductance of a coil wound with two wires connected in parallel is given. It is shown that the resulting power factor will be considerably greater, and the resulting inductance smaller, than the corresponding values for the single coil-half, especially if the coupling factor is near unity, and the inductance ratio of the coil-halves deviates from unity. From general but somewhat intricate formulæ simpler formulæ are derived for special cases with aiding and opposing mutual inductance between the coil-halves.

## Measuring Instruments



X 30183

This catalogue contains the first complete collection of the telephometric equipment manufactured by Telefonaktiebolaget L. M. Ericsson for testing and control of telephone lines.

In the introduction of this catalogue is it emphasized, that the rapid development of long distance telephony during the last decade has made the problem of checking-up and supervision of long distance telephone lines particularly urgent. The increasing value of investments in transmission plants has made it economically imperative for the operating telephone companies to take to their aid modern and efficient measuring instruments in

order to discover impending faults and forestall interruptions in the service through better maintenance of equipment and lines. In this way, trouble and losses on account of service interruptions may to a considerable extent be avoided.

Ericsson has been working for several years to find suitable methods and instruments for measurements with audio, as well as other frequencies. It might be observed that several of the Ericsson measuring instruments offer completely unique advantages in comparison with others commonly used. Everyone that takes an interest in the matter will find many useful designs of equipment in the present catalogue.

The name of Telefon A.-B. L. M. Ericsson guarantees the sturdy construction and the excellent electric properties of every instrument.

The contents of the catalogue are arranged in a clear and instructive manner. To each instrument is devoted a description, with good photographs and diagrams, which make clear all its various possibilities in use, the theoretical principles on which the design is based, the degree of accuracy of the results, the mechanical construction of the equipment etc. The catalogue thus also serves as a work of reference concerning the use of measuring instruments.

A detailed description of the extensive materials contained in the catalogue would be too long; we will, however, mention a few of the most important instruments. A closer acquaintance with the catalogue itself will, of course, prove profitable to every telephone engineer.

### Impedance Measuring Set, Type ZA 350.



X 3019

Fig. 1.

This instrument, of patented design, is a bridge for measuring the amplitude and phase angle of impedances. It differs from other similar instruments available in the market in that the values required can be read direct from the dials; this is a definite advantage compared with other instruments, which permit only the measurement of the real and imaginary components of the impedances, and where the re-

sults have to be computed therefrom.

The instrument is intended for the frequency range between 300—4 280 cycles, corresponding to the angle frequencies  $\omega = 1810—26\ 900$ . It gives direct readings of amplitudes up to 11 110 ohm and phase angle up to  $\pm 90^\circ$ . Higher amplitudes may be measured by connecting additional decade resistances. By connecting a standard inductance of  $\frac{1}{2\pi}$  Henry, the measuring set may also be used as a frequency meter.

## Transmission Measuring Set, Type ZB 450.



X 3020 Fig. 2.

This set, which is also of patented design, is used for measuring transmission levels on telephone lines. The instrument may further be used in combination with a generator for transmitting a zero level voltage, for determining the loop attenuation of lines and for measuring the gain of a repeater. Compared with other designs this transmission measuring

set has the advantage that a built-in amplifier takes the place of a separate auxiliary generator when making level measurements. Hereby the advantage is obtained, that errors on account of varying frequencies and curve shapes in the main generator and auxiliary generator are eliminated. Another appreciable advantage is that no generator need be included in the equipment when making measurements with portable sets.

The instruments contained in the catalogue are normally designed as portable sets. Instruments for different measurements have, however,

been assembled on test racks in order to fit in better with the fixed equipment of a telephone exchange, and thus appreciably simplify routine measurements on interurban lines. The figure shows one of these combined measuring sets—the test rack for measurements with audio frequency and direct current, type ZG 400. In another rack—type ZG 450—the measuring equipment for carrying out high frequency measurements has been assembled.

The catalogue is published in English and Swedish in a handy and attractive volume.

## The Duration Meter

There is now available in English, German and Swedish, a detailed description of the design and use of a new type of electricity meter of Ericsson manufacture, which is quite unique in its kind and offers a remarkable variety of practical applications. It has been called the Duration Meter, its prime purpose being the measuring and registration of the duration of different loads, particularly in power consumption. This is the immediate object, and its importance can hardly be overrated, but the usefulness of the instrument does not stop at this. For, owing to its ingenious design, it produces the measurements in such form as to make them directly applicable to the solution of a variety of problems in technical and economic management. To make this perfectly clear, it will be best to discuss briefly the underlying problems and principles.

### *Irregular loads in power production and consumption.*

The most salient feature of any curve representing the power consumption of an industrial enterprise, is its irregularity. This is true not only of a curve representing some considerable period, say a year, but holds equally good for the daily power consumption, that will rise in a very short time from next to nothing during night hours to the full



X 3023

amount necessary to keep the whole plant working at full, then fall back again during lunch hours and rise anew in the afternoon, reinforced by the current consumed for lighting purposes, and finally come down to zero level after the day's work is over.

From the point of view of the individual power consumer, this rhythmical variation would not in itself constitute any important problem. The responsibility for meeting peak loads is simply shifted over to the power producer. This latter, however, can not be content to leave the matter alone. He has to take care of the total load of a whole



X 3021 Fig. 3. Test Rack ZG 400/10.

community, and for him the irregularity of the curve has all-important consequences. He has to design and build his plant large enough to meet the highest peak load occurring, which means that his plant will be partly idle most of the time. In order to make a profit, he must so adjust the rates that those primarily responsible for the irregularities shall also pay the extra cost incurred on account of peak loads. But the equitable distribution of overhead is closely bound up with the possibility of securing accurate statistical data both for the plant as a whole, and for the power consumption of single customers and classes of customers. Hence the need of power companies for measuring instruments giving these data promptly and compactly. The rate-making and the economic policy in general of these enterprises has to be governed by considerations of this kind.

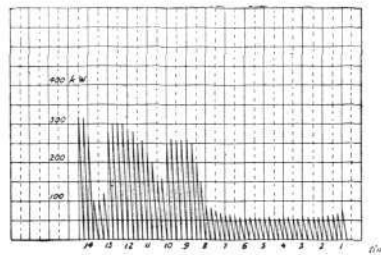
For the manager of industrial concerns using electric power the problem is exactly the reverse of the above. If he is not an important enough customer to induce the power company to make special concessions, he has to consider the system of rates prevailing in his place as fixed by forces outside his control; his particular object is then how to organize and contract for his power supply so as to make the best of existing conditions. And here again the problem of loads and their duration is at the very base of the problem. Without accurate knowledge of the load data of his business the manager has no firm ground to stand on in making his decisions on the important matter of power supply.

Thus both producers and consumers of electric power are faced by the same difficulty: to devise reliable and economical means of measuring loads and determining their time characteristics. The best method of control so far available has been the use of so-called *duration curves*. The computation and plotting of the necessary figures is, however, a very lengthy business,

and abridged methods do not give sufficiently reliable results.

The new Ericsson Duration Meter solves all these problems and is the only instrument of its kind on the market that permits direct reading of all the relevant data. By the use of the Duration Meter, the calculation and control of power consumption takes on a new aspect.

The important feature of the Duration Meter is that the duration of different load ranges is registered in different metering mechanisms, twelve in number. At the end of any given period the readings on these mechanisms give the number of time units during which certain load levels have been reached. The duration curve is then easily plotted by choosing the numbers of the metering mechanisms, or, still better, their corresponding load values, as ordinates and their readings as abscissæ.



Record strip from a maxigraph.

For the calculation of the annual duration curve by means of such diagrams, about 35 000 figures must be grouped and added. The Ericsson Duration Meter gives the necessary data by direct reading.

## Practical Applications.

### A. Power Consumers.

For power consumers the Duration Meter, as mentioned above, has its main importance as a guide to the most economical methods of securing the current supply necessary for the operation of the plant. The problems to be solved by the Duration Meter are of different kinds depending on the rate system prevailing in the district, but they all consist in finding the best combination of the following possible sources of current supply:

1. purchasing all the necessary power from outside;

2. generating it in the plant;

3. purchasing power up to a certain load level and handling peak loads by method 2.

The Duration Meter gives directly the necessary load data, no complicated working-up of statistics being necessary.

### B. Power Producers.

For power producers, the Duration Meter affords a simple solution of several fundamental problems.

1) It gives a compact and clear picture of the load characteristics of the plant as a whole.

2) It may be used to ascertain the influence exercised on total load by certain individual customers, or classes of customers, or sections of the distribution network.

It also serves the inverse object of measuring the effect of different rate schemes on load, thus affording a reliable check and a continuous control on the soundness of the economic policies adapted by the management.

3) Apart from the above information, which applies more especially to problems of rate-making and economic policy in general, the Duration Meter, by measuring the range of load fluctuations, also gives valuable guidance in technical questions, as, e.g. in determining the suitable dimensions of conductors etc.

These are, of course the principal problems the solution of which is simplified and facilitated to a remarkable degree by means of the new Ericsson instrument. Incidentally, however, the Duration Meter allows an indefinite number of applications to all kinds of load problems. A few instances will make this clear.

a) *Calculation of energy losses.* Problems of this kind may be simply and accurately solved with the assistance of duration curves.

b) *Gas and water works* may use the Duration Meter for statistics of consumption.

c) *Railway companies* may use the Ericsson Duration Meter for the

control of engine speed, and utilization of engines.

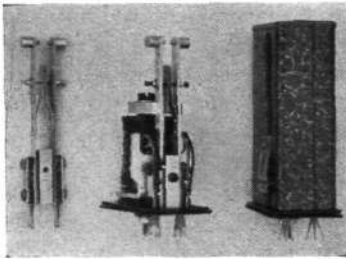
The above is only a few hints about this remarkable instrument and all further details regarding its construction, use, methods of treating the data obtained for the solu-

tion of specific problems is explained at length in the booklet, that may be obtained on request. No executive interested directly or indirectly in the economics of power production, distribution and consumption can afford to neglect this new

development in metering technique, and, as we have said before, every business to which load fluctuations of any kind is a factor of importance will find valuable hints for the treatment of its own cost and organization problems.

## News from the Research and Development Department

### A New Tuning-fork Buzzer Generator.



X 3024

Fig. 1.

The Ericsson Research and Development Department has worked out a new buzzer generator, which is characterized by a great reliability as well as frequency stability. The great reliability is obtained by using tungstene as a contact material; this metal possesses a considerable hardness and a high melting point as well as good conductivity. A considerable stability of the frequency with respect to the working voltage and the mechanical setting has been rendered possible by the application of the tuning-fork principle, by means of which the frequency is determined chiefly by the material and the dimensions of the branches of the tuning-fork.

The new buzzer generator, which is shown in Fig. 1 and 2 is of the same size as a single relay, and is mounted in the same manner. It consists of a tuning-fork unit and an electromagnet which are mounted on an iron corner. The magnet is, on its front part, fitted with a pole piece formed in U, which encloses both branches of the tuning-fork. These are of steel and insulated from each other and from their support, and further provided with one

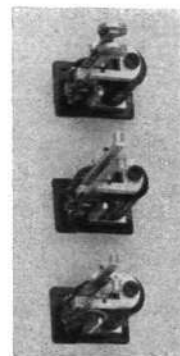
internally directed contact spring each; contact electrodes are riveted to the free top part of the springs. Set screws bring the electrodes in contact with each other at rest. When the magnet is excited, the branches are attracted by the pole pieces and are bent apart with the result that the contact electrodes separate. The winding of the magnet are connected to the contacts according to the self-interruption principle. A secondary winding placed on the magnet and adjusted for the purpose is capable of delivering a secondary output ranging from 1 to 1,5 W at 24 V primary voltage. It is possible to obtain a satisfactory sine shape of the secondary current by connecting in parallel with the primary winding a protecting resistance connected in series with a condenser of from 0,2 to  $2 \mu F$ , depending on the number of turns of the winding and the frequency. The ratio between the effective secondary alternating voltage and the primary direct voltage is approximatively the same as the ratio between the secondary and primary numbers of turns, independently of the frequency.

The support of the tuning-fork unit is provided with 4 insulated soldering lugs for connexion to the ends of the windings, and 2 lugs for the current to the branches of the tuning-fork.

The frequency of the buzzer may not be appreciably altered by adjusting the set-screws, but, however, by adapting different loading masses to the branches. In order to cover a greater frequency range than would be possible according to this method, without being compelled to use mas-

ses of exaggerated size, two different types of tuning-fork units have been designed. These types differ in the thickness of the branches of the tuning-fork. In Fig. 2, the buzzer in the middle has a frequency of about 400 p/s and those to the left and the right respective frequencies of 225 p/s and 125 p/s. These latter are, as will be seen from the figure, only variations of the same type, different masses having been adapted to the branches, while the former is fitted with a tuning-fork unit of another type, having thicker branches. Both types are interchangeable.

Still another type of tuning-fork unit has been designed. It is fitted with double contacts, insulated from each other, one of them being used for the buzzer, while the other may be used for certain other purposes, as, e. g., the D. C.—A. C. conversion of appreciable outputs, by using an auxiliary transformer. The tuning-fork buzzer will in this case work as an interrupter mechanism only. This tuning-fork unit also is interchangeable against the above mentioned types.



X 3025 Fig. 2.

## Pendulum Relay.

In telephony and telegraphy and other related fields of activity, delayed action relays are often required.

Generally a delayed action of short duration only — ranging about some tenths of a second — is necessary. A far slower action is, however, very often required, and the usual designs, based on copper sheathing of the iron core, will not prove satisfactory.

The Research and Development Department has taken up this problem and designed of a *pendulum relay*.

This relay consists of an ordinary relay, fitted with a pendulum contact assembled in the same manner as a spring group.

When the armature is attracted, the pendulum begins to vibrate and effects during a few seconds a series of contacts, which are sufficient to keep a normal delayed action relay attracted during the same period.

The pendulum relay may be adjusted for an approximately constant delayed action ranging up to 5 seconds.

## Instrument for Testing Dials.

This instrument has been designed in order to make possible a rapid and efficient testing of the *impulse ratio* and the *speed* of dials, these data being currently used to characterize the properties of a dial.

During the rotation of the dial, the break contact effects a series of impulses, i. e. a series of alternating contacts and ruptures. If we design the make time in milliseconds as  $S$ ,

the break time in milliseconds as  $A$ , the duration of the impulse will be:

$$S + A$$

the impulse ratio:  $\frac{S}{A}$

and the speed of the dial:  $\frac{1000}{S + A}$

All necessary devices for the measurement of these data are assembled in the instrument described below.

The apparatus contains a voltmeter, a frequency meter, a triple-throw commutator, a relay with two spring groups, two adjustable resistances, a potentiometer and push buttons for the connecting of the battery and the relay. The source of energy consists of three 1.5 V dry batteries.

In order to measure the impulse ratio, one of the resistances is adjusted so that the voltmeter is deflected to the end position (100 divisions of the scale). The relay is then connected; the deflection of the voltmeter will consequently be reduced to a value, which is regulated by means of the potentiometer so that the deflection of the voltmeter corresponds to the assumed make time, in %, of the dial. The dial is then brought round, and released. The current through the voltmeter will then be alternately broken and closed in cadence with the movement of the dial. The deflection of the voltmeter will accordingly correspond to the average

$$\frac{S \cdot 100 + A \cdot 0}{S + A} = \frac{S}{S + A} \cdot 100,$$

i. e., the make time, in %, of the dial.

If the voltmeter has been adjusted to this very value by means of the potentiometer, the needle will stand still; if not, the needle will move to the value indicating the make time of the dial, in %.

The determination of the speed of the dial is effected simply by winding up and releasing the dial, after putting the frequency meter in circuit by means of the triple-throw commutator. The reed of the frequency meter corresponding to the number of impulses per second will then vibrate, and the result may be read directly.

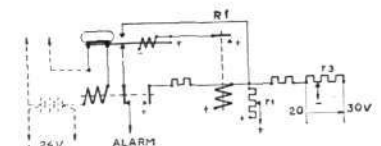
## Automatic Control Unit for Accumulator Charging.

Voltage regulators have not been much used before for the control of automatic accumulator charging, firstly because the voltage does not, at minimum values, constitute a reliable indicator of the state of an accumulator; and, secondly, because the design of reliable and unexpensive voltage regulators is a difficult task. The Research and Development Department of the Ericsson group has, however, designed an automatic charging control unit, which depends on the tension of the battery, but still works very reliably, being based on a maximum voltage value, to which it tends to bring the charge of the battery.

The arrangement is shown in Fig. 1. The voltage relay  $R_1$  is conveniently adjusted to the tension desired by means of rheostats  $r_1$  and  $r_2$ . If the tension of the battery is lower, it will be charged over a mercury contact until the voltage relay is energized at the adjusted tension, thereby putting a thermic relay in circuit. This latter trips the mercury contact, and the charge is interrupted. As soon as the bimetallic spring of the thermic relay has attained its maximum deflection, the voltage relay  $R_1$  is short-circuited, and the current through the thermic relay is cut off. The bimetallic relay will then cool down and leave the contact position; this motion is not sufficient, however, to close the mercury contact. Should the tension at this moment be high enough, the relay  $R_1$  is connected again, the temperature of the thermic relay rises, and the above mentioned process is repeated until the tension of the battery has fallen to the operating voltage of the relay  $R_1$ . The thermic relay is then completely cooled off and reaches its initial position. The mercury contact



X 3027

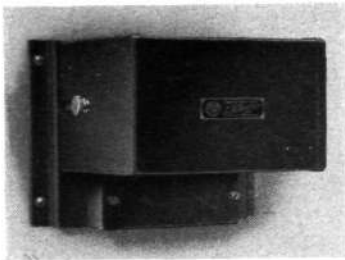


X 3028

Fig. 1.

is then closed and connects the charging current to the battery. The battery will thus, by means of this repeated testing, be continuously supervised.

An alarm relay connected in the charging circuit indicates if the charging current should for some reason fail at the closing of the mercury contact. This same relay also connects and disconnects a resistance, which energizes the relay  $R_1$  at a lower voltage than the tension at which the charge is interrupted. In this way, the voltage drop on account of the internal resistance of the battery when the charge stops is compensated.



X 3038

Fig. 2.

The automatic charging control unit is shown in Fig. 2, and is normally intended for charging 24 V batteries with a maximum charging current of 6 A, but may be built for other voltages as well. The tension of the battery may be regulated with a variation of 1—2 V.

## P. A. X. for 10 lines.

Among the new designs from the Research and Development Department we find a 10-lines P. A. X. of very small dimensions.

This exchange gives a cheap and efficient solution of the problem of private intercommunication, when the number of stations is limited.

The exchange is shown in the figures with and without cover. The whole equipment consists of 3 relays, 1 selector, 1 condenser and a few resistances. As current feed for the whole installation, a number of dry cells of 1.5 V connected in series up to 8 V are required. In this way, expensive accumulators with corresponding charging units, requiring continuous supervision or must



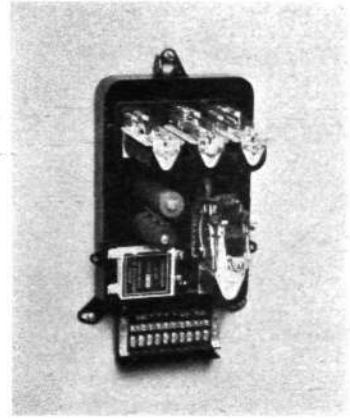
X 3029

Fig. 1.

be automatic, are avoided. In normal service the batteries should last a couple of years.

The exchange has one cord circuit, and the calls are not secret. The exterior of the telephone instruments is identical with that of the standard automatic sets, but the internal wiring is different.

When the subscriber takes off the receiver and sets up the number desired, a ringing signal is emitted during a few seconds to the called set. When both subscribers have replaced their receivers, the selectors return automatically to rest. The telephones are connected to the exchange by means of two wire conductors.



X 3030

Fig. 2.

## New Designs

*The new Ericsson bakelite set, which has already in its standard design had such well deserved success, has already been adapted to several special purposes. We give here below a short account of the principal uses.*

### Two-line Instruments.

As will be seen from the figure, the case and the handset are identical with that of the standard set, with the exception of the two push buttons placed above the dial.

The apparatus contains a complete equipment for two lines, and may be connected to automatic or CB exchanges. Each line equipment consists of a polarized magneto bell, a condenser and two resistances. One of the bells is built-in in the apparatus, the other being mounted in the wall fitting.

When no call is going on, none of the push buttons is depressed; when the handset is put down at the end of a call, the buttons are automatically brought to rest. When a call arrives, the bell belonging to

the calling line rings; the micro-telephone is taken off and the corresponding button is pressed down, after which the call is connected. The call is interrupted as soon as the handset is put back again.

In order to originate a call from the instrument, the handset is taken off; no connexion to the line is, however, effected before one or the other push button is depressed.



X 3031

Should the operator wish to communicate with a third person, during a call on one line, e. g., in order to ask for information or give urgent orders, this is done by pressing down the button belonging to the other line. The first line is then disconnected, but the circuit is held over a resistance; the operator may thus continue the first call by pressing down the corresponding button.

The principal advantages of the new two-line set are the following:

- a) simple handling;
- b) call-back device;
- c) inadvertent calls are eliminated, as the connexion is not effected when taking off the phone, but only after the subsequent pressing down of a button;
- d) long distance calls may be received even on the line held by call-back;
- e) the two lines cannot be connected together, even if both push buttons are pressed down simultaneously.

## Intercommunication Set for 10 and 20 Lines.



X 3032

Fig. 1.

Intercommunication set for 20 lines.



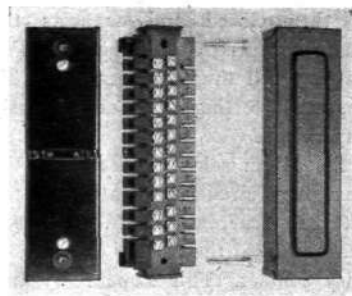
X 3033

Fig. 2.

Intercommunication set for 10 lines.

In order to meet the need for suitable junction boxes for intercom installations,

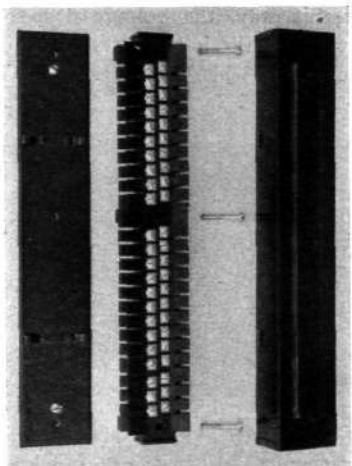
10 and 20 lines junction boxes of very practical construction have



X 3034

Fig. 3.

Junction box for 10 lines.



X 3035

Fig. 4.

Junction box for 20 lines.

As shown in the figure, the case is the same as that of the standard sets; the dial has, however, been replaced by a bakelite cover-plate.

Each set requires a separate microphone battery and, for the ringing, a signal battery common to all sets is needed.

When a call is received, the bell rings. By taking off the handset, the apparatus will be connected to the calling apparatus independently of the position of the dial.

To send a call, the dial is set to the number desired, the handset is taken off and the signal push button is pressed down. The bell in the instrument called will then ring. When the push button is released, the microphonic circuit will be connected to the called apparatus.

been designed. These blocks will certainly prove suitable for other purposes as well.

The junction boxes consist of the following parts:

1) a *bottom plate* of black enamelled steel, which is fixed to the wall by means of two screws,

2) a *terminal strip*, moulded in bakelite. On this are fixed 13 *terminals* (for the 10 line box), or 10+13 (for the 20 line box), which are fixed in the bakelite.

The terminal strip as well as the terminals offer many ingenious details of design.

The cables are thus drawn in open channels alongside of the strip. Open grooves in the walls of the channels guide the individual wires.

The terminals are fitted with connecting washers placed on the top and the bottom of the strip. Guiding and locking devices allow for a convenient mounting of the cable wires. The terminals of each pair are placed in a bevel position with respect to each other in order to facilitate the connection.

3) a *protecting cover* of black enamelled iron, secured by means of a snap lock.

The junction boxes are supplied with cord. The line cables are connected direct to the strip.

The junction boxes permit the connexion of up to four cables, two in each channel. In this case, it will prove suitable to connect one of the cables of each side to the terminals on the top, and the others to the terminals on the bottom of the strip.

# REX



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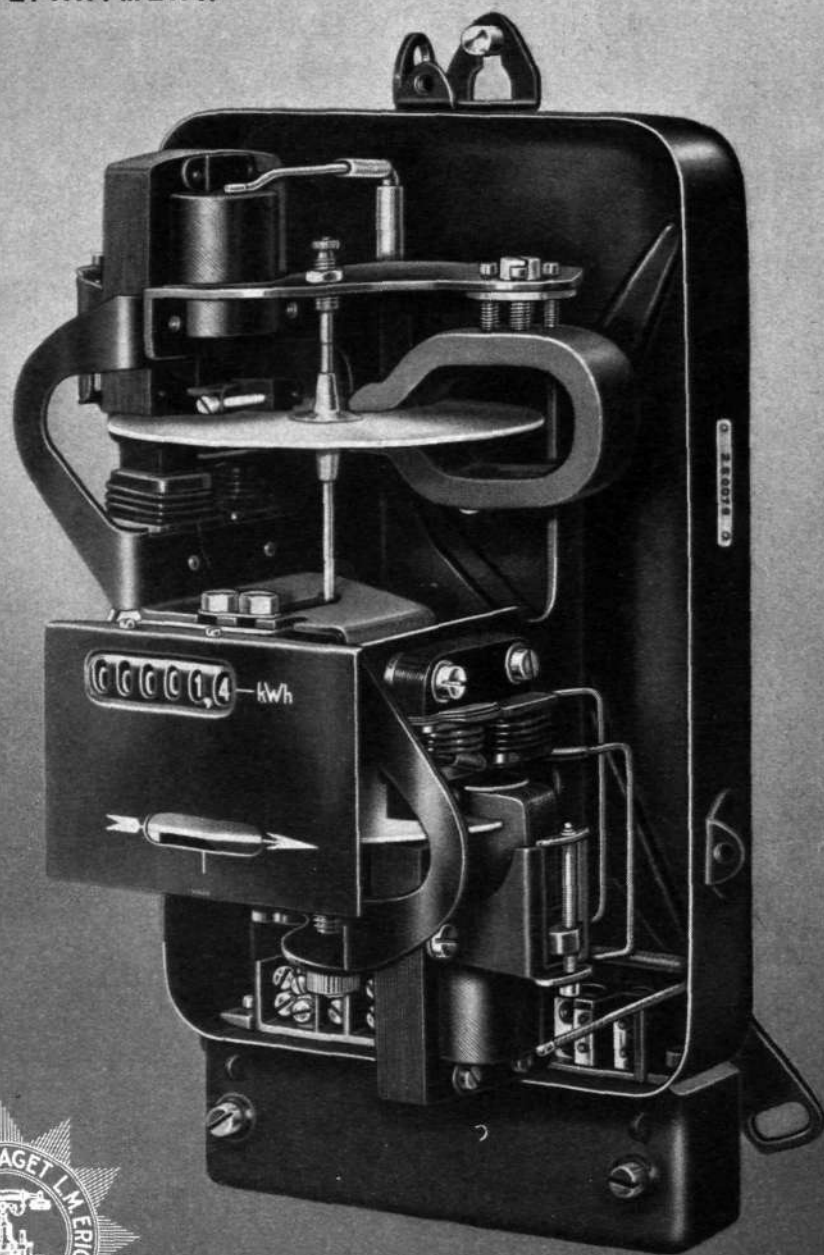


## AS ELEKTRISK BUREAU

OSLO

NORWAY

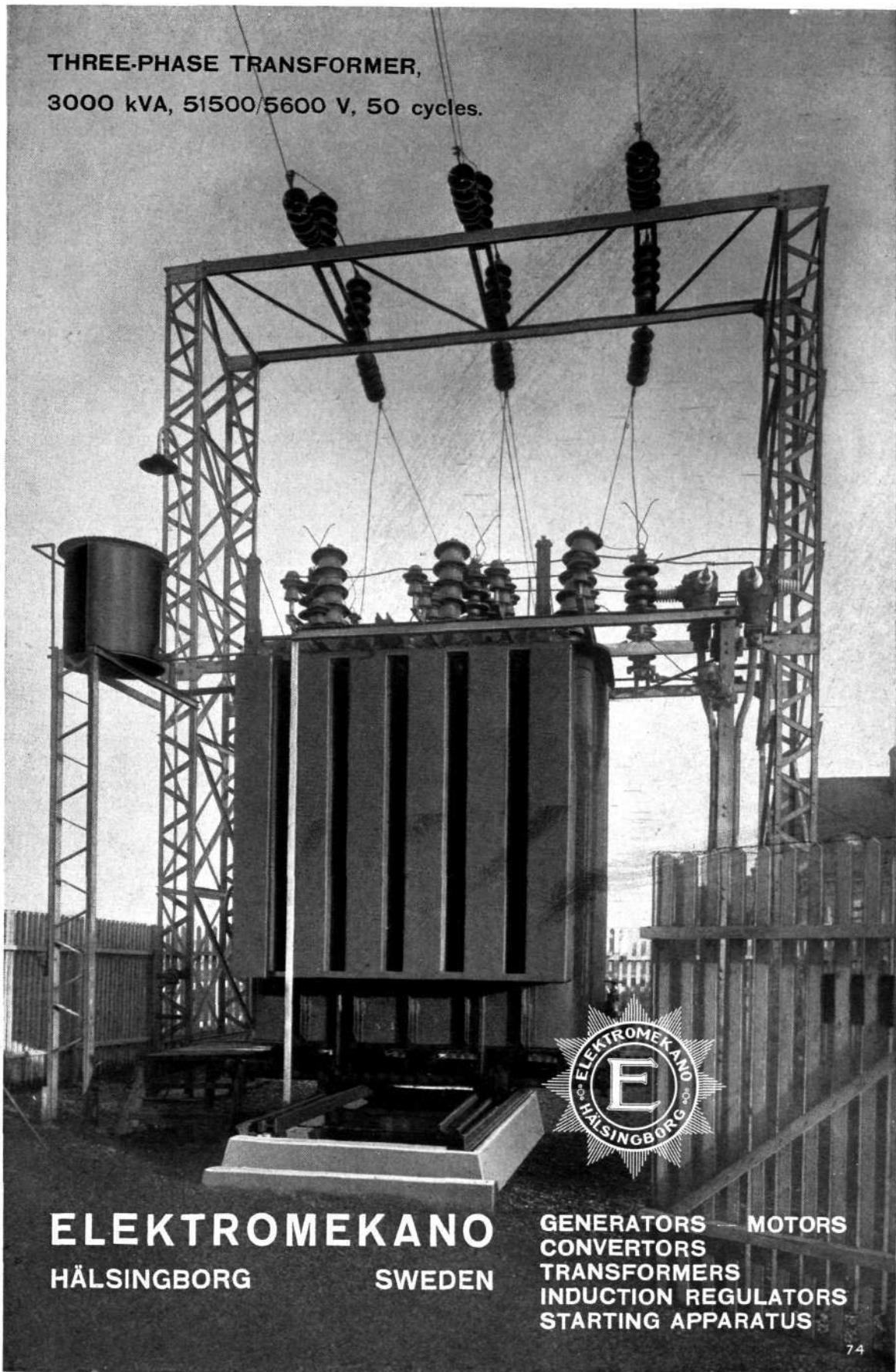
A NEW HIGH-QUALITY THREE-PHASE ELECTRICITY  
METER, DEVELOPED BY OUR RESEARCH AND DEVE-  
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**TELEFONAKTIEBOLAGET L. M. ERICSSON**

STOCKHOLM

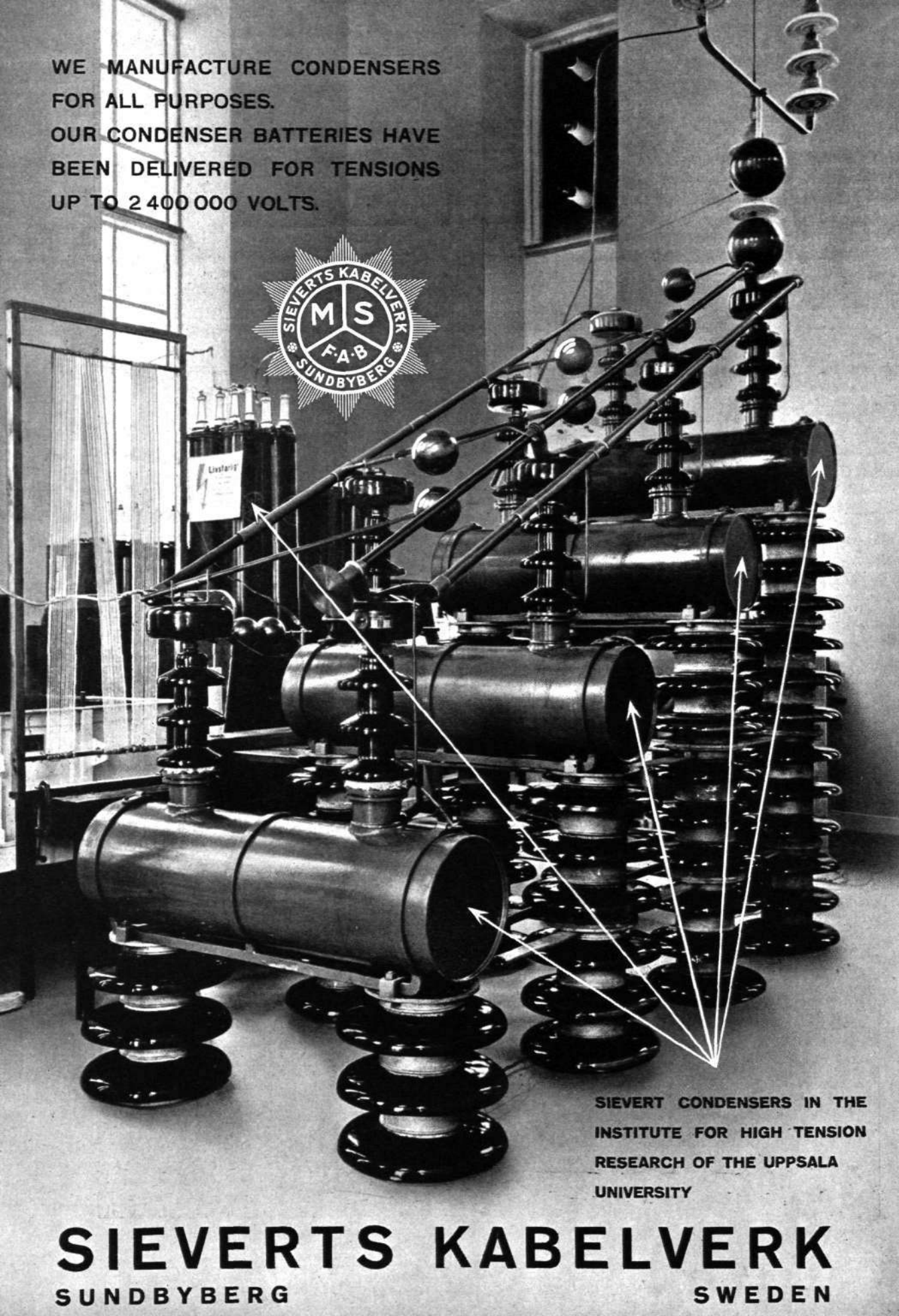
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The L.M. Ericsson  
Review

1933 Nr. 2

THIS CONFLAGRATION OCCURRED IN STOCKHOLM IN 1929  
AND COST THE INSURANCE COMPANIES £ 182.000.



**THE THERMOCONTACT**  
CALLS THE FIRE BRIGADE AUTO-  
MATICALLY AT THE CRITICAL  
TEMPERATURE.

In the night of 22 Nov., 1932, another fire started in the building erected on the site of the previous catastrophe. Thanks to Ericsson's automatic fire alarm system, the fire brigade was called instantly, and the damage caused was insignificant.

Several hundred million are paid annually for fire losses. Three quarters of these losses are due to fires during night hours.



**TELEFONAKTIEBOLAGET L. M. ERICSSON**

STOCKHOLM, SWEDEN

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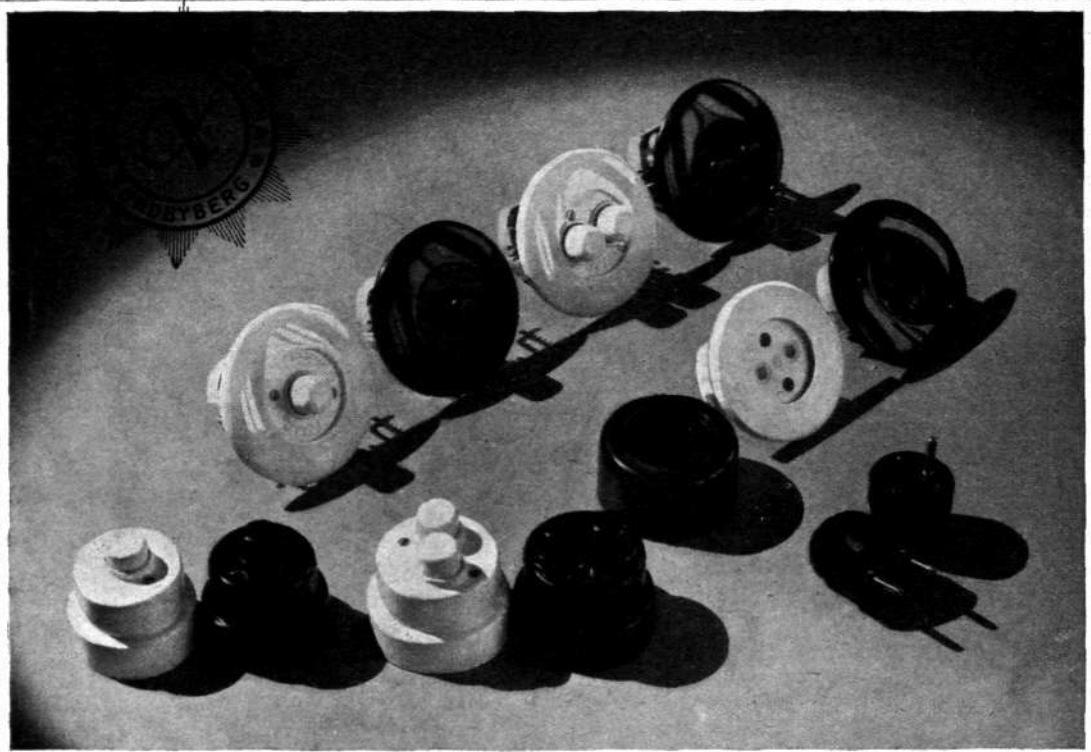
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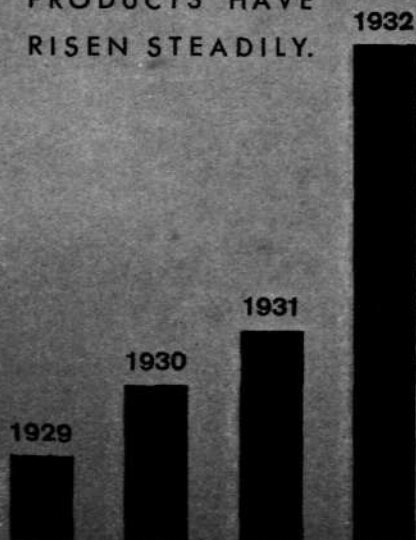


# ALPHA

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## AKTIEBOLAGET ALPHA

SUNDBYBERG, SWEDEN

# Carrier Telephone Systems of Ericsson's Design

By  
A. WESTLING



Central Sales Department,  
Telefon A. B. L. M. Ericsson,  
Stockholm.

The following article gives a brief orientation regarding the Ericsson Carrier Systems for aerial lines and their most important technical characteristics. The article has been written by request of the Secretariat of the CCI.

Older designs of the Multi Channel System have previously been described in the Ericsson Review, and a detailed description of the Single Channel System will be published shortly in the series Ericsson Technics. Also a catalogue containing detailed information about the Ericsson Carrier Systems is forthcoming.

These systems are, of course, founded on the same basic principles of multiple telephony laid down already in the eighties or nineties, and in the practical design also these systems make use of the fundamentals of valve technics developed mainly in connection with wireless apparatus. Different conditions of service and special designs

of some of the basic elements have, however, led to considerable differences in plant.

Already in the first systems installed in Finland and Sweden, the first time in 1921, a number of these distinctive features are to be found, and have proved valuable, these eldest systems still being in service. Later on, when the erection of a modern toll line system in Mexico was begun, the principles for the selection of carrier frequencies and other system questions were settled in a way to allow the best use of the carrier systems from the point of view of toll line operation.

Mexico seems to be one of the first countries of the world, where the toll line system has from the start been based on an extensive use of carrier facilities. It presents the same problem, which is now actual in many of the thinly populated countries of the world, i.e. to provide sufficient facilities for a gradually growing telephone and telegraph traffic or one or a few pairs. In order to provide for the best possible spare for all kinds of facilities it is in such cases important that both telephone and telegraph carrier channels could be operated on the same pair. Ericsson's multi-channel system is designed to comply with this demand.

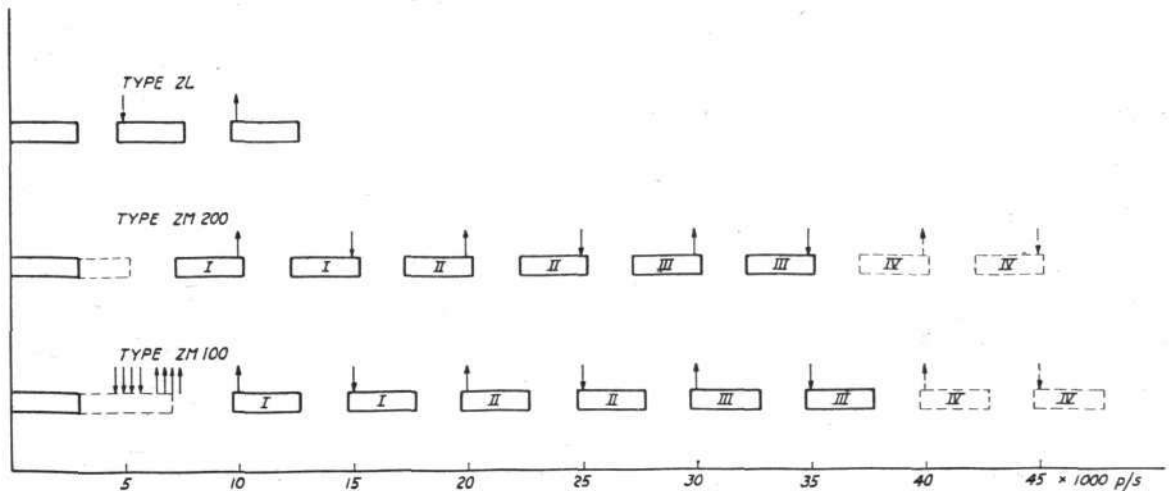
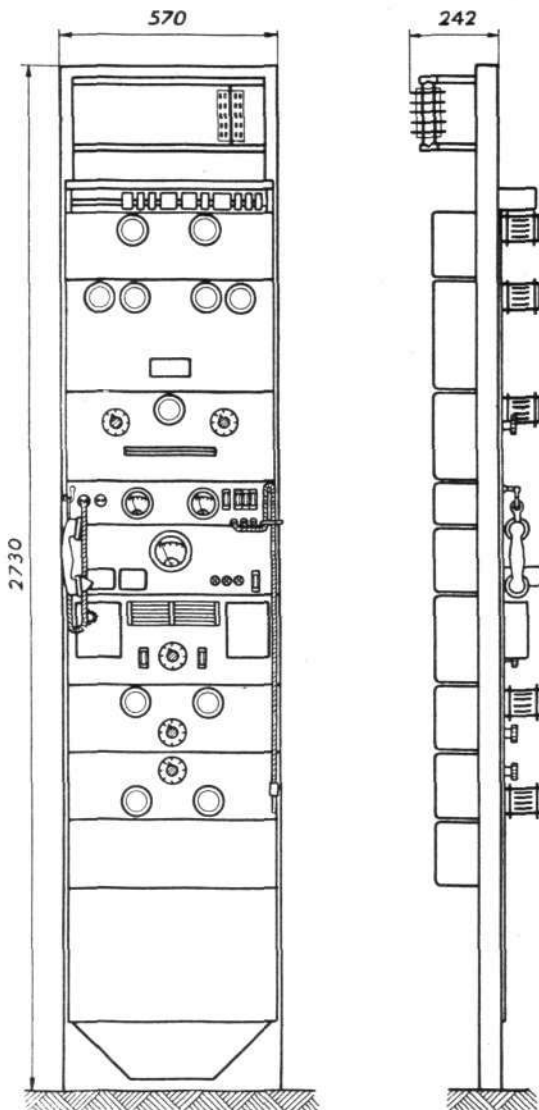


Fig. 1. Frequency allocation of carrier systems, Type ZL and ZM.

The arrows indicate the direction of transmission. The band width of the voice frequency channel is generally 3000 cycles, but may be increased to 5000 or 7000 cycles in the system ZM 200 and ZM 100 respectively for program transmission purposes.



X 1080 Fig. 2. Telephone channel bay, Type ZM.

## Distinctive Features of Ericsson's Systems.

Before describing the present systems some general questions of carrier design ought to be mentioned.

It is well known that Carrier Telephony is based on a frequency transformation of the currents of the different telephone connections from the ordinary voice frequency band to higher bands, which are previously not made use of on the line, and which are different for different channels. This is done by modulators and demodulators and the separation of the different bands is obtained by aid of frequency selective networks,

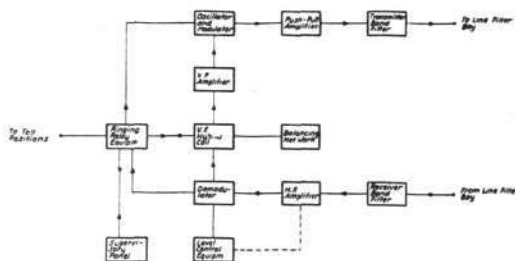
i. e. wave filters. The essential parts of a carrier equipment are, therefore, modulators and demodulators with oscillators as well as filters of different kinds.

## Modulators and Demodulators.

The type of *modulator* used in Ericsson's systems is the compounded modulator, the theory of which is published by Vos and Sterky.<sup>1</sup> It is characterized by the anodes of the modulator valves being connected in parallel while the grids are connected in push-pull, and by the compensation of the anode reaction through a kind of feedback arrangement making the anode current independent of the external load.

Also for the generation of the carrier frequencies a similar principle has come to use in some cases, viz. the multiple generator, described in the aforementioned paper.<sup>1</sup> In this generator the different carrier frequencies are produced as multiples of a common master frequency, thereby eliminating every possibility of disturbances through beat frequencies between one carrier frequency and the harmonics of another.

The *demodulators* in the receivers are of the same type as the modulators. The carrier transmitted over the line is used for demodulation, i. e. it is not necessary to generate a separate carrier frequency in the receiver. Compared to systems with suppressed carrier this system tends to make the equipment more expensive, the output amplifiers having to be dimensioned for a greater output. This has in Ericsson's system led to the use of separate output amplifiers for every channel. On the other hand an advantage in quality is obtained, distortion due to frequency differences between two carriers as well as to intermodulation in common amplifiers being avoided. The use of separate amplifiers also gives a free choice



X 1081 Fig. 3. Diagram of a telephone channel bay, Type ZM.

<sup>1</sup> M. Vos and H. Sterky: »The Use of Thermionic Valves for Generating Multiple Frequencies.» Svenska Teknologföreningens Skrifter Nr. 8.

when selecting carrier frequencies for the two directions.

The greatest advantage in transmitting a carrier of sufficient strength over the line, is that it provides, in a simple and efficient way, for certain necessary auxiliary functions, in the first place for ringing and level indication or automatic level adjustment. Ringing is made simply by modulating the carrier with ordinary ringing current and the ring signal is received in an AC tuned relay after demodulation. For indicating or automatically adjusting the level the rectified carrier may be used without complicated additional equipment. This method of level control has, compared to arrangements with a separate pilot channel, the very great advantage, that it indicates the alternations in line attenuation for each individual channel and also alterations in the amplification of the equipment proper.

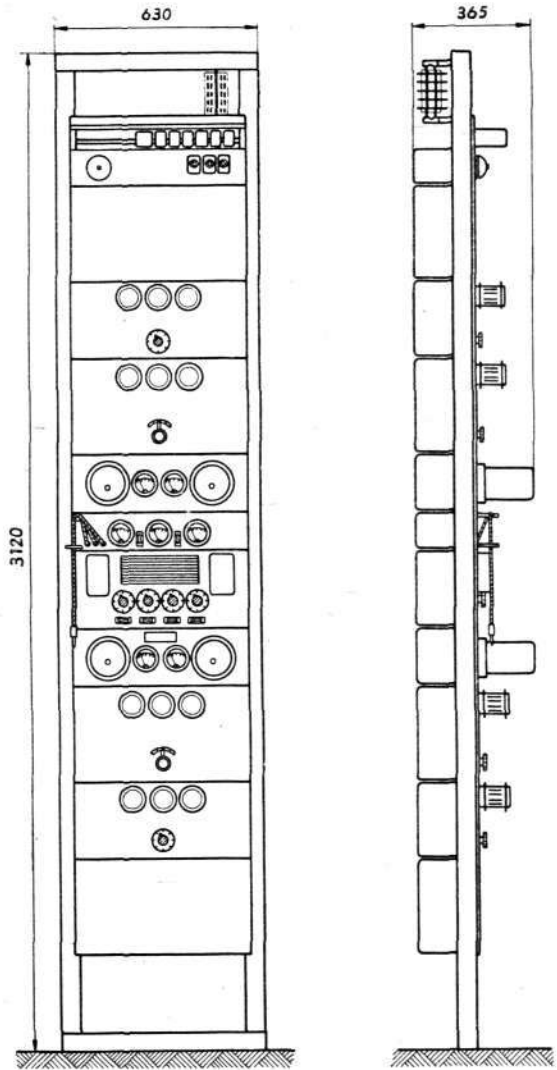
## Filters.

Of the many problems involved in the design of *filters* for carrier purposes only some of greater general importance can be mentioned in this paper.

It has been shown in a paper prepared for the 3rd commission of CCI by Vos<sup>2</sup> that cross-talk between two carrier systems operating on adjacent pairs on the same pole line are due to reflections between the lines and the filter equipments connected to them and, consequently, that cross-talk may be diminished by matching the filter impedance to the line impedance in the best possible way. Also inside the equipment good matching between the different apparatus is of great importance from this and other reasons. For obtaining this purpose two special designs used in Ericsson's carrier systems are of great value. One is the double-filter, described in French Patent 706439, which possesses a practically frequency independent impedance also in the proximity of the filter limits. The second design is known under the name of « $\alpha$ -matching» and is described in a paper by Sterky.<sup>3</sup> According to this method the filter impedances and the terminal load resistances are well matched without increasing the number of elements of the filter prototype.

<sup>2</sup> M. Vos: «Cross Talk between Telephone Lines.» Ericsson Review Nr. 7—12, 1930.

<sup>3</sup> H. Sterky: «Simplified Methods of Designing Electric Wave Filters and a Contribution to the Theory of Matching Filter Quadrupoles.» Ericsson Review Nr. 1—3, 1932.

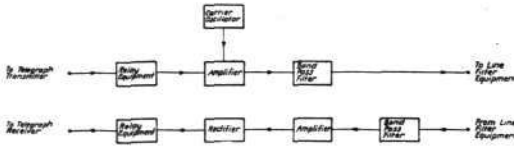


x 1082

Fig. 4. Telegraph channel bay.

Another special feature in the design of line filter equipment in Ericsson's systems is *high frequency line transformers*. These quadrupoles which replace ordinary repeating coils pass a frequency band between 20 and 50 000 cycles with a very small attenuation. They solve in a simple way the problem of keeping the phantom balance when one of the physical circuits is carrying high frequency, and when there is no phantom circuit they give a possibility of earthing the mid point of the line in order to reduce line noise.

Finally it ought to be mentioned that high frequency hybrid coils are used in the line filter equipments for the Ericsson's systems. It is true that such hybrid coils are not necessary, when different frequency bands are used for transmission in each direction, but it has proved to be of



X 1083 Fig. 5. Diagram of telegraph channel rack.

advantage to use such coils which allow the channel band filters to be made electrically shorter and cheaper. This depends upon the fact that the hybrid coils will introduce a certain useful attenuation also if the balance is not perfect. Balancing filters must in any case be provided for balancing voice frequency repeaters on the physical circuits of the line in question and may then as well be used also in connection with hybrid coils, the costs of which are very small.

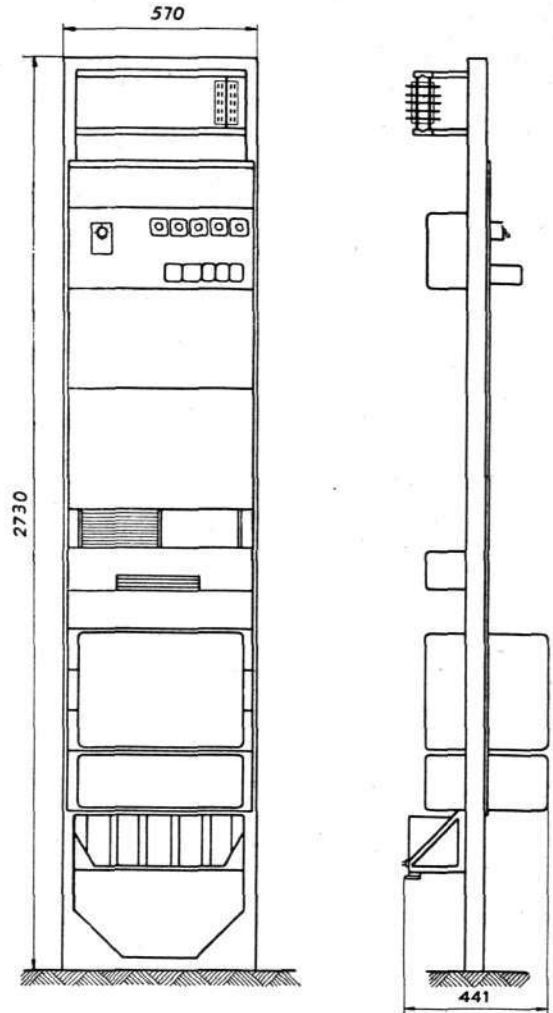
## Telegraph Receivers.

Among the details of the telegraph equipment may be mentioned the detector of the receiver, which operates with combined anode bend and grid rectification. If the input signal tension varies, an increase of the anode current on account of the anode bend rectification will thus be compensated by a decrease on account of the grid rectification; the current in the receiver relay is thus kept practically constant even if the line attenuation varies. With his arrangement the relay operates better, and less supervision is required.

It is not possible to describe in this paper the other units of the design which, together with modulators and filters, form a carrier equipment. Regarding mechanical design and items belonging to ordinary telephone practice, it is sufficient to say that these are of normal Ericsson design.

## Multi Channel System, Type ZM.

It has been mentioned before that Ericsson's multi channel system provides for both telephone and telegraph channels on the same pair. The maximum number of channels of each type may be varied by altering the limit between the bands used for telephony and for telegraphy. Normally the limit frequency is 9 500 cycles, and it is possible to supply 4 duplex telegraph channels and 3 or, when the distance is not too great, 4 telephone channels. Fig. 1 shows the frequency allocation of this system, Type ZM 100.

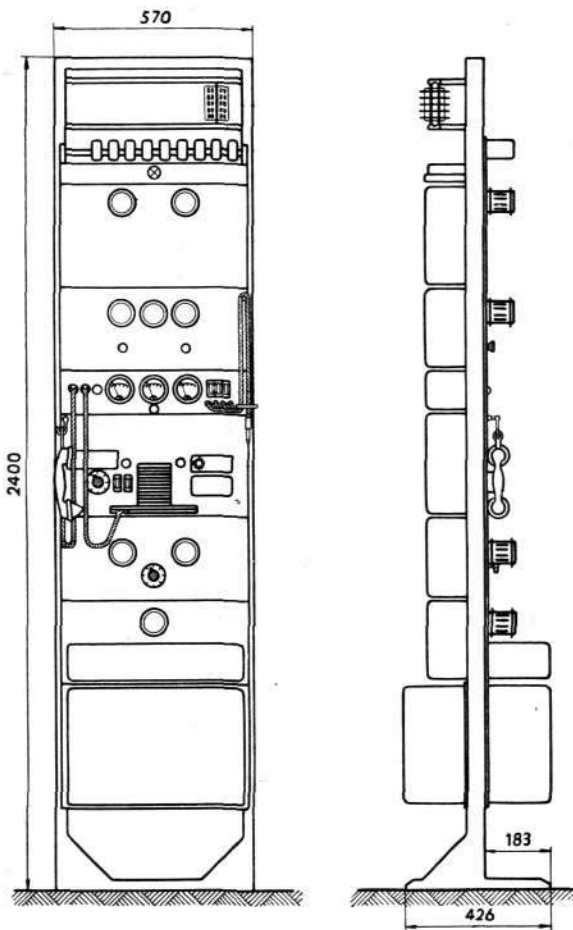


X 1084 Fig. 6. Line filter bay, Type ZM, for one overhead line.

It will be seen that the carrier frequencies for telephony are all multiples of 5 000 cycles. The carrier and the upper side band are transmitted over the line.

When two multi channel systems are to be operated on adjacent pairs on the same pole line one system of Type ZM 100 and one system of Type ZM 200 are used. The latter system uses the same carrier frequencies, but the lower side band is transmitted instead of the upper side band. No telegraph channels are provided for in this system.

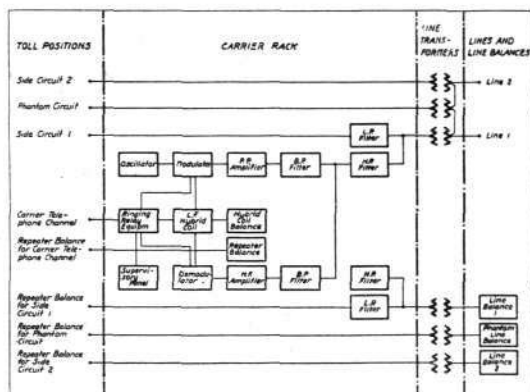
The carrier frequencies for telegraphy are chosen so that the relation between a certain carrier frequency and the adjoining lower carrier frequency is constant. The lowest carrier frequency is 4 600 cycles and the highest 7 600 cycles. At the same time the band widths of the filters have been calculated so that the relation between



X 1085 Fig. 7. Single channel rack, Type ZL.

the upper cut-off frequency and the mean frequency of a band is constant. The minimum band width is 200 cycles, permitting a maximum telegraph speed of about 200 words per minute which corresponds to 160 Baud. In the high channels greater speed can be used. The carrier frequencies are divided in two groups of adjoining frequencies, one group for each direction.

The equipment of one carrier telephone channel is mounted on a common bay according to Fig. 2 and contains the main parts shown on the schematic diagram, Fig. 3, as well as current distribution and other auxiliary equipment. The equipment for two duplex telegraph channels are generally assembled in one bay, Fig. 4. Each equipment comprises the parts shown in the diagram, Fig. 5, as well as auxiliary equipment common for both channels. The line filter equipment common for all the channels is mounted on a separate line filter bay, Fig. 6, which also contains a main fuse panel for the rack. When two



X 1086 Fig. 8. Diagram of single channel rack, Type ZL.

carrier systems are installed at the same office it is possible to mount both the line filter equipments on the same line filter bay.

A complete terminal equipment for a system with duplex 3 telephone channels and will consequently consist of one line filter bay, two telegraph channel bays and three telephone channel bays.

The amplification of the transmitter and receiver is sufficient for a line attenuation of about 4 neper measured at the highest frequency used. Systems with automatic level adjustment have a still greater amplification. It is, however, well known that the practical range of a carrier system is not limited only by the amount of amplification provided, but also by the properties of the line in question, at first hand its noise level. The figures in the following table are calculated for ordinary well constructed lines without intermediate cables.

Line Type	2 mm	2.5 mm	200 lbs	3 mm	300 lbs	4.5 mm
Range in km with 4 Telephone channels .....	215	245	265	280	315	345
Range in km with 3 Telephone channels .....	240	275	300	325	350	400
Range in km with 2 Telephone channels .....	285	355	350	380	415	475

When the distance is greater, intermediate carrier repeaters are used consisting of line filter equipments and amplifiers of the same type as those used in the terminal equipments.

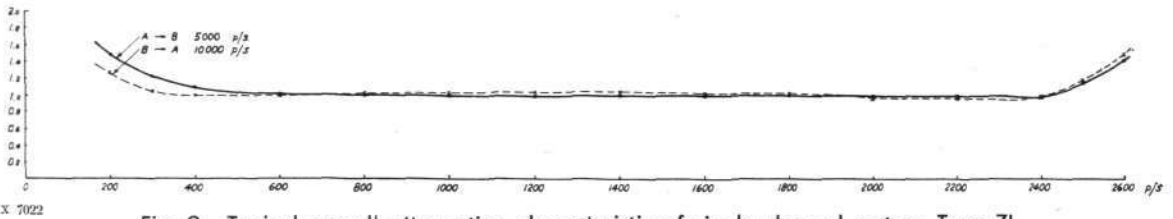


Fig. 9. Typical overall attenuation characteristic of single channel system, Type ZL.

## Single Channel System, Type ZL.

It must be emphasized that the carrier current telephone systems are not only temporary means of increasing the number of facilities, but must be regarded as an ordinary part of modern toll line systems. It presents nevertheless a great advantage that the carrier systems may easily be moved, as this feature makes the toll line system more flexible than a system containing only physical circuits. In systems where such rearrangements are common or may be expected, single channel systems are specially suitable. The properties of the lines are not of so great importance when such a system is used, owing to the lower frequencies employed. The equipment is mounted on one single rack which may be easily moved from one place to another. They provide one telephone connection in addition to existing circuits, and three systems may be operated on one phantom group without cross-talk.

Ericsson's single channel system, Type ZL, is designed according to the same principles as the multi channel system. The carrier frequencies are also in this system multiples of 5 000 cycles, viz. 5 000 and 10 000 cycles resp. and the carrier frequency as well as the upper side band are transmitted over the line. Amplifiers are used both on the transmitter side and the receiver side and therefore the system covers large distances. The amplification is sufficient for a line attenuation of more than 4 neper, which at these frequencies corresponds to the following practical ranges on ordinary lines:

Line Type	2 mm	2.5 mm	200 lbs	3 mm	300 lbs	4.5 mm
Range in km .....	375	465	485	525	580	700

Modulators, demodulators and ringing equipments are of the same type as those used in the multi channel system and also the meter and supervisory equipments are practically the same.

It has been possible to reduce the filter equipment considerably, and no hybrid coils are used.

The complete equipment is mounted on one single bay according to Fig. 7. The diagram is shown in Fig. 8. The rack is delivered completely wired and may be connected on the office side of the repeating coils if these are of good quality. The erection is, therefore, very simple.

The same care has been taken in this system as in the multi channel system to ensure the best possible quality of transmission, as will be seen from the typical overall attenuation frequency characteristic shown on Fig. 9. It is, therefore, possible to obtain any range wanted with this

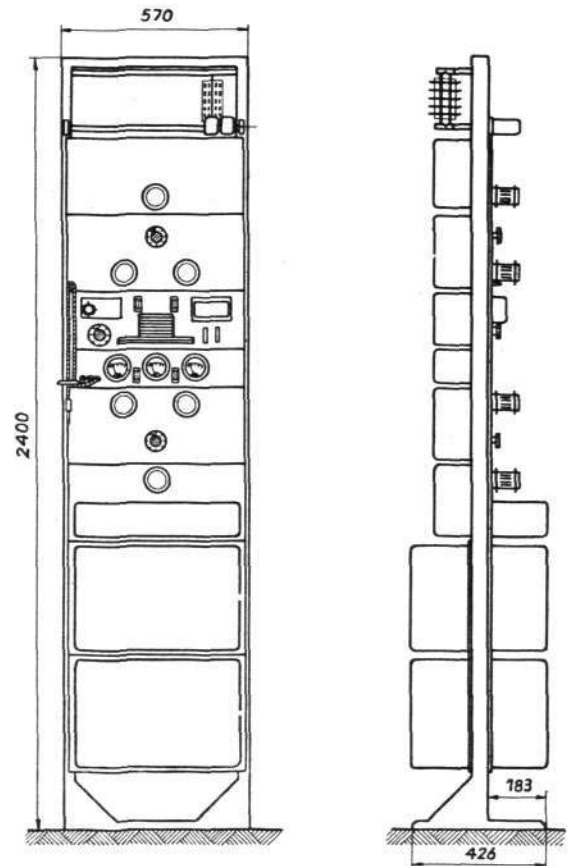


Fig. 10. Carrier repeater rack, Type ZL.

system by aid of intermediate carrier amplifiers. These amplifiers are mounted on a rack, Fig. 10, of the same size as a terminal rack and contain the same filter and amplifier elements. When the range is very great the system is provided with automatic gain adjustment of the same type as in the multi channel system.

Of special interest is the use of single channel systems on railway telephone lines with selector equipments. In such cases a great number of

high frequency shunts are necessary and a special type of shunts is used which presents a sufficiently low attenuation and may be manufactured at a reasonable cost.

In such offices, where the necessary tensions are not available from batteries installed for other purposes, for instance for ordinary repeaters, both anode and filament currents may be supplied from the power mains by aid of rectifiers and a small floating battery.

## Single Channel Carrier Telephone System Operated on Selective Calling Telephone Lines

A telephone line is generally used for only one communication at a time. If more communication facilities are wanted, several lines or some kind of carrier system must be used. The choice is normally determined by economic considerations.

In railway service, selective calling telephone systems are nowadays widely used. A telephone line with selector equipment can, however, carry only one communication at a time. By dividing the line into a convenient number of sections a better utilization of the line is obtained (see article on Selective Calling Telephone Systems in the Ericsson Review Nr 1, 1933); the usefulness of such an arrangement is, however, limited, as a great many calls may be exchanged between two main stations at a great distance from each other. In that case no sectioning devices will help, as the communications will occupy the whole line between these stations.

The only really effective solution is to install a new line, which can not be blocked by calls between the way-stations. The building of a new line is, however, expensive, and the modern method is to use the existing lines for a carrier channel. Ericsson has designed a suitable system, described in this article.

A carrier telephone connection between two principal railway stations is fully independent of the selector telephone connection and requires only a terminal rack with appurtenant arrangements for power supply at each of the two principal stations, and small filters inserted in the line at the way-stations.

The arrangement of the system is shown in Fig. 1.

At the principal railway stations, A and B, terminal racks of the single channel system are connected to the selector line. One of the terminals transmits the carrier frequency, 5 000 cycles,

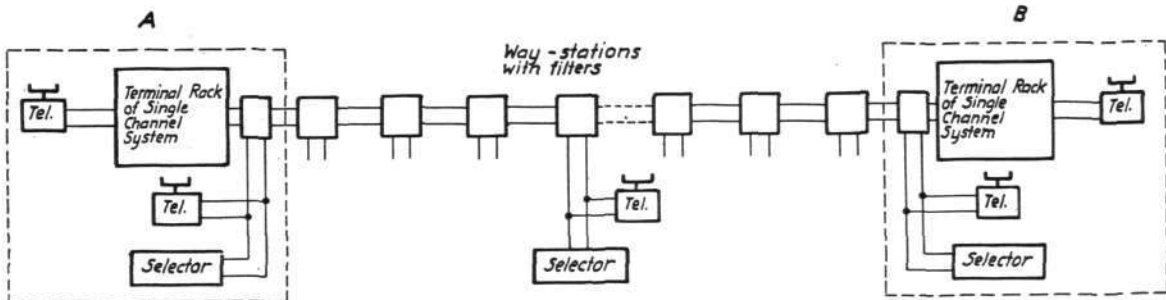
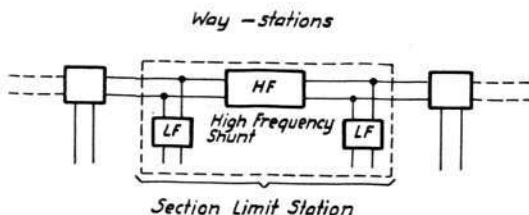


Fig. 1. Diagram of single channel telephone system operated on a selector line.



X 1088

Fig. 2. High frequency shunt at section limit station

and receives 10 000 cycles, the other terminal being designed for receiving 5 000 cycles and transmitting 10 000 cycles.

By means of filters the carrier communication and the selector telephone communication are separated, the selector telephone channel being led to the selector telephone equipment, whilst the carrier channel is led to another telephone set via the terminal equipment, thus permitting direct speech between the stations A and B independent of whether the selector line is engaged or not.

At every way-station a filter is installed. The filter is inserted into the line and composed of two filter links, one letting through the carrier communication and connected in parallel with the other link, which lets through the voice frequency selector telephone communication, the selector equipment and its telephone being connected to the mid-point of the latter link.

The additional effective attenuation introduced into the selector channel by each way-station filter is less than 0.03 neper for frequencies between 200—2 500 cycles, except for the filters at the two stations for the moment engaged, for which the additional effective attenuation will be about 0.20 neper for frequencies between 200—2 900 cycles. The corresponding DC loop resistances are 6 and 35 ohm only.

The effective attenuation for the carrier connection caused by each way-station filter is only 0.015 neper, a very small value compared with the line attenuation.

At section limit stations of the selector system, *i. e.*, at stations where the line is interrupted to permit the separation of two selector telephone sections, a high frequency shunt has to be installed in order to pass the carrier currents from one section to the other without disturbing the normal operation of the two selector sections (see Fig. 2).

The terminal stations are of the standard design of the Ericsson single channel carrier current system, Type ZL. For a description of the single channel system see the preceding article.

The range is, however, somewhat smaller for a system operating on selector lines, as each way-station filter involves an additional attenuation of about 0.015 neper. In the table below there are to be found the range without way-station filters, and the decrease of the range caused by each way-station.

Line Type	2 mm	2,5 mm	200 lbs	3 mm	300 lbs	4.5 mm
Range without way-stations, km .....	375	465	485	525	580	700
Decrease of range caused by each way station, km.....	1.4	1.7	1.8	2.0	2.2	2.6

Example: A selector system with 50 way-stations operates on a telephone line of 3 mm copper wire. The range on such a line is 525 km, according to the table. From this value ought to be subtracted:

$$50 \times 2.0 = 100 \text{ km.}$$

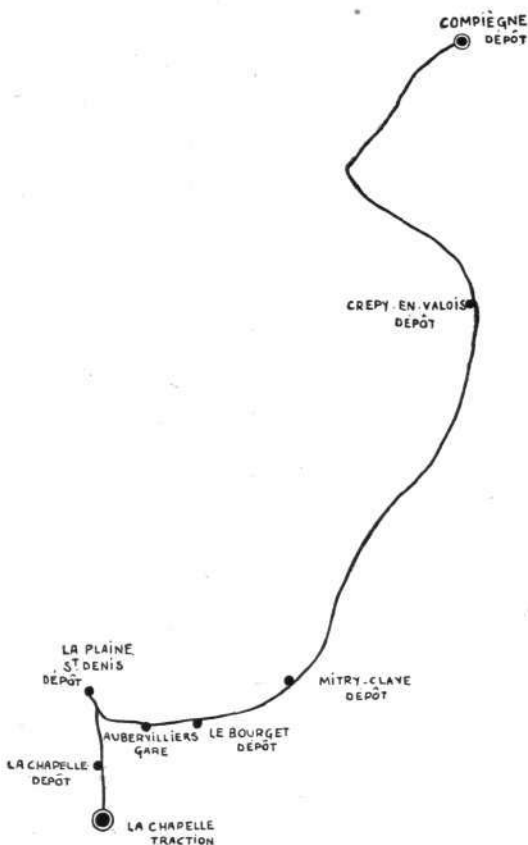
The remaining range is thus:

$$525 - 100 = 425 \text{ km.}$$

A single channel system can thus in this case operate between the terminal stations, if the distance does not exceed 425 km.

In the standard design the way-station filters are mounted in dustproof cases of sheet-iron; the filters are then mounted in the same room as the selector equipment. If the filters are to be inserted in the line, two two-wire connections between the station and the shunting point at the nearest pole are required. If one two-wire connection only is available, the filter must be mounted on the pole, and enclosed in a waterproof box of cast iron.

# Installation of Selective Calling Telephone System on the Paris—Compiègne Railway Line



X 1114

Fig. 1. Map of the line Paris—Compiègne.

With a view to modernizing their telephone installation, the Compagnie des Chemins de Fer du Nord has decided to replace its old system by a modern installation in order to ensure reliable and rapid communications between the stations. This substitution will be performed without any substantial alterations of the lines.

As the funds available for rebuilding the lines do not permit the construction of direct connections between stations, the possibility of building new lines is thus a priori eliminated.

The Chemins de Fer du Nord have specified the use of a system with the line divided into a number of sections. This means that a conversation between two stations will only occupy the line section between them. The rest of the line from the stations calling and called, is free for communications between adjoining stations.

These circumstances have limited the choice of systems considerably. In order to realize the above requirements the only system available is *inter-*

*communication with selective calling* and a separate battery at each station.

It is thus an installation according to this system, for a line between Paris and Compiègne, that the Compagnie des Chemins de Fer du Nord has ordered from Société des Téléphones Ericsson, Colombes.

We are now going to examine the problem given by the railway company; we will see below in which way it has been solved.

The line from Paris to Compiègne is intended for traction service and permits communications between the different engine depots. The length of the line is 90 km with eight stations connected (see Fig. 1).

Each apparatus must permit the following combinations to be made:

1. To call any station on the line, while letting the line sections not used for the connection remain free. E. g.: le Bourget, when calling Mitry, Crépy or Compiègne, must leave the line between Paris and le Bourget free.

2. To answer a call from any station on the line while letting the part not in use remain free. E. g.: Mitry when answering a call from le Bourget must let the line between Mitry and Compiègne remain free.

3. To permit communication between the stations on the selective calling line and the stations in adjoining circuits connected to the switchboards at the engine depots. In this case the line not used must remain free.

Further, if the connection between one selective calling station and an external station passes the switchboard at another selector station, the end of the conversation must be automatically indicated at the switchboards when the handset of the selective calling station in circuit is replaced.

The different arrangements are shown in Fig. 2.

At each station the line passes four push-buttons which are normally in rest position. The two inner buttons are used for disconnecting the part of the line not engaged when the operator is calling. The two outer buttons disconnect the

Switch boards.

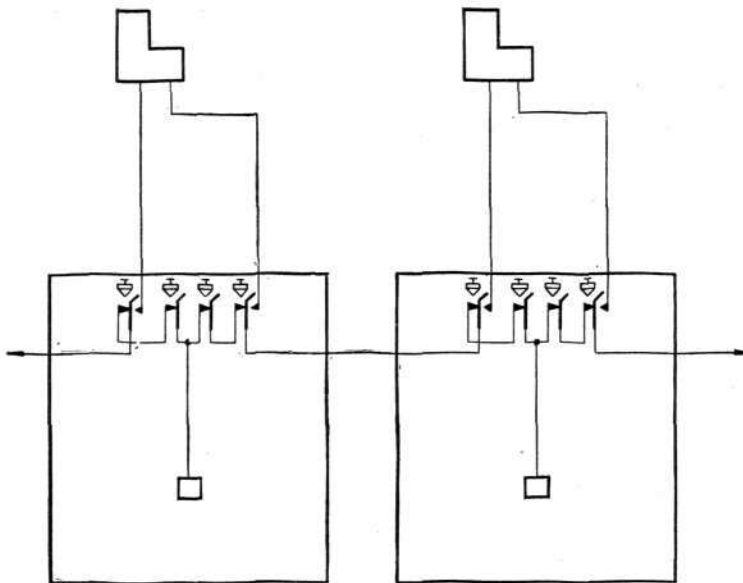


Fig. 2.  
Diagram of a selective calling  
telephone line.

X 5040

right or the left part of the line to the switch-board to which the external lines are connected and at the same time the part not in use.

The communications passing through the selector stations are called CD (*communications dérivées*).

In order to know whether a call has reached the station wanted, a signal is heard at the calling station when the station called receives the ring signal. If no signal is heard by the operator the line is disconnected at some station between his apparatus and the station called.

## Technical Design.

Société des Téléphones Ericsson has used a selective calling system with AC selection. The ringing current is supplied from the AC mains by means of a transformer. In the country it will sometimes happen that the current supply is interrupted. On such occasions, when the normal signal generator fails, it will be automatically replaced by a pole changer.

The selector operates by means of a local 6 V battery and the microphone current is supplied by another battery. The idea is to avoid the necessity of fitting each station with a high tension battery which would mean high installation and maintenance cost.

The apparatus is shown in Fig. 3. It consists of a metal case supporting the different parts. To the left the handset is seen hanging on a switch

hook; the second receiver is to be found below the apparatus.

To the right is the handle of the auxiliary generator. On the upper part of the front side three drop indicators are situated. The middle indicator falls and actuates the bell when the station is called; the plate below this indicator shows the number of the station.

The other two indicators marked »Amont» (*Above*) and »Aval» (*Below*) indicate the end of a conversation if a CD connection has been made.

The row of buttons consists of two sets of two buttons each. The two inner buttons correspond to the interruption button shown in Fig. 2. The two buttons are released when the handset is placed on the hook. A mechanical arrangement ensures simultaneous operation when cutting the line. The two outer buttons correspond to the button CD in Fig. 2. These buttons are provided for connection but are released neither by the switch hook nor by each other. When pressed they insert the drop indicator in the line to the switchboard. The star signal indicator on the left of the dial indicates whether the line is engaged or not; the handset must not be lifted as long as the white signal is shown. The two buttons on the right are marked »Appel» (*Call*) and »Annulation» (*Cancel*); we are going to examine their functions below.

The dial is of the type currently used in automatic telephony but is locked when turned from resting position the number of holes correspond-



X 1115  
Fig. 3. Selective calling telephone instrument.

ing to the number of the station called. It may be released in three different ways:

1. When the call-button is pressed in order to call a station.
2. When the generator is turned in order to call a station, the AC supply being out of order.
3. When the cancel-button is pressed in order to correct in error or to cancel a call already made.

The locking of the dial is necessary for the two following reasons:

1. The engagement of the line is not indicated at the stations except when the operator presses the call-button. It is of course important to reduce to a minimum the time during which the handset is lifted but no call made. If the dial were not locked the operator would first have to listen if no conversation was going on, then replace the handset, turn the dial with the left hand and at the same time press the calling button with the right hand; thereupon he would have to lift the handset to hear the call returned. All these manoeuvres have been avoided by means of locking the dial.

2. If the generator is to be used, the operation would be still more complicated if the dial were not locked. It would then be necessary to dial with the left hand and at the same time to turn the generator with the right. This would give a very irregular ringing voltage and frequency.

Different operators would further turn the generator at different speeds, thus giving varying ringing conditions.

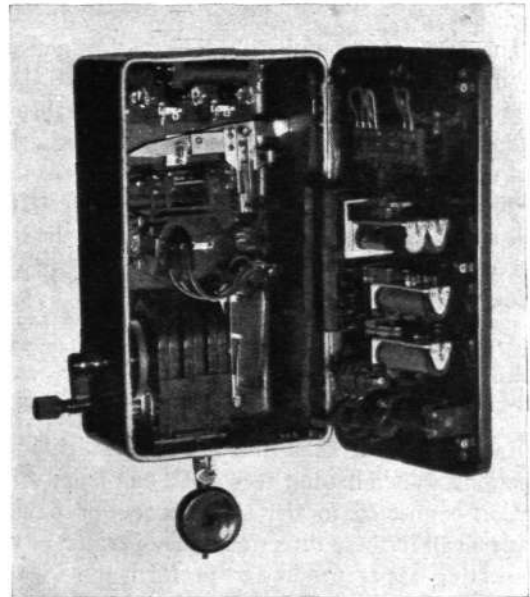
In the system made by Ericsson the dial is released by means of a relay operated by the generator.

The relay does not operate and connect the generator to the line until the voltage, and consequently the frequency, have reached a convenient value.

The operator has thus only to keep the speed during the rest of the call.

Fig. 4 shows the interior of the apparatus, the connections of the hook, the dial and the button strip. On the bottom plate are found the connection strip, the selector and the two relays necessary for operating the station and further the induction coils of the filter permitting the conversation.

It is also shown how the apparatus is protected against dust by means of a felt lining around the cover.



X 1116  
Fig. 4. Selective calling telephone instrument, opened for inspection.

## Operation.

The apparatus functions in the following way: An operator desiring to call another station makes sure by means of the star signal indicator that no dialling is going on, and then sets his dial on the number desired. The handset is lifted and the operator listens if the line is free; if this is the case he presses the call-button. The dial is released and the impulses are transmitted. The call-button must remain pressed when the dial has returned to resting position, and if the called station is reached the return of the call will be heard.

At the station called the signal will cease

- 1) when the call is answered,
- 2) when the calling operator ceases to press the call-button.

## Sectionizing.

The stations calling and called cut the line at their apparatus leaving free the sections not used. In order to do so, the operators press the buttons »Above» or »Below». When the handset is replaced these buttons are released, and one clearing signal is transmitted automatically on the section used. This signal is intended for indicating the end of a CD.

When the line is cut at a station the receiving apparatus is automatically connected to the part not used in order to ensure the termination of the line.

The number 0 has been reserved for general or urgent calls.

If a station wants to make an urgent call and finds the line cut the number 0 is dialled; this will cause all call indicators to fall inclusive that of the station where the line is cut. This latter will receive instructions, the continuity of the line is reestablished and the urgent call can thus be made.

## CD Communications.

Each apparatus can make two CD communications. When having received a call from some station connected to the switchboard or having made a call in these directions, the operator of the connecting apparatus has to perform the following operations:

1. press the connecting button,
2. replace the handset.

When the connecting button is pressed, the selector line is connected to the external line over two condensers and a supervisory indicator.

At the same time the selector apparatus is connected to the line not used, and may continue to operate as an ordinary apparatus on this section.

When the conversation is finished, the clearing signal transmitted by the Ericsson instrument will release the supervisory indicator. The switchboard operator having established the CD pulls the connecting button and replaces the supervisory indicator.

The system operates in the same way when the auxiliary generator is used.

The end signal from the Ericsson station may, however, be made in the usual way by giving a long signal with the generator.

The apparatus at Aubervilliers is not fitted with the CD buttons but is otherwise identical to the others except that it can only call the numbers 1, 2 and 3, i e.,

Chapelle Traction . . . . .	1
Dépôt de la Chapelle . . . . .	2
Dépôt de la Plaine . . . . .	3

The Aubervilliers station only answers the number for general calls.

This number is only used when a station wishing to make an urgent call finds the line cut.

## Operation Results.

The plant has been in service for several months in a very intense traffic. Each station performs 80 to 100 calls a day. The railway company is very well satisfied with the installation and its various parts as well as with the operation of the system as a whole.

The installation will be used on trial for one year. During this time the maintenance was to be ensured by the agents of Société des Téléphones Ericsson, but as interruptions have been negligible and almost always due to line trouble or bad contacts, the railway company has taken over the maintenance after a few months.

Every morning all stations have been systematically tested and the results filed. The fact that the company has ordered the plant to be manufactured before the end of the delay prescribed for the manufacture makes evident that the installation has been entirely satisfactory. This kind of plant may thus be expected to become an important article for railway telephone plants.

# Reliability and Maintenance Cost of the Automatic Telephone Exchanges of Stockholm during 1932

By A. LIGNELL,  
Director of Telephones, Stockholm.

*The author gives an account of the operation of the Stockholm automatic telephone exchanges, with a summary of operation statistics for 1932, proving that the reliability of the Ericsson automatic system is extremely high, and that the number of faults, as well as maintenance cost and power consumption, are remarkably low.*

In 1932 the fifth automatic telephone exchange in Stockholm has been put in operation, and in April 1933 about 16 000 subscribers' lines were changed over to a new automatic exchange in Östermalm. This latter is equipped for 25 000 lines and will replace the two manual exchanges in Östermalm. When these lines have been changed over, more than 100 000 of the 116 000 subscribers' lines in Stockholm will be connected to automatic exchanges of the Ericsson system.

Capacity, number of subscribers' lines, number of calls per subscriber and the date, when the exchange was put in operation, are shown in the table below. All exchanges in operation during 1932 are included.

Exchange	Capacity	Average number of subscribers during the year	Average number of calls per subscriber and working day (8 a. m. —9 p. m.)	The exchange was put in operation in
Norra Vasa ...	10 000	8 011	6.19	Jan. 1924
Kungsholmen	21 000	14 576	5.25	June 1928
Centralen .....	20 000	16 495	13.17	Jan. 1929
Söder .....	40 000	25 911	5.30	July 1931
Södra Vasa ...	30 000	19 719	4.98	March 1932
Total	121 000	84 712		

## Reliability.

Experience of the automatic exchanges of Stockholm has shown, that the best way to control the reliability is to control a sufficient number of calls made by the subscribers. The reliability control has for several years been performed in the following way: When a call is connected to a register, a white lamp in a supervisory board is lighted (white register lamp). If the call is to be watched, the operator makes a connection to the line, when the white lamp is lighted and thus follows the connection process. Any irregularity in the connection is noted, and, if faulty, the connection is locked and the cause of the fault is traced. As a great number of calls over all registers of the exchange are controlled during all months of the year, the result obtained gives a correct view of the reliability during the year.

In the Ericsson Review Nr. 4—6, 1932, an article was published on the results of the control during 1931. In the table below the results of the control of reliability during the whole year of 1932 are shown.

As may be seen of 413 806 controlled calls  
97.09 % have had no faults,  
2.66 % faults caused by the subscribers,  
0.04 % » » » » operators,  
0.21 % » » » » technical apparatus.

The average percentage of correct calls is 97.09 and varies in different exchanges between 98.10 and 96.32, the variation being caused chiefly by the

## Reliability control statistics at the automatic exchanges during 1932.

Exchange	Total number of controlled calls	Faultless					Faults by subscriber	Faults by operator	Faults in the technical equipment located to					Faults not located	Total
		Calls put through	Number changed, vacant or cut off	No reply	Engaged	Total			own exchange	other exchange	lines	subscribers' telephone	Total		
Norra Vasa	76 331	61 503	493	5 755	6 289	74 040	2 185	25	20	15	4	2	41	40	81
Kungsholmen	85 069	65 948	450	7 657	7 884	81 939	2 869	22	79	14	—	1	96	143	239
Centralen ...	77 598	63 731	329	5 458	6 609	76 127	1 218	8	71	13	—	1	85	160	245
Söder .....	115 914	91 897	728	9 561	10 180	112 366	3 236	71	131	31	—	—	162	79	241
Södra Vasa...	58 894	46 322	423	5 234	5 300	57 279	1 518	25	22	12	1	2	37	35	72
Total	413 806	329 401	2 423	33 665	36 262	401 751	11 026	151	323	85	7	6	421	457	878
%		79.60	0.59	8.14	8.76	97.09	2.66	0.04	0.08	0.02	—	—	0.10	0.11	0.21

subscribers' share in the fault percentage. This latter, the average of which is 2.66, is lowest, 1.57, at the »Centralen» exchange, which has the greatest traffic intensity, and where chiefly business telephones are connected, and highest, 3.37, at »Kungsholmen», where there are chiefly residence telephones.

The average percentage of »engaged» is 8.76, and varies between 9.27 and 8.24, and the average percentage of »no answer» is 8.14 varying between 9.0 and 7.03; the last mentioned number refers to »Centralen», where chiefly business telephones are connected.

As the percentage of residence telephones is great—more than 60 % of the number of subscribers—the percentage of »no answer» has, of course, been greatest in July and August, the holiday and travelling season.

The percentage of calls lost by technical faults, the faults having been traced, is 0.10; 0.08 % have been traced to the exchange under control and 0.02 % to other exchanges. Faults traced to the lines and subscribers' instruments have been less than 0.005 %. Some part of the 0.11 % of lost calls, where the faults have not been traced, falls, of course, outside the automatic equipment: in manual exchanges, or in lines and subscribers' instruments. The percentage of calls lost by faults in the automatic equipment is surely considerably less than 0.2 %. The total percentage of lost calls, caused by technical faults, on the traffic to automatic and manual exchanges varies between 0.11 and 0.32, and is greatest at the »Centralen» exchange, which has the highest traffic intensity.

The average percentage of lost calls is remarkably small and is a good proof of the *excellent reliability of the Ericsson automatic system.*

Additional loss caused by insufficient trunk capacity will not occur, as the only effect in this case will be to make the connection time longer.

## Number of Faults.

The total number of faults repaired at the three exchanges in operation during the whole year are shown in the table below; the calls to these exchanges from manual exchanges are directed via digit key strips. The corresponding numbers of »Norra Vasa» are given separately in the table; these numbers are not comparable to the number of faults at the other exchanges, as the traffic from manual exchanges to this exchange is handled over manual B-positions. The number of faults at the nine years old exchange must nevertheless be considered remarkably small.

The average percentage of faults at the three exchanges was

- 0.363 faults repaired in the automatic equipment per 1 000 outgoing calls,
- 89.4 faults repaired in the automatic equipment per 1 000 subscribers,
- 39.2 faults repaired in the plant outside the automatic equipment per 1 000 subscribers.

The small number of faults repaired in an automatic exchange is no proof on the satisfactory operation of the automatic equipment. The number of faults repaired shows nothing as regards hidden faults in the apparatus; such faults are sometimes so numerous, that the reliability cannot be considered satisfactory. Not until, as has been the case in the Stockholm automatic exchanges, a simultaneous thorough control of reliability gives an excellent result, a low number of faults repaired may be regarded as evidence of the good quality of the automatic system.

## Routine Control.

It is of great importance from the economic point of view that routine control should not take too much time. The tracing of faults is done partly on actual traffic, and partly by means of

Fault statistics during 1932.

Exchange	Average number of subscribers' lines	Number of outgoing calls during the year	Number of faults repaired during the year				
			In the automatic equipment			in exchanges outside the automatic equipment	
			Total	Per 10 000 outgoing calls	Per connected subscriber's line	Total	Per connected subscriber's line
Centralen .....	16 495	68 719 323	1 979	0.29	0.12	865	0.05
Kungsholmen .....	14 576	26 830 717	1 156	0.43	0.08	498	0.03
Söder .....	25 911	47 450 109	1 960	0.41	0.07	872	0.03
Total and average	56 982	143 000 149	5 095	0.363	0.0894	2 235	0.0392
Norra Vasa .....	8 011	16 681 655	274	0.164	0.034	252	0.031

the routine tests (*i. e.*, the regular testing of all connection devices).

The tracing of faults on the ordinary traffic is made, partly in connection with the above mentioned reliability control, and partly by means of the constant traffic control. In the latter case the operator plugs into such connections where a supervisory lamp (red register lamp) is glowing, indicating that the register has been engaged too long, either because of mistakes in dialling made by the subscriber, in which case he will receive assistance, or by some fault in the connection. In the other case the operator locks the connection and orders the fault to be traced and repaired. Faults detected by the alarm devices of the exchange and not by the traffic control are of course also traced and remedied by the staff.

The chief purpose of traffic supervision at the control desk is to give reliable information regarding the development of the traffic, to indicate how good service may be maintained, and further to assist and control the subscribers. As it has been arranged in Stockholm, it is of great importance for fault tracing. In the above-mentioned article in the Ericsson Review Nr. 4—6, 1931, it is shown, that the attempt, made as an experiment, to stop for some time the tracing of faults in connection with traffic control caused a considerable increase in the number of faults; this proves conclusively the importance of tracing faults in connection with traffic control. The most convenient and time-saving method has

proved to be the tracing of faults on current traffic, as well as by means of routine tests, and it may be taken as a rule, that the less the number of faults, the less time should be used on the routine tests.

An investigation of what part of the faults have been cleared by means of the different methods shows that 33.3% of the faults have been cleared by the traffic control: 5.3 % by the control of current traffic, 28 % by means of the register alarm lamps; and the remaining 66.7 % by the alarm equipment and the routine tests (about 19 % by means of the routine tests).

## Maintenance.

The number, working hours, and wages of the staff, and the cost of material per year at all automatic exchanges are shown in the table below.

The figures include the maintenance of the automatic equipment, as well as the work at the main distribution frames, and on the fault staff of each automatic exchange, the cost for cleaning the automatic connection apparatus, and the cleaning of the rooms which is made by female labour. Vacuum cleaning is not used, as the dust is then set in motion in the automatic equipment, thus causing contact faults. The method used is, that each connecting device is regularly removed about once a year, and thoroughly cleaned and lubricated in a separate room.

The different kinds of work at the four big exchanges per subscriber and year is shown below.

Maintenance cost statistics.

Exchange	Average number of subscriber's lines during the year	Cost of labour including night service, holidays and sick leave				Cost of material			Total maintenance cost	Average per connected subscriber's line and year				
		Number of staff		Working hours	Kr.	In the automatic exchange	Outside the automatic exchange	Number of staff		Working hours	Cost of labour	Cost of material		Total maintenance cost
		male	female									In the automatic exchange	Outside the automatic exchange	
		Kr.	Kr.	Kr.	Kr.	Kr.	Kr.	Kr.		Kr.				
Centralen ...	16 495	13	5	41 602	63 630:—	3 285:—	5 096:—	72 011:—	0.00109	2: 52	3: 86	0: 19	0: 31	4: 36
Kungsholmen	14 576	9	4	30 293	46 961:—	1 663:—	1 756:—	50 380:—	0.00089	2: 07	3: 22	0: 11	0: 12	3: 45
Söder .....	25 911	14	5	46 942	66 689:—	1 765:—	5 934:—	74 388:—	0.00073	1: 81	2: 57	0: 07	0: 23	2: 87
Södra Vasa...	19 719	12	2	35 277	52 763:—	1 511:—	1 440:—	55 713:—	0.00071	1: 79	2: 67	0: 08	0: 07	2: 83
Total and average	76 701	64		154 114	230 043:—	8 224:—	14 226:—	252 492:—	0.00083	2: 01	3: 00	0: 11	0: 19	3: 29
Norra Vasa...	8 011	8	2	22 847	36 623:—	2 644:—	2 159:—	45 288:—	0.00125	2: 85	4: 57	0: 08	0: 27	5: 64

<sup>1</sup> The figures for »Södra Vasa», which has been operating from April 1, have been increased by  $\frac{1}{3}$ .

<sup>2</sup> Kr. 4 526:— for repair of battery.

<sup>3</sup> The maintenance cost of »Norra Vasa» is shown separately, as these figures are not comparable with the others, the traffic from manual exchanges being directed via manual B-positions and the figures being extraordinarily high, owing to partial renewal of the batteries.

	Average per connected subscriber and year		
	Number of staff	Hours	Cost Kr.
Main distribution frames and fault clearing .....	0.00016	0.37	0.59
Automatic equipment (connecting devices, exchange equipment for subscribers' lines, junction boards, and power plants) .....	0.00047	1.17	1.99
Cleaning of automatic devices (female labour) .....	0.00012	0.26	0.25
Cleaning of floors (female labour) .....	0.00009	0.21	0.17
Total	0.00084	2.01	3.00

The staff required for the maintenance of the four automatic exchanges equivalent in respect of operation, with 76 700 subscribers' lines connected, has been 64 workers during 1932, *viz.*, 36 male workers for the repair work in the equipment rooms, and 12 for the work at the main inter-connection frames and in the clearing of faults. For cleaning, female labour is used, and the number of female workers has been 7 for the cleaning of the rooms, and 9 for the regular cleaning of the automatic apparatus.

This makes 0.63 and 0.21 female or total 0.84 workers per 1 000 subscribers and year.

The average number of working hours per subscriber's line and year is 2.01, comprising 1.54 hours of male labour and 0.47 hours of female labour.

The average maintenance cost per subscriber's line and year is Kr. 3.29: Kr. 3.00 labour cost, Kr. 0.11 cost of material for the automatic equipment, and Kr. 0.19 for exchange equipment outside the automatic equipment.

A comparison with a modern two cord CB-exchange in Stockholm »Riks Östermalm», will be of interest.

The exchange is equipped for .. 10 000 numbers  
 Average of connected subscribers' lines ..... 7 044  
 Number of trunk calls per subscriber and year ..... 3 140

	Staff	Hours	Cost Kr.
Main distribution frames .....	1	2 460	4 003:—
Tracing of faults in the exchange	3	7 363	14 463:—
Cleaning (female labour) .....	3	2 460	1 960:—
		12 283	20 434:—
Cost of material .....			8 430:—
Total maintenance cost			28 864:—

The average per subscriber and year is  
 Hours ..... 1.74  
 Cost of labour ..... Kr. 2.90  
 Cost of material ..... Kr. 1.20  
 Total maintenance cost per subscriber and year ..... Kr. 4.10

The maintenance cost per subscriber is thus considerably higher than the average of the four automatic exchanges Kr. 3.29, and only slightly less than at the »Centralen» exchange, which has the greatest traffic intensity, *viz.* Kr. 4.10 compared to Kr. 4.36.

The maintenance cost (cost of labour and material) per 100 outgoing calls during 1932 at the four equivalent exchanges was Kr. 0.141, and the cost of the traffic control Kr. 0.020 per 100 outgoing calls.

In return for this cost of traffic control a thorough knowledge of traffic conditions is obtained, besides the assistance in fault testing.

## Power Consumption.

The power consumption of motors and for the charging of batteries, and the cost of power was as follows in 1932:

	KWh per subscriber			Cost per subscriber Kr.
	Motors 220 V	Battery charging 48 V	Total	
Centralen .....	1.47	— <sup>1</sup>	— <sup>1</sup>	— <sup>1</sup>
Kungsholmen .....	1.28	2.44	3.72	0.224
Norra Vasa .....	0.85	3.06	3.91	0.222
Söder .....	0.83	2.35	3.18	0.179
Södra Vasa ( <sup>1</sup> / <sub>4</sub> —3 <sup>1</sup> / <sub>12</sub> )	0.60	1.87	2.47	0.140

<sup>1</sup> The battery of the »Centralen» exchange is used for the long distance and short distance exchanges as well, these exchanges being situated in the same building.

## Summary.

From what has been said above it is evident that the reliability of the Ericsson automatic system is extraordinarily high, that the reliability is maintained even after a long period of service (the oldest automatic exchange has been operating for 9 years), that the number of faults in the automatic equipment is remarkably low, that the maintenance cost is consequently very small, and that the power consumption is negligible.

# Traffic Safety and Economy

By  
HUGO LUNDQVIST



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*The perfection of traffic safety and economy must always be kept in view by railway managers. This aim is realized by the following means.*

- 1. The use of electric interlocking plants, permitting greater interlocking ranges and consequently reductions in staff and maintenance costs.*
- 2. The introduction of dwarf signals requiring less shunters and permitting the shunting work to be performed with greater speed and precision.*
- 3. The arrangement of track circuits in such manner that the trains will do the signalling themselves and thus make human labour superfluous. The traffic work can further be performed more quickly and the traffic density be increased.*
- 4. The mounting of an illuminated track diagram in the station master's office, representing the track circuits of the adjoining lines. The trains will thus report themselves as soon as they leave the preceding station, and reporting by telegraph and telephone can be dispensed with.*

The perfection of safety devices, and economic handling of the traffic are the two aims that railway companies managers must always keep in view.

Everything must, of course, be done to make the movement of trains perfectly safe. It is not only great material values that are exposed to danger, but in the first place the human lives must be considered. Every moment great numbers of people are under the protection of the railways: both employees, and passengers who confidently use the railways for long or short journeys.

On the other hand, the economic position of the railways is at present very difficult, and, consequently, the possibilities of reducing costs are given more attention than ever before. The demands for simplification and rationalization have steadily increased. In order to meet the present demands and stand up under the heavy competition from other means of transportation, the railways have been forced to take various economy measures. In railways operation, as in other lines of business, wages are now one of the greatest items of costs. If expenses are to be reduced, the wagebill must in the first place be cut, *i. e.*, the number of employees must be kept as low as possible.

In dealing with such activities as the safety service of the railways, where the highest possible degree of perfection must always be endeavoured it may appear inconsistent to demand a reduction of the staff. But here we are in the happy situation that these two points of view can and must coincide. The safety departments of the railways have always tried as far as possible to eliminate human imperfection. These circumstances point directly towards the installation of *electric interlocking devices* which not only ensure perfect safety, but also require a minimum staff for their operation.

## The Technical and Economic Advantages of the Electric Interlocking Plant.

Interlocking devices have been used for a long time in railway safety plants, whether large or small. Not however until the last few years has the electric interlocking plant come up. Formerly the interlocking devices were of the *mechanical* type that is still the most commonly used. In such an interlocking plant all points, scotch blocks, semaphores and other signals, are connected to levers or cranks in the control cabin by means of steel-wireropes.

The wire passes several corner and support pulleys, is stretched by means of one or more weights, and is consequently hard to move. If, further, the inertia of the semaphore signal or the point is added, the range of the mechanical interlocking plant will be limited to about 1 000 m



X 1080 Fig. 1. Point on the line operated from a signal cabin at a distance of 1.5 km.

or less. Several interlocking plants have consequently to be installed in great station yards, and further, some kind of telephone system between the control cabins will be necessary.

The *electric interlocking plant*, with motors at all points and semaphore signals, can operate these by means of underground electric cables at almost any distance, and has thus an almost indefinite range. By means of an electric interlocking plant it is possible to operate points and signals situated on the lines at sidings, loading tracks etc.

A valuable device, which can only be utilized to its full extent in electric interlocking machines, is the *dwarf signal*. This signal is among the latest advances of signal technics. The dwarf signal consists of an iron case, about  $\frac{3}{4}$  of a meter high, fitted with four lamps, the light of which is visible both day and night, as is the case with so called light signals. The dwarf signals are mounted on the left side, and at right angles with the track. They can show three signal combinations: »stop» (two lights beside each other), »clear» (two lights above each other), and »caution» (two lights at an angle of  $45^\circ$ ). By means of these dwarf signals all shunters that are otherwise required in great station yards for the supervision of points, engine motions etc., become superfluous. This signal arrangement facilitates the shunting work considerably, and gives great safety and speed thanks to the electric interlocking machine.

In mechanical interlocking machines all wires, corner pulleys, weights, semaphore wings, etc., are continually in motion, and subject to wear; they will thus often require repair and supervision. In cold weather the wires may get stuck. The means of transmission in the electric interlocking plant, underground cables, are in-

dependent of the weather, and in the semaphore signals there are no mobile parts. The semaphore signals with mobile arms have been replaced by the modern, powerful *light signals*. These latter consist of poles of medium height, fitted with signal lamps with scientifically designed lenses, which permit the signals to be seen both day and night. These signals have no mobile parts, and are further more easily visible in fog or other bad weather.

The most valuable feature of the electric interlocking plant is, however, the *track circuit*. The tracks, which interconnected in certain sections, are fed with electric current of low tension; the circuit is closed when trains or single vehicles pass, and the current operates relays or series of relays in the control cabin. These relays are, in their turn, connected so as to break or close electric circuits to signals, scotch blocks, flashlight signals, etc., in various combinations; thus an automatic signalling system is realized, which is of great value to modern railway technics. The trains themselves will to a certain extent operate the signals, and the human work thus becomes superfluous.

Other comparisons could be made, and cases cited in order to show the advantages of the electric interlocking machine in respect of both safety and staff requirements. The instances above may, however, be sufficient.

It stands to reason that the great advantages of the electric interlocking machine. The uncertainty as to whether the capital invested will pay any return or not, is probably the cause, why this new type of safety plant has not gained more ground than it actually has. Local conditions, of course, have considerable influence, but investigations have shown, that already in small stations estimates point to the employment of electric interlocking machines.



Fig. 2.  
Dwarf signal and  
point drive motor.

X 3054

As a starting point the cost to the company of the existing safety plant must be figured out, *i. e.*, the cost of the safety plant of the station and adjoining lines, or in other words the whole range of the new interlocking plant. It is then of great importance to take into account not only the wage-bill for the staff in the actual interlocking service, but also for shunters, signal guards, look-outs, track road inspectors, repairmen and telegraph operators who exchange train questions and are responsible for train schedules, reserves, medical treatment, insurance, etc.

Concerning material costs it must be observed, that besides the direct cost for repair and maintenance of the interlocking plant, cables, signals, etc., the maintenance cost of buildings such as signal cabins and rooms for the staff is included.

If the estimates indicate, that an electric interlocking plant will be advantageous, the details remain to be worked out, so that the plant will give the best possible service, and at the same time the cost may be kept below a reasonable limit.

At this stage it is of great importance, that a traffic expert, well acquainted with movements of the trains in the station, should take part in the planning work, and get acquainted with the operation of the new plant, so that, already at an early stage, attention is given to the traffic points of view. Intimate cooperation between the technical and the traffic departments is vital in order to get the best possible result.

Before we proceed to discuss the planning of the electric interlocking plant, the main principles and operation of the plant will once more be considered.

## The Planning and Working of the Electric Plant.

The fundamental principle of an electric interlocking plant is, as mentioned above, the use of insulated tracks with track circuits. Both the lines and the station yard are divided into a number of insulated track sections; these sections are fed with electric current, which operates the corresponding relays. When vehicles pass a section, the axles short-circuit the current; the relay is de energized but takes its normal position as soon as the short-circuit is broken, *i. e.*, when the vehicle has passed the section. This automatic operation of the relays is used for controlling other and considerably stronger currents for signals, etc. A vehicle or train can thus, by means of the automatic change of the signals, stop or warn other vehicles in dangerous proximity to its own track. As soon as the last axle of the vehicle has left the section, the corresponding points may be thrown over, which means that a road may be liberated as a train proceeds; the opposite is the case at mechanical interlocking machines, where the whole road is locked until the train has passed, or stopped at, the station. As mentioned above,

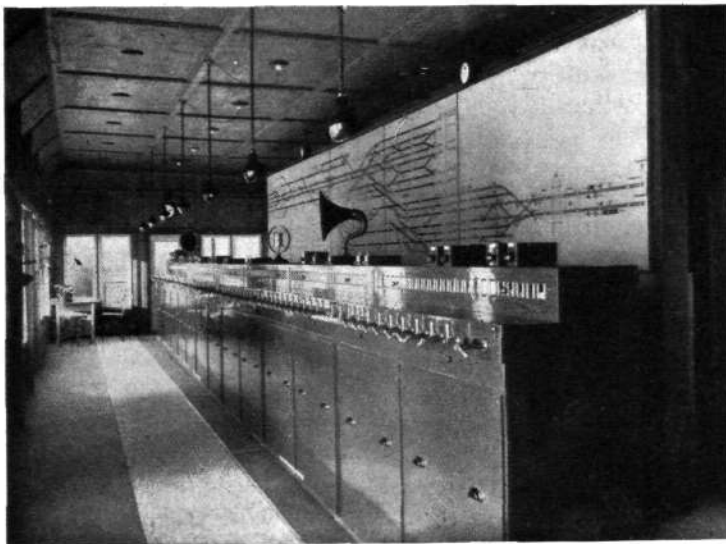


Fig. 3. Interlocking machine with illuminated track diagram.

X 5022

all signals regulating the movement of trains are light signals, giving great advantages. For shunting motions the above-mentioned dwarf signals are used, *i. e.* for permitting motions over one or more tracks.

In the signal cabin an illuminated track diagram is mounted. This diagram shows all signals, and with different colours in small signal windows if the signals are in »stop» or »clear» position, and further the positions of all point signals in the station yard. Other signal lamps show whether the sections are occupied by vehicles or not.

The staff of a signal cabin fitted with a track diagram is thus less dependent of whether the track range is visible or not. If a number of points and signals are included in the interlocking machine of a section of the station yard, where chiefly shunting of wagons, division of trains, shunting of engines, and similar, permanently varying motions occur, it is, however, important, that the motions should be visible to the staff. Part of the shunting will soon be familiar to them and, without being reminded by telephone, the staff will soon be able to establish the necessary roads, to help the shunters and see that all possibilities of the track system are utilized as far as possible. It will be the staff of the central cabin that will determine the speed of the shunting, and the greater the number of small movements it can see and anticipate, the faster and smoother the work will run. For the shunters must be distracted as little as possible by going to the telephone posts. When choosing the position for a new central cabin, it must be stated, whether there is such a shunting range, and in such case attention must be paid to this fact.

By mounting a track diagram of the adjoining lines in the station masters office (the train dispatching office), the reporting of trains may, as a rule, be eliminated. The trains will report themselves on the track diagram as soon as they leave the adjoining station.

The division and determination of the length of the insulated track current sections in the station yard, and in connection with this, the number of dwarf signals requires careful consideration. All movements of vehicles, which may be performed simultaneously and without hindrance on the existing tracks, must receive signals for these motions from the dwarf signals, but, on the other hand, these signals must indicate »stop», where different roads touch each other. When a signal indicates »clear», this means, that all points are

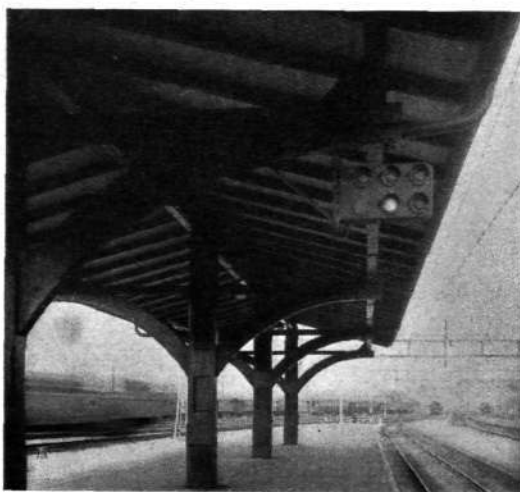
in the correct positions, and the section free from vehicles. When »caution» is indicated, the points are in the correct positions, but there may be vehicles in the section, or the next dwarf signal may indicate »stop».

As long as a section is occupied by vehicles, no points in the section can be switched. The problem is thus to get the greatest possible freedom of motion, but at the same time sufficient safety. Sometimes a road may be considered of no importance as it is seldom used and connected to the adjoining track, thus saving a dwarf signal. This can, however, not be recommended. The time-table may be changed, the trains get other times of departure, and the shunting consequently has to choose other ways. It is far more expensive to change a plant, than to make it as complete as possible from the outset, and thus handle a change or increase of the traffic, which may occur in the future. Wherever possible, with regard to the positions of the points and the shunting work, the dwarf signals and sectionings must not be placed too near the points or scotch blocks. It may occur that a vehicle moves towards a signal indicating »clear» and that at the same time the interlocking staff wants to change other points farther on. The dwarf signal will then indicate »stop», and the point motor will start. If the engine driver does not succeed in stopping the train fast enough, it may occur that the signal changed from »clear» to »stop» is passed. A free track length of about 10 m between the dwarf signal and the point or scotch block will in most cases be sufficient to prevent this.

It must be observed that the dwarf signals should be placed so that they are easily visible to the staff concerned. The position of the dwarf signals may seem perfect on a drawing, but platforms, telephone and light poles, etc., will often screen them from sight. In consequence the position must be selected on the station yard itself.

At points separating different track groups from each other, or limiting transfer tracks to other station yards etc. it will often be advantageous to place signals, indicating to which track group such a point is thrown so that the shunters can see the road already at a distance, and push the wagons to these track groups at a suitable speed.

The staff serving the interlocking system conducts the shunting in the station yard by means of the dwarf signals. The corresponding switches in the central cabin must be accessible to the



x 1000 Fig. 4. Repetition signal on the platform for the station master.

operator. In a modern interlocking system the signal switches ought to be placed, not in one separate group as the signal levers in an interlocking machine of the old type, but alternating with the point switches, so that when one man has to operate a certain range of the station yard, he will find all switches in an order corresponding to the actual position of the points and dwarf signals. The staff can thus be better utilized, and has only to move along a certain range of the interlocking machine.

The positions of the fix signals wanted for train motions at the stations are so far given, as the home and starting signals are as a rule placed on the border-line between the station yard and the adjoining lines. In large stations a number of supplementary and repeating signals are required for driving across the station yard. When necessary, the engine staff may be informed on which track or track group the train will be received, or to which line the road for a departing train leads; this is performed by means of various signal combinations shown simultaneously with the »clear» signal.

In large stations fixed repeating signals in connection with home and starting signals ought to be mounted in such number, and at such places, that the engine drives may always easily know his exact position, and never need to hesitate, whether the road is clear, even if fog makes the signals difficult to observe. The driving speed across the well utilized station yard depends on these arrangements. For despatched trains a separate repeating signal ought to be situated near

the place, where the station master or the person responsible for the despatching signals for the trains stands; this signal should indicate, that the road goes from the *right* track and to the *right* line.

It is often of importance, particularly in the case of late arrivals of trains, that the staff for the loading and unloading of luggage and mail, porters and ticket collectors are informed when trains are arriving at the station. This may be easily arranged so that when the »clear» signal is shown to a train, one or more signal lamps (preferably with coloured light) situated at convenient places, are automatically lit by the signal relays, and then automatically put out when the train has arrived at the station. In stations with several tracks the same principle may be used to indicate on which track the train will arrive; when the track is changed the staff thus needs no particular information. It has been found in practice, that, by means of this information system, the staff has time to move to the place where it is required at the moment, and, when the train succession is changed, rearrange wheel-barrow and platform trucks in time. The importance of every man being in his right place, and ready to start work as soon as the train has stopped, will be easily understood, particularly when the train stop is short.

It has lately become more common, that the roads across the station yards are optional, *i. e.*, that a train can use different roads to the same track. Such an arrangement gives a great flexibility to the movement of the trains, and permits better utilization of the track system. The trains as well as the shunting may then find their way where the road is free.

The number of switches in a modern interlocking plant operating a great station yard and the section blocks of the adjoining lines, would be very great, if certain steps had not been taken in order to prevent this. Thus, points are very often connected to the same point switch. 90 % of the points in a station yard may frequently be combined two by two, as both have to be thrown over in order to form a certain road. It is therefore quite natural that they should be operated simultaneously by means of the same switch, thus saving time and work. These points are often connected in parallel; in that case, they are thrown over in the same time as *one* point. The signal switches may be combined in the same manner.

In order that the shunting staff should always be in contact with the traffic manager of the station, and with the staff moving in the station yard, a number of telephones must be mounted at convenient places. For the shunting, a loud-speaker may be used to advantage, as the interlocking staff need not leave their place at the instrument table, but answers by arranging the shunting road required.

## Section Blocking.

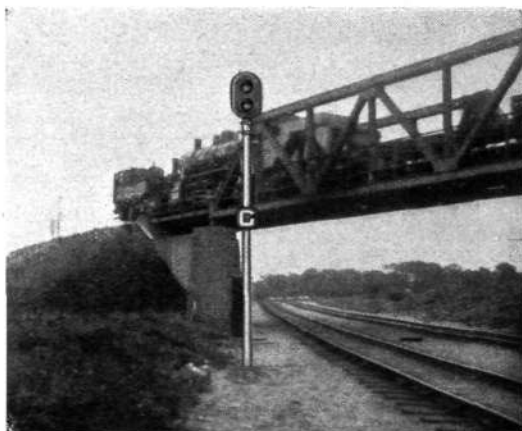
Concerning section blocking the electric interlocking plant offers great advantages compared to the old system. In the case of double track lines, where the signals must protect a train from being run into from behind, the signal plant may be made purely automatic. This will require a considerably smaller staff and further give greater speed in train despatching. When the line is free from trains all signals will indicate »clear». A train in motion will automatically change the nearest signal behind to »stop». This signal will then change to »caution» and finally to »clear» as the train moves on. The length of the block sections must be determined so that they are made short where the trains have a low speed, and longer where the trains pass at full speed so that the trains occupy the block sections about the same time, and thus can move on without unnecessary stopping or slowing down.

The number of block sections depends on the interval wanted between the trains on the line in question.

Concerning single track lines where the train direction is continually changed, the interlocking staff has to intervene by regulating the signals according to the time-table (semi-automatic system). The track current, however, is here also of great importance, as it prevents a new signal being given before a previous train has left the section.

When section blocks are used, guards at roads, bridges, etc., may be informed by means of light signals, automatically operated by the track current, when a train is on the line. Particularly when trains are late, or when extra trains are on the line, such an arrangement is of inestimable value, as it saves many telephone calls at a time when the station staff is particularly busy.

The block sections, both automatic and semi-automatic, should be indicated by lamps on the



X 1091 Fig. 5 Intermediate block signal, replacing a mechanical interlocking device.

abovementioned illuminated track diagram in the signal cabin, so that the staff may have a bird's-eye view of train movements on adjoining lines. This is of great importance when the problem is to judge the times of arrival, and to prepare the road in the station yard, and set the home signal in »clear» position.

When a double track line is used as a single line, and trains move on the wrong line, the sectioning of this line is put out of function for these trains. By means of a switching device in the central cabin it is possible to switch over the track current, and in connection with separate single track signals make these latter operate in the same way as in a semi-automatic system, *i. e.* to prevent a train being despatched on the line before the first train has arrived at one of the stations.

## The Master Central.

The modern interlocking cabin, where all central devices are assembled, all points are thrown over, and all signals are set, must be the point at which the control of train movements, as well as a certain amount of shunting, is concentrated. The employee in command must continuously follow the developments within the range of the interlocking plant, and by means of the signals on the illuminated track diagram, telephone information, and observations from the signal cabin form his opinion of the requirements of the moment, and in the best way serve the traffic, decide the succession of different movements, and work the station yard to capacity, without upsetting the time-



X 1092

**Fig. 6. Automatic block signals.**  
Those marked B distant signals as well.

table. The central cabin thus becomes a master control, which requires a skilled staff ready to act immediately, and well acquainted with the operation of the apparatus and the movements in the station yard. In emergencies, the orders of the traffic manager of the station can be confined to directions or orders concerning the succession of trains; the details are thus left to the staff, that has the best view of the operations, and is able to regulate the motion in the best way.

The experience from electric interlocking plants and electric section blockings with track current has shown, that these plants have functioned remarkably well, that they have surpassed expectations, and that they are far better than the old mechanical interlocking system, in respect of both safety and speed; besides, they give station yards and line sections a considerably greater capacity. Among experts there is only one opinion: that these plants meet all reasonable demands on economy. The cost of operation has come down to a fraction of what it was with the old methods.

The continuous control and interdependence of parts in a modern electric plant, has ensured traffic safety in a higher degree than when it is only based on human observation and attention. Every responsible railway management thus ought to do its best to extend the use of such plants in railway operation.

At no distant time the electric interlocking system will be installed in every station yard of importance, and the control of train movements on lines with heavy traffic will be ensured by means of automatic apparatus.

# New types of REX products

By  
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Oslo

Last year the factory of A/S Elektrisk Bureau for electric bells and telephone apparatus and equipments had existed fifty years. Since 1922 the company has also manufactured apparatus for electric cooking and heating. The sale of these products, which are known under the name of REX, has been steadily increasing during all these years, and the factory for thermal apparatus is now one of the biggest in Scandinavia.

The best market for REX products is, of course, Norway where the application of electric power for all purposes is encouraged by the low power rates; but thanks to superior quality the sale of REX products has been successfully pushed on foreign markets as well. Thousands of REX flat-irons are now used in South-America, and REX kitchen ranges are installed in a great number of households. Competition is, however, very keen in this line, and so, special efforts are required to maintain a constant increase in the turnover.

The REX products are built from material of high quality and high resistance to rust and wear. Their design is based on the experience of many years, and the thermal properties have been carefully worked out through calculations and laboratory research.

At present, Elektrisk Bureau manufactures a whole series of electric appliances, *e. g.*,

flat-irons, stoves, radiators, heaters for curling-irons, hot-plates, water boilers, ovens and kitchen ranges.

We will here confine ourselves to describe the kitchen ranges as these are of most interest. These

products are made in two sizes: one small size, Type G, and one large size, Type H. These two sizes are described below.

## REX Kitchen Range, Type G.

This range, shown in Fig. 1, 2 and 3, is intended for use in small families of about five persons.

The oven has the following internal dimensions:  
height: 210 mm,  
width: 290 mm,  
depth: 385 mm,  
volume: 23.5 dm<sup>3</sup>,  
power consumption: about 900 W.

The heating of the oven is effected by two elements placed *on the outside*, above and below. The elements are thus visible and are, moreover, well protected from moisture and mechanical injury. The interior and the door are of nickelled sheet-iron and thus of high resistance to rust and wear.

The stove has a baking-oven, two cooking-plates and a grill, all these parts are chromium-plated and thus protected from rusting. A thermometer and a ventilator are mounted on the door (see Fig. 1). The oven and the door are both fitted with a layer of insulating material which will give fast and economic heating.



Fig. 1. REX kitchen range, Type G.



Fig. 2. REX kitchen range, Type G.

The plate-warmer (Fig 2, door open) has the following internal dimensions:

height: 110 mm,  
width: 370 mm,  
depth: 480 mm,  
volume: 19.5 dm<sup>3</sup>.

When the oven is heated, the plate-warmer will have a temperature of about 50° C.

## ALO-REX Hot-Plates.

The REX kitchen range, Type G, is mounted with two hot-plates with the diameters 22 and 18 cm. The 22 cm plate can be made for 900 to



Fig. 3. REX kitchen range, Type G.  
(back view.)

1 800 W and the 18 cm plate for 600 to 1 200 W. The power consumption can be regulated in three steps.

All plates, including the largest size for 1 800 W, are made so that the power consumption does not exceed 300 W when the regulation is set on the lowest step. Thanks to this new method longtime cooking becomes especially economical. The external dimensions are determined according to the prescriptions of »Deutsche Industrie Normen« (DIN). The new type of ALO-REX heating elements is the result of scientific research, and has been a great success on the market for several years. The top plate is cast with ridges on the bottom side, and is further metal-plated so that it does not rust even if exposed to moisture.

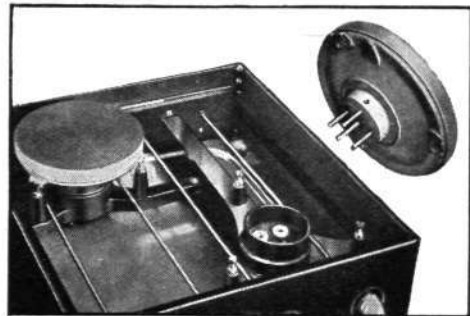


Fig. 4. REX kitchen range, Type G.  
(The hot-plate removed.)

The resistance coils are enclosed in a special cement in a hydraulic press under high pressure. The cement has a high thermal conductivity which gives good efficiency and at the same time the life of the heating coils becomes practically indefinite.

The cement block is protected at the bottom by a plate with elastic edges. This plate is covered on both sides with the same anti-rust metal as the cast plate. The plate is perfectly tight and thus protects the heating element from being injured by water. On the bottom side the plate is protected by a bottom plate which is covered with anti-rust metal (Fig. 5) the three contact-pins being mounted on this bottom plate. One extra contact-pin in the middle is intended for earthing the hot-plate when placed in the range.

The hot-plate support, Fig. 4, consists of a bridge placed on the bottom of a well, the edge of which fits into a furrow on the bottom side of the plate. This arrangement prevents water from entering

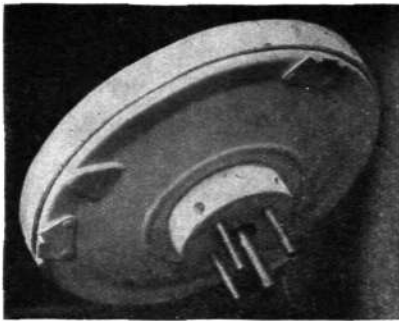


Fig. 5. ALO-REX standard hot-plate, System DIN.

into the well. The contact-pins are made of a sturdy anti-rust material and are designed to give good contact between the plate and the socket.

The contact-pins are floating in order to prevent them from being burnt. The plates rest on three set-screws permitting the plate to be adjusted to the correct position.

The *spill water receptacle* is placed on top of the plate-warmer and collects the water spilt or condensed from the hot-plates. The receptacle may easily be removed for cleaning.

The top-plate of the stove is made of cast-iron and fitted with hinges to permit the plate being lifted up for inspection and cleaning.

The *regulating switch* is one of the most important parts of the range. It is thus of great importance that it should be of strong construction and well protected from moisture and heat.

In the REX range, this problem is solved in a very satisfactory way. As shown by Fig. 3, large-sized 10 A switches are mounted on the back of the stove and operated from the front by means of shafts. The power is regulated in three steps. Two-pole switches are used so that both conductors to the hot-plates and the oven are switched off when the switch is set on zero.

The *connections* (see Fig. 3) are made with brass-wire mounted on solid steatite insulators giving a reliable insulation for voltages up to 380 V.

The *exterior of the range*. The standard type of the range is coated with black enamel of high quality and great resistance to heat. If specified, the stove can be delivered in other colours. All iron parts on the front side are nickel plated and polished.

## REX Kitchen Range, Type H.

This type, shown in Fig. 6, 7 and 8, is very similar to Type G, but larger.

It may be fitted with 2, 3 or 4 hot-plates as desired. The plate-warmer is provided with a heating element for 150 W.

The oven has the following internal dimensions:

- height: 270 mm,
- width: 420 mm,
- depth: 350 mm,
- volume: 40 dm<sup>3</sup>,
- power consumption: about 1 200 W.

The interior and the door of the oven are made of anti-rust metal, containing 67 % pure nickel. In other respects the oven is made exactly as in type G.

The *plate warmer* has the following internal dimensions:

- height: 110 mm,
- width: 480 mm,
- depth: 480 mm,
- volume: 25.5 dm<sup>3</sup>,
- power consumption: 150 W.



Fig. 6. REX kitchen range, Type H.

## ALO-REX Hot-Plates.

a) Type H 2, has two hot-plates of 22 cm diameter. Power consumption 900 to 1 800 W each.

b) Type H 3, has two plates similar to a), and one more plate of 18 cm diameter and 600 to 1 200 W power consumption.

c) Type H 4, has two plates similar to a) and two plates similar to b).

The REX products described in this article are the results of the research work of many years. The choice of material as well as the design of the ranges is based on the experience of many years along with a thorough study of the electro-thermal problems involved.

The REX ranges are thus the most modern and perfect on the market.



Fig. 7. REX kitchen range, Type H.  
(Observe regulating switches and wiring.)



Fig. 8. REX kitchen range Type H.

# Paper Wound Condensers for Telephony and Wireless

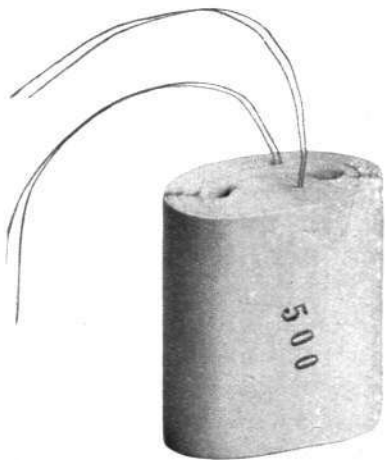
*Paper wound condensers are manufactured by several of the Ericsson factories. A brief description of the condensers made by Aktiebolaget Alpha, Sundbyberg, is given below.*

## Production Methods.

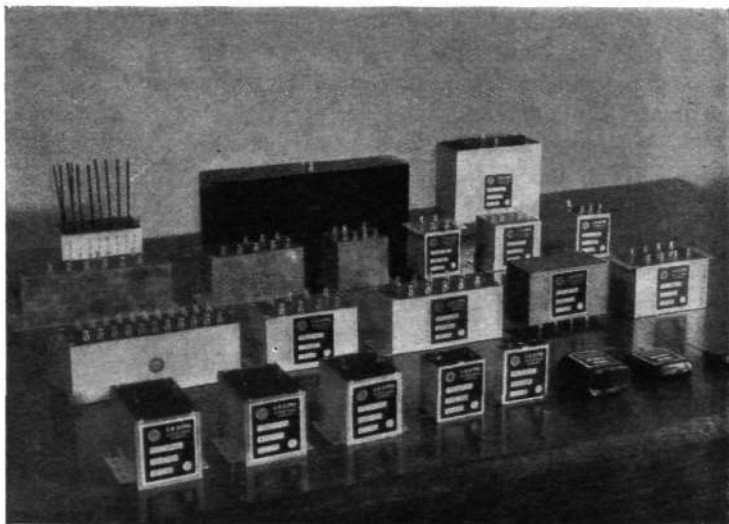
The most important materials in a paper condenser are paper, metal foil, impregnating wax and filling compound, container of sheet-iron, pasteboard, pertinax or bakelite, and lid with terminals, often consisting of soldering tabs, or of bare or insulated wire.

For condensers, linen as well as woodpulp paper of a thickness of down to 0.0065 mm is used in two or more layers, depending of the test voltage. The homogeneous structure of the paper is of course of great importance; special and in certain respects very strict specifications are given in order to reduce the dielectric losses and to increase the break-down voltage.

Aluminium foil is generally employed for the condenser sheets, but for inductionfree condensers tinfoil is used, so that the connection wire may be soldered to the foil.



X 3061 Fig. 1. Condenser winding, 1  $\mu$ F.



X 5022

The winding of the condensers, Fig. 1, forms the first stage in production, and is made in special hand or motor driven machines, in which a convenient number of foil coils are mounted.

The winding requires skill and great care. It is of great importance that the tension of the paper in the winding machine is constant, in order to avoid too great a variation in capacity of the wound condensers. The foil must further be prevented from moving sideways. During the winding fastening and terminal wires are fitted; their position has a great influence on the internal resistance and self induction of the condenser.

The next stage consists of drying and impregnating the wound condensers. This is performed in electric impregnation ovens of a special design, with automatic control of the temperature.

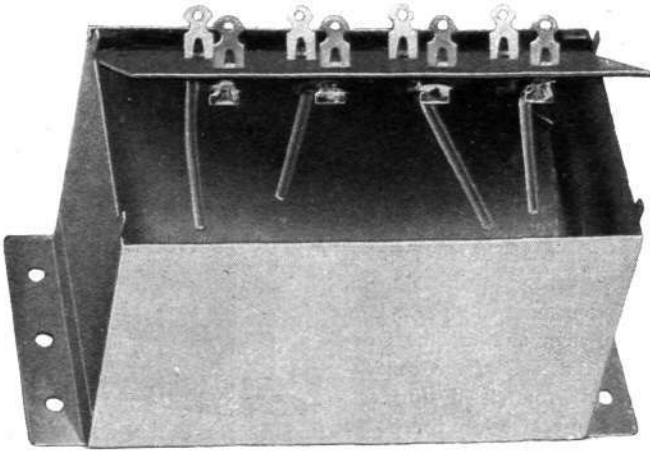
Paraffin is often used for the impregnation. As the demand for small dimensions has increased in the last years, a number of other impregnating materials are now used. These materials have a higher dielectric constant, and the volume

of the wound condensers is in consequence considerably smaller. The cost of the other component materials is thus reduced, which for large condensers compensates the increased costs of these impregnating materials; the labour cost will further decrease. The magnitude of the dielectric losses will, of course, depend on the choice of impregnating material.

The impregnation of the condensers is carried out in the following manner: the wound condensers are thoroughly dried in vacuum, whereupon the impregnating stuff, also well dried, is added and absorbed by the condensers. In certain cases it will be convenient to subject the condenser to pressure before the wax has hardened; a certain adjustment of the capacity is thereby obtained, but the break-down voltage is decreased at the same time.

The next stage is a test of the capacity and break-down voltage of the condensers.

In most cases in telephony as well as in wireless the condenser, or in certain cases, several condensers, is mounted in a protecting sheet-iron box or cover, which is then filled



x 5023 Fig. 2. Block condenser before final filling,  $2+2+2+0.5 \mu\text{F}$ , 1500 V.

with bes'-wax or compound, Fig. 2. In some cases the filling is made in vacuum depending on the requirements on the condensers.

After the filling, the terminal wires of the condenser are soldered into the soldering tabs or the connection wires, the lid is fitted, and the box is enamelled.

Especially in wireless technics condensers are used without any protecting cover or sheet-iron box. As cracks and pores will easily occur in the paraffin, which will then allow moisture to penetrate, the condenser, Fig. 3, is dipped into compound or enamel in order to get an impermeable protecting cover.

The manufacturing process completed, the final measurement of capacity and leak resistance will be performed, as well as the prescribed voltage test.

When the condensers have been cleaned, stamped and labelled, there is a last control, before the condensers are ready for packing.

## Testing.

The strict requirements on telephone material as well as wireless apparatus involve corresponding requirements on all component parts, and especially on the condensers.

We will mention below some standard data concerning the manufacture of the Alpha condensers.

**Capacity:** The capacity indicated on the condenser is measured with DC. The capacity value has a toler-

ance of  $\pm 10 \%$ , a smaller tolerance involving a higher price.

**Insulation:** The leak resistance is measured with DC. In condensers for telephone purposes the leak resistance between the terminals or the tappings of block condensers may not be less than 200 Megohm/ $\mu\text{F}$ . Between the cover and the wound condenser or the terminals the leak resistance may not be less than 2 000 Megohm independently of the capacity. The measurement is generally performed after half a minute's electrification at a tension of 130 V. A temperature of  $20^\circ \text{C}$  is often prescribed.

The testing of condensers for wireless purposes is made according to similar prescriptions.

**Test voltage.** Tension and kind of current used at the voltage test vary with the use for which the condensers are intended.

Condensers for telephone purposes are subjected to a voltage test at 400 to 450 V DC during 1 minute.

Condensers intended for wireless receivers are tested with 500, 700, 1 000 or 1 500 V DC, depending on the position of the condenser in the receiver.

For other purposes higher test voltages are also used.

Condensers for radio noise filters are generally tested with 1 500 V AC.

The voltage of operation should be limited to about one third of the test voltage. Some manufacturers

even recommend a greater margin of safety. This can be regarded unnecessary for Alpha condensers, as the break-down voltage of all types of Alpha condensers exceeds the break-down voltage of condensers of other make, when subjected to the same voltage test.

If not otherwise stated the Alpha condensers are stamped with test voltage, not with operating voltage, which is often the case with other condensers.

**Thermal constance.** In continuous operation the condensers must endure a DC voltage corresponding to the indicated test voltage at a temperature of  $45^\circ \text{C}$ . If wanted, this temperature may be increased to  $60-65^\circ \text{C}$ .

**Dissipation phase angle.** The dissipation phase angle is measured at a frequency of 800 to 1 000 cycles and may, in case of strict requirements, not exceed  $30'$  at a temperature of  $20^\circ \text{C}$ .

**Endurance against moisture.** The condensers must answer certain requirements when tested in an atmosphere of a given high percentage of moisture, and can, if wanted, be



x 3062 Fig. 3. Wound condenser,  $2 \mu\text{F}$  1500 V, enamelled.



X 3063 Fig. 4. Telephone condenser, Type RI 253, 1  $\mu$ F, 45 × 50 × 15 mm.

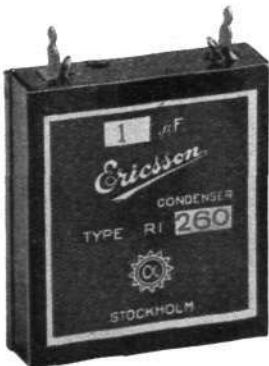
manufactured of a design suitable for tropical climate.

## Different Designs of Condensers.

Depending on the use of the condensers, various types of covers have been constructed. Without mentioning all types used in telephony we show some of the most current types, Fig. 4, 5 and 6. The container is made of tinned sheet-iron, soldered at the edges; fixing flanges are often soldered on to the cover, and on the top side the edges are bent in order to fix the lid of pertinax or ebonite. Some types have a lid of sheet-iron, soldered on to the box and fitted with a block for the soldering tabs.

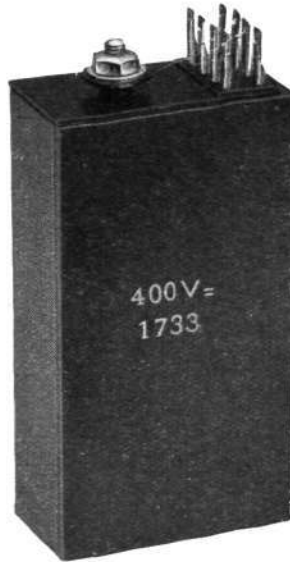
The boxes are enamelled in grey or black, and labelled or stamped.

For the wireless industry two



X 3064 Fig. 5. Condenser for the new Ericsson bakelite telephone instrument, Type RI 260, 1  $\mu$ F, 43 × 50 × 12 mm.

principal groups have been developed; single condensers, each containing one condenser only, and block condensers, containing several condenser units in the same box; in this case each condenser can be fitted with separate terminals, or the condensers can be connected under the lid if ordered. The first group comprises condensers of up to 2  $\mu$ F, with the dimensions: width = 45 mm, height = 50 mm, and thickness depending on the size of the condensers, Fig. 7. From 3  $\mu$ F upwards, single condensers have the same



X 3065 Fig. 6. Condenser for mounting on relay plates, Type RI 158, 0.25 + 0.25 + 0.25 × 0.25  $\mu$ F, 53 × 98 × 27.6 mm.

dimensions as block condensers: width = 50 mm, height = 55 mm, the same end walls being used for the box. The part of the box connecting the two end walls is made by means of adjustable cutting and bending tools, and any length between 25 and 170 mm can thus be obtained. The tabs of the end walls are bent down in order to keep the lid in position. If ordered, the boxes are made with the fixing flanges placed so that the lid with the terminals will point downwards. Since the other parts of a wireless apparatus are often covered with aluminium or bronze enamel, condensers

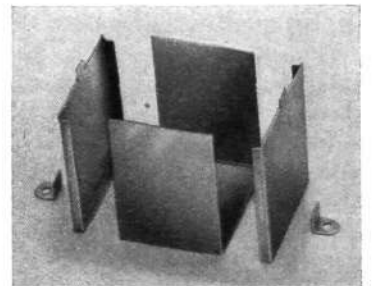


X 3066 Fig. 7. Single condenser, Type 76410, 1  $\mu$ F, 1500 V, 45 × 50 × 15 mm.

for such purposes are treated in the same manner.

As mentioned above, the soldering tabs may be moulded into a bakelite block on the lid, Fig. 9, but they are generally fastened on the ebonite or pertinax lids with a special tool. The holes for the soldering tabs in the lids of block condensers may be pressed in convenient positions.

If wanted, the terminal wires of the wound condensers may be connected to cables, brought out through the top, and of such length, that they may be directly connected to other apparatus, Fig. 10. The standardization of the boxes of block condensers involves a standardization of the width of the paper and aluminium foil and thus also of the wound condensers. A very efficient process of manufacture can thus be arranged, and at the same time the requirements of the buyers, in respect of combining the normal con-



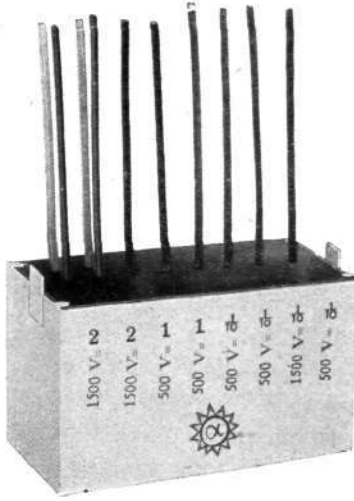
X 3067 Fig. 8. Box for single condenser, before soldering.



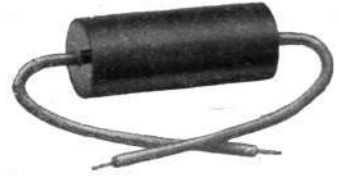
X 3068 Fig. 9. Terminal block with soldering tabs mould into the bakelite, for the condenser, Fig. 6.

condensers in the boxes as well as the position of the fixing flanges can easily be met with great accuracy and short delivery time. It is thus of interest to the buyer to accept this standard.

Condensers of small capacity, *e. g.*,  $0.1 \mu F$  and less, are often made in round shape and fitted in a protect-



X 3069 Fig. 10. Block condenser,  $2 + 2 + 1 + 1 + 0.1 + 0.1 + 0.1 + 0.1 \mu F$ , 1500 V, with terminal cables.



X 3070 Fig. 11. Condenser for noise filter,  $0.1 \mu F$ , 1500 V 50 cycles, with terminal wires.

ing cover of ebonite, trolite, bakelite or pertinax, and are then called tube condensers. Such condensers can be fitted with connection cables (see Fig. 11, showing a condenser for noise filters built on the motor of a vacuum-cleaner) or with blank connection wires which is the most common for wireless purposes.

## The Automatic Telephone Exchanges in Iceland

*As mentioned in the previous issue of the Ericsson Review the automatic telephone exchanges of Reykjavik and Hafnarfjörður were put in service towards the end of last year. The transfer was performed on December 1st, the national day of Iceland, and the official opening took place on the 14th of the same month. A summary of the most characteristic technical properties of the new exchanges on Iceland is given below.*

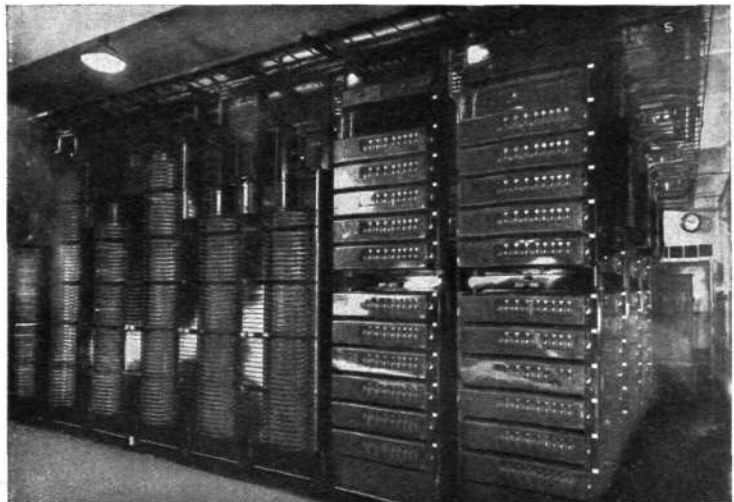
The Reykjavik automatic exchange is installed in a new building containing also the headoffice of the State Telegraphs and the broadcasting company.

The subscribers' lines are led in underground cables through a con-

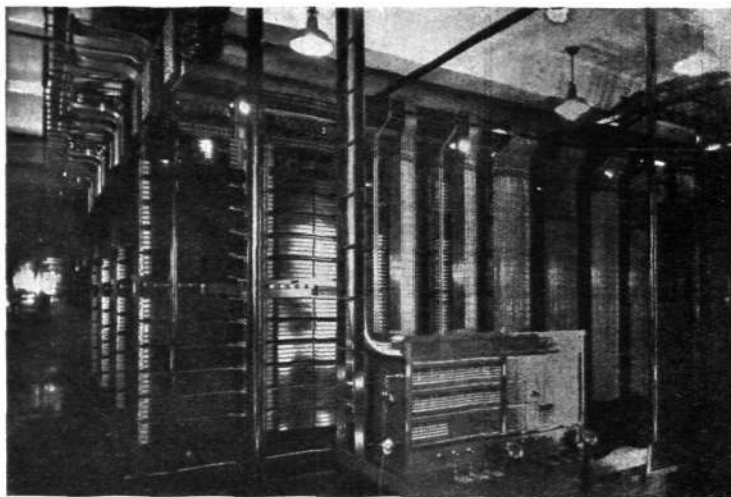
crete channel into the cellar, where they are terminated by lead distribution boxes. The cables are mounted on angle-bars and are easily accessible.

They include as a total 6 000 pairs besides the interurban lines.

From the distribution boxes 120 bare lead cables of 50 pairs each



X 5024 Fig. 1. View of the automatic exchange, showing the five rows of racks installed. The front row shows a unit rack containing the connecting devices (line selectors, group selectors and registers) for one group of 1000 subscribers. In the same row, but not visible in the picture, are mounted the line relays for the 1000 subscribers.



X 5025 **Fig. 2.** The automatic exchange, seen from the rear of the racks.  
In front, the traffic supervision table.

lead up to the main distribution frames on the first floor. From the test jacks of the main distribution frames, lead cables of 20 pairs each lead the subscriber's lines to the line relays of the automatic exchange on the second floor.

The exchange is built for 4 000 numbers, 1 000 of which are made for PBX service. The total capacity of the plant is 9 000 numbers.

The different devices are mounted on racks, each comprising the equipment for 1 000 lines. Each rack has a separate 24 V motor, which at the same time supplies the ringing current required, and high frequency AC for the buzzer tone.

Each group of 500 comprises  
43 line selectors (max. 50),  
43 group selectors (max. 50),  
43 cord circuit relays (max. 50),  
11 registers (max. 50),  
50 main line selectors (max. 50),  
6 interurban line selectors (max. 10).

Interurban and connecting circuit equipment for Hafnarfjörður is mounted on a separate rack. Call meters are supplied for each subscriber's line.

On the third floor the trunk switchboard is placed. There are six positions for the long distance lines, two for the record operators' circuits, and further one supervisory board. Equipment has been supplied

for 40 long distance lines, 10 record operators' circuits and 8 lines from public call offices.

Regarding the record operators' circuits, it might be mentioned, that waiting-time, number of subscribers waiting, and working time are controlled by means of signal lamps, counters and meters. For the automatic connection between the long distance lines and the subscribers' lines there are 20 lines available, and the setting up is performed by means of a dial. The equipment for the public call offices besides the multiple in the trunk switchboards—consists of two key sets with appurtenant signal lamps, mounted in the record board in the telegraph work

office. Recording of long distance calls is lead by service lines from the public call offices to the interurban positions. When the long distance line is clear, the interurban operator plugs a ringing cord into a free multiple jack of a public call office; a white lamp is then lit in the public call office. The operator then presses a corresponding button, receives information about which call is on, and calls the name of the orderer and the number of the call office. When the handset of the call office telephone is lifted, the lamp is put out, and the operator is disconnected from the circuit. When the call is finished, a red lamp is lit at the operator's position, the corresponding button is pressed again and from the interurban office, the operator is informed of the duration and of the conversation cost.

For handling telegraph service by telephone, a special board is supplied, to which there lead four single-cord two-direction automatic lines, arranged to that the lines may be put through to assistant operators in case of intense traffic. Further, there are 5 CB lines for assistant operators, radio telegraph station, etc., and 5 magneto lines for direct communication with the trunk switchboards. For service purposes there are service line multiples in the interurban boards, the supervisory boards, the public call office, and the telegraphone board.



X 5026

**Fig. 3.** The long-distance exchange.

At Hafnarfjörður the automatic exchange is situated in a new part of the old exchange building. The cables are lead in in the same manner as in Reykjavik, but both the main interconnection frames and the exchange are placed on the same floor.

The capacity of the exchange is 900 numbers, 300 of which are connected at present.

The communication between the towns of Reykjavik and Hafnarfjörður is automatic and the lines are lead in underground cables the whole distance of 11 km. About half-way, the cable passes a cable cabin, where the long distance over-

head lines are taken in and lead in to Reykjavik in the same cable.

The 16 intercommunication lines are supplied with repeating devices, performing a six-fold counting for calls between the two towns. These calls are broken after five minutes, the engaged tone being sent out to the two subscribers. In connection with the zone registering it may be mentioned that the prepayment coin boxes, that are going to be delivered to Reykjavik, are of such a design as to make it impossible to get trunk calls from them. The communication will be broken if the number 9, indicating a call to Hafnarfjörður at a six-fold rate, is

taken as the first number on the dial.

In connection with the official opening of the exchanges the Board of Telegraphs of Iceland gave a dinner. To this dinner Mr Hliddal, director of telephones, had invited representatives of the Government of Iceland, the authorities of Reykjavik and Hafnarfjörður, the telephone administration etc. Next day, Director Kvaal of A/S Elektrisk Bureau, Oslo, who had come over for the opening of the exchanges, gave a lunch at which representatives for the government, and official and local authorities were the guests of Elektrisk Bureau.

## The Birmingham Telephone Area

*For the automatization of the Birmingham telephone area, the British Post Office has adopted the Director System, which was primarily designed for London. Ericsson Telephones Ltd. takes part in the work with 8 of the 29 exchanges.*

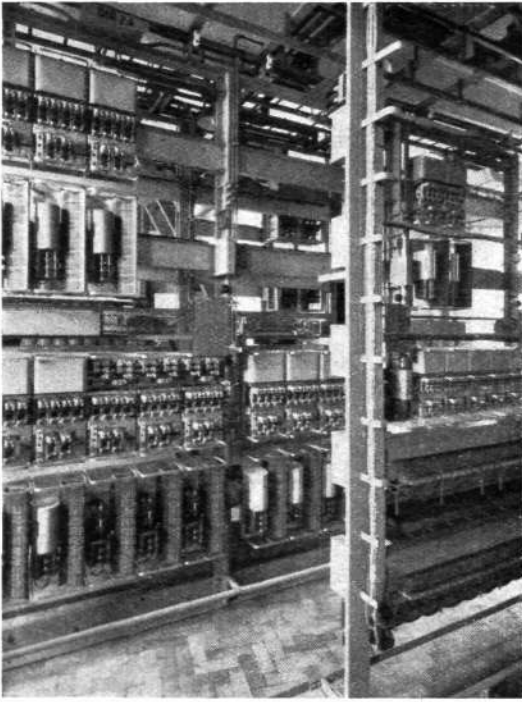
*A brief account of the main points of the automatization is given below.*

Before the installation of automatics, the following classes of exchanges existed: magneto, central battery signalling and common battery, and as a complete transfer cannot be carried out at one time it was necessary to provide arrangements for connection to be made between any of the above classes and the automatic exchanges as the latter came into service. In order to do this special positions are supplied at the manual exchanges, equipped with a lamp display, so that a visual indication is given of the number dialled by the automatic subscriber. The manual operator then completes the connection by plugging into the multiple jack of the required subscriber. For dealing with calls from manual to automatic where direct junctions exist, the

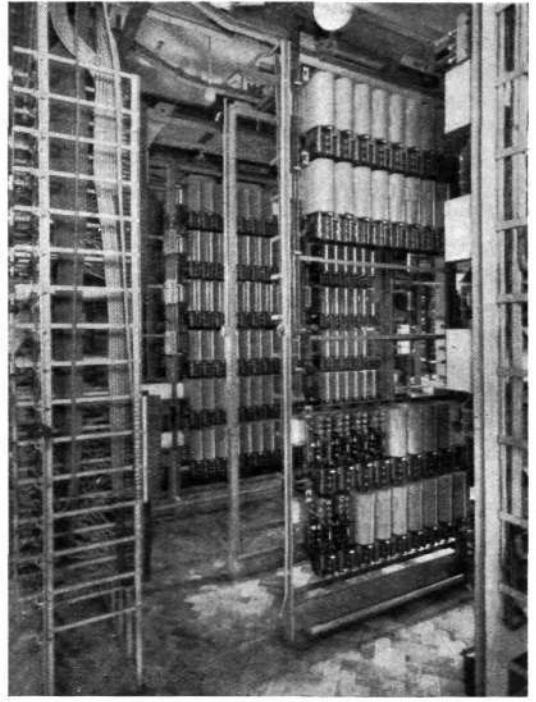


manual positions are equipped with dials and the operator can obtain the number automatically. Where direct junctions are not available the calls are routed via a tandem exchange. This exchange is purely a switching centre and has junctions to all exchanges in the area.

On receipt of a request from a manual operator for a number in an automatic exchange, the tandem operator by means of her digit keys is able to operate the switches at the distant exchanges and so establish connection with the required subscriber.



X 1095 Fig. 1. Director racks, Smethwick Exchange.



X 1096 Fig. 2. 1st and 2nd numerical selectors, Smethwick Exchange.

The straight numbering scheme as adopted for smaller areas would be uneconomical from the point of view of switching in an area of the size of Birmingham.

A subscriber dials 7 trains of

digits of which the first 3 are letter codes corresponding to the first three letters of the desired exchange name, and the remaining 4 trains constitute the required subscribers number dialled in the usual way; the

dial is suitably marked with letters as well as numbers for this purpose. These trains of impulses are received on the director at the exchange and by suitable translation facilities any train or trains of impulses are sent out to operate local and tandem switches in order to reach the required exchange. The numbers dialled by the subscriber are stored in the director and are sent out after the translated impulses. It can thus be seen that if it is desired to route the calls to a particular exchange via another path due to altered traffic conditions, it is only necessary to re-arrange the jumpering on the translation field so that the appropriate impulses are transmitted from the director.

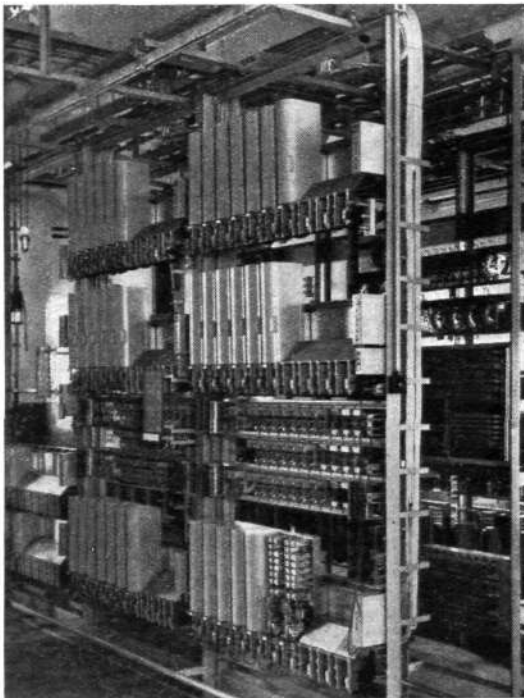


Fig. 3. 1st code selectors, Priory Exchange.

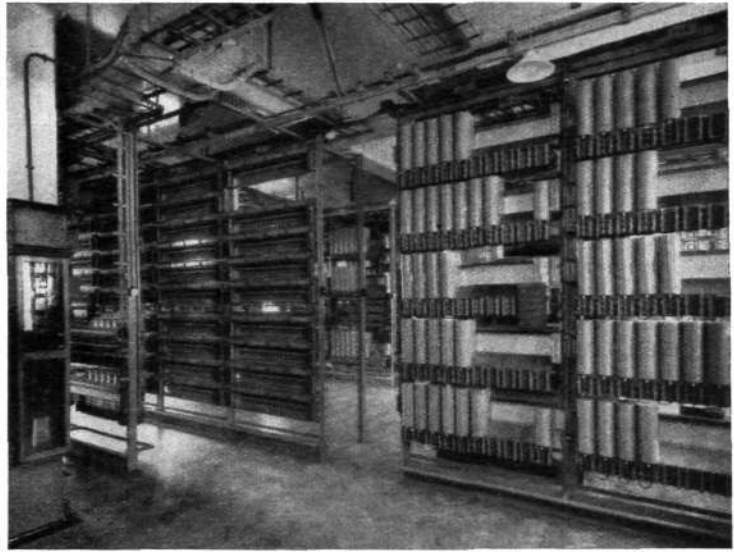
X 1097

Excess fee metering facilities up to 3 units are provided. To each 1st code selector, which is the selector receiving the first train of translated impulses from the director, there is an associated subsidiary bank and according to the level to which the selector is stepped so it is decided whether 1, 2 or 3 meter pulses shall be applied to the calling subscribers

meter when the called subscriber has answered.

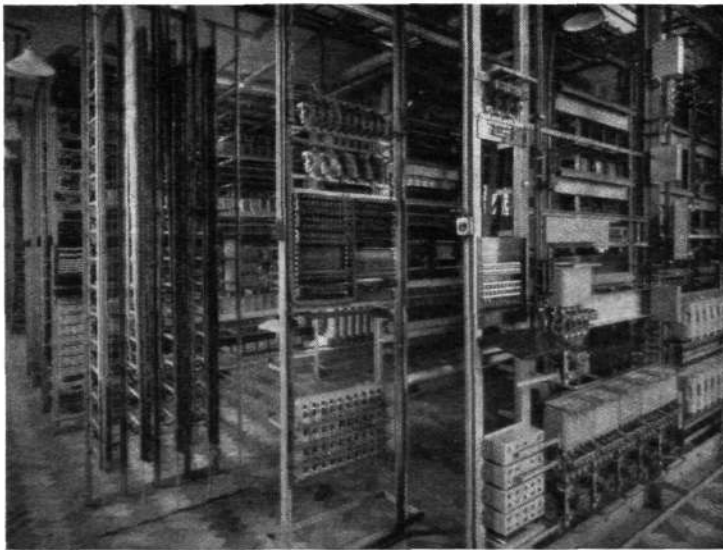
In order to ensure that the equipment is working satisfactorily, automatic routiners are employed to apply stringent tests and are capable of locating faults which would not be noticed in the ordinary way. The routiner is set testing by means of keys and will then apply a complete cycle of tests to each piece of equipment. In the case of a fault the routiner stops and indicates the nature and position of the trouble. After taking particulars, the routiner may be stepped on to continue the testing.

As some of the exchanges in the area are of small initial and ultimate



X 5029

Fig. 4. Uniselectors, and final selectors, Priory Exchange.



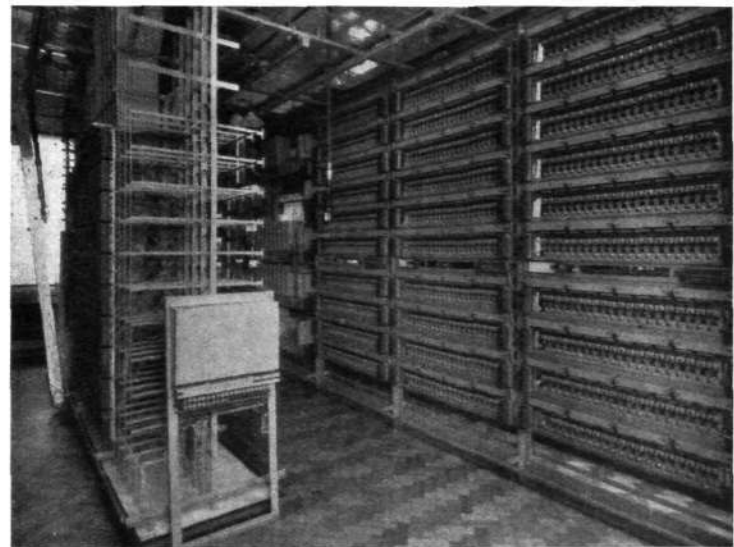
X 5090

Fig. 5. Coder call indicator equipment, Acocks Green Exchange.

Fig. 6. Uniselectors, Acocks Green Exchange.

equipment, it was considered unnecessary to fit a manual board, and in these cases assistance calls are dealt with on a manual board at one of the main exchanges. These boards deal with toll and assistance calls and have access to the automatic equipment if this facility should be required. For toll working the positions are fitted with lamp time indicators to display to the operators the duration of the calls direct in minutes.

The power equipment includes the usual 50 V batteries which together with motor generators for charging purposes and ringing machines are supplied in duplicate.



X 5031

# The Ericsson Automatic Telephone System 10 Years

It is now ten years since the first automatic exchanges of the Ericsson system with 500-line selectors were put into service. The first two were the exchanges of Rotterdam West, and Hamar, Norway.

During these ten years the Ericsson automatic system has scored great success; Ericsson exchanges are now in service all over the world, and, even if the technical perfection of the system has involved some alterations in design, the Ericsson automatic system was so perfect already when first intro-

duced, that all vital parts are still of almost exactly the same design and construction.

The table below shows the number of lines, built and under construction, of the Ericsson system. Since in those countries where other automatic systems are installed the factories of the Ericsson group have taken part in the automatization according to these systems, the corresponding numbers have been entered in order to complete the picture.

Ericsson automatic system with 500-line selectors ..	712 845
Strowger system, British Post Office, manufactured by Ericsson Telephones Ltd, London—Beeston .....	63 534
Rotary system, manufactured by Société des Téléphones Ericsson, Colombes, France .....	46 000
Small automatic exchanges with step-by-step 25 and 50-line selectors (OL and similar systems) .....	80 602
<b>Total</b>	<b>902 981</b>

## Extension of the Repeater Station at Vercelli, Italy

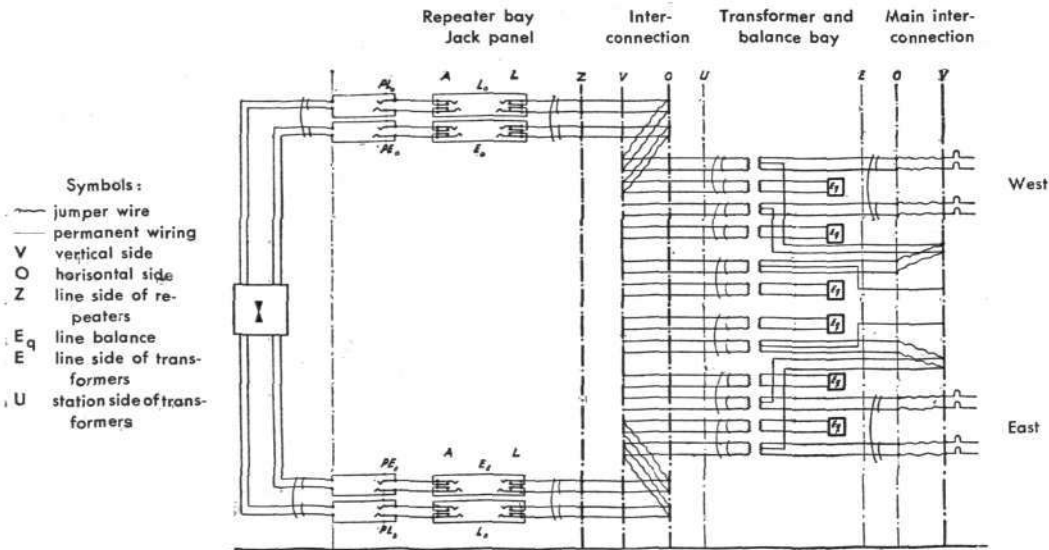
In the summer of 1932 the concessionaire in the first Italian telephone zone, Società Telefonica Interregionale Piemontese e Lombarda (STIPEL), ordered the extension of the repeater station Vercelli from Telefonaktiebolaget L. M.

Ericsson. On November 10th of the same year, the installation was handed over to STIPEL after having been subjected to severe tests during the preceding day.

Some information about the new plant might interest the readers of

the Ericsson Review; a brief description is given below.

The repeater station of Vercelli is situated about half way on the cable line between Milan and Torino. The circuits are chiefly medium-loaded but part of the equip-



X 5032 Fig. 1. Diagram of the repeater station at Vercelli.

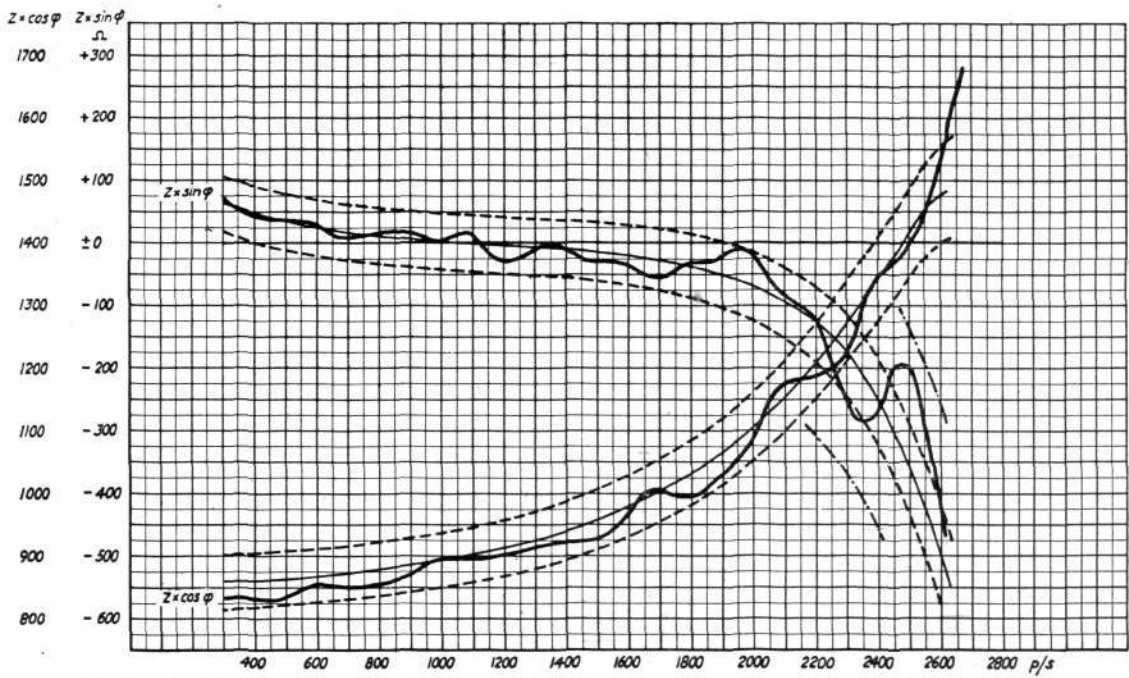


Fig. 2. The impedance curve of the normal balance, compared with a typical impedance curve of a medium loaded circuit.

Dotted lines show 5% deviation from the numerical value of the impedance of the normal balance. Point-dotted lines show 15% deviation from the numerical value of the impedance of the normal balance.

ment ordered is intended for use on easy-loaded circuits.

The extension of the Vercelli station comprises twenty repeaters, Type FPB 332, mounted on three unit bays, each containing eight repeaters with current supply, jack-and measuring panels, as well as relays required for alarm and repeating of signals. The middle bay is fitted with equipment for talking and monitoring, as well as measuring instruments for the control of voltages and currents. This equipment is common to the three bays and may by means of cords be connected to all the repeaters. One equipment for talking and monitoring has been built into an existing pulpit for audio frequency measurements.

Two bays for repeating coils and line balances are made for the equipment of 20 side circuits and 10 phantom circuits each; equipment for 20 through connections has been delivered. The connecting strips required are mounted in the existing jumper and interconnection bays.

Lines and line balances are connected to the repeater by means of repeating coils; the Hoyt-balance

is thus a direct image of the cable circuit impedance.

Fig. 1 shows schematically the

wiring in the office and Fig. 2 shows the accordance between a typical impedance curve of a medium-

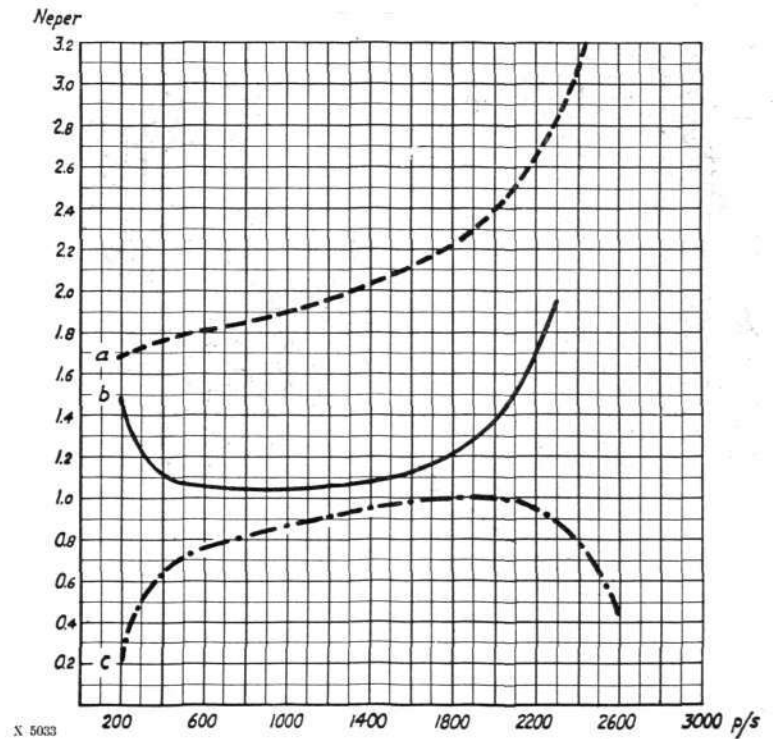
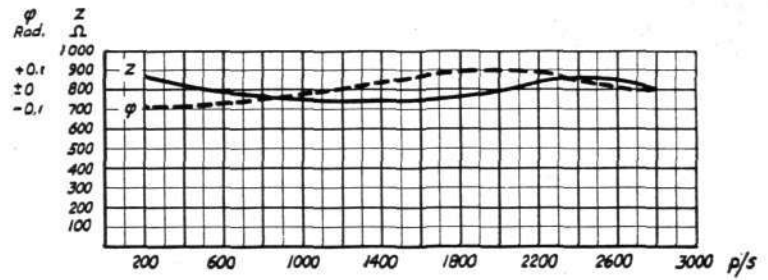


Fig. 3. a: the variation of the line attenuation with the frequency for a circuit Milan-Torino; b: the variation of overall attenuation with the frequency for a circuit Milan-Torino; c: the variation of gain with the frequency for a circuit Milan-Torino.

Fig. 4. Typical impedance curve of the amplifiers, measured according to the CCI.



X 5034

loaded side circuit and that of a normal line balance; both curves are measured through the transformers.

Fig. 3 shows the variation of line attenuation, gain and overall line attenuation with the frequency for

a circuit between Milan and Torino.

Fig. 4 shows a typical impedance curve of a repeater measured according to CCI.

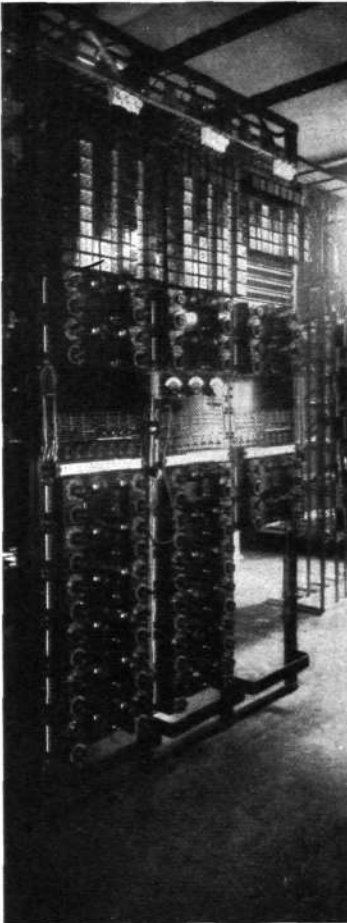
Attenuation equalizers of constant impedance are inserted in the grid circuits of the repeaters. By strapings, the slope of the attenuation curve is adjusted according to the attenuation curves of the line connected. The slope of the attenuation curve may in this way be regulated in four steps.

The Ericsson repeaters are fitted with secondary potentiometers for adjusting the gain in both directions; by means of these potentiometers the gain may be regulated in steps of 0.02 neper.

By pressing a feed-back button and regulating the secondary potentiometer till the repeater starts to sing it is further possible to compensate the difference in gain of different valves so that each step on the potentiometer means a certain gain which does not vary more than  $\pm 0.01$  neper from one repeater to another.

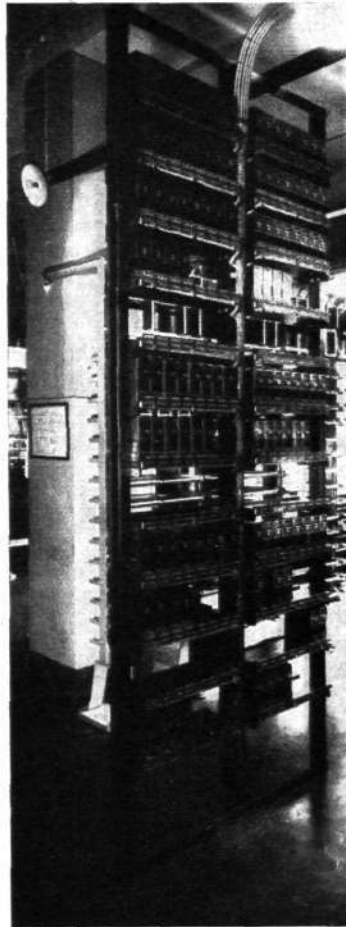
The pictures show the plant delivered.

For those who are interested in the design of the Ericsson repeaters we recommend the article of T. Laurent in the Ericsson Review, Nr. 10—12 1931, called »The standard Two-wire Repeater of the Ericsson Concern».



X 3079

Fig. 5. Repeater bay.



X 3080

Fig. 6. Transformer and balance bay.

# Signalling Plants in Hotels

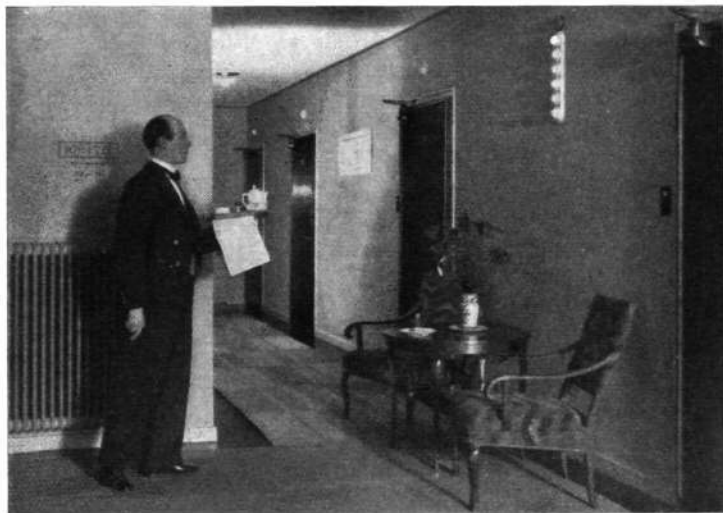
All hotel managers realize nowadays that a signal plant is a necessary part of the technical means available for maintaining a perfect service. But few have understood to solve the problem of such plants satisfactorily. The most common systems use ringing signals or other kind of acoustic signals; the easier the signals are to perceive the more the guests will be disturbed.

Compared to the acoustic signal plants, luminous signals, besides their noiseless operation, have this advantage, that for the calling of different groups of service, multicolour signals are used, which are more easily distinguishable than different bells. As the signal is immediately observed and can not be misunderstood, the staff will be able to do their work much faster than in other cases. The saving of time realized will often permit a reduction in cost through better utilization of the staff.

The luminous signal can be repeated at any number of points in the corridors or the whole building, so that they may be observed from anywhere in the hotel. The staff called needs only to follow the lit lamps and will thus be conducted to the calling room. By pressing a button the guest can call exactly the servant he wants. In most cases an acoustic plant will only be able to call one certain person. This one has then to transfer the order to, *e. g.*, the waiter or the boots, which involves the possibility of misunderstandings, and in any case a delay that can be avoided by means of the distinct luminous signals.



X 3077 Fig. 2. Table pushbutton box.



X 5027 Fig. 1. Corridor in the hotel of the Royal Automobile Club in Stockholm. The waiter is directed instantly to the calling room by the group and room lamps.

The signal can only be reset at the door of the room of the calling guest. The staff must thus first receive the order of the guest before the signal can be cancelled by pressing the corresponding reset button.

The guest further has the possibility of calling several servants at a time. When the order has been received each signal can be reset separately. The resetting of one signal does not involve the resetting of the others. It can thus not arrive, that a servant, by simultaneously resetting two signals, forgets to wait on a guest, as signal and control lamps will light as long as any call is not answered.

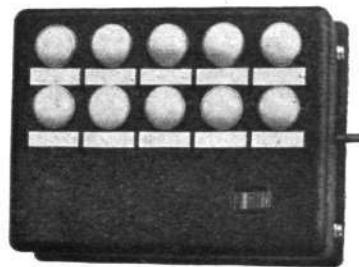
The signal or room lamps are mounted in the corridor above the door of each guest's room. When a call has been made, these lamps will light until the corresponding reset button is pressed. If the staff consists of maid, waiter, and boots, lamps of three different colours are used. If there are two or one class of servants only, lamps of two or one colour are used.

As especially in great hotels the room lamps are not visible from all parts of the corridor, group or di-

rection lamps are used, indicating the direction, in which the calling room is to be found. In great hotels a number of rooms on each floor are collected to one group and every such group is represented by a group or direction lamp.

When the staff is not in the corridor but in the service rooms, the calls are indicated on supervision boards, mounted in these rooms. Generally, only the groups are indicated on these boards, which will be quite sufficient; when the staff comes out in the corridor, the group and direction lamps, and finally the room lamp will direct them to the calling room.

For the house maid, who will be occupied during the morning hours



X 3078 Fig. 3. Supervision board.

making the rooms, a special arrangement is provided. If a key is put into a hole in the contact of the room, a buzzer, built into the contact, will be sounded, when the house maid is called from another room. In this way the call will come through, in spite of her not being able to see the signals.

For purposes of staff control, control boards can be mounted, in the porters office; these boards will indicate how long the guest has to wait before his call is answered. If this time is too long, the staff may have too much work, or else it may be inattentive. In both cases there is the possibility of controlling and attending to any deficiency in this respect.

At night, when the staff is needed less, all signals may be switched over from the ordinary boards to a

main board in the night porter's office.

Signals from the baths are indicated in a special manner. These calls are often made in emergency by persons overcome by illness in the bath and thus requiring immediate assistance.

These hotel signals can of course be made of any design so as to suit all requirements and local conditions.

Finally a number of auxiliary devices might be mentioned as, *e. g.*, an indicating device, used in connection with the night bell. As soon as the porter has heard the night bell, he presses a button, mounted in a convenient place, thus lighting a small light signal with the inscription »coming» above the night bell. This will indicate that the call has been noticed.

Electric door locks, permitting the guest to open the door by pressing a button at the bed, or the porter to lock a certain door in the hotel from his place, are practical devices, that many hotels have found advantageous to install. Like the devices described above, these facilities will save the staff a lot of unnecessary work and will at the same time improve the comfort of the guests and thus contribute to the success of the hotel.

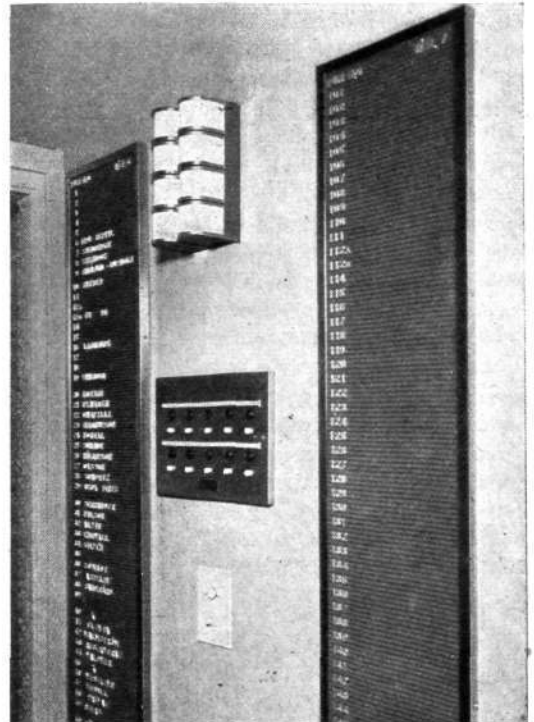
Signalling equipment for hotels has been manufactured for a long time by Ericsson, and has been installed in a great many hotels all over the world. The figures show details of plants recently completed where Ericsson equipment was chosen on account of its excellent technical properties as well as its attractive appearance.



X 1093

Fig. 4. Signal plant in a hotel.

At the intersection of two corridors, a group lamp is mounted, indicating at a distance from which part of the corridor the signal comes.



X 1094

Fig. 5. The porter's office.

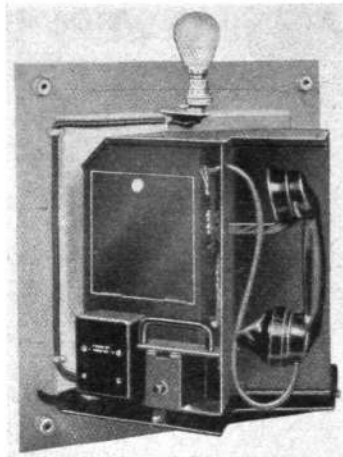
The porter can easily control that the calls are answered in time by means of the lamp group, which at night is used as a main supervision board.

# A New System of Police Telephones and Signals

Rapid and reliable means of communication are just as essential for the efficient functioning of a police force as they are for the operations of an army in the field.

Police forces to-day are becoming more and more alive to this truth, and where not oppressed by false doctrines of economy they are making bold efforts to adapt to their requirements all the means of communication which present day science has made available.

The post, the telegraph, and the public telephone systems of the country, as well as wireless telegraphy and telephony both stationary and mobile, are all means of communication which police generally employ, and most forces have



X 3056 Fig. 2. The telephone equipment for the police side.

also pressed into their service the modern fast motor vehicle for communication purposes as well as the rapid transport of personnel.

Here and there in the past an enterprising police authority has provided throughout its area a system of private telephones for police use, but no close study of the particular problems of police communication appears to have been undertaken until after the Great War, when an investigation was begun which has resulted in the carefully planned system now manufactured and marketed by Ericsson Telephones Ltd.

This new system was first demonstrated to police authorities in 1930, when an early model equipment was set up at police headquarters in the City of Glasgow, and was there inspected by the Chief Constables and senior police officials of Scotland.

The first authority to realise that in this new system lay the solution of local police communication problems was the Renfrewshire Constabulary, and orders were speedily placed for two complete installations for the towns of Renfrew and Johnstone.

The Chief Constable of Renfrewshire, Mr. John Robertson, had long been a keen advocate of the more

ample use of the telephone for police purposes, and had been striving to find reliable means for making the police telephone network available also to the public, to the end that the police might the more efficiently fulfil their role of public servants as well as guardians of the peace. To him great credit is due as the pioneer user of this new system, and the experience gained in the operation of these two initial installations should prove of great benefit to his area as well as to the police forces of the country at large.

Following upon the enterprise of the Renfrewshire authority many other forces became interested in the facilities afforded by the system, and the General Post Office decided to adopt it as their standard system for police purposes. At the beginning of 1932, the City of Edinburgh Authorities signed the first contract for the provision of the system by the Post Office. This contract covers the whole of the police divisions of the City.

General interest then led to an invitation to the Post Office to arrange an address on the subject to the Annual Conference of the Chief Constables' Association, and a most interesting and instructive paper was read before that body at the Guildhall, London, on 17th June, 1932, by Mr. L. Simon, Director of Telegraphs and Telephones, G.P.O.

The system is fundamentally of the common battery type, and it embodies a party-line feature which considerably economizes in line



X 3055 Fig. 1. Street telephone pillar.

At the top, the signal lamp, which glows steadily when the telephone is used by the public, and flashes to call for an officer nearby. At the middle the telephone and loud-speaker equipment. In the column, compartment for first-aid outfit etc.



X 3057 Fig. 3. The loud-speaker for the use of the public.

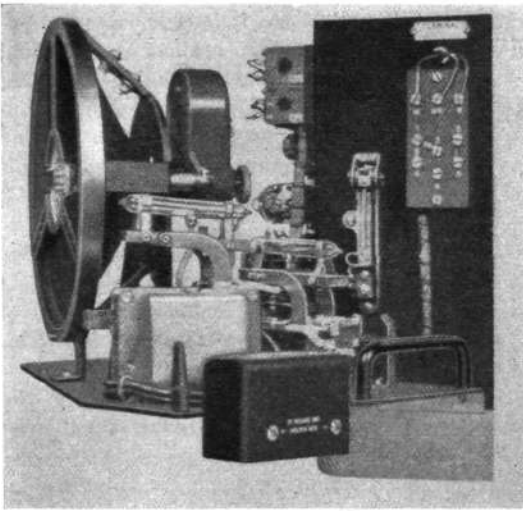


Fig. 4.  
The loudspeaker.

X 1092

plant requirements. Another feature, which is of much value in keeping down the line fault duration figure, is a system of continuous electrical line test, whereby any class of line fault is indicated at the police station immediately upon its occurrence.

With a view to minimizing the duration of apparatus faults, the whole of the equipment associated

with the police lines is constructed in units which can be jacked-in and out without the need for undoing terminals or unsoldering connections.

Spare units are held in reserve at the police station, and can be used for speedy replacement when a fault develops in any equipment unit.

Signalling on the party-line is fully selective to three stations, and where outward calling facilities are not required, additional stations can also be connected to the same line.

For the street points an equipment can be provided either of the pillar type or for mounting in the wall of a police kiosk, and the signal call lamps may be mounted upon wall brackets, suspended from over-street wires, or fixed upon the tops of the street pillars.

At the street points dual telephonic facilities are provided, namely, (a) by normal microtelephone available only to police or other authorised persons in possession of a key, and (b) by loud-speaking telephone available to the public at large upon simply holding open a door which is self-closing but non-locking.

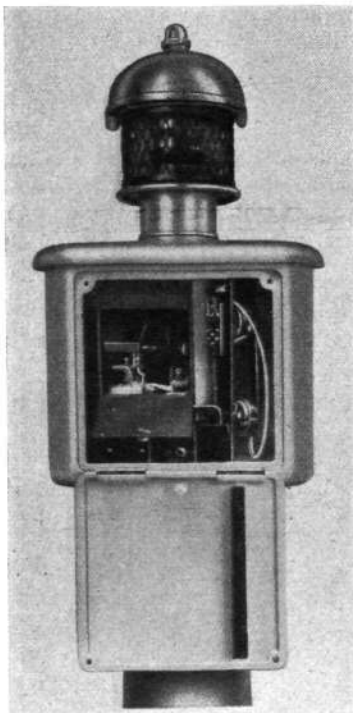
The class of call originated at a street point is automatically signalled to the answering operator at the police switch-board, a police call being indicated by a green light and a public call by a red light.

The loud-speaking telephone for

public use is located behind a protective grille and requires no handling by the caller. It is only necessary to »pull and hold open the door», and thereafter to speak in a normal manner in the general direction of the grille. The answering voice of the police operator can be clearly heard, even in street traffic noises, as an amplifier at the police station is employed in the circuit.

In order to reduce the risk of false calls and skylarking, the action of opening the public door can be arranged to cause the associated signal lamp at the street point to light up as a steady signal throughout the period during which the door is open. This arrangement is also useful for indicating to any police officer within vision that a member of the public is communicating with the police station, and if the officer is not already more seriously engaged he would proceed to the street point in order to investigate the reason for the signal, or to render such assistance as may be desired.

The same signal lamp is employed when the police operator rings out to call any nearby officer to speak on the telephone, but in this case the lamp operates as a flashing signal. The operation of calling out to street points is entirely controlled by the police operator. He can



X 3058 Fig. 5. The pillar head, opened for inspection.



X 3659

Fig. 6.  
Switchboard at the police station.  
The apparatus is composed of units acc. to Fig. 8, connected to one line each.

switch on the ringing condition to one street point, or to any number of these simultaneously, and can likewise terminate the flashing of the signal call lamps at will. No re-setting of relays at the street points is involved. As soon as an outward call is answered at the street point, ringing is automatically disconnected from the line concerned, and a »reply signal» given to the police operator by the glowing of a white lamp associated with that line.

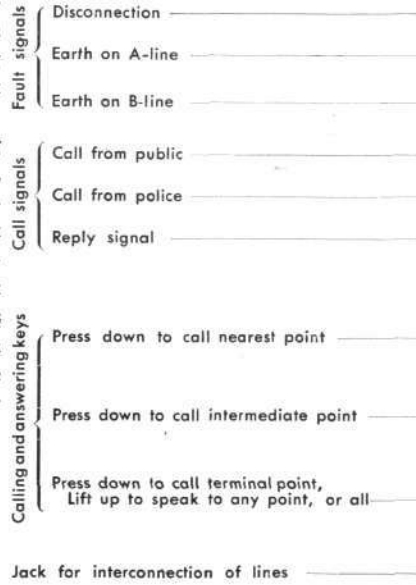
In the event of a line being already in use from one street point, a public call which may be originated from any other point on that line will still set up the »public call» signal at the police station, so that priority is always assured to calls from the public, on the assumption that such calls will generally be brought about by some emergency calling for immediate attention.



X 9006 Fig. 7.

Public exchange facilities for the purposes of the police, are provided by the General Post Office in connection with this system, but connection of public callers beyond the police system proper is barred.

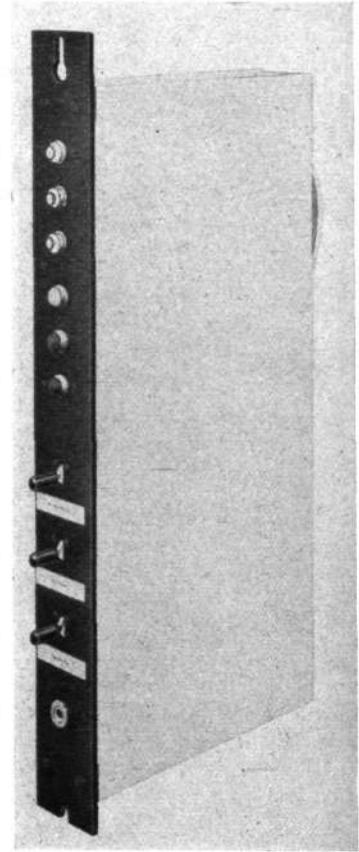
The provision of exchange faci-



ilities is of great value to the police, particularly in view of the greatly increasing mobility of the criminal.

The extent and requirements of different police areas varies within

wide limits and to meet this several sizes of switchboards have been developed.



X 3060 Fig. 8. Switchboard line unit, for one line.

## News from L. M. Ericssons Signalaktiebolag

The new interlocking plant at the *Stockholm Central Station* was put in service on March 25. This was performed without any disturbance of the regular traffic, which, on both the 25th and 26th, amounted to 342 ordinary and 18 extra trains, or, together, 360 trains per day. All signals and points are operated from the new central cabin, which replaces the five former cabins. The plant is of the most modern type: electric interlocking machine without mechanical locking register. Both the interlocking plant and the illu-

minated track diagram have been supplied by Ericsson companies.

A description of the plant will be published later in the *Ericsson Review*.

The *Swedish State Railways* have ordered an electric interlocking plant with an illuminated track diagram and other signal equipment for the rebuilding of the *Hagalund* station, and

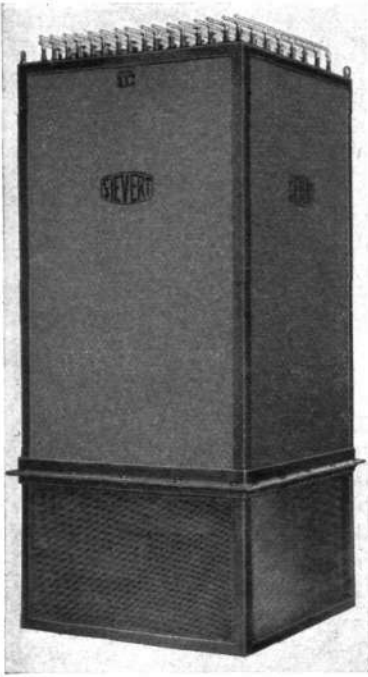
the *Stockholm Tramways* an automatic section blocking plant for the

new *subway* under the southern part of *Stockholm*.

The *Nederlandsche Staatsspoorzwegen* have further ordered an electric interlocking machine for the *Maarn* station, near *Utrecht*, and

the *Polish State Railways* an electric interlocking plant for the *Warszawa-Czyste* station, near *Warszawa*. The equipment for this plant, interlocking machine, point operation devices, etc., will to a great extent be manufactured by the Ericsson factory at *Welnowiec-Katowice* in *Poland*.

# Condensers for the Improvement of Power Factor of High Frequency Furnaces



x 3081 Fig. 1. One of the six condenser units, 2800 kVAr, 2300 V. The ventilator is mounted inside the grid.

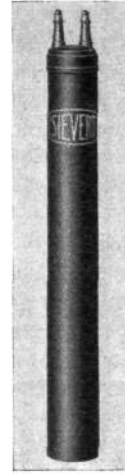
At the beginning of this year, Sieverts Kabelverk has delivered a set of condensers for improvement of the power factor of a furnace plant at the Hagfors mill of Uddeholms Aktiebolag. This installation is of great interest, partly as it is one of the biggest ever made. The total effect of the condensers is no less than 14 600 kVA at a tension of 2 300 V. As the condenser set takes a considerable part of the total cost of the plant, it is of great importance that the price of the condensers should be brought down as far as possible, and the demands on the design are consequently very severe.

Fig. 1 shows one of the six units. The condensers are built up of a number of cylindric elements (Fig. 2), consisting of thin metal foils, insulated from each other by means of paper. These elements are fitted

in a cylinder of sheet-iron, one on top of the other, vacuum-dried and impregnated with oil. The cylinder is then hermetically closed by a cap fitted with two bakelite insulators.

A number of cylinders are mounted in a frame, thus constituting a condenser set of the size wanted. The bottom side of the frame is fitted with a silent ventilator for cooling. In order to direct the air current, the group of cylinders is surrounded by sheet-iron walls, as shown in the figure. As the perfect functioning of the condensers depends on the cooling functioning in a satisfactory way, relays are connected, that are operated by the air current, so that the condensers are switched off, if the motor should stop for some reason or other.

The connections are made on the top side of the condenser cylinders. Because of the high currents, it is of great importance, that the conductors should be drawn the shortest way possible. In this respect also, the Sieverts design gives considerable advantages; finally, the accurate regulation of the capacity might be mentioned, which is due to



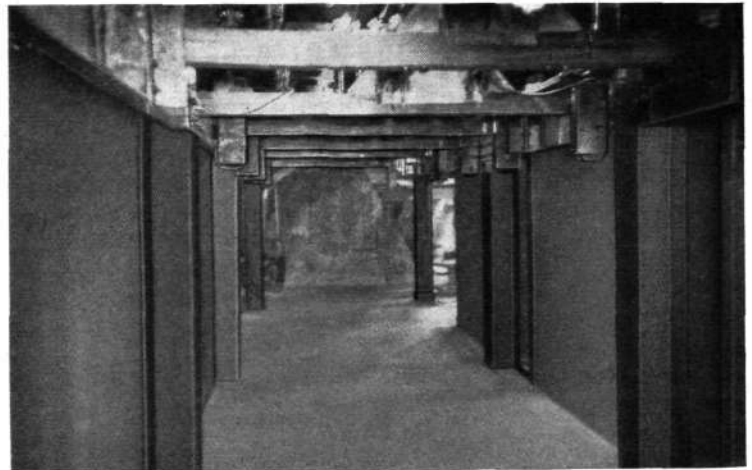
x 3082

Fig. 2. Condenser cylinder. 42.5 kVAr, 2300 V.

the grouping of the condensers into small units.

Fig. 3 shows the Hagfors plant. The condenser sets are situated on both sides of the passage. The ventilators are mounted under the floor. The whole quantity of air for cooling is, in this case, taken direct by a duct from outside.

Sieverts condensers for furnace plants have now been in operation for several years, not only in Sweden, but also in several other countries, *i. e.*, France and England.



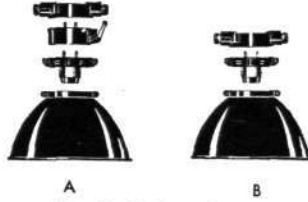
x 5085

Fig. 3. The condenser plant in Hagfors Bruk. The condenser units are erected on each side of the gangway. The ventilators are mounted under the floor.

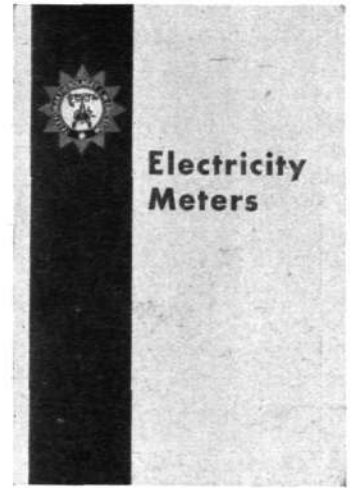
# New Catalogues



The following sections cover the *Sievert Gebe material*, one of the most important and interesting specialties of the company. The Gebe system is in principle a hermetically closed connection box, and a solid cable, insulated with india rubber and protected by a lead cover.



X 3805 Fig. 2. Ceiling lamp.  
a. with, b. without switch.



After the publication of the first 1933 issue of the Ericsson Review some new catalogues have been published.

Sievert Kabelverk has thus published an «illustrated price list» of the products handled by their sales organization and manufactured by that firm or other companies of the Ericsson group.

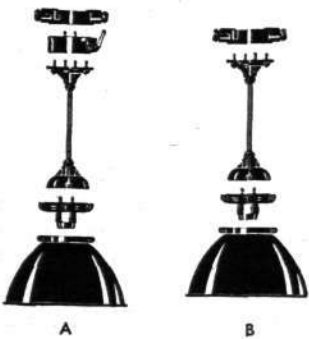
The arrangement of the catalogue is very clear; by the judicious use of modern types the numerous tables in particular have been made more easy to use. As a uniform method for the arrangement of the text and illustrations has been used, it is very easy to find any product among the great number of types.

The first three sections deal with cables and wire for telecommunication and power purposes, as well as insulation tubes.



X 5036 Fig. 4 Gebe-installation in a workshop.

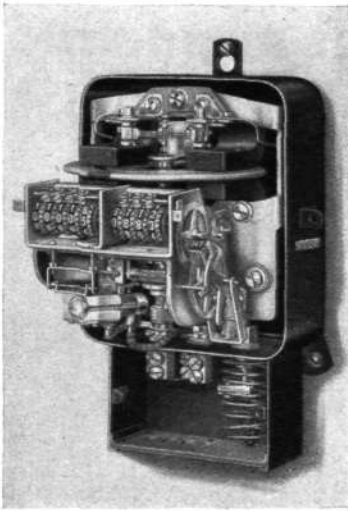
The Gebe equipment is composed of a number of standard parts — connection box, switch, lampholder, pendant cover, and shades and screens of various kinds — of such design that a small number of parts make possible a great many combinations for various purposes. One particular advantage of the Gebe material is, that the switch can be built together with the lamp-holder to a separate unit. The parts are interconnected by means of contact devices in the same way as a wall socket with the appurtenant plug. This means, that the mounting of a lamp does not involve any connection of wires, except the connection



X 3084 Fig. 1. Complete ceiling pendant.  
a. with built-on switch.  
b. without built-on switch.



X 3086 Fig. 3. Wall bracket.  
a. with, b. without switch.



X 3087

Fig. 5.

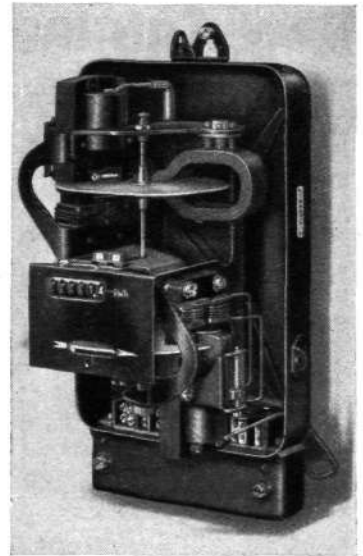
**Two-rate house service meter for DC.**

of the fixed Gebe cable to the connection box. The various parts are then put together and fixed by means of two screws. The illustrations show, how various types of Gebe material are composed of stan-

dard parts. As each point has its own connection box, there is this great advantage, that a Gebe installation can be made without special distribution boxes. For the shunting of the wires the connection boxes of the various devices are used. The installation will consequently be better, cheaper and neater.

The next section covers switches, wall sockets, etc., mostly made of bakelite. One section includes the *Sievert condensers for power plants*, previously described in the Ericsson Review.

The last and largest section of the catalogue describes the *Ericsson electricity meters*, and forms the first complete catalogue of this material. This section has also been issued separately in Swedish, English and Spanish; by means of an instructive arrangement with excellent illustrations and concise descriptions of the various types, it gives a good idea of Ericsson's ma-



X 3088

Fig. 6.

**Three-phase kilowatt-hour meter, unbalanced loads, without neutral.**

nufacturing activities in this line, which at present comprise all important types of meters.

## Ericsson Technics

**Ericsson Technics** 1933, Nr 4. H. Sterky: *Methods of computing and improving the complex effective attenuation, load impedances and reflexion coefficients of electric wave filters.*

In telecommunication technics electric wave filters, forming a special group of so-called quadripoles, have reached a growing importance. Carrier current telephone systems, super audio and audio frequency carrier telegraph systems, superheterodyne receivers for radio and several other systems or types of apparatus contain filters as essential constructional elements.

The theoretical basis for the computation of electric wave filters has been founded during the last decade and formulæ have been developed, which render the application of the theory to practical problems possible. At first the main interest was devoted to methods for the computation of the propagation constant and image impedances for filters designed as ladder structures with different kinds of impedance networks in the series and shunt arms. Later on,

however, the so-called effective attenuation, defined according to the »Comité Consultatif International des communications téléphoniques à grande distance» and generally accepted as the quantity which best characterizes the operational properties of a filter, has come into the foreground, and several methods for the computation of this quantity have been published.

In this treatise a method has been developed for direct computation of the complex effective attenuation of low pass, high pass, band pass and suppress filters belonging to the »constant k» and the »m-derived constant k» classes. The formulæ given are general and well suited for practical use, depending upon the fact that the relation between the parameter of the effective attenuation formulæ and the frequency is very simple.

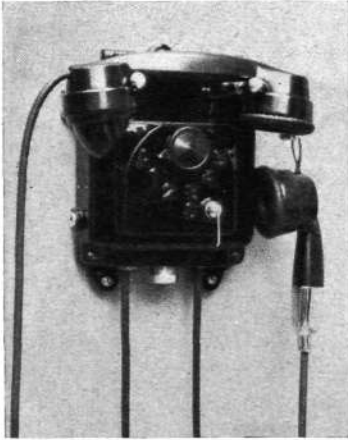
The shape of the effective attenuation curve depends on the matching of the filter image impedances to the external load impedances. The paper treats particularly this question, and a special method for find-

ing the matching which gives the best effective attenuation curve is indicated. Through a consistent and systematic application of this method a considerable improvement of the effective attenuation compared with the effective attenuation according to matching methods previously used, is obtained. Thus a lower and more constant effective attenuation in the pass range and a greater effective attenuation in the attenuating range of the filter is obtained.

The question of the influence of the losses on the effective attenuation is treated as well as the modifications in the matching conditions depending on the losses. Simple formulæ for the computation of load impedances and reflexion coefficients for the filter classes mentioned are also derived.

Finally some examples of the application of the computation methods to practical problems are given, and the author has the opportunity to prove the good conformity between computed and measured values of the effective attenuation of different filters.

# Telephones on Board Ships



X 3071 Fig. 1. Instrument of normal design, with extra receiver.

There is a steady increase in the use of telephones on board ships for the purpose of giving orders, for communication between different parts of the ship, etc. In the Royal Swedish Navy a special type of loud speaking telephones for directing the gunfire has been used for several years. With these devices as a basis, Ericsson has designed a number of instruments for merchant vessels.

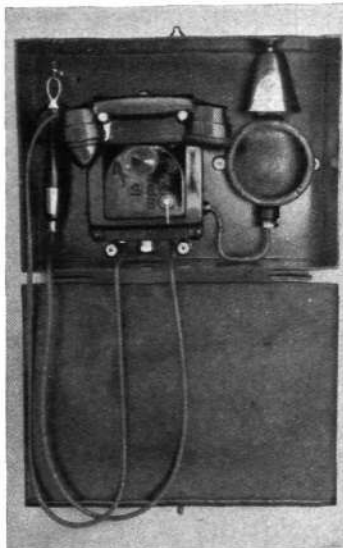
The telephone net on board a ship must be waterproof, and the telephone instruments are consequently of waterproof construction with packings for the cables. The area of the conductors is made so great, that the resistance of the cables is negligible, in order to obtain a »loud speaking» system, *i. e.*, that the current generated in a microphone is attenuated as little as possible by the resistance of conductors, etc.

Fig. 1 shows an instrument suitable for mounting on the bridge, in the wireless cabin, or in other fairly well sheltered places. As shown in the figure it is fitted with a handset and one extra receiver, both being of the new bakelite type. The telephones are supplied with leather pads, fitting close to the ear and preventing the person listening being disturbed by outside noise. The cables to the telephones are

insulated with rubber and are of sturdy construction.

Each instrument has a selector device with six positions: one reply position *A* and five calling positions. *S* is the signal button. For reception of incoming signals, the instrument is connected to a waterproof bell, shown in Fig. 5. This bell may be combined with a hooter or, if still more intense signals are required, with a relay closing the circuit of a siren or other similar device.

At places exposed to the sea, *e. g.*, the forecabin or the roof of the quarter, deck, the instrument is protected by a case, shown in Fig. 2.



X 3072 Fig. 2. Instrument in protective case, with waterproof bell.

A special type is made for mounting in the engine room, Fig. 3. This instrument has a handset, as well as an extra receiver and a laryngophone. This latter is a handset, that is not influenced by external noise; the current variations are produced by vibration when the microphone is held close to the larynx or the cheek.

It is thus possible to transmit a message from the engine room, without the engine noise disturbing

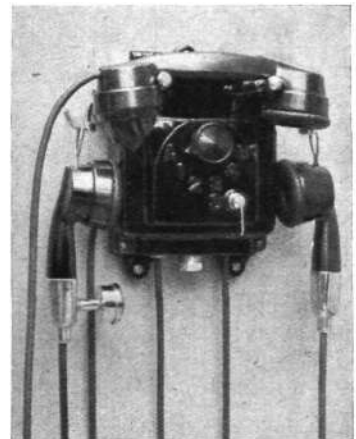
the speech. When the ship is at rest, the ordinary handset is used; this is also the case, if the speech from the laryngophone is not clear enough.

Fig. 4 shows an instrument for use in well sheltered places. Connection will often be wanted between the engine room and the engineer's cabin, between the bridge and the captain's cabin, etc. This type of instrument is suitable as a cabin telephone but has no selector device, and can thus only correspond with one or two other telephones.

For incoming signals, waterproof membrane bells, Fig. 5, are used, that are sufficiently powerful where there is not too much noise, and further single stroke bells with a gong diameter of 240 mm, suitable for engine rooms. This latter type of bells has proved to be superior to hooters and sirenes, since modern machines produce a howling tone, and signals differing from this are consequently wanted.

The plant is fed from a 12 V storage battery. If relays for sirenes, lamp signals, etc., are used, the current for these may be taken from the light plant, if convenient.

Fig. 7 shows a diagram of an installation where the forecabin, the wireless cabin, the quarter, and the engine room can be called from the bridge, and vice versa. Calls can further be made between the fore-



X 3073 Fig. 3. Instrument with extra receiver and laryngophone, for use in the engine room.



X 3074 Fig. 4. Instrument for use in well sheltered places, e. g., the engineers cabin.



X 3075 Fig. 5. Waterproof membrane bell.



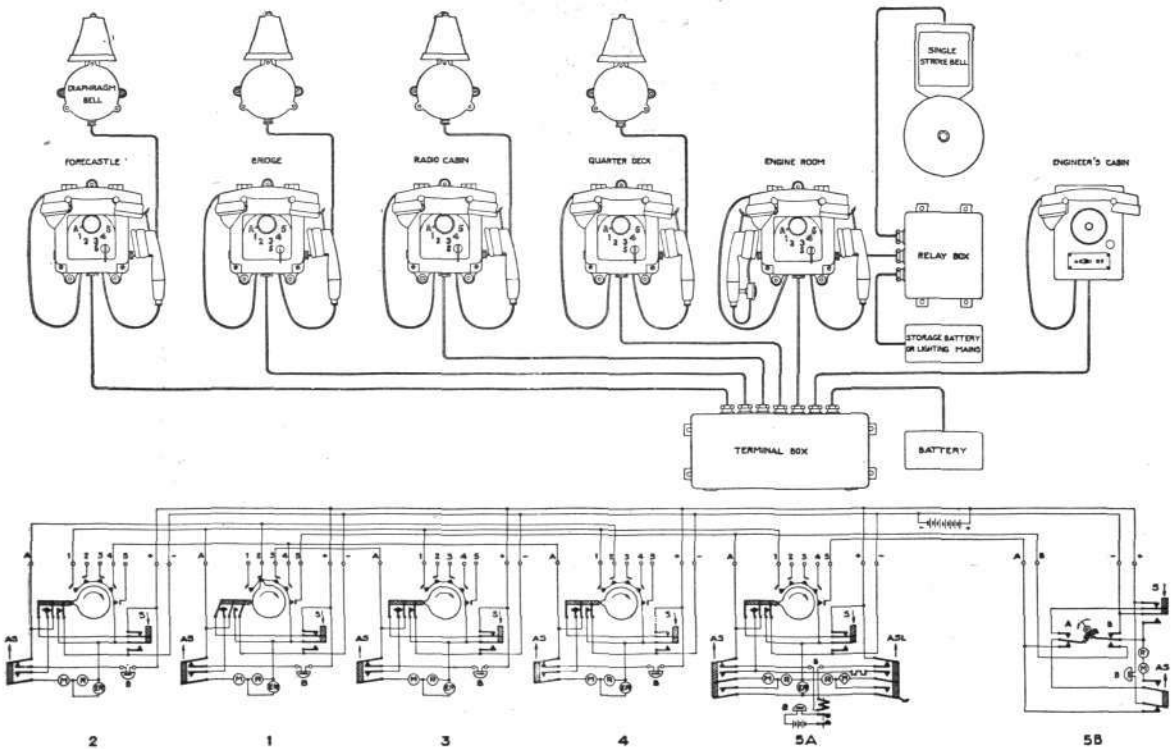
X 3076 Fig. 6. Single stroke bell.

castle and the quarter deck. Other combinations can of course be made, but the abovementioned will be the most common.

In order to make the circuit waterproof, the cables from the different instruments are drawn to one or more distribution boxes, as required. The diagram shows such a distribution box for all incoming cables from instruments and storage battery. The number of wires in the

cable to a telephone instrument is three plus the number of instruments this particular instrument shall be able to call. From the forecastle there are thus five wires in the cable, from the bridge seven, etc.

The frames of instruments, bells, distribution boxes, etc., are made of brass, so as to resist the corrosive influence of salt water and the salt in the atmosphere.



X 7025

Fig. 7. Diagram of a telephone plant on board a ship.

# Baby Ericsson

*Société des Téléphones Ericsson, Colombes, has recently developed a new telephone instrument made of bakelite, of modern appearance and very small dimensions. By slight alterations of the calling device, the instrument can be used in CB, automatic, or LB systems.*

*Besides these different types a press-button intercom instrument of the same design has been developed, intended for small installations, comprising not more than one exchange line and four local lines. This instrument is described below.*

The operation and connection diagram of the intercom instrument are the same as those of the Ericsson instrument, that was selected in 1932 as official standard, type of the French P.T.T.

The calls on the main line are wholly secret; the local calls, however, are not secret, which permits the number of parts to be reduced to a minimum. The adaptation of the Baby Ericsson to an intercom system has been performed after thorough technical investigations, in order to obtain simple adjustment and maintenance, as well as long life-time of the different parts, even under hard traffic conditions.

The instrument is very sturdy; the bottom plate is thus fitted with a rubber lining, ensuring good



X 5038

**Fig. 1. CB instrument.**

The dial is replaced by an electric clock.

adherence to the support. In order to reduce the wear of the wall-box cord, the entrance of this cord in the instrument has been designed with great care, and the cord is further protected by a special spring.

To each instrument belongs a connection box, with the different relays, resistance sets, and condensers. These are mounted on a detachable inset, the back of which is fitted with terminals for the connection of the local lines. By this arrangement it has been possible to reduce the dimensions of the instrument to a minimum, and, further, the installation and maintenance have been considerably simplified.

A number of instruments of this type compose an intercom installation, where each instrument can come in connection with the main line for both incoming and outgoing calls; the master station, that is otherwise used, is thus avoided. In

the same way the instruments can come in connection with each other.

When a call is made from the main line, the subscriber, who first lifts his handset and presses the left key of the bottom row, connects himself to the main line. In the other instruments the main line is then indicated as engaged by means of the indicator, situated beside the key. If the call is intended for himself, the subscriber performs the conversation and then replaces the handset as usual; the key then returns to home position, and the main line is liberated.

If, on the contrary, the call is intended for some other instrument, the person answering transfers the call to the instrument called by pressing one of the three local keys. The main line is then held, a ring signal is transmitted to the instrument called, and the speech devices of the first mentioned instrument are switched over to the local lines of the plant.

When the local instrument called answers, the subscriber gives the information that he will transfer a call from the main line, and then presses the red button on the left of the sloping side of his instrument. When a sound is heard in the receiver, the subscriber releases the button and replaces the handset. The button and the key then return to home position, and the call from



X 1098

**Fig. 2. Automatic instrument.**



X 5039

Fig. 3. Intercom instrument.

The key at the left connects the set to the main line, the other three to the local lines. The indicator shows if the main line is free. The pushbuttons are intended for signalling and the transferring of calls to another instrument.

the main line has been transferred to the other subscriber.

If one subscriber wants some information from another local instrument during a call from the main line, he operates in the same way as when transferring a call, but having received the information he presses the main line key once more

instead of pressing the red button, and in consequence the local key, that has been pressed down, returns to the main line. This can be performed as many times as wanted. The local calls can, of course, not be heard on the main line.

If a subscriber wants to be con-

nected to the main line, he first makes sure that the line is free, which is shown by the indicator, an then lifts his handset and presses the main line key, that will connect him to the exchange. If the exchange is automatic the subscriber only has to set up the number wanted on the dial. If the line plant is of the CB system, the black button on the right of the sloping side of the instrument has to be pressed for a moment, in order to transmit a ring signal to the exchange. When the operator answers, the number is demanded in the ordinary way. If the operator does not answer, ring signals can be transmitted as often as wanted by pressing the black button.

Clearing signal is transmitted when the handset is replaced, independent of the system of the line plant. The very appealing dimensions and appearance of the instrument makes it suitable for small offices and homes. In France it has been a great success; only a few months after the instrument was entered on the market, several hundreds of instruments have been sold.

## News from the Research and Development Department

### A New Design of Dial.

In the Research and Development Department a new dial has been designed, that will meet any demands on this detail which is of so great importance to automatic telephony.

The exterior of the dial has not been changed, as is shown in Fig. 1, but is identical with that of the existing Ericsson standard dial. The internal parts, on the contrary, have been designed according to radically new principles.

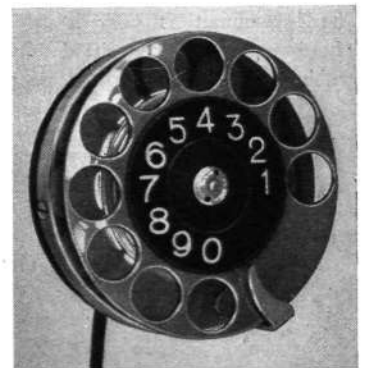
A characteristic property of the new design is, that the intermediate shaft, that transfers the power from the main shaft to the regulator, has been fitted with a double lock mechanism, which makes possible the throwing out of gear of both the regulator and the impulse wheel

independent of each other. By means of this arrangement the regulator need not be stopped, when the finger wheel returns to home position, but the rotation power of the regulator can be thrown out of gear by its own lock mechanism.

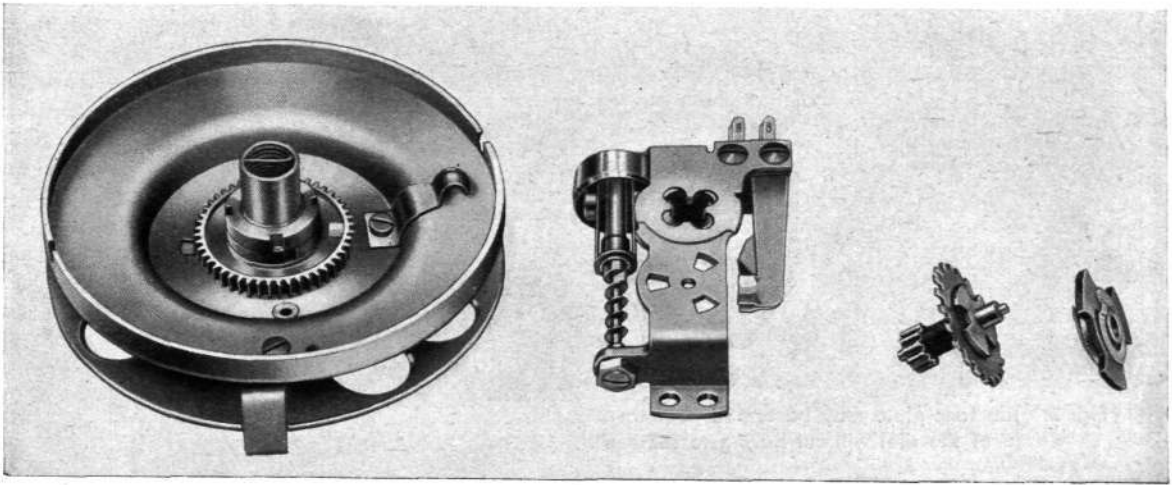
The advantage is thus obtained that the regulator, rotating at high speed, passes more softly from full speed to stop.

The lock mechanism consists of a specially adapted spiral spring, surrounding the part of the worm wheel, that has the same diameter as the shaft; the worm wheel, which is supported by bearings on the shaft, is thus thrown out of gear when rotated in one direction, and is made to move when rotated in the other, Fig. 3 c.

The impulse wheel, Fig. 3 d, fitted on the same shaft has a determined home position in relation to the finger wheel, and can thus not be connected to the devices co-



X 3090 Fig. 1. The exterior of the new dial is identical with that of the standard Ericsson dial.



x 7026 Fig. 3. The new dial, disassembled; a: finger wheel and main shaft; b: frame with regulator and impulse springs; c: intermediate shaft; d: impulse wheel.

operating with the regulator, but has been fitted with a separate lock mechanism. This mechanism consists of two springs of sheet-steel, fitted on each side of the three-part impulse wheel by means of the same pins. One of these springs fits into the three-part clutch disk, shown on top of Fig. 3 c, in order to carry the impulse wheel, while the other fits into one of the three grooves, shown on Fig. 3 b, whereby the impulse wheel is prevented from going backward, and disturbing the impulse springs.

All these details, which are of so great importance for the functioning of the dial, are, as shown in the figures, of simple design and small dimensions. Wear is thus reduced to a minimum, and the reliability is consequently increased.

Another arrangement for reducing wear has been performed by altering the gear between the main shaft and the intermediate shaft from 1:6.5, as in the previous dial, to 1:4 in the new one. The speed of the regulator has thus been brought down from 97 to 70 revolutions per 10 impulses.

In the tests made with a number of dials, wear as well as impulse ratio and speed has been controlled with great accuracy.

Tests with oscillograph have shown, that the new dial functions very evenly, and that it has not changed after half a million operations.

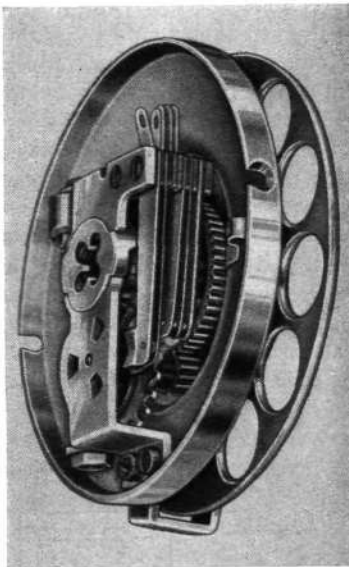
## A New Impulse Ratio Tester.

Various methods of measuring the impulse ratio generated by an automatic telephone dial have been devised, but they are usually not designed to give a steady reading, or if so, accuracy is obtained only if the dial speed be kept constant.

The Ericsson patented impulse ratio tester, however, gives a direct indication of the impulse ratio of

dials, even if the dials tested have different or unknown impulsing speeds. The pattern illustrated is suitable for testing the standard British Post Office type dial.

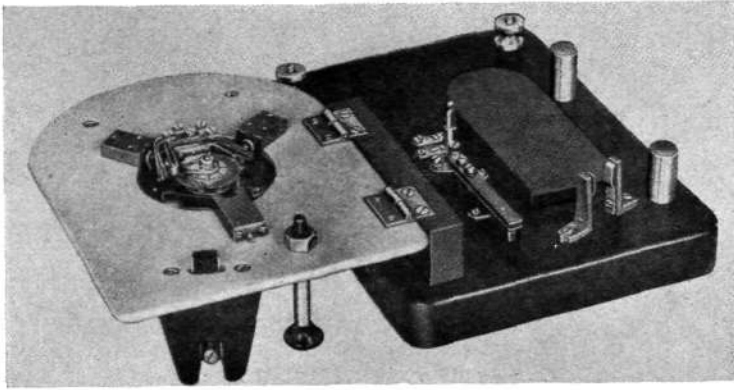
In order to make a test, the dial is placed in a dial-holder on the face of the instrument, and an electromagnetic clutch attachment is clipped to the label-holder of the dial. The clutch attachment has an arm that is pressed between spring clips fixed to the base in order to prevent the attachment from rotating as a whole when the finger-plate is operated. The spring clips also engage contacts to which the clutch magnet winding is connected, and contact springs behind the dial-holder engage the impulse spring terminals of the dial. The instrument is wired so that the clutch magnet is in series with the dial impulsing



x 3091 Fig. 2. The internal parts of the new dial are designed according to entirely new principles.



x 3092 Fig. 1. The ratio tester with the dial in place for the test.



X 5037 Fig. 2. The face-plate may be turned over to allow for adjustments of the dial without having to remove it.

springs, the circuit being normally opened at the contacts of a key.

The dial and clutch having been fixed in position, the finger is placed in the »O» finger-hole and brought round to the dial finger-stop, a pointer on the clutch moving round with the finger-plate until it also encounters a stop. The key is then operated and the finger-plate released.

The clutch magnet energizes in a circuit completed by the key and attracts an iron disc to which the pointer is attached, thus preventing it from rotating with the finger-plate. During each break period of the impulses however, the circuit is broken by the dial impulsing springs so that the clutch magnet de-energizes and allows the pointer to move with the finger-plate. The pointer thus moves in a series of jerks and its final position indicates the ratio measurement.

For workshop use, the ratio scale has three marks representing the normal ratio and the upper and lower limits allowable; these correspond to impulse breaks of  $66\frac{2}{3}\%$ , 70 % and 63 % respectively of a complete impulse. If desired, the scale may be divided in any other suitable manner and marked with ratio values.

In order to allow adjustments to be made to the dial without having to remove it from the ratio tester, the face-plate is hinged and has a large hole through which the back of the dial is accessible. If therefore, a

dial under test is found to fall outside the allowable limits, the face-plate is merely turned about it hinges and the dial adjusted to alter the impulse ratio; the result of the adjustment is then checked by making another test.

A condenser and resistance are provided which serve as a spark quench, thus preventing damage to the dial impulsing contacts.

When not in use, the clutch is attached to a holder provided for this purpose on the face-plate.

The instrument can be designed to work on a specific DC voltage such as that of a telephone exchange battery, or of a battery having, say, four dry cells.

The fact that no correction has to be made to allow for varying impulsing speeds can be demonstrated in a very striking manner by making repeated tests upon the same dial, during which, the finger-plate is either deliberately speeded up, slowed down, or even momentarily stopped. Even under these conditions the final position of the pointer after each test varies inappreciably, thus providing convincing evidence of the reliability of the ratio tester to cope with all variations in impuls-

ing speed likely to be met with in practice.

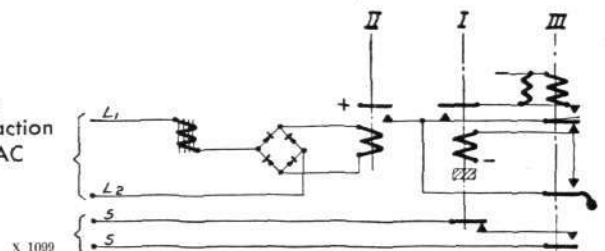
The ability to indicate impulse ratios correctly at varying speeds is due to the fact that the final angular displacement of the pointer is equal to the sum of all the angular displacements of the dial finger-plate during the break periods of each impulse. The angular displacement per complete impulse (comprising a make period and a break period) of the dials standardized by the Post Office Engineers has been fixed at  $\frac{180}{7}$  degrees, and this obviously is not changed by altering the dialling speed.

## Delayed Action Relay.

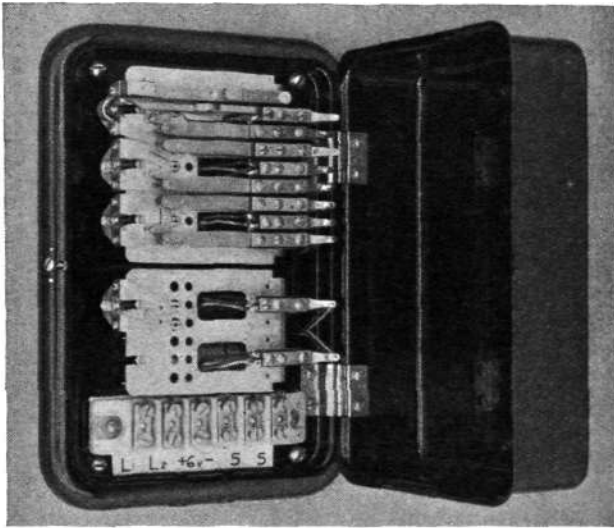
With the pendulum relay described in the previous issue of the Ericsson Review, a delayed action relay has been designed, operated by impulses of a certain duration — 2 à 3 seconds.

The device has been used on telephone lines with several telephone instruments connected in parallel, the various instruments being called by means of code signals, *e. g.*, railway lines. Such lines are often connected to a manual exchange, where they can be connected to other lines. It is of importance that the operator should be called only when such interconnections are wanted, and that she should not be disturbed by code signals from one instrument when calling another on the same line. This problem is solved in a simple manner, if this delayed action relay is used as calling relay in the manual exchange; the exchange is then called by a long signal, and the instruments on the line by means of a code, composed of short signals. The calling relay is attracted by the long signal but the code signals are of too short

Fig. 1.  
Diagram  
of delayed action  
relay for AC



X 1099



**Fig. 2.**  
The delayed action relay is mounted in black enameled sheet iron cover.

X 1100

duration to attract the delayed action relay.

The device can be used for other similar purposes as well, *i. e.*, on railway telegraph lines. In this case the delayed action relay is mounted at a branch station, which is called by a long signal from the telegraph key; calls to other stations, performed by normal telegraph impulses, will not attract the delayed action relay and thus not disturb the branch station.

The device can be made for both DC and AC signalling on the lines.

Fig. 1 shows a diagram of the relay for AC signalling. Relay *II* is a standard relay receiving the impulses from the line, when transformed to DC. When a signal is received, relay *II* is attracted and closes a circuit over relay *I*, which in its turn is attracted and closes the circuit of the pendulum relay *III*. The circuit of relay *I* is then broken, but the relay receives impulses from the pendulum contact of relay *III*, this contact being brought into vibration, when the armature is attracted. Relay *I*, being a delayed action relay, remains attracted until, after a certain time, *e. g.*, two seconds, adjustable by means of the pendulum contact, the pendulum contact has ceased vibrating.

If relay *III* is attracted when relay *I* is released, the signal current *ss* is closed, and a signal is obtained. The condition of relay *III*

being attracted, when relay *I* is released, is that the signal has been of at least two seconds' duration. If the signal on the line should be of shorter duration, the rapid action relays *II* and *III* will fall before relay *I*, and the signal current *ss* will thus remain broken. Even if relay *I* has not fallen before the relays *II* and *III* are attracted by a new signal on the line, the signal circuit will remain open, the pendulum contact receiving oscillating power when relay *II* is intermittently attracted. Not until relay *II* has been attracted so long a time, that the oscillation of the pendulum contact has faded away, a new signal can be obtained.

If the delayed action relay is made for DC signals, the relay *II* is connected directly between the line branches *L1* and *L2*, but in other respect the device is the same as for AC signalling.

Fig. 2 shows the delayed action relay. If there is no current supply for other purposes, the most convenient will be a few dry cells, connected in series and of a total tension of 6 V.

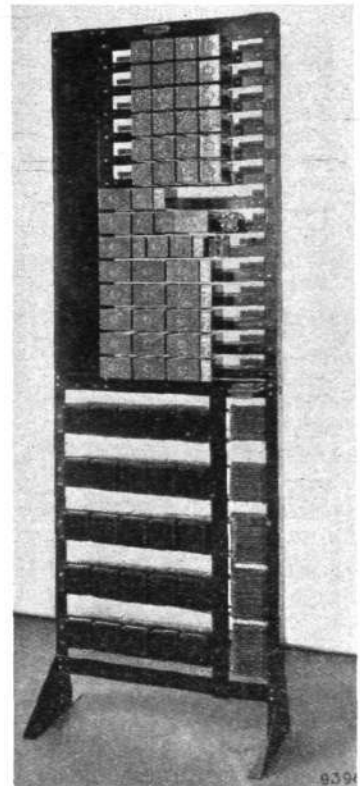
## A New Design of Private Automatic Exchanges.

A new P. A. X., Type OL 45, intended for private plants of up to 90 lines, has been developed. For

this exchange ordinary telephone instruments with dial are used, being connected to the exchange by 2-wire lines. The numbers are 10—99 at full capacity, and the call is made in the ordinary way by lifting the handset and setting up the number. A periodic ring signal is then sent out to the number called. The operating tension is 24 V, and lines with a resistance of up to 1 000 ohm can be connected to the exchange.

Characteristic for this new exchange is that the different connection devices are assembled in units, which are connected to the rack by means of jacks. The great advantage is thus obtained that the exchange can successively be completed in respect of both number of subscribers and traffic capacity, as additional units can easily be fixed on the rack.

The exchange, when complete, consists of two subscribers' groups mounted on two frames with a maximum of ten cord circuits. The first group comprises 48 lines and the second 42 lines. The racks are both



X 3094

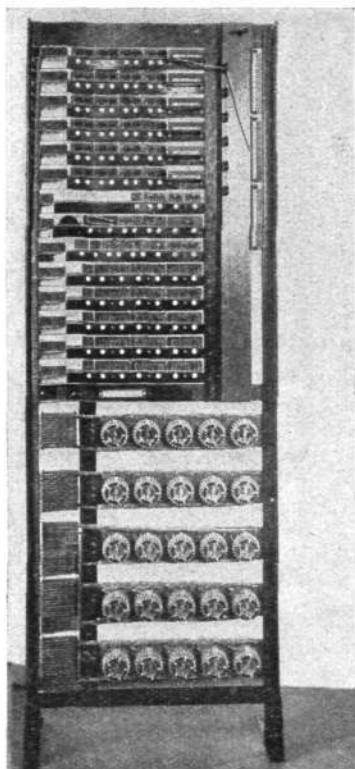
**Fig. 1.**

of the same design and may each be operated as a separate exchange of 48 lines.

Fig. 1 shows a front view of a complete rack for 48 lines and 5 cord circuits. The removable units are mounted on strips and from the top they are as follows: 6 strips with 8 line relays each, 1 strip with the starting relays common for the line group, 2 strips for all signal and driving devices, and finally 5 strips for the cord circuits of the line group.

Below the rows of relays there are 4 rows of 5 selectors each for the traffic in the group, and at the bottom one row of 5 selectors intended for the intercommunication with the next line group, when the exchange is extended. This row of selectors need only be installed when an extension is undertaken.

Fig. 2 shows the back of the same frame. On the right there is the main distribution strip, the capacity of which is 60 lines, and on the left there are the jacks of 20 and 40 contacts each, which are used for connecting the units to the frame.



X 3095

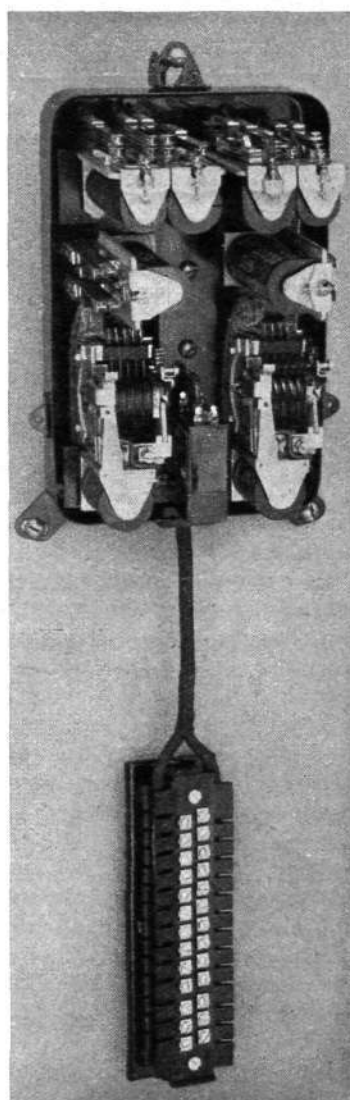
Fig. 2.

## P. A. X. for 10 Lines, with Secret Conversations.

In the previous issue of Ericsson Review there was a brief description of a P. A. X. for 10 lines for one non-secret call. This exchange has been given the catalogue number OL 10.

A corresponding design for one secret call has now been developed and given the catalogue number OL 12. The figure shows the exchange without cover (same as that of OL 10). The equipment consists of two selectors, six relays and one condenser. As current supply a main battery of 8 to 12 V is used, preferably composed of eight dry cells with a capacity of about 150 Ah. The telephone instruments, connected to the exchange by means of two-wire conductors, are standard sets with a special internal wiring, as is the case with the telephone instruments of OL 10.

When a subscriber lifts the handset and hears a buzzer tone, he sets up the number by means of the dial; a ring signal of a few seconds duration is then sent out to the subscriber called. Both subscribers having replaced their handsets, the selectors of the exchange return to rest position. If the exchange should be engaged by another conversation, when a subscriber lifts his handset, no buzzer tone will be heard, indicating that no communication can be performed through the exchange for the moment.



X 3096

## An Audio Frequency Generator of an Interesting New Design.

In laboratory work an audio frequency generator is often required for producing purely sinusoidal current of constant tension at various frequencies.

Ericsson has developed such a generator presenting a number of interesting features. The generator is made for connection to a 220 V DC net, or to an AC net of 50 cycles and any voltage required. The shifting for different kinds of current supply is made by means of a switch, which can be locked.

The apparatus is designed as a beat generator. There are two valve oscillators in dynatron connection, one having a constant frequency and the other being adjustable by means of a variable condenser. The voltages produced are fed to a detector, the high frequency is eliminated by means of a filter, and the beat frequency is fed to the output valve over an amplifier valve. In the middle of the instrument on Fig. 1, the scale of the variable condenser, regulating the beat frequency, is



X 3097

shown. The condenser is made so that a turning of  $270^\circ$  will make the frequency pass over the range from 0 to 10 000 cycles. At low frequencies, the variation is nearly linear. For compensating the variations of the frequency, the instrument is fitted with a zero adjustment, by means of which the zero-gradation of the frequency scale may be adjusted with an accuracy of 0.1 cycles. The generator will normally give an output of about 200 mW, containing not more than 2 % harmonics. If the percentage of harmonics may be increased to 6 %, the output can be doubled. If the load on the output terminals of the generator is about 6 000 ohm and real, the output tension will be constant within about 2 % between 20 and 10 000 cycles. This will make the generator particularly suitable for rapid measuring of amplification curves in telephone repeaters, wireless receivers, etc.

For such purposes, it is possible to connect a separate condenser for regulating the frequency, so that, e. g., a frequency of linear variation with the angle of revolution of the condenser may be obtained. This has proved to be convenient for some special purposes.

The instrument is mounted on a sheet iron panel and fitted in a transport case of the dimensions  $600 \times 250 \times 250$  mm. The weight is about 68 kg.

The generator has been developed especially for research work on the analysis of noise from revolving machines and for various acoustic measurements. For such purposes a number of auxiliary instruments

have been manufactured. These will, however, be described in another article.

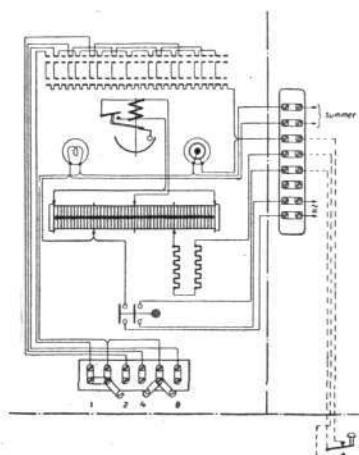
## Search Control Apparatus.

The Research and Development Department has developed a new instrument for staff control in factories, stores, etc. The apparatus, which is mounted in a box of polished oak, consists of a selector device, a neon lamp, a red signal lamp, a switch for the current supply, a rectifier, and resistances. There is further a marking pushbutton which can be connected to a turnstile, if wanted.

The apparatus is designed for connection to the mains and can operate with AC or DC 110—220 V. The series resistances, which are easy to replace, are adapted to the available voltage. The neon lamp and the signal lamp must also be adapted to this voltage. A buzzer and one extra signal lamp may be connected in parallel with the signal lamp of the apparatus.

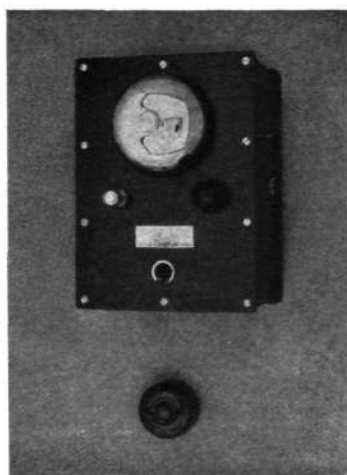
When the current is switched on the neon lamp is lit.

When the marking button is pressed the current to the neon lamp is switched off, the lamp ceases to light, and current is fed to the selector, which moves rapidly over a self-interrupting contact a number of steps depending on how long the button is pressed. On the armature



X 3099

Fig. 1. Diagram of search control apparatus.



X 3098

Fig. 2. Search control apparatus.

of the selector there is a clapper, which strikes the gong on the front side of the apparatus, when the selector is in motion. In this way a control is obtained that the marking button is properly pressed.

When the button is released the current through the selector magnet is switched off. If the selector stops in a position where the signal lamp is connected, this lamp is lit, indicating that the person in question is to be searched. In other cases the neon lamp only is lit.

The apparatus operates according to the laws of probability so that the succession of the search signals is quite indeterminate, and the average percentage of searches only is determined. By means of connections on the terminal block of the apparatus this percentage can be varied between 4 % and 60 %. By means of a connection strap on the terminal block the signal lamp can be connected to 15 of the 25 contacts of the selector. On the terminal block there are terminals marked 1, 2, 4 and 8 which are connected to 1, 2, 4 and 8 contacts on the selector. The signal lamp is connected to the two other terminals on which the connection straps are placed. By means of these connection straps the signal lamp can thus be connected to any desired number of contacts on the selector between 1 and 15, which corresponds to from 4 % to 60 % searches.

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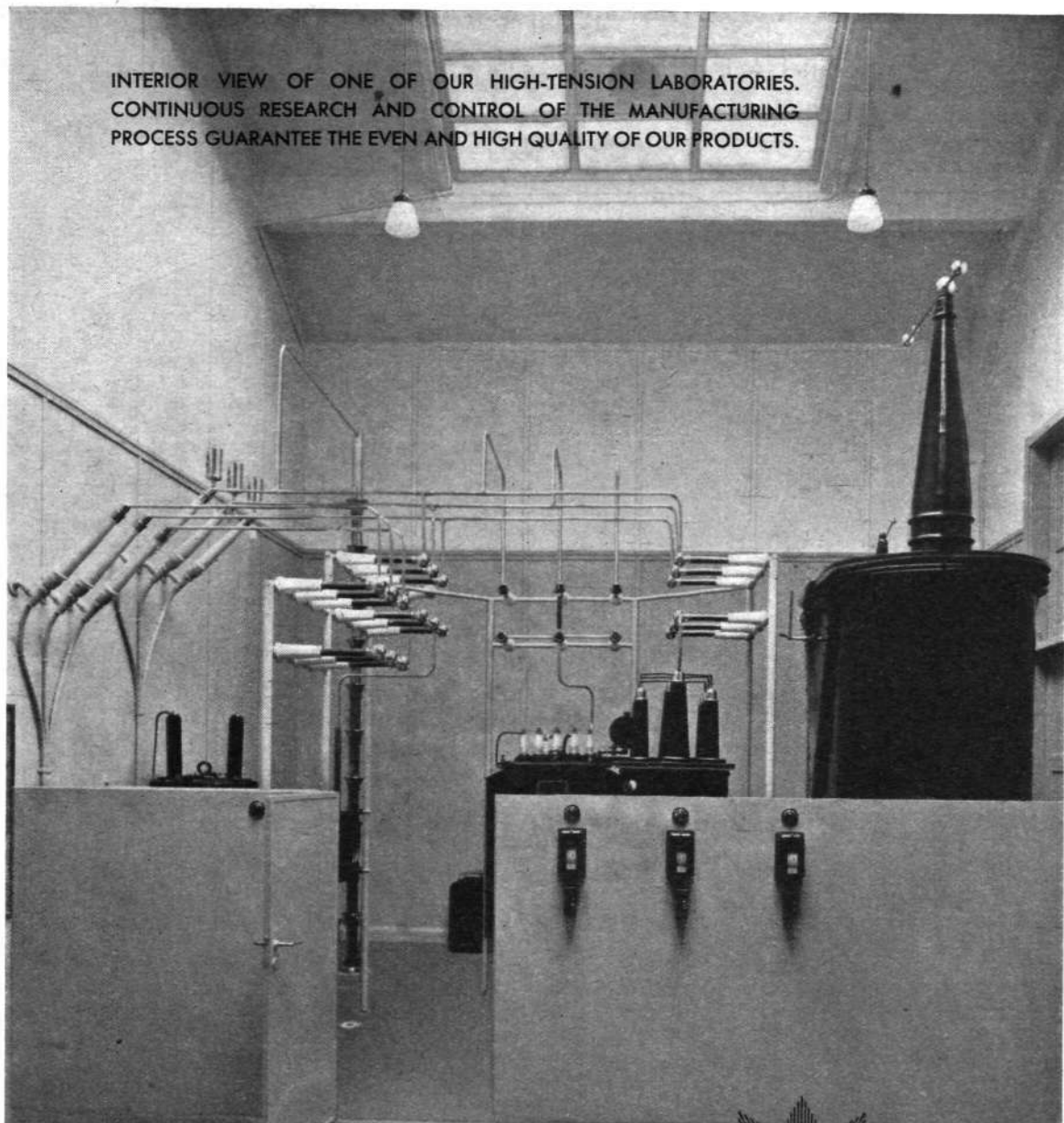
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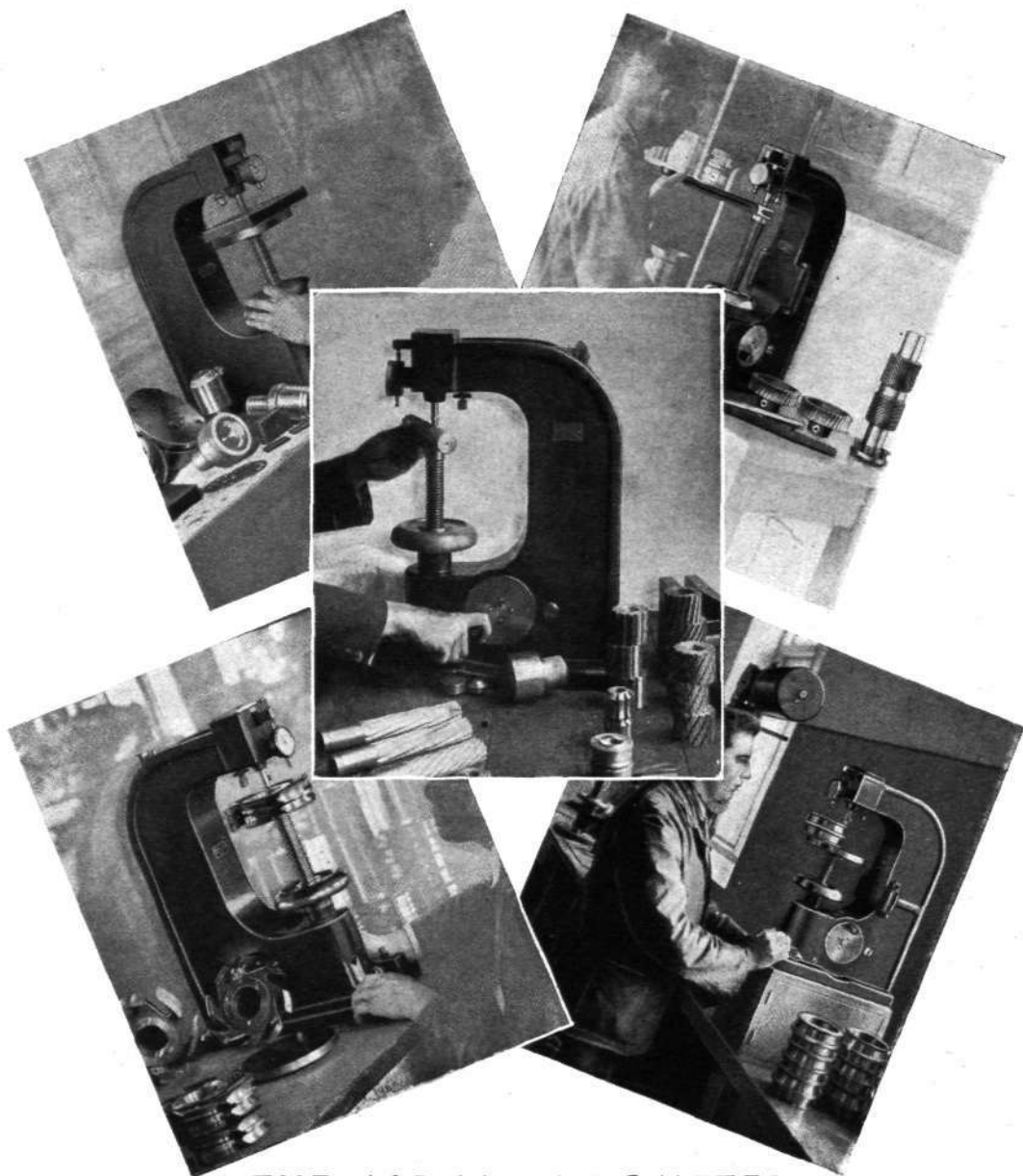
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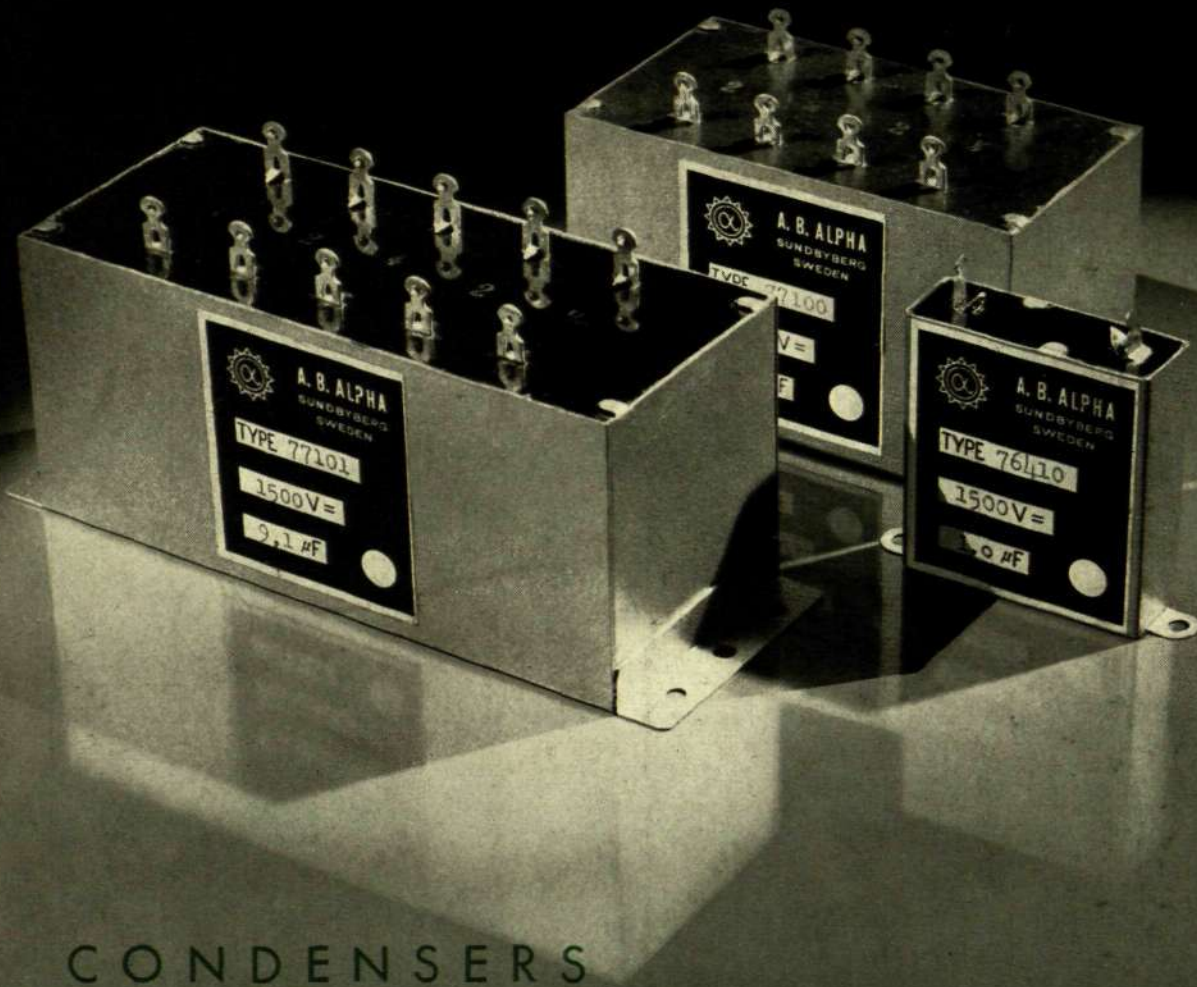
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FOR RADIO AND  
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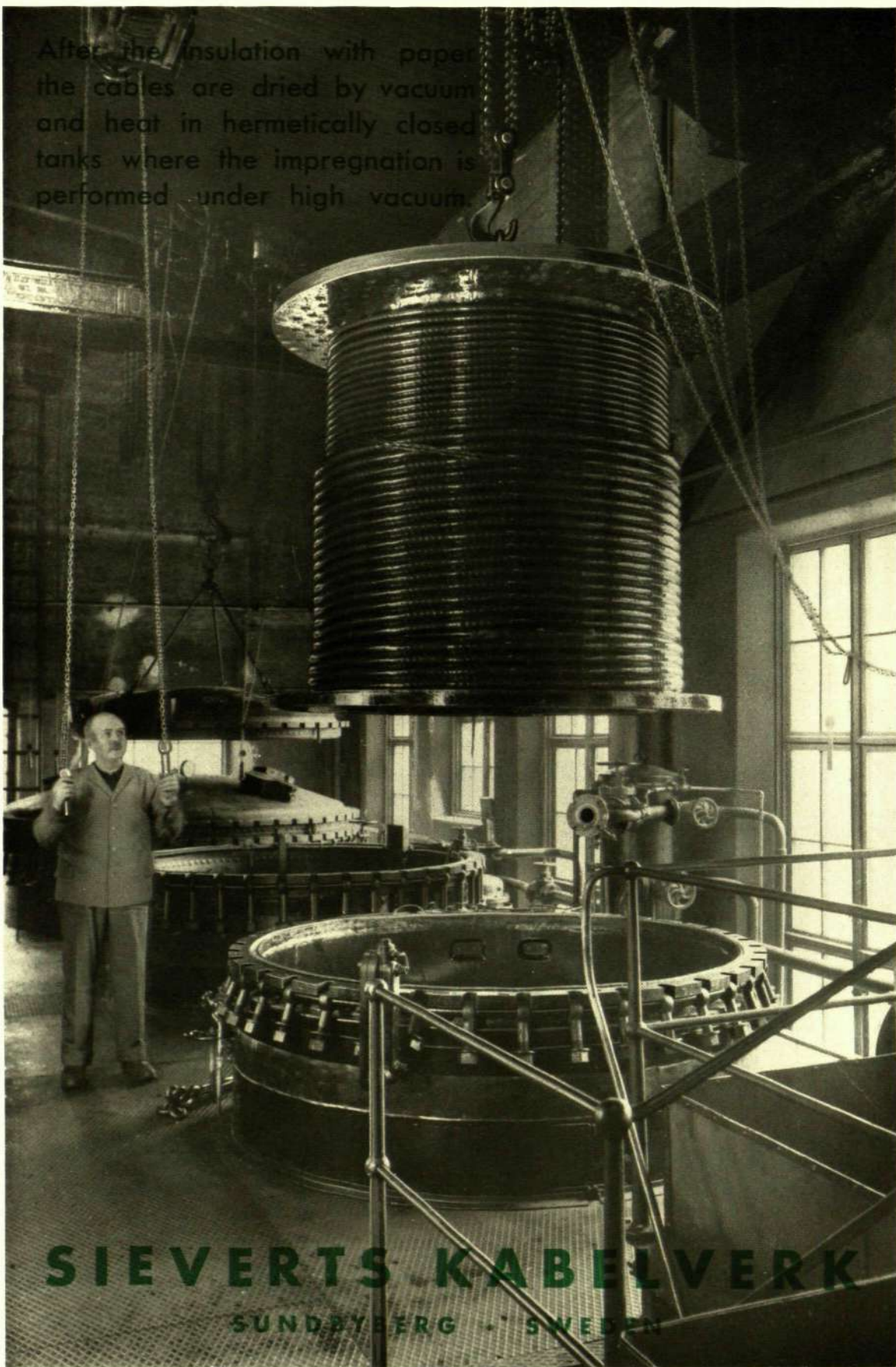
SUNDBYBERG, SWEDEN

# The L.M. Ericsson Review



1933 Nr. 3

After the insulation with paper  
the cables are dried by vacuum  
and heat in hermetically closed  
tanks where the impregnation is  
performed under high vacuum.



**SIEVERTS KABELVERK**

SUNDBYBERG - SWEDE

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# The Ericsson Long Distance System in Mexico

By  
G. SEGERSTRÖM



Concessions Department,  
Telefon A.-B. L. M. Ericsson,  
Stockholm.

The interurban line system of Empresa de Teléfonos Ericsson is without doubt one of the first planned from the start for the widest possible use of carrier facilities. In Mexico this is of very great importance, the low density of population and the difficult topographical conditions making the building of lines very expensive.

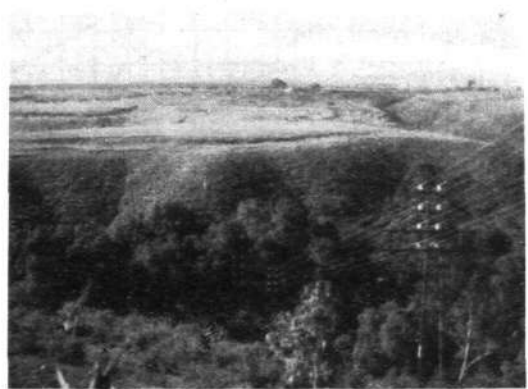
This article describes the Ericsson long-distance system in Mexico and the principles followed in the construction.

On June 17th 1926, Empresa de Teléfonos Ericsson S. A. was granted a concession for building long-distance lines in the Republic of Mexico. Up to that date only short interurban lines had been built in the Federal District, *i. e.*, the capital and its surroundings.

As a first long-distance extension of the exist-



X 1128  
Fig. 2 and 3. The figures show the difficult topographical conditions under which the Mexican lines are built.



X 1129

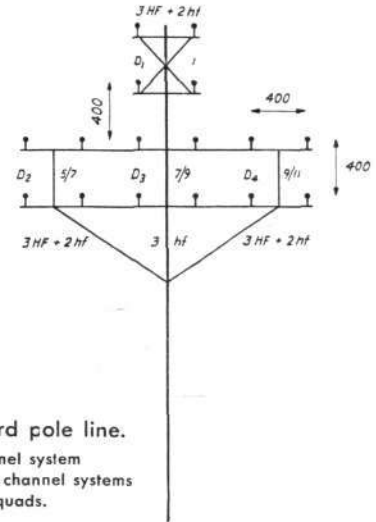
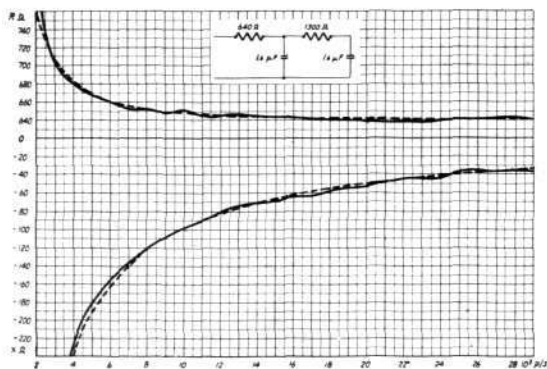


Fig. 1. Standard pole line.

3 HF three-channel system  
2 hf two single channel systems  
D<sub>1</sub>—D<sub>4</sub> diagonal quads.

X 3100

ing system a pole line from the capital to the important port of Vera Cruz was built. Next came the pole line to Celaya and Guadalajara, the second city of Mexico, followed by a line northwards to San Luis Potosí and Satio. From there a pole line was built by way of Monterrey and Nuevo Laredo to Laredo Texas in the U. S., where connection with the long-distance lines of the American Telephone and Telegraph Company and through them with the Canadian system was made in June 1930. At the same time the pole lines Satio—Torreón and Mexico D. F.—Pachuca were completed.

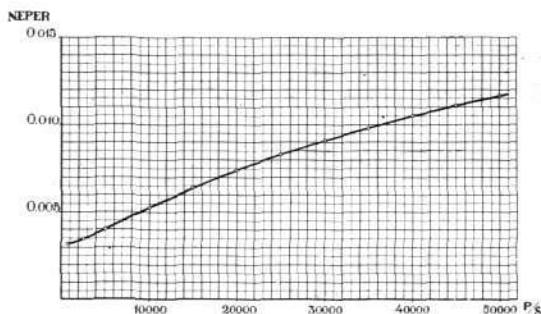


X 1130 Fig. 4. Impedance curve of a side circuit with appurtenant balance.

— line of aluminum cable nr. 6.  
 - - - balance.

After the completion of these main lines, towards the middle of 1930, the next step was to build lines serving the more remote parts of the country. It will be seen from the map how lines have been built between the cities of Chihuahua in Mexico and El Paso in the U. S., and also, in the western provinces, from Nogales in the U. S. via Hermosillo and Guaymas to Navojoa. From Mexico D. F. a new pole line has been built by way of Querétaro to Celaya, and from Vera Cruz to Jalapa and Teziutlán. In addition Mexico D. F. has been connected with the popular bathing resorts of Cuernavaca and Cuautla, and Puebla with Tehuacán, known for its medicinal springs.

On May 9th 1932, following the completion in the previous March of the connections between



X 1131 Fig. 5. Attenuation per km of a side circuit of aluminum cable nr. 6 at a temperature of +15° C.

America and Europe, Mexican telephone communication was extended to all countries in telephone communication with the U. S.

For special reasons the Ericsson interurban lines in Mexico have been designed on principles differing from those generally applied. Thus the overhead lines have been constructed of aluminum cable with iron cross bars on Mannesmann iron poles, except in the coastal regions where copper wire and wooden poles have been used to avoid corrosion due to salt-laden air. Glass insulators have been used, as in this way, because of the intense sun and the absence of shadow below the insulators, insects are prevented from nesting there.

The iron poles are comparatively short, 6.5 m as a rule, and they are fitted at the top with a crossbar supporting a quad, below which are two cross bars with six pins each. This standard type

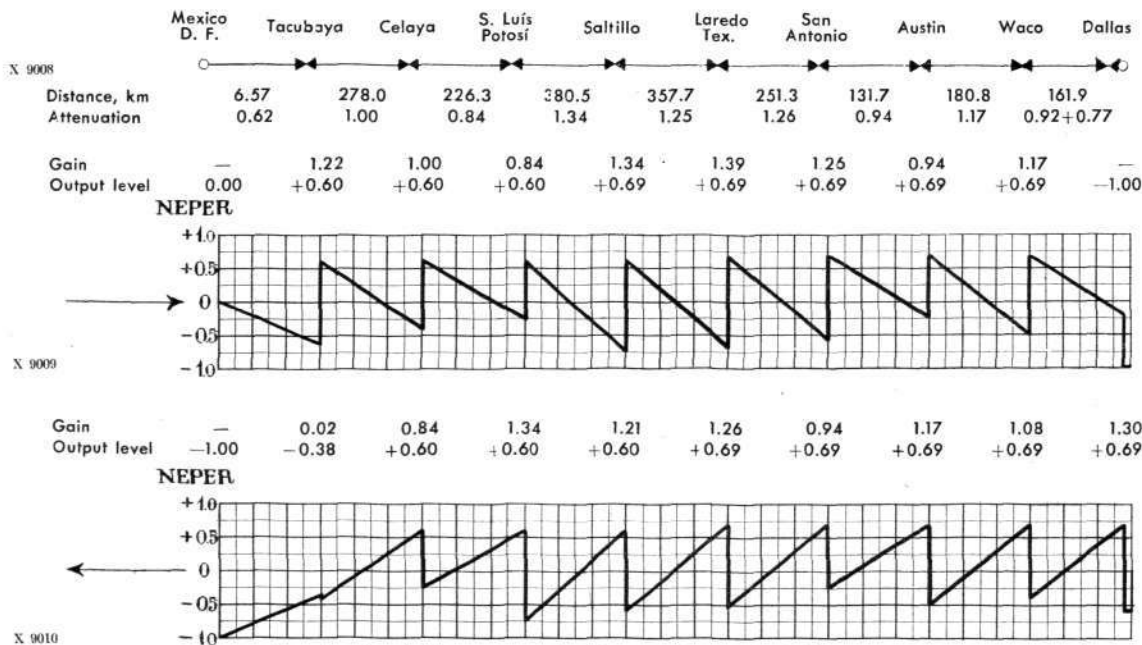


Fig. 6. Level diagram of the line Mexico D. F.-Dallas.

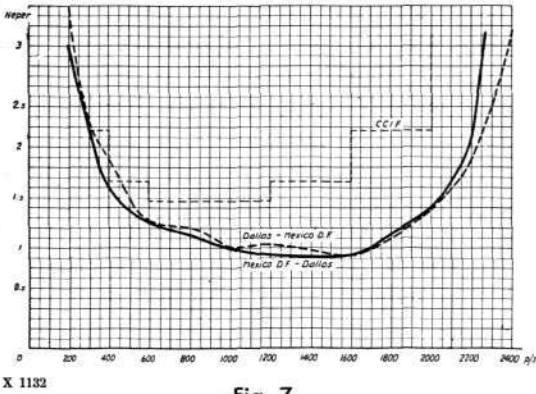


Fig. 7.

Overall attenuation curve of the line Mexico D. F.-Dallas.

of main pole line is built with a view to avoid extension later unless absolutely necessary, since the great distances and the incidental high cost of construction make the use of carrier channels preferable where possible instead of physical circuits.

The lines are joined into quads two by two; the two wires forming a side circuit are placed on the diagonal of a square with 400 mm sides. In order to avoid cross-talk the different quads are twisted in different ways. The quads of the standard pole line, Fig. 1, are thus twisted as follows.

The top quad is given one quarter turn for every pole interval, indicated 1.

The middle quad is twisted one quarter turn for every 7 poles and is drawn straight in 2, indicated by 7/9.

The two side quads are twisted one quarter turn for every 5 and 9 poles respectively and are drawn straight in 2, indicated by 5/7 and 9/11.

On the top quad and the two side quads three-channel systems are operated on the first side circuits with a single channel system for each of the second side circuits and for the phantom circuits.

On the middle quad three single channel systems are operated, one for each of the side circuits and one for the phantom. Beside the 12 voice frequency circuits, 18 carrier channels are obtained, or

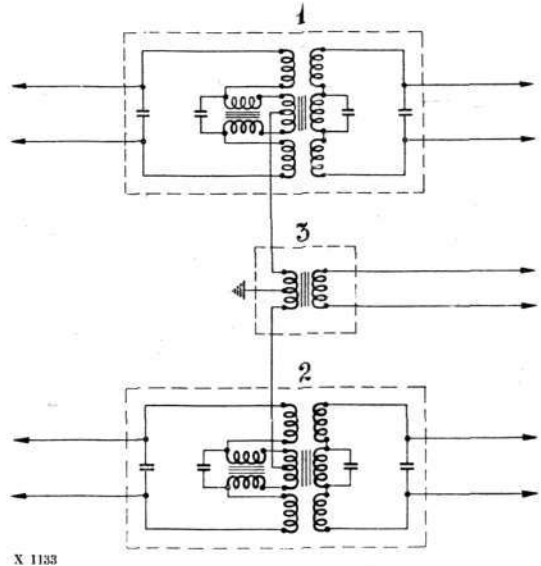


Fig. 8.

Diagram of a quad with high frequency transformers. 1, 2 high frequency transformers, 3 voice frequency phantom coil.

30 communications in all on 16 wires. If necessary, 4 duplex carrier telegraph channels can be operated on each of the quads to which the three-channel system is connected, *i. e.*, in all 12 duplex telegraph channels.

Fig. 2 and 3 show the difficult conditions under which the Mexican long-distance lines have often to be built.

The longer voice frequency circuits are equipped with two-wire repeaters, Type FPB, and voice frequency signalling equipment, Type TM, with a signalling frequency of 1 000 cycles, interrupted in a 20 cycle tempo. The reason a frequency of 1 000 cycles is used for signalling, instead of the 500 cycles as generally used in Europe and recommended by the CCIF, is that it permits the establishment of direct cooperation over the international lines with the U. S. where the higher frequency is commonly used.

In order to obtain the highest possible stability and absence of distortion, low frequency trans-

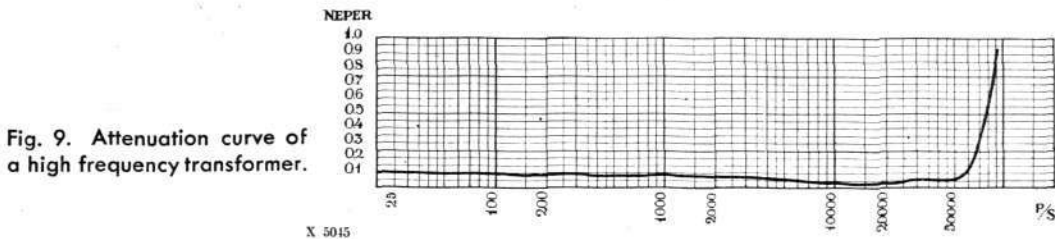
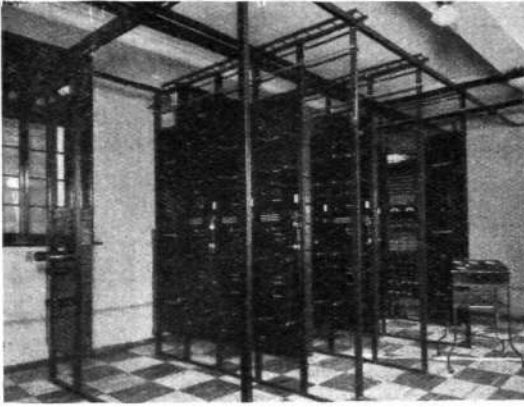


Fig. 9. Attenuation curve of a high frequency transformer.



X 1134  
**Fig. 10. The long distance station at Tacubaya, Mexico D. F., the carrier equipment.**  
 To the left carrier telegraph boys.

formers with special impedance ratio have been used for matching the two-wire repeaters to the aluminum lines.

Fig. 4 shows the impedance and Fig. 5 the attenuation curve of a line of aluminum cable nr. 6. As may be seen from the curve this type of line gives slightly better results than a line composed of 3 mm copper wire. Fig. 6 shows the level diagram of the line from Mexico D. F. to Dallas, in which 9 two-wire repeaters are inserted. The output levels are 0.6 neper at the Mexican stations and 0.69 neper (6 decibel) at the U. S. stations.

At present the following carrier systems are in operation in Mexico:

- Mexico D. F.—Vera Cruz: 2 channels.
- Mexico D. F.—Celaya: 6 channels.
- Celaya—Guadalajara: 2 channels.
- Celaya—San Luís Potosí: 3 channels.
- San Luís Potosí—Sáttilo: 1 channel.
- Sáttilo—Torreón: 2 single channel systems.

In the very nearest future the following single channel systems are to be installed:

- Mexico D. F.—Tehuacán.
- Mexico D. F.—Pachuca, and
- Sáttilo—Nuevo Laredo.

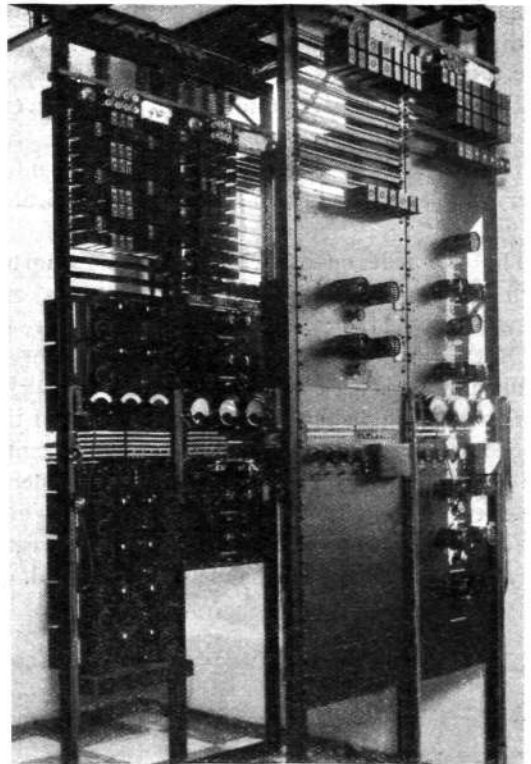
One carrier repeater only is in operation, *viz.*, in San Luís Potosí, in the channel Celaya—Sáttilo. All other channels either operate without intermediate repeaters, or are connected to voice frequency circuits by means of two-wire repeaters.

All quads, the first side circuit of which carries a three-channel system, are fitted with special transformers that pass the high frequency. By

this method no extra additional filters are required in the second side circuit of the quad. As is well known, these are necessary in other cases where a carrier system is connected outside the ordinary voice frequency transformers and the phantom circuit is to be utilized. Furthermore, the filters need not be made with such a high degree of accuracy of the balance between the two branches.

Fig. 8 shows a diagram of a quad with high frequency transformers in the side circuits; as will be seen from the figure the midpoint of the phantom transformer is connected to earth. This makes the acoustic shocks due to the frequent afternoon thunderstorms less disagreeable to the public. The earth-connection of the phantom transformer will also tend to minimise the disturbances caused by power lines on sections where it has been impossible to avoid drawing the telephone lines parallel with power lines. Fig. 9 shows the attenuation curve of a high frequency transformer.

As shown in Fig. 1, single channel systems are to be used on the second side circuit and the



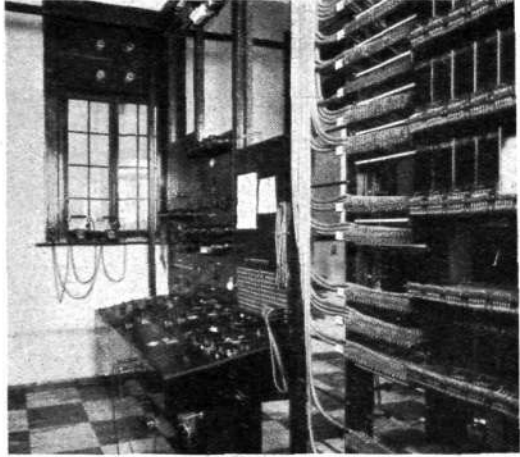
X 1135  
**Fig. 11. The long distance station at Tacubaya, Mexico D. F., the voice frequency equipment.**  
 To the left repeaters bays, to the right voice frequency signalling equipment.

phantom circuit of the quads where the three-channel system is operated on the first side circuit. Cross-talk measurements have proved that this can be done without exceeding the cross-talk values recommended as maximum by the CCIF.

With regard to the provision of circuits in the near future the quad situated below the top quad is not to be supplied with a three-channel system but it is intended to substitute for this three single channel systems.

If it be found that more circuits are required than those provided the intention is to use the Ericsson three-channel system, Type ZM 200, where the speech is transmitted by means of the lower side bands instead of the upper ones. In this way cross-talk from the existing three-channel systems which use the upper side bands will be avoided. In such case the ease with which the single channel systems can be moved to other parts of the long-distance line plant will be a great advantage.

The three-channel systems used in Mexico are of the older Ericsson type, and are being moder-



X 1126

Fig. 12. The long distance station at Tacubaya, Mexico, D. F., the test desk.

nized at present. The automatic gain regulator employed in the Ericsson single channel system will thus be used for the three-channel systems in Mexico. By simplification of the existing voice frequency signal receivers it has been possible to arrange the gain regulation without adding further valves to the channel bays. The automatic gain regulators will thus be installed individually for each channel and no separate pilot channel will be required. By the use of automatic gain regulation a variation of the overall HF attenuation of 1.5 neper will only cause a variation of 0.2 neper of the VF overall attenuation. A variation of the HF attenuation of 2.5 neper will cause the VF attenuation to vary 0.4 neper as a maximum.

The automatic level regulator will be described in more detail in Ericsson Technics Nr. 5, 1933.

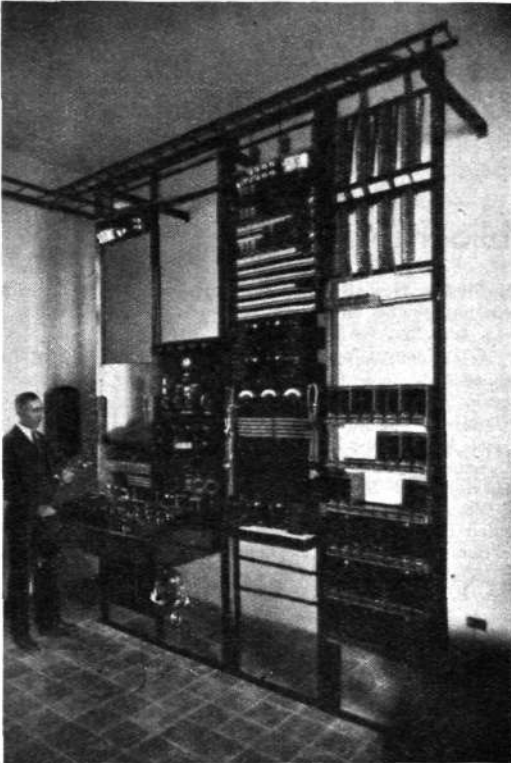
Fig. 10 and 11 show the carrier and voice frequency equipment at the long distance station of Tacubaya; Fig. 12 shows the test desk at the same station.

Fig. 13 shows the equipment of a small repeater station at Hermosillo.

At present the Ericsson long-distance line system in Mexico comprises:

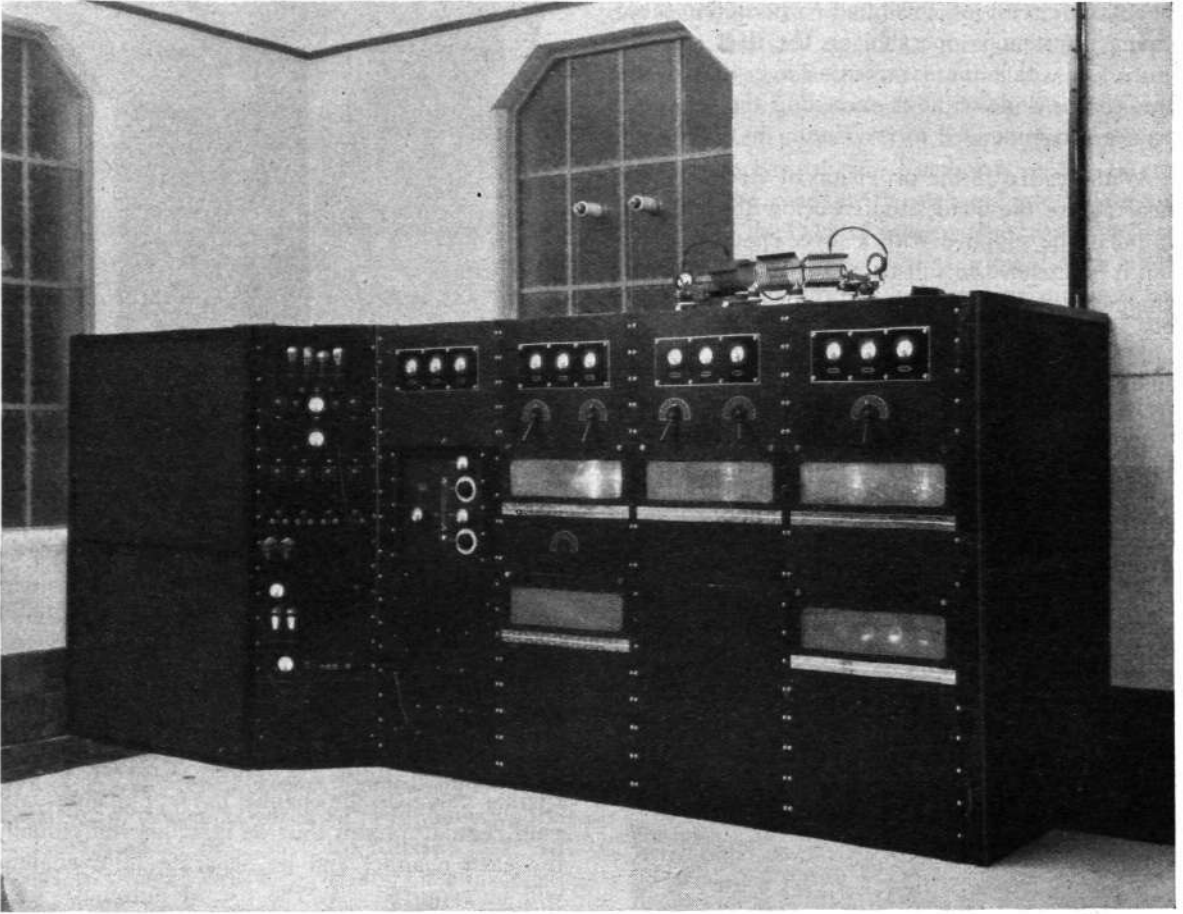
- pole lines: 6 000 km,
- side circuits: 15 000 km,
- phantom circuits: 6 700 km,
- carrier channels: 5 000 km.

The carrier communications thus form 19% of the total number of circuit kilometers, and, as



X 1137

Fig. 13. The equipment of a small repeater station, Hermosillo.



X 7029

Fig. 14. Experimental radio station for short waves in Mexico D. F.

extension proceeds, this percentage will increase considerably.

An important problem to be solved by the Ericsson company in Mexico was the connection of remote places, *e. g.*, Merida, to the central interurban line system in a reliable and inexpensive manner. Fig. 14 shows the experimental radio station in Mexico D. F. at present operating as the broadcasting station of the Ericsson company. Experiments are carried out at this station in order to find out if short-wave wireless can be used to advantage for connecting up of these remote places.

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# Static Power Condensers and their Use

by  
H. ÅBERG



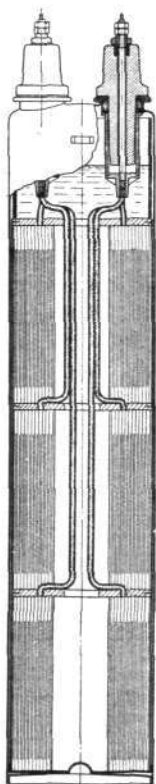
Exports Department,  
Sieverts Kabelverk,  
Sundbyberg.

*In power technics condensers are of particular importance for the improvement of power factor, for excess voltage protection and for voltage regulation. Condensers have, however, found application also in related fields, among which the article deals with the starting of single-phase induction motors, condensers for test rooms and filter circuits.*

During the last few years we have witnessed a steady increase in the application of static power condensers. From the beginning condensers were employed practically only for telecommunication purposes, but in a short time they have become indispensable in the power field. The reason condensers have not previously been employed in power work is that great difficulties had to be overcome before reliable power condensers could be manufactured. Their usefulness had been recognized a long time ago, but a dependable type had first to be developed.

Fig. 1. Section of a condenser cylinder.

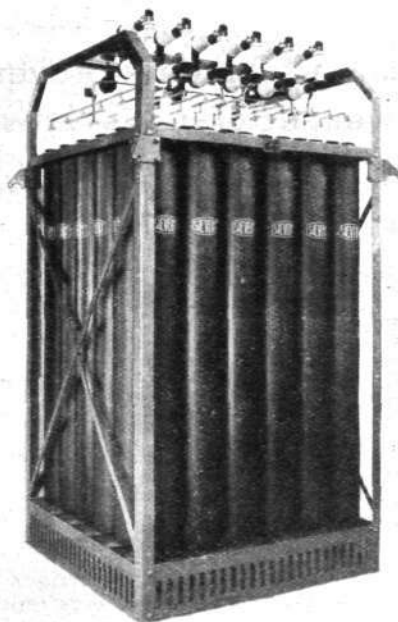
Each element fits closely to the cylinder walls, which ensures a satisfactory cooling. The cylinder being entirely filled by the elements, the motion of the insulating fluid is insignificant; sludge and bubbles, which may cause the breakdown of the condenser can thus not arise.



X 9005

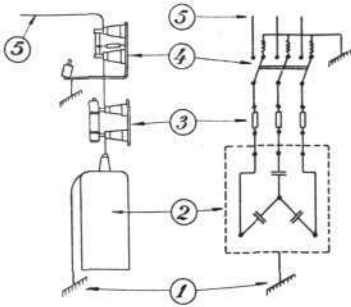
When the power factor question came into the foreground and the importance of a satisfactory value of  $\cos \varphi$  was duly recognized, especially in connection with the heavier loading of existing lines, much work was devoted to the development of a reliable condenser. Sieverts Kabelverk was one of the first to solve the problem, and the leading position which this firm gained already at the start has not only been retained but also strengthened. From the beginning static power condensers could be manufactured only for rather low voltages but nowadays they are designed even for the highest operating voltages.

The Sievert condensers, Fig. 1, consist of cylindrical elements with conductive layers of aluminum. The insulation between these layers consists of a specially treated paper carefully dried in vacuum and impregnated with oil specially made for this process. One of the greatest advantages with Sievert's design, and a matter of the utmost importance for the useful life of the condensers, is the mounting of the elements in metal cylinders which exactly fit the elements. Satisfactory cooling is ensured as each element



X 1138

Fig. 2. Condenser battery,  
500 kVAR, 10 kV, 50 cycles.



**Fig. 3.**  
**Connection of a small high-tension condenser through fuses and disconnecting switch with discharge resistances.**  
 1. earth connection  
 2. condenser  
 3. fuses  
 4. disconnecting switch with discharge resistances  
 5. to the line.

X 3101

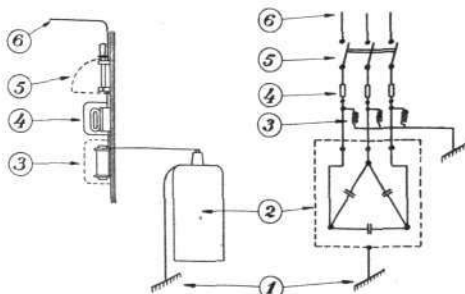
fits closely to the wall of the cylinder; at the same time this arrangement prevents any motion of the oil in the condenser as the elements completely fill the cylinders. Thus the risk of accumulation of sludge with consequent breakdown and damage to the condenser is eliminated. In certain types for comparatively high power, the cooling has been further improved by fans built into the condenser groups.

Peculiar to the Sievert construction is, furthermore, that the losses, within the temperature limits with which we are concerned, decrease as the temperature rises. This ensures great stability in operation.

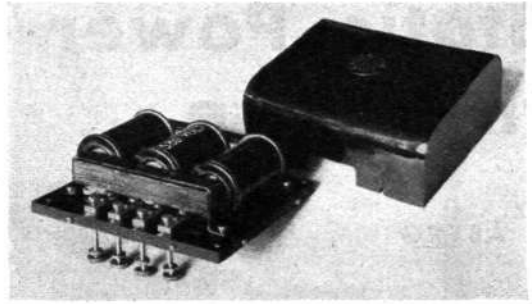
For certain types of condensers a number of cylinders are assembled in a frame to form a condenser battery of the desired capacity. These batteries are equipped with built-on fuses, discharge resistances etc. depending on their application (Fig. 2).

## Condensers for the Improvement of Power Factor in AC Networks.

As already mentioned it was the use of condensers for improvement of power factor that started the development of static power condenser



**Fig. 4.** Connection of a small low tension condenser with permanently connected discharge resistances through fuses and disconnecting switch.  
 1. earth connection  
 2. condenser  
 3. discharge resistances  
 4. fuses  
 5. disconnecting switch  
 6. to the line.



**Fig. 5.** Three-phase discharge resistances with protecting cover.  
 For low tension, up to 500 V.

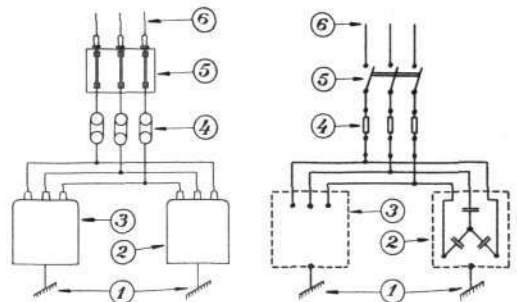
X 1140

manufacture, and although several other fields of use are now prominent that type is still the most important.

Attention was at one time centered on the advantages and disadvantages of delta versus star connection for three-phase condensers, and the delta connection was especially advocated as the best type. Leaving aside the theoretical considerations underlying these opinions we shall, however, mention that Sieverts Kabelverk have delivered many big condenser batteries for both types of connection and that no troubles traceable to the connection method have been experienced in actual operation. One advantage with the star connection should, however, not be overlooked, as condensers for excess voltage protection are nowadays gaining importance. It is, namely, possible to employ a power factor correcting condenser also as a protector against excess voltages by earthing the neutral point.

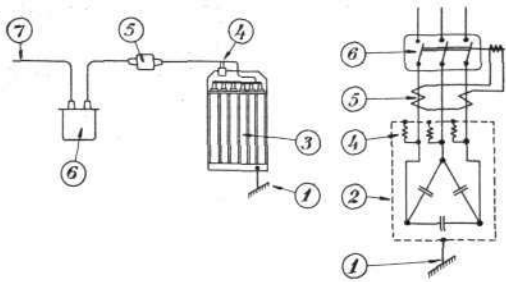
Fig. 3, 4, 6, 7 and 9 show some diagrams for connecting three-phase condensers for improvement of the power factor.

In Fig. 3 is shown a small high tension condenser equipped with fuses and disconnecting switches with discharge resistances. The discon-



**Fig. 6.** Connection of a condenser to a motor. No extra apparatus is required for the condenser.  
 1. earth connection  
 2. condenser  
 3. motor (or transformer)  
 4. fuses  
 5. disconnecting switch  
 6. to the line.

X 1141



X 1142 Fig. 7. Connection of a large low tension condenser through an oil breaker with automatic release.

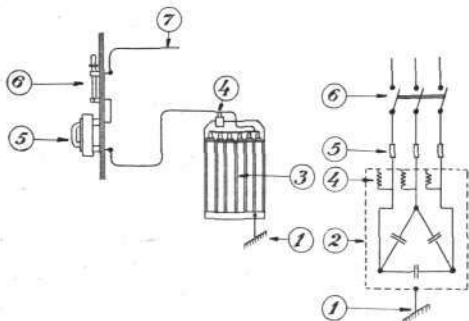
The discharge resistances are permanently connected.

- |                          |                                    |
|--------------------------|------------------------------------|
| 1. earth connection      | 5. current transformer             |
| 2. frame                 | 6. oil breaker with overload relay |
| 3. condenser             | 7. to the line.]                   |
| 4. discharge resistances |                                    |

necting switch is designed in such a way that the resistance is inserted in the circuit after the condenser has been disconnected from the line. This is contrary to the practice in low tension networks where the resistances remain connected across the condensers even while the latter are in operation.

A small low tension condenser connected through fuses and disconnecting switches is shown in Fig. 4. The discharge resistances which have the appearance shown by Fig. 5; are in this case permanently connected.

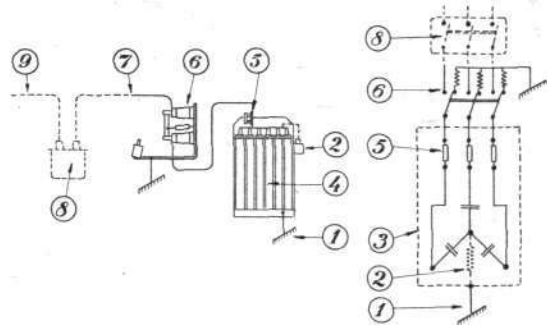
Fig. 6 is a sketch showing a condenser mounted close by a motor, and connected to its terminals. No extra apparatus or protection for the condenser is required in this case, as the latter is already protected by the fuses supplied for the motor and, furthermore, is connected and disconnected by the motor switch. As the condenser and the motor are always disconnected simultane-



X 1143 Fig. 8. Connection of a low tension condenser, with a rating of less than 120 kVAR, through a disconnecting switch.

The discharge resistances are permanently connected.

- |                          |                         |
|--------------------------|-------------------------|
| 1. earth connection      | 5. fuses                |
| 2. frame                 | 6. disconnecting switch |
| 3. condenser             | 7. to the line.         |
| 4. discharge resistances |                         |



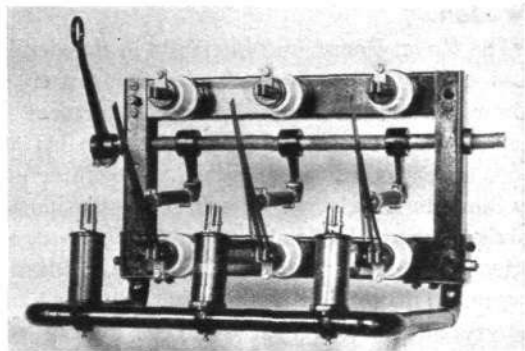
X 1144 Fig. 9. Connection of a large high tension condenser through an oil breaker and disconnecting switch with discharge resistances.

- |                     |   |
|---------------------|---|
| 1. earth connection | 6. disconnecting switch with discharge resistances                |
| 2. induction coil   | 7. under 120 kVAR, to the line; over 120 kVAR, to the oil breaker |
| 3. frame            | 8. oil breaker  |
| 4. condenser        | 9. to the line.   |
| 5. fuses            |   |

ously the former will discharge itself through the motor windings.

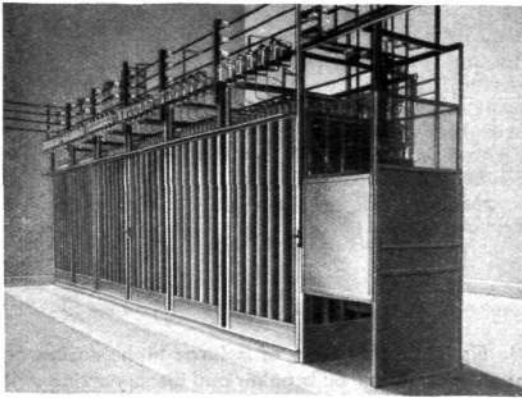
Larger condenser batteries are shown in Fig. 7, 8 and 9. The low tension condenser in Fig. 7 is connected to the line over a discharge resistance through an oil breaker with automatic release. The discharge coils are permanently connected between the condenser terminals and earth.

For condensers of less than 120 kVAR it is usually not necessary to use oil breakers. This figure can, however, only be considered as a rough approximation, because, where frequent connections and disconnections take place, it is preferable to insert oil breakers also for smaller units in order to avoid the burns which have a tendency to appear on the contacts of the disconnecting switches. For this reason it should be remembered in selecting oil breakers for condensers that the breaker contacts should be calculated for heavier currents than would normally be considered necessary.



X 1145 Fig. 10. Three-pole disconnecting switch with discharge resistances.

For high tension up to 12 kV.



X 1146 **Fig. 11. Condenser installation, Hedemora Sweden,**  
3000 kVAR, 6 kV, 50 cycles. The first batteries of this installation were put into service in 1926.

Fig. 8 shows a low tension condenser connected through fuses and disconnecting switches and equipped with discharge resistances which are permanently in circuit.

Larger three-phase condensers for high tension are preferably connected as shown in Fig. 9. What has been said already concerning oil breakers applies also in this case: condensers of 120 kVAR and upward should always be connected through oil breakers.

It is difficult to make high tension discharge resistances for continuous operation, and Sieverts Kabelverk has therefore designed a special type of switch shown in Fig. 10, where the condenser is connected to earth through the discharge resistance, when disconnected from the line.

For the functioning of a power factor correcting condenser, and for the proper choice of capacity, the reader is referred to an article by A. M. Andersson in the Ericsson Review Nr. 1—3, 1930.

### Condenser Installation at Hedemora, Sweden.

The Royal Board of Waterfalls in Sweden has used condensers extensively for improving the power factor, and the capacity at present installed totals 15 000 kVAR for tensions between 6 000 and 55 000 V at 50 cycles, all manufactured by Sieverts Kabelverk. The first installation was carried out at Hedemora in 1926 (Fig. 11), and is located at the end of a 40 kV line, 106 km in length. The original installation consisted of a battery of 960 kVAR at 6 000 V, and in 1929 1 950 kVAR for the same tension were added. It should be mentioned that no difficulties have been encountered although connection is made in three

steps of 1 000 kVAR each, through oil breakers and without starting rheostats.

Calculations give the following data regarding the improved utilization resulting from the condenser installation:

Condenser rating kVAR	Gain in power at			
	Max. load kW	Average load at day time kW	Average load at night kW	Average 24-hour load kW
1 000	190	150	70	117
3 000	450	330	90 <sup>†</sup>	213

<sup>†</sup> The power gain amounts to 100 kW if 1 000 kVAR be disconnected at night.

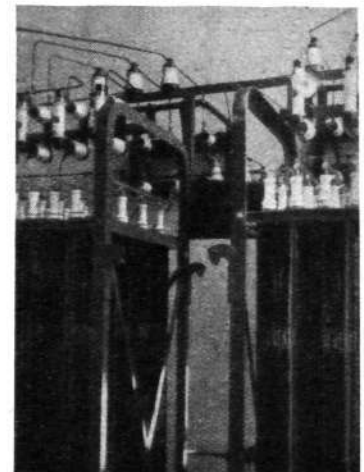
At the time the aforementioned condensers were installed a synchronous condenser of 2 500 kVAR, 6 000 V was already available. An investigation showed, however, that the yearly cost for the static condensers was so much lower on account of the very small losses and the negligible upkeep that the decision was in favour of the static condensers.

As to the design it should only be mentioned that each battery has been equipped with fuses built into the frames.

In ETZ Nr. 50, 1931, Fritz Jacobsson has described the condenser installations belonging to the Royal Board of Waterfalls.

### Condenser Installation at Bandoeng, Java.

An installation of particular interest on account of the climatic conditions in which it is operating, has been supplied in 1931 by Sieverts Kabelverk to the works of the State Railways at Bandoeng, Java (Fig. 12). In designing these condensers special attention had to be paid to the



**Fig. 12.**  
Condenser installation for tropical conditions, Bandoeng, Java, 2 × 200 kVAR, 6 kV, 50 cycles.

high temperatures met with in a tropical climate, and also the disastrous effects of high humidity on metallic parts. The aforementioned order, which comprised three condensers of 200 kVAr each at 6 000 V and 50 cycles has splendidly proved the reliability of the Sievert manufacture. The condensers have functioned without any disturbances whatsoever during the time they have been in operation.

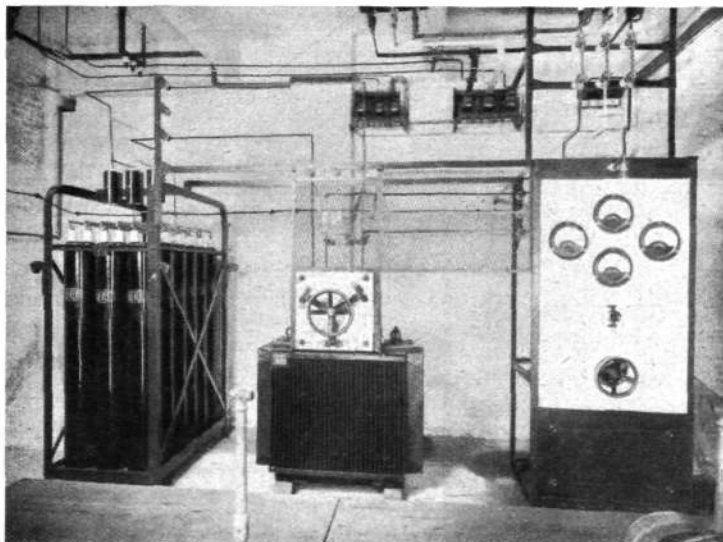


Fig. 13. Condenser with intermediate transformer, Bologna, Italy.  
Condenser voltage 500 V.

X 5047

### Condenser Installation at Bologna, Italy.

On account of the increased capacity necessary at lower voltages for one and the same number of kVAr, condensers for voltages higher than the line voltage have sometimes been connected to the line through a transformer. Such an installation, shown in Fig. 13, has been made at Bologna, Italy, for Officine Fonderie Parenti & Co. A condenser for 500 V and 42 cycles is connected to the low tension line through an auto-transformer.

This arrangement can, however, not be generally recommended. It is true that the price of a high tension condenser with a transformer may be less than that of the corresponding low tension condenser, but if due consideration is given to the cost *per annum* it will be found in practically all cases that the low tension condenser is preferable. The losses in a condenser usually amount to 2—3 W per kVAr, while the losses in a transformer are at least 20—30 W per kVA. The cost of these higher losses will, at least for normal operating conditions, warrant the installation of a low tension condenser.

### Condensers for the Improvement of Power Factor in High Frequency Furnaces.

These condensers show considerable deviations in many respects from the condensers used at 25 to 60 cycles. High frequency furnaces for melting and refining metals are more and more coming into use and, as larger units are intro-

duced, the demand for more reliable condensers has increased. The high frequency makes the heating of the condenser the leading consideration in its design, and the voltage stress is of secondary importance. In other words, the insulation required to take care of the voltage stress can be housed in a comparatively small space, and the necessity of neutralizing the heat resulting from the losses, *i. e.*, the cooling, decides the size of the condenser.

The Sievert cylinders have made a simple solution of the problem possible. The cylinders are placed in a frame, in the lower part of which is mounted a fan which forces an air current in between the cylinders. The temperature of the battery can be kept within the desired limits by regulating the quantity of air.

All condenser terminals are located on top of the cylinders. This arrangement eliminates long bus bars, which is of great importance in view of the large currents used in installations of this type.

The small cylinder units also allow a simple regulation of the capacity.

### Condenser Installation at Ugines, France.

An installation of this type in operation at Uddeholms Aktiebolag, Hagfors Bruk, Sweden, is described in the Ericsson Review Nr. 2, 1933. The condenser battery is of 13 000 kVAr at 2 300 V and 1 035 cycles. A smaller battery of similar design which has been delivered to Aciéries Electriques d'Ugines, France, is shown in Fig. 14. A current of air enters through the

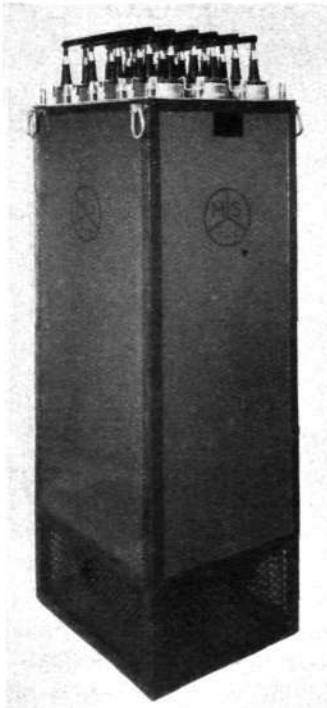


Fig. 14. Condenser for high frequencies, with draught ventilation, Ugines, France, 300 kVAr, 1 200 V, 1 000 cycles.

X 9006

perforated bottom plate and is directed between the cylinders by four walls surrounding the cylinder group. The condenser shown in the picture has a rating of 300 kVAr at 1 200 V and 1 000 cycles.

## Condensers for Voltage Regulation.

It is a well known fact that a condenser connected to a power line causes a rise in voltage, and, by suitable choice of the capacity, the voltage at a point of a line can be made equal to, higher, or lower than the voltage at the power station. The rise in voltage can be approximately computed from the following formula:

$$e_v = \frac{P_c}{V} \cdot X$$

where  $e_v$  = rise in voltage, V,  
 $P_c$  = condenser rating, kVAr,  
 $V$  = line voltage, kV,  
 $X$  = inductive line reactance, ohm.

The voltage therefore rises in direct proportion to the size of the condenser.

### Condenser Installation at Hadsbjerg, Denmark.

An installation for voltage regulation using Sievert condensers at the Randers Municipal

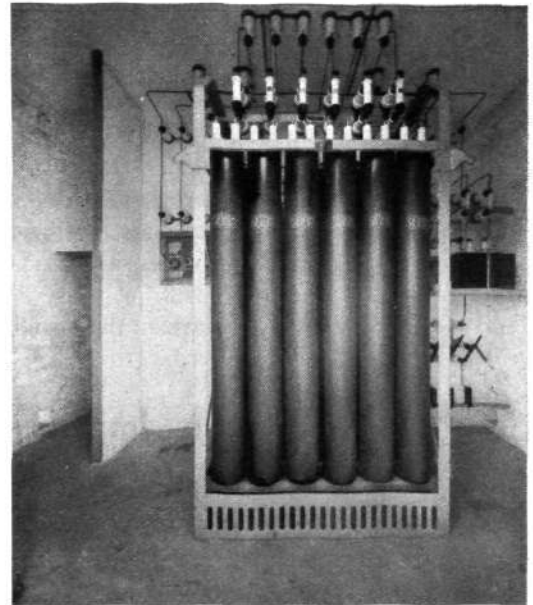
Electricity Works, Hadsbjerg, Denmark is shown in Fig. 15. The line voltage is 10 kV.

In order to simplify the necessary calculations for this installation we will make certain approximations. We assume the power factor to be the same for all loads, and equal to the value measured at the power station, *i. e.*,  $\cos \varphi = 0.717$ . Furthermore certain loads have been superimposed; the four largest loads have been treated as peak loads, while for the intermediate line sections an even distribution of the load has been assumed.

The total voltage drop actually measured for the corresponding load at the power station was 1 000 V. In order to check the effect of the aforementioned approximations, the voltage drop without condenser was first calculated. As the power factor has been assumed to be the same for all loads, the total drop is the algebraic sum of the voltage drops in the different sections. It was found that these calculations gave a voltage drop of 860 V and that the deviation therefore is about 15 %. A good idea of the most suitable condenser size can nevertheless be obtained.

For various condenser capacities the gain in voltage will be as follows:

Condenser rating, kVAr	105	125	170	200	300	400	500	1 000
Gain in voltage, V.....	136	162	221	260	390	520	650	1 300



X 1147 Fig. 15. Condenser for voltage regulation, Hadsbjerg, Denmark, 100+300 kVAr, 10 kV, 50 cycles.

The line losses have also been computed for different capacities.

Condenser rating kVAr .....	0	100	170	200	300	400
Losses, in day time, W.....	28 950	19 220	17 920	17 960	21 850	39 300
Losses, at night, W.....	2 610	—	8 620	11 560	25 690	69 500

The table above shows that in the day time minimum losses arise for condensers between 170 and 200 kVAr. Condensers of suitable capacity for day-time conditions will always cause an increase in the losses during the night.

In the case of the installation just mentioned, the question of the losses was disregarded, and the gain in voltage was made the deciding factor in determining the size of the condensers. A battery of 300 + 100 kVAr was installed and 100, 300 or 400 kVAr can therefore be connected, as required.

## Condensers for Excess-voltage Protection.

The question of excess voltage protection on power lines is of great current interest and a large number of different types of protecting devices have been suggested. As shown by R. Lundholm in an article in the Ericsson Review, Nr. 1, 1933, condensers constitute a very effective protection for power stations, transformer stations and other equipment connected to the power lines. The reader who is interested in more detailed information is referred to that article, which deals extensively with the use of condensers for protection against lightning surges.

It should be pointed out, however, that a condenser functioning as excess voltage protection also contributes towards an improvement of power factor and thus simultaneously serves two purposes. It is further possible to arrange voltage taps on the condenser thereby obtaining a fraction of the voltage for various purposes, as, *e. g.*, voltage measurements.

### Condenser Installation at Gothenburg, Sweden.

Fig. 16 shows an installation for excess voltage protection supplied to the Royal Board of Waterfalls at Gothenburg, Sweden. Nine single-phase units of 20 kVAr each at  $55/\sqrt{3}$  kV and 50 cycles



Fig. 16.  
Condenser for excess voltage protection, Gothenburg, Sweden,  
 $3 \times 0.19 \mu\text{F}$ , 55 kV,  
50 cycles.  
The voltage transformer connected to the measurement taps is seen on the floor.

X 3103

are connected three and three in parallel between each phase and earth. Each cylinder has therefore a capacity of approximately  $0.063 \mu\text{F}$ , that is, the capacity connected between each phase and earth is  $0.19 \mu\text{F}$ . Each cylinder is connected through a disconnecting switch and a fuse, and, furthermore, a common disconnecting switch is installed for each single-phase group.

Each condenser in this installation consists of eight elements connected in series; tapings are arranged after the first and second elements. A voltage transformer is connected to the taps; this transformer can be seen in the picture on the floor below the cylinder.

For outdoor installations the bakelite cylinder is replaced by a cylinder of porcelain.

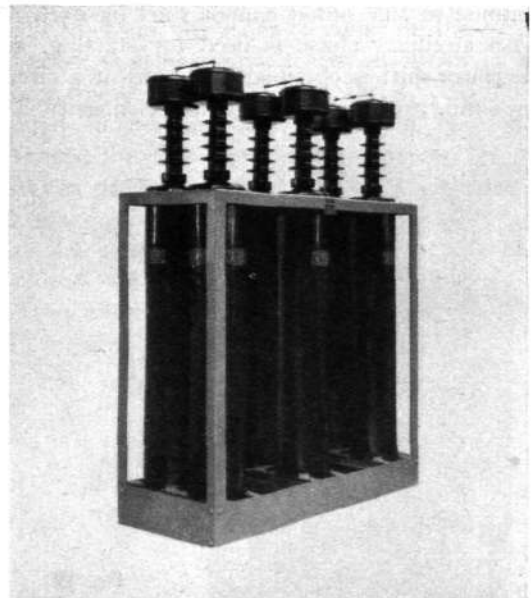


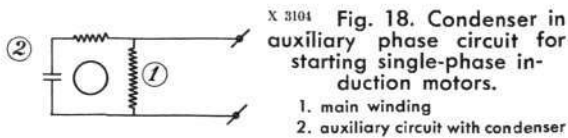
Fig. 17. Three phase condenser for excess voltage protection, Virkkala, Finland,  
 $6 \times 0.11 \mu\text{F}$ , 35 kV, 50 cycles.

## Condenser Installation at Virkkala, Finland.

A deviating type of condenser for excess voltage protection is found at the Virkkala plant of Imatran Voima O.-Y., Helsingfors, Finland. Six single-phase condensers are built together in a frame to form a three-phase group of  $6 \times 0.11 \mu\text{F}$  at 35 kV and 50 cycles. No tappings for voltage measurements have been provided in this case, which has made a simpler construction possible. The cylinders are made of metal sheets, and expansion chambers are mounted on the top in order to prevent an increase in pressure due to the heating of the oil.

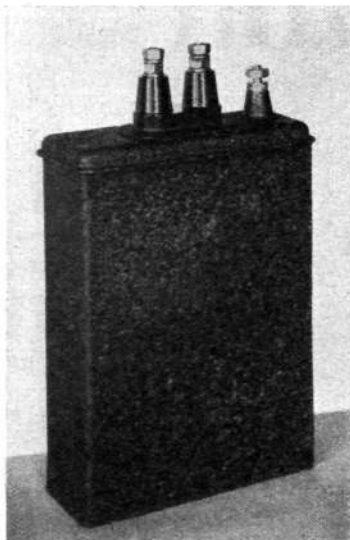
The battery, shown in Fig. 17, is of the outdoor type.

## Condensers in the Auxiliary-phase Circuit for Starting Single-phase Motors.



The simplest type of single-phase motor has a squirrel-cage armature, and requires a rotating field to start. Once started, such a motor will continue to run, but it cannot start by itself.

An auxiliary phase is used for starting, and the phase shift is obtained by means of a circuit containing resistance, inductance or capacity. The



X 3105

auxiliary phase forms a rotating field together with the main winding. In this case, a condenser offers considerable advantages, *i. e.*, by contributing to an improvement of the power factor.

The connections are shown in the diagram, Fig. 18. The main winding is represented by 1 and the auxiliary circuit by 2. By a suitable choice of condenser the following advantages may be attained:

1. self-starting with large torque,
2. negligible surge of current at start,
3. satisfactory power factor,
4. high efficiency.

As a guide to determining the necessary capacity it may be mentioned that for a starting torque of 70 % of normal, about 1 kVAR per HP is required. By a suitable choice of condenser any desired starting torque may be obtained. It should be noted that the voltage across the condenser exceeds the voltage across the motor terminals. In case of a motor voltage of 220 V the condenser voltage may read between 240 and 350 V.

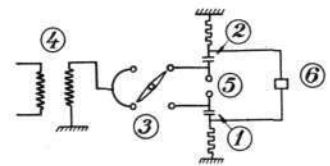
It may be found suitable to have the condenser divided in two parts. The whole of the condenser is then connected at the start in order to obtain the desired torque. When the motor has started, one section is disconnected and the remaining one has been chosen to ensure a satisfactory power factor under ordinary operating conditions.

A condenser designed for use in connection with an auxiliary phase circuit is shown in Fig. 19.

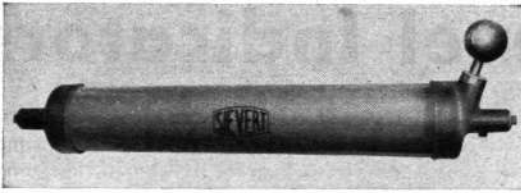
## Condensers for Test Rooms.

Fig. 20. Diagram of a surge testing installation.

- 1, 2 condensers
- 3 rectifier
- 4 transformer
- 5 spark gap
- 6 tested object



The four above-mentioned uses of condensers belong to power technics, but condensers have also been used for other purposes which, although not falling exactly within the boundaries of power technics proper may preferably be mentioned in this article.



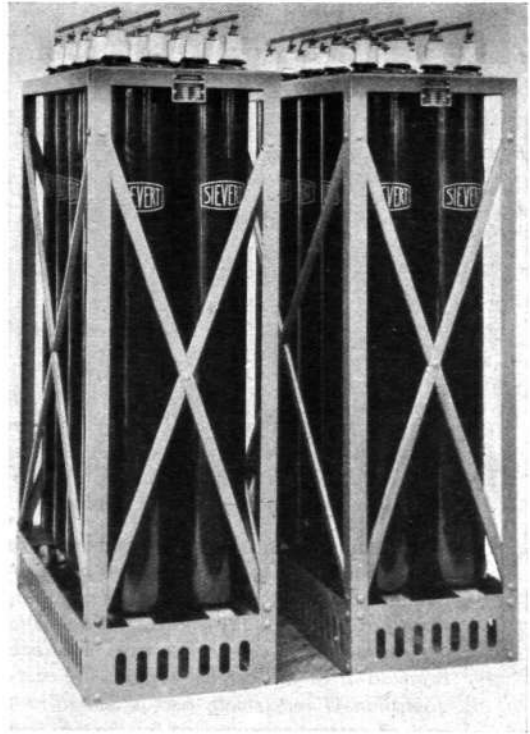
X 1175 **Fig. 21. Condenser for surge tests, Ludvika, Sweden.**  
32 000 cm, 150 kV. Sixteen similar units are connected in series to give a total voltage of 2 400 000 V.

The voltage across an insulating material in air can be raised above the flashover voltage in case the voltage rises sufficiently rapidly, *i. e.*, if the ionisation of the surrounding air takes place at a slower rate than that at which the voltage rises. The voltage wave of a surge can have such a steep wave front that the above-mentioned case may occur in practice.

Insulation materials should therefore be tested for such stresses, and this is done by suddenly connecting the object under test through a discharging spark gap to a condenser under tension.

The diagram, Fig. 20, shows the arrangement of such a circuit. The condensers 1 and 2 are charged from a rectifier 3 connected to the transformer 4. When the desired voltage has been reached, a discharge takes place across the spark gap 5 resulting in the insulator 6 being subjected to the voltage previously existing across the electrodes in the spark gap.

In the diagram the arrangement is such that the voltage is doubled but there are no objections against multiplying the voltage several times by parallel charging and series discharging of a number of condensers. Thus sixteen condensers in accordance with Fig. 21 have been supplied to the Ludvika laboratories of *ASEA*, Västerås, Sweden. When connected in series they will give a voltage of 2 400 000 V. A similar equipment is being assembled for delivery to the University of Uppsala.



X 1149 **Fig. 22. Filter condenser, Riga, Latvia,**  
50  $\mu$ F at 12 kV.

## Condensers for Filter Circuits.

The DC delivered from mercury arc rectifiers will always contain certain harmonics of audible frequency and will therefore in many cases cause disturbances in neighbouring telephone lines and radio receivers. In order to eliminate these disturbances it is necessary to install filters in the power lines. The harmonics naturally exist in a limited number and one filter circuit is usually arranged for each disturbing frequency.

When designing condensers of this type it is necessary to have two conditions in mind, firstly that the condenser must be able to withstand the total voltage stress, secondly that it must be able to neutralize the heat resulting from the AC voltage. Two filter condensers for 12 000 V DC with a total capacity of 50  $\mu$ F are shown in Fig. 23.

# Electric Water Level Indicators

By

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The following features are characteristic of the Ericsson water level indicators:

1. The equipment is made in standard types for measuring ranges of 5 and 10 m, and measuring intervals of 2,5 and 5 cm respectively. If desired, the instruments can be made for greater measuring ranges and intervals.
2. The transmitter has its own generator and thus requires no separate current supply for its main functions. This is a great advantage in respect of reliability and cost of operation. No disturbance can arise from a possible breakdown of the current supply. The cost of operation is very small, and is limited to the cost of current consumption for the additional apparatus that may be connected.
3. The receiving instruments are made for indication only, or for simultaneous indication and recording.

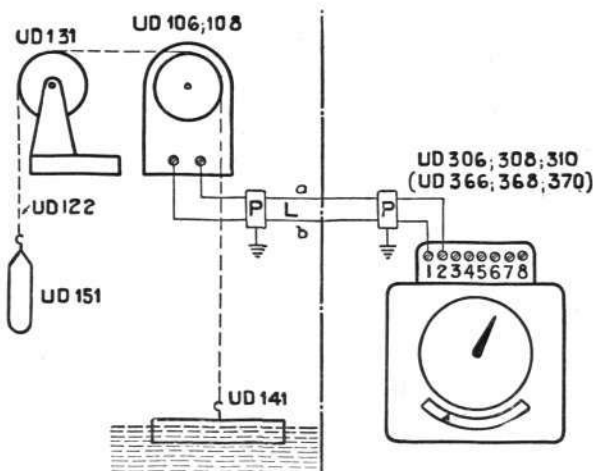
For the rational operation and effective supervision of the supply and consumption of water of hydro-electric plants, canals and locks, irrigation plants, as well as water-works, special technical means are required.

Electric water level indicators provide such means, making possible the regulation of the water supply from districts with varying water resources. A system of water level indicators, suitably placed at the sources, will automatically report all variations in the supply to the receiver apparatus installed in the control office. On the basis of these reports, steps can be taken in order to deal with floods and so avoid disasters, or to store surplus water during excess water periods.

In water supply works, the electric water level indicators ensure accurate information regarding the levels in the reservoirs. In conjunction with signalling and control apparatus, automatic working can be arranged.

The simplest water level indicator consists of a stick with gradations, by means of which the height of the water level can be read directly. Other simple water level indicators are, e. g., level

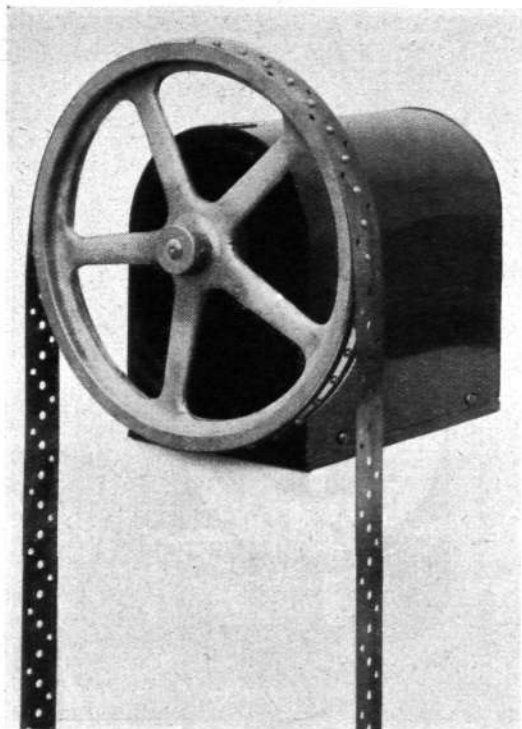
4. The system can work over an external resistance of up to 3000 ohm. This means that the range covered is very great. If wanted, this range can, however, be extended further by the installation of repeating relays. For the connection between transmitter and receiver, two-wire lines without earth connection are used.
5. Two receivers may be connected in series to the same transmitter. By the insertion of repeating devices the number of receivers can, however, be further increased.
6. The operation will not be disturbed by variations in line resistance produced by great changes in temperature or imperfect insulation.
7. The accuracy is very great and practically independent of the measuring range.
8. Secondary apparatus for alarm devices and the starting of motors etc. can easily be connected. Owing to the design of the system a great many combinations can be obtained.
9. The lines are under tension only during the short periods when impulses are transmitted.
10. The system permits of the lines between transmitter and receiver being utilized simultaneously for telephony.
11. The installation is very simple and no specially trained staff is required.



X 1117 Fig. 1. Diagram of an electric water level indicating plant.

- |                               |                        |
|-------------------------------|------------------------|
| UD 106 transmitter generator. | L line.                |
| UD 122 driving belt.          | P lightning arresters. |
| UD 131 corner pulley.         |                        |
| UD 141 float.                 |                        |
| UD 151 balancing weight.      |                        |
| UD 306 receiver.              |                        |

pipes and floats in cooperation with mechanically operated indicating devices. In most cases, how-



X 1118 Fig. 2. Transmitter, Type UD 108.

ever, such simple mechanical devices are not sufficient, since they give no possibility of long distance indication.

Already in the middle of the nineties Ericsson put on the market electric water level indicators, which made possible long distance indication of the variations of water levels. The new type of water level indicator, described below, is the result of the experience gained during more than one third of a century.

A plant of the simplest kind is shown in Fig. 1. It is composed of the following parts: transmitter with appurtenant float, balancing weight, driving belt and corner pulley, and receiver.

## The Transmitter.

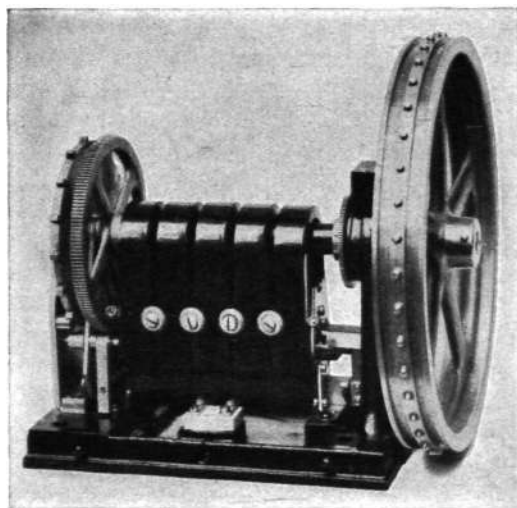
The transmitter is shown in Fig. 2 with, and in Fig. 3 without cover. It comprises a powerful electric generator geared to the driving pulley, a releasing device for the generator, and a line terminal strip. The various parts are mounted on a sturdy frame of black enamelled cast-iron.

The transmitter is made in two types:

Type UD 106 for a measuring interval of 2.5 cm,

Type UD 108 for a measuring interval of 5 cm.

The transmitter shown in Fig. 2 and 3 is of Type UD 108. The driving pulley of Type 106



X 1119 Fig. 3. Transmitter, Type UD 108, without cover.

has half the diameter of that of Type UD 108; in other respect the two transmitters are identical.

The driving pulley is made of nickel-plated brass and has teeth for guiding the driving belt (see Fig. 2).

The float, Type UD 141, has a diameter of 500 mm and is made of copper.

The balancing weight, Type UD 151, is of cast-iron and has a coating of anti-rust enamel.

The corner pulley, Type UD 131, has a frame of enamelled cast-iron and a wheel of nickel-plated brass. The pulley guides the driving belt, so that the float and the balancing weight can move freely.

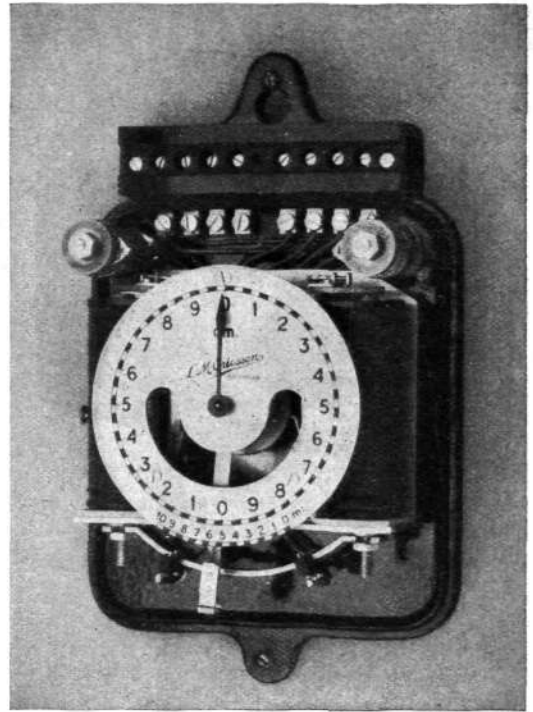
The driving belt, Type UD 122, is made of phosphor bronze with holes corresponding to the teeth of the transmitter driving pulley.

When variations of the water level occur, the driving belt transfers the motion of the float and the balancing weight to the driving pulley. According to Fig. 1 the driving pulley will turn clockwise, when the level sinks. The weight of the float will then set the releasing device of the generator. When the wheel has turned an angle corresponding to a change in level of 2.5 or 5 cm, the generator is released, and by means of a spring is brought to rotate about one half revolution. A DC impulse is then sent out over the line to the receiver.

When the level rises the balancing weight will turn the pulley counter-clockwise. When the generator is released a DC impulse is sent out in the opposite direction of the impulse sent out at sinking level.



X 1120 Fig. 4. Indicating receiver, Type UD 310.



X 1121 Fig. 5. Indicating receiver, Type UD 310, without cover.

## The Receiver.

The most important parts of the receiver are an indicator and two driving magnets, which are operated by the current impulses and thus move the indicator step by step. The two driving magnets are connected in series and shunted with electric valves in such a manner that only one of the magnets is operated by a current of a certain direction.

When the level varies the transmitter is operated by the float, and the generator sends out impulses in one direction or the other. These impulses in their turn operate the driving magnets of the receiver, which move the indicator pointer. The indicator will thus always indicate the height of the water level controlled by the transmitter.

There are two types of receivers, one for indication only, another for simultaneous indication and recording.

The *indicating receivers* are made in the following types.

Type UD 306 for a measuring range of 5 m and measuring intervals of 2.5 cm.

Type UD 308 for a measuring range of 10 m and measuring intervals of 5 cm.

Type UD 310 for a measuring range of 10 m and measuring intervals of 2.5 cm.

Fig. 4 shows a receiver, Type UD 310, and Fig. 5 the same receiver with the cover removed.

The pointer dial has two scales and two pointers. The lower scale covers the whole measuring range and is graded for whole and half meters. On the top scale each gradation represents one measuring interval. The use of two scales and two pointers makes the indication clearer and facilitates the reading.

On Fig. 5 the two driving magnets are seen behind the pointer dial. The two electric valves consist of metal rectifiers. When impulses are received, these valves direct the current through either of the magnets depending on the direction of the current.

The lower pointer cooperates with a contact device consisting of a contact spring fitted on the pointer and electrically insulated from it, and further two riders fitted with contact points and mounted on a fork.

The riders are mobile and can be fixed in the positions where contact is wanted. When the lower pointer reaches this position, a connection is established between the contact points of the riders by means of the contact spring on the pointer. The fixation of this spring is floating so as to ensure the least possible friction losses and the most suitable contact pressure.

As a standard the apparatus is fitted with two riders; two different circuits can thus be operated, *e. g.*, for the lowest and highest permissible level. On request, two further riders may, however, be added.

The receiver is mounted on a sturdy frame of black enamelled cast-iron. The cover, fitted with a glass window, is made of black enamelled sheet-iron and is fixed on the frame by means of two screws.

The terminal strip of ebonite is placed outside the cover, and the terminals are protected by a metal cover. Thus the cover need not be removed when the apparatus is installed. There are two fixing holes, which are also placed on the outside.

The *indicating and recording receivers* are made in the following types:

Type UD 366 for a measuring range of 5 m and measuring intervals of 2.5 cm.

Type UD 368 for a measuring range of 10 m and measuring intervals of 5 cm.

Type UD 370 for a measuring range of 10 m and measuring intervals of 2.5 cm.

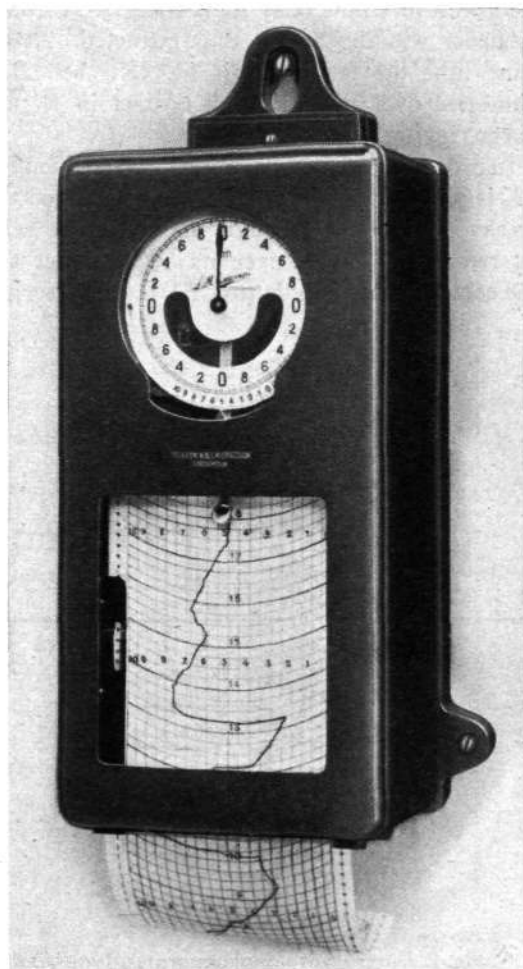
Fig. 6 shows a receiver, Type UD 369, and Fig. 7 shows a receiver, Type UD 366, with the cover lift off.

The indicator with the appurtenant driving magnets, metal rectifiers and adjustable contacts, is of the same design as that of the indicating apparatus. The pointer of the lower scale, however, is extended and fitted with a recording pen.

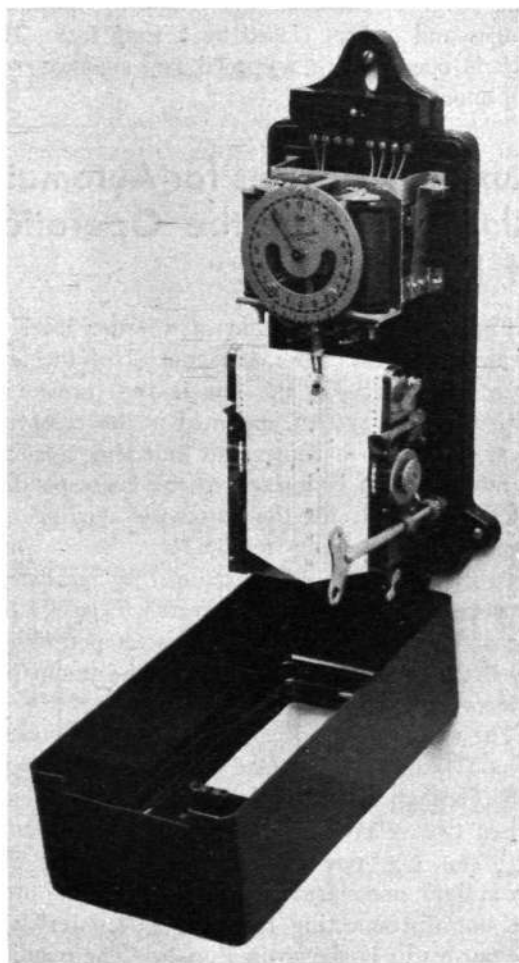
The registering mechanism consists of a powerful clockwork for eight days running, a recording drum, and feeder arrangements.

The registering chart is supplied in rolls of 25 m. The paper moves at a speed of 2 cm per hour. One roll will thus last about 50 days.

The various parts of the recording receiver are mounted on a sturdy frame of black enamelled



X 1122 Fig. 6. Recording receiver, Type UD 368.



X 1123 Fig. 7. Recording receiver, Type UD 366, without cover.

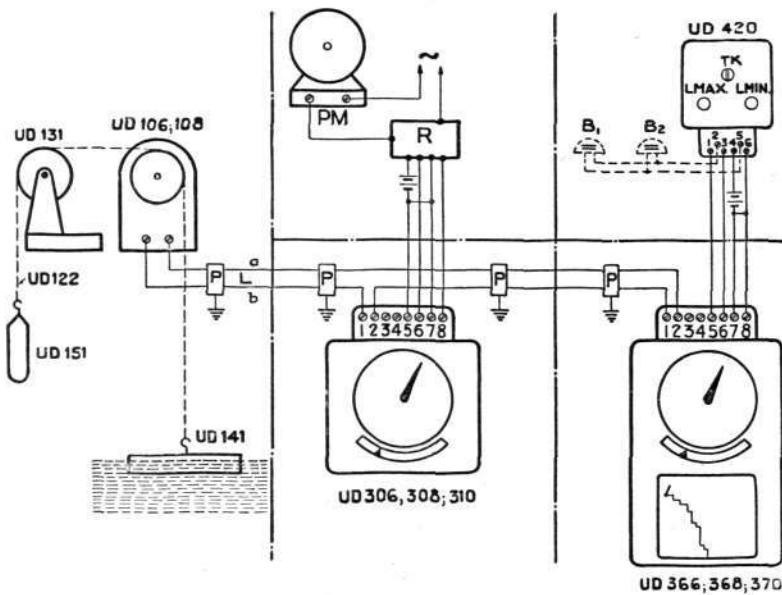


Fig. 8. Diagram of a plant for automatic water level control.

- UD 106 transmitter.
- UD 306 indicating receiver.
- UD 366 recording receiver.
- UD 420 signal apparatus.
- $B_1, B_2$  alarm bells.
- L line.
- P lightning arresters.
- PM pump motor.
- R relay.

cast-iron with the fixing holes outside the cover. The cover is fixed on the frame by means of hinges and is kept closed by a snap lock. This lock is opened with a special key supplied with the apparatus.

## Auxiliary Devices for Automatic Alarm and for the Operation of Pump Motors.

Fig. 8 shows a diagram of a water level indicator plant for automatic control of the level in a reservoir. On the left is the transmitter with the float system, mounted at the reservoir. Near the pump machinery an indicating receiver is mounted and connected to the corresponding set of relays  $R$ , for the automatic starting and stopping of the pump motor.

In the office there is a registering receiver in cooperation with a signal apparatus, Type UD 420, for alarm at the highest and lowest permissible level, and for the supervision of the pump machinery.

The set of relays  $R$  and the signal apparatus, Type UD 420, are operated by DC of 6 V. Fig. 9 shows a diagram of the signal apparatus. It comprises two relays  $R_1$  and  $R_2$ , two signal lamps  $L_{max}$  and  $L_{min}$ , one with red and the other with green light, one alarm bell  $B$ , and one push-button  $TK$  for disconnecting the bell. The exterior of the apparatus is shown in Fig. 10. The terminal strip is placed outside the cover on the bottom side of the apparatus and is not shown in Fig. 10.

When the contact in the receiver is closed at the lowest level, the relay  $R_1$  is energized through its upper winding and is thus attracted. At the same time the lamp  $L_{min}$  is lit. The bell  $B$  is connected over the operation contact in  $R_1$  and starts ringing.

In order to stop the bell ringing, the push-button  $TK$  is pressed; the relay  $R_2$  is then energized and breaks the current through the bell. The relay  $R_2$  remains attracted over its own contact and one contact of  $R_1$ . The button  $TK$  is self restoring.

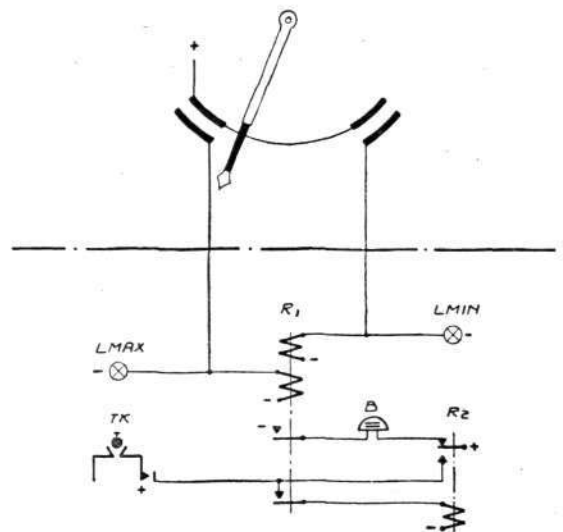


Fig. 9. Diagram of signal apparatus, Type UD 420.

- B signal bell.
- $L_{max}$  signal lamps.
- $L_{min}$  signal lamps.
- $R_1$  relays.
- $R_2$  relays.
- TK push-button.



X 1125 Fig. 10. Signal apparatus, Type UD 420.

When the water level rises and the pointer of the receiver moves so that the signal contact is broken, the relays  $R_1$  and  $R_2$  are released, and the lamp  $L_{min}$  is put out.

The same will happen at the highest level, when the lamp  $L_{max}$  is lit, and the bell rings.

From the above it is seen that the signal apparatus, Type UD 420, returns to home position, when the signal contact of the receiver is broken. It is thus impossible to disconnect the bell permanently by negligence or faulty operation; for the bell can only be disconnected when a signal has been received, and the disconnection will last only as long as the pointer of the receiver rests on one of the signal contacts.

The set of relays  $R$  must be adapted to the voltage and kind of current of the pump motor, the main points of the operation being as follows.

At the lowest level a starting relay for the motor is energized over the contact in the receiver. The relay is kept attracted and thus closes the current through the motor, until the highest level is reached. Another relay is then energized over the high level contact of the receiver, the current through the starting relay is broken, and the motor is thus stopped.

## Impulse Repeaters.

If more than two receivers are to be connected to the same transmitter, repeaters must be used.

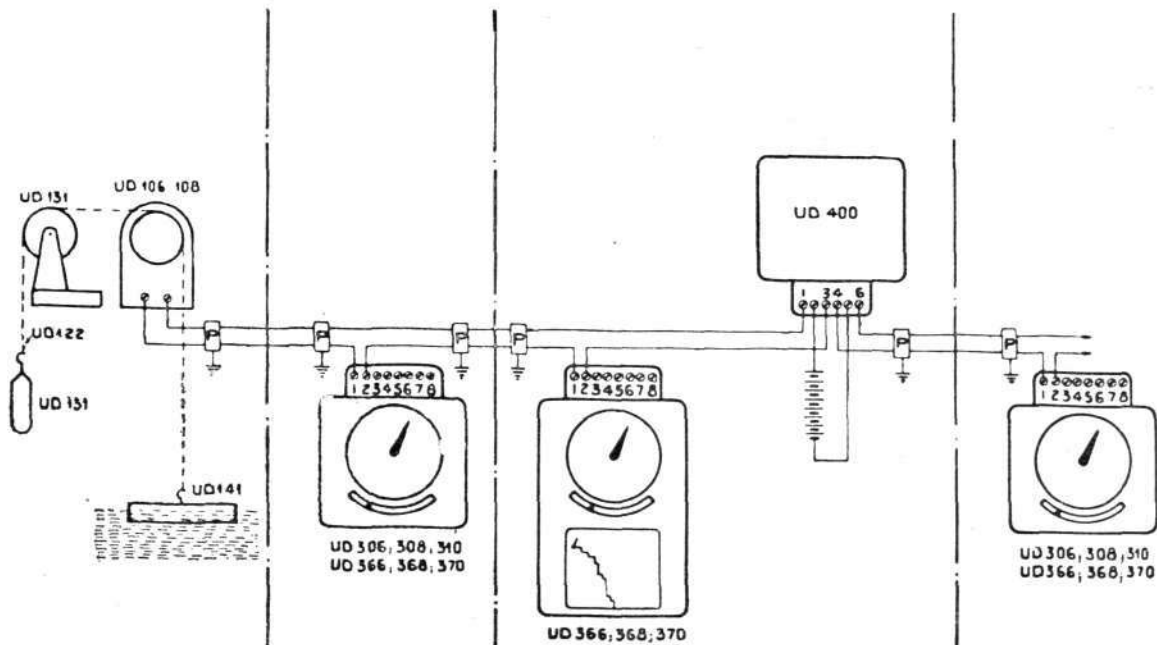


Fig. 11. Diagram of a plant with impulse repeaters.

- UD 106 transmitter.
- UD 306 indicating receiver.
- UD 366 recording receiver.
- UD 400 impulse repeater.

P lightning arresters.

X 7027



X 1126 Fig. 12. Impulse repeater, Type UD 400.



X 1127 Fig. 13. Telephone instrument, Type AB 5105.

Such a case is shown by Fig. 11, where a repeater, Type UD 400, is inserted between the second and third receiver. Such a repeater consists of four relays, mounted in a black enamelled sheet-iron cover. As the signal apparatus, the repeater has its terminal strip outside the cover, Fig. 12.

The repeater receives the impulses sent out from the transmitter through the first two receivers, and transmits amplified impulses to the following receivers. For the generation of these impulses a battery is required, the voltage of which depends on local conditions, *e. g.*, the line resistance and the number of receivers connected. This battery must be dimensioned separately for each case. In the table below the approximate minimum values of the voltage are given.

Maximum line resistance for the loop after the repeater, ohm	Minimum value of required voltage V	
	1 receiver after the repeater	2 receivers in series after the repeater
500	17	33
1 000	22	36
2 000	30	45

The batteries are conveniently made up of dry cells.

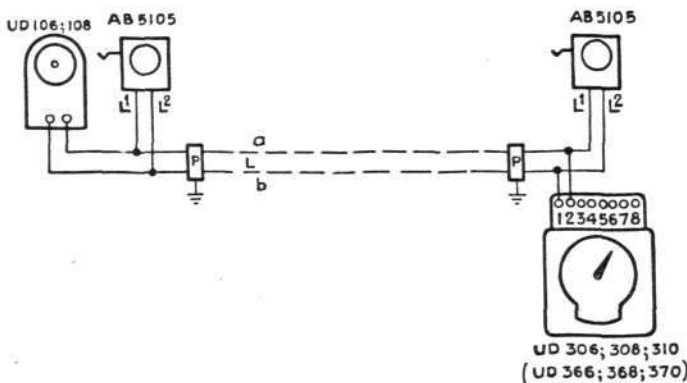


Fig. 14. Connection of telephone instruments, Type AB 5105, to the line.

- UD 106 transmitter.
- UD 306 receiver.
- AB 5105 telephone instruments.
- L line.
- P lightning arresters.

X 5041

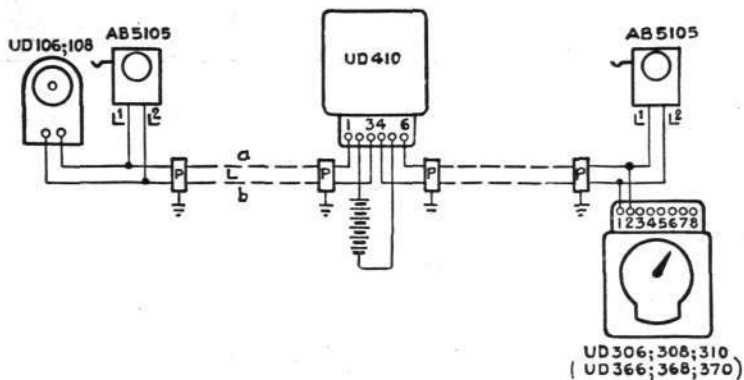


Fig. 15. Connection of telephone instruments, Type AB 5105, to a line containing impulse repeaters.

UD 106 transmitter.  
 UD 306 receiver.  
 UD 410 impulse repeater.  
 AB 5105 telephone instruments.  
 L line.  
 P lightning arresters.

X 5042

## Simultaneous Telephony and Water Level Indication.

Special telephone instruments, Type AB 5105, are used for simultaneous telephony and level indication, Fig. 13.

The signalling between the telephone instruments is performed by means of voice frequency. The equipment wanted for this purpose, *i. e.*, a buzzer with a push-button for transmitting, and a howler for receiving, are built into the instruments.

Each instrument requires a microphone battery of two dry cells, and a signalling battery of four to five dry cells.

Fig. 14 and 15 show the connection of the instruments to the line. In the latter case, *i. e.*, when a telephone circuit is wanted between two points of a line with a repeater between them, a special repeater, Type UD 410, is used.

The signals between the telephone instruments do not disturb the operation of the level indicators.

## Lightning Arresters for the Lines.

In order to protect transmitters and receivers from atmospheric disturbances, suitable lightning arresters for discharge to earth should be used for overhead lines. In Fig. 1, 8, 11, 14 and 15, these lightning arresters are indicated by a *P* in a square.

## Information to be Supplied with Inquiries for Water Level Indicators

The above description of the Ericsson water level indicators refers to standard equipments. On account of the character of the system, the water level indicators as well as the auxiliary apparatus can be used for many different purposes.

In order to facilitate the planning of an installation, the following information should be supplied when making inquiries:

- The total measuring range and the measuring interval wanted.
- The length of the driving belt, or information regarding the approximate height between the highest water level and the place, where the transmitter is to be mounted.
- Will the float be exposed to strong current or waves?
- The number of receivers to be connected to the same transmitter

- Will the connection between the transmitter and receiver consist of overhead lines or cables?
- Do thunderstorms occur frequently? This question is of importance only in case of overhead lines.
- The total resistance of the loop, or the length and area of the line. If several receivers are to be connected to one transmitter, the resistance, or length and area, of each line section should be stated, in case more than two receivers are to be connected or the total line resistance exceeds 2 000 ohm.
- Is telephone equipment to be included? If this is the case, information should be given regarding the points of the line, where the telephone instruments are to be inserted.
- Special requirements, *e. g.*, concerning the functioning of the auxiliary apparatus.

# New Types of Electric Clocks

By  
R. AUGERON



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*Some time ago the Société des Téléphones Ericsson, Colombes, provided a new impetus to the development of the clock industry by placing on the market new modern instruments for the indication of time with the aid of electricity.*

*The range of manufacture of this company comprises all existing types of clocks, from the biggest central clock plants to wall and table clocks for private houses. Among the latest novelties, clocks for connection to electric mains, offering great advantages, deserve special mention. This kind of clock will be chiefly treated here, without neglecting the small clocks for battery operation which form a special group and are also very popular.*

The days of sun-dials, hour-glasses and water-clocks came to an end a long time ago, but even if these ancient time-meters are left out of account it must be remembered that it was not until the last century that the clock industry had developed so far as to use electricity. Among the numerous scientists who worked in this field, Wheatstone was the first to find a practical solution by the use of electricity, particularly for time-indication at long distances. Later electric motors were used for the winding of big and small clocks, independently of each other, but in the older clocks the works required fundamental reconstruction based on the great improvements which had been introduced.

The motor drive of clocks can be performed in two different ways: by means of synchronous or asynchronous motors. There is at present not much to say concerning clocks driven by synchronous motors as this type is rather new. Still it is much in use owing to the reliability of current distribution at present, which makes it possible to take advantage of the constancy of the frequency of AC for the indication of time.

On the other hand the details of the operation of clockworks with the aid of asynchronous motors are of far greater interest since in its basic principles this system does not aim at replacing the mechanical clockwork but only at using the electric power for the winding up of the movement.

For this reason, we will not treat here the synchronous clocks, which are moreover manufactured by several of the other Ericsson factories, and will therefore be dealt with in a comprehensive article in a following issue of Ericsson Review.

The various systems of electric winding may be divided in two principal groups.

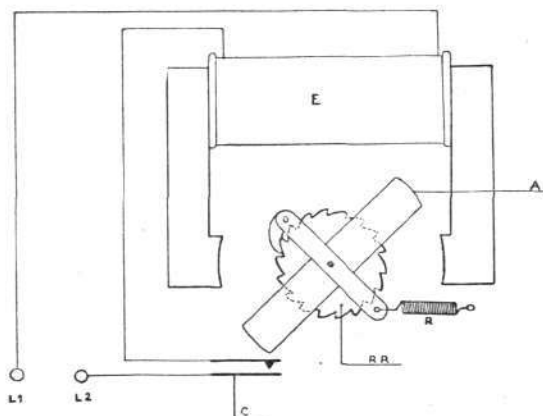
1. Systems with interruption of the winding current.
2. Systems without interruption of the winding current.

## Systems with Interruption of the Winding Current.

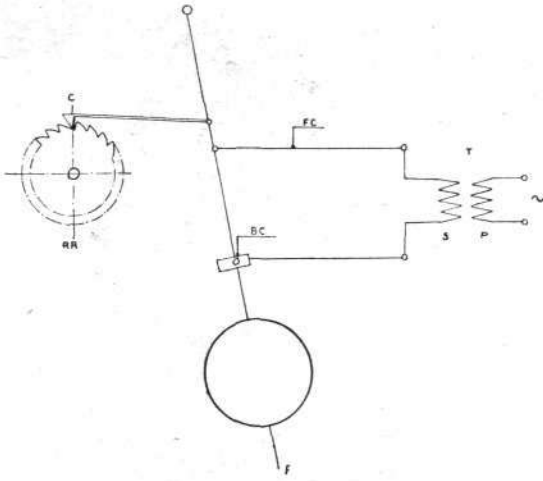
### Winding by Means of a Swinging Armature.

The winding device, Fig. 1, consists chiefly of an electro-magnet *E*, a swinging armature *A*, a cylindrical spring *R*, a ratchet wheel *RR*, and a contact *C*.

When the spring *R* is not strengthened, the armature *A* rests on the contact *C* thus closing the winding circuit. The armature is attracted by the electro-magnet *E*, and the force of the strengthened spring *R* is transferred to the



X 1150 Fig. 1. Diagram, showing winding by means of a swinging armature.



X 1151 Fig. 2. Diagram, showing winding by means of a hot wire.

ratchet wheel *RR* by means of the ratchet fitted on the armature. The ratchet wheel in its turn drives the movement, which is fitted with an escapement.

This kind of clock can be used with either *DC* or *AC*, by simple adaptation of the coils of the electro-magnet to the current available.

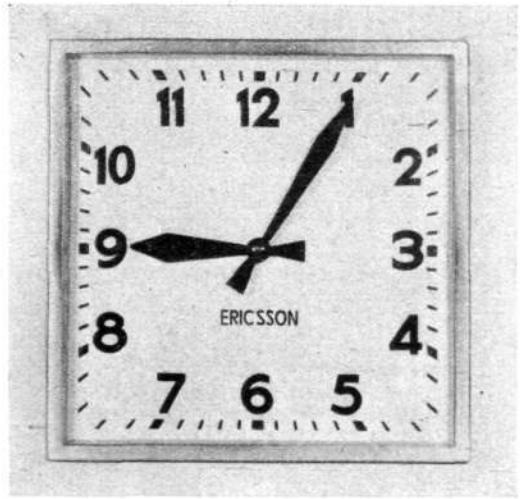
#### Winding by Means of a Hot Wire.

In rest position the pendulum *P*, Fig. 2, is kept in the farthest limit position by the wire *FC*. The following circuit is then closed: the secondary winding of the transformer *ST*, the hot wire *FC*, the pendulum bar, the contact *BC*, the secondary winding of the transformer *ST*. As it becomes heated the wire *FC* stretches, and the pendulum moves over to the opposite limit position. The above mentioned circuit is then broken, the wire contracts on cooling and moves the pendulum *P* back to rest position. The swing of the pendulum is transferred to the clockwork movement by the ratchet *C* and the ratched wheel *RR*.

The pendulum thus serves as a motor; the speed of the clock is regulated by an escapement.

#### Electro-pneumatic Winding.

In this system the electro-magnet is replaced by a glass vessel filled with air and by a tube connected to an expansion chamber containing a piston. When the winding current is closed, it runs through and heats a wire in the glass vessel, the heat causing the pressure to increase. This increased pressure operates the piston of the expansion chamber so that the movement is wound up.



X 1152

Fig. 3. Wall clock.

## Systems without Interruption of the Winding Current.

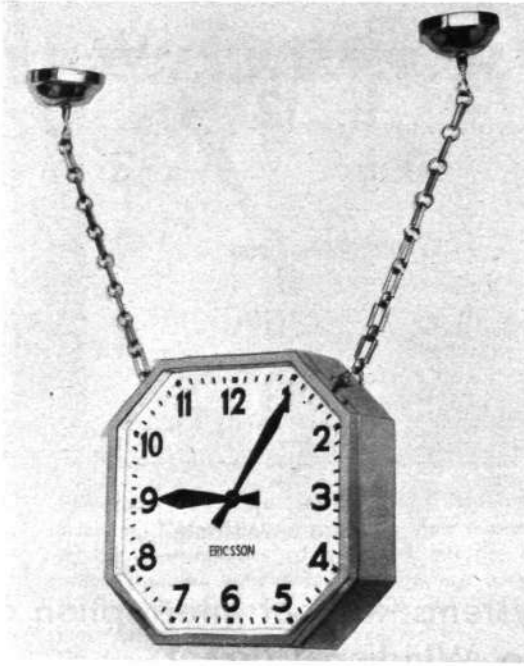
### Winding by Means of an Asynchronous Motor.

At first electric motors were used for big clocks only, such as those on towers. Not until 1920 was this system of winding applied to small clocks, table clocks, etc. The motor used must in the first place have a very small power consumption, and further, it must not need much supervision. The *DC* motor does not fulfil the second of these requirements, as the commutator frequently requires cleaning and the brushes need constant renewal. A slip ring motor needs about as much attention as the winding mechanism of



X 1153

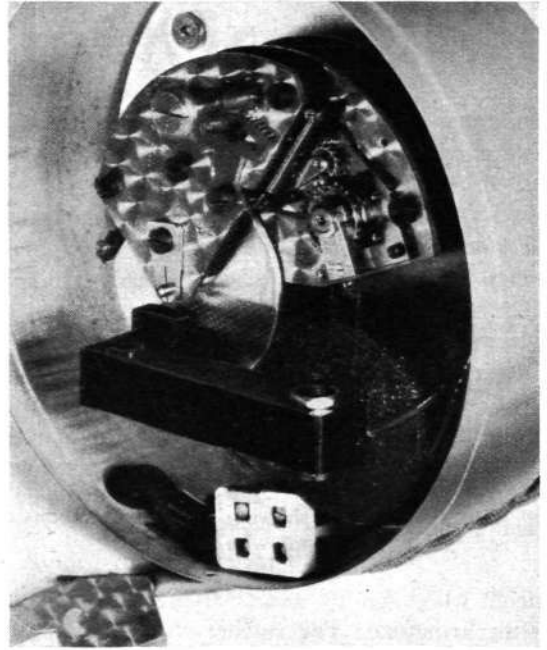
Fig. 4. Wall clock.



X 1154 Fig. 5. Double-side clock with suspension chains

ordinary clocks, and the current consumption of these small motors is not sufficiently low to permit them to remain continuously in circuit. A switch is thus required to switch on the motor when the clockwork has run down. This type of motor is thus seldom used and has been replaced by the induction motor of Ferrari's type, such as is used for electricity meters. The construction of these induction motors is most simple; they are composed of one electro-magnet and one aluminum disc mounted on a shaft and require no switch for the whole time they last. The current consumption of such motors is so low that it may be disregarded, and their long life permits them to remain in circuit continuously. The constructors have particularly aimed at avoiding starting switches where possible.

The Ericsson electric clocks with winding mechanism are fitted with motors of this type



X 1200 Fig. 6. Movement with winding mechanism.

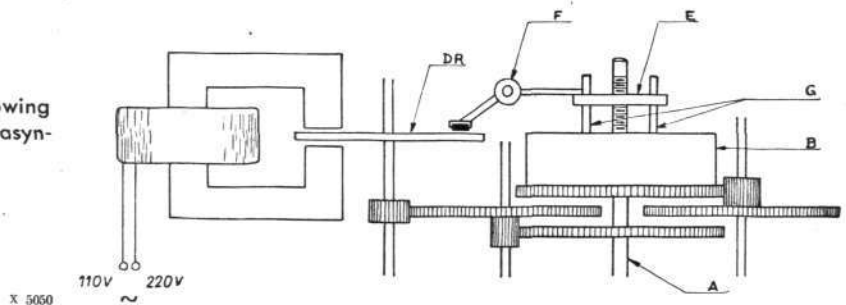
and can be connected direct to the mains without intermediate transformers. The clocks are provided with a precision movement and an asynchronous motor which winds up the clock automatically. All clocks are made for either 110 or 220 V. The induction coil needs only be adapted to the operating voltage available.

Fig. 3 and 4 show the standard wall clocks. Fig. 5 shows a double-side clock with suspension chains and Fig. 6 shows the movement with winding mechanism in protective cover.

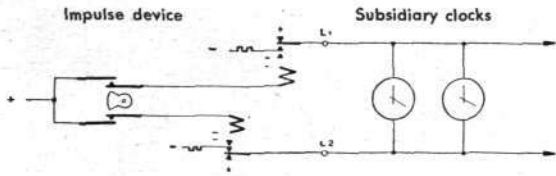
Fig. 7 shows movement in diagram. During the winding the rotor *DR*, consisting of an aluminum disc, transfers its motion, which is geared down, to the shaft *A* of the main spring *B* which turns slowly.

If the spring has completely run down the winding will last about 5 hours, after which the stored power can drive the clock for 45 to 48

Fig. 7. Diagram, showing winding by means of asynchronous motor.



X 5050



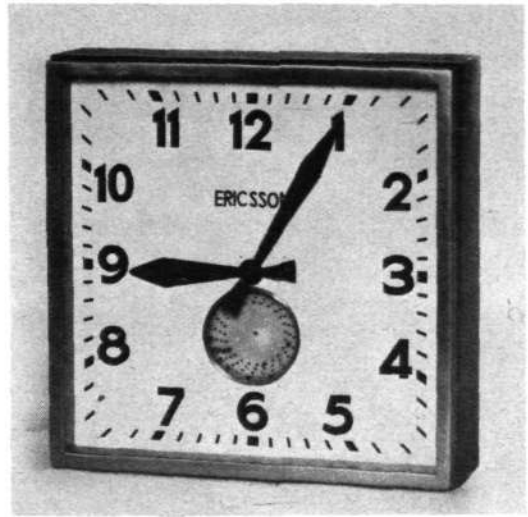
X 1155 Fig. 8. Diagram of impulse transmitting device for the operation of subsidiary clocks.

hours. This reserve, however, is utilized only in case of a break-down of the mains, as normally the spring is kept wound up as long as the clock is connected to the mains. For this reason the motor must have a brake, which operates as soon as the spring is fully wound up so that the winding-up moment is not added to the moment of the spring, as this might cause either the spring to be broken or the clock to run irregularly.

The brake *F* functions in the following manner: As has been stated, the disc *DR* during winding transfers its motion, which is geared down, to the shaft *A* which turns faster than the spring drum *B* with which it is connected by a spring. The top part of the shaft *A* has a thread fitting into the nut *E*, which is directed by the bar *G*. During the winding up the nut *E* moves away from the spring drum and returns when the spring slackens. As soon as the spring is fully wound up, the nut *E* lifts the lever of the brake *F*, whereby the winding up disc *DR* is stopped. In this manner the spring is kept permanently wound up and slackens only in case of a break-down of the current supply.

Such an electric clock may be used as a master clock for the operation of several subsidiary clocks; in this case the master clock is fitted with a disc mounted with impulse contacts.

These contacts are operated by a master disc, driven by the escapement, and the contacts alternately close the current to a relay, which in its turn drives the subsidiary clocks. The diagram



X 1156

Fig. 9. Master clock.

The signal times are adjusted by means of the regulator disc in the middle of the clock plate.

in Fig. 8 shows the impulse transmitting device and the relays.

Another type of electric clock may be used for giving acoustic signals at regular intervals by means of bells or hooters. Such a master clock is shown in Fig. 9; the regulator disc is seen in the middle of the clock plate.

Société des Téléphones Ericsson, Colombes, manufactures other types of winding movements as well which are intended for small clocks and table clocks. Such a clock with winding device is shown in Fig. 10. When the spring has completely run down the winding will take about two and a half hours. The power stored during this time gives the clock a running reserve of about 70 hours. In this case also the brake comes into operation when the spring is fully wound up. During the winding the rotor transfers its motion to the spring drum by means of a worm gear. The brake, which is operated by a lever, moves

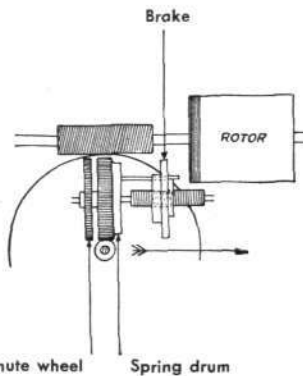
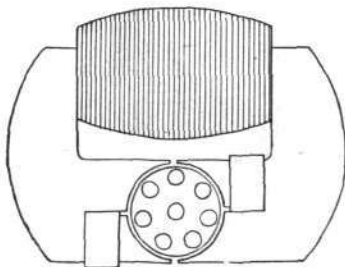


Fig. 10. Diagram, showing winding by means of asynchronous motor, simplified design.

During the winding the brake moves in the direction of the arrow.

X 5031

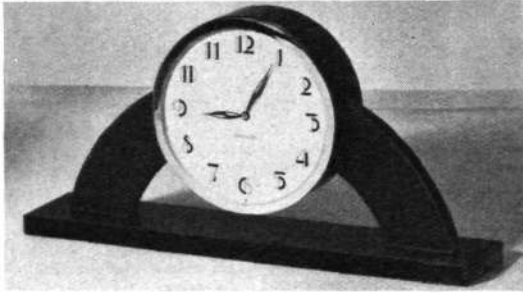
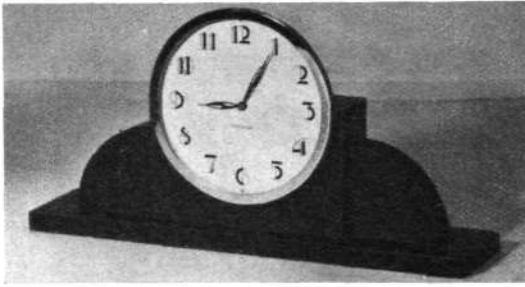


Fig. 11, 12. Table clocks.

X 1157  
X 1158

slowly along the screw fitted at the end of the spring drum shaft. When the winding-up is completed the front of the brake reaches the rotor, which is thus stopped. In this manner the spring is kept wound up and it will only run down in case of a break-down in the current supply.

Fig. 11 and 12 show some small table clocks with winding device. These clocks are modern in outward appearance and thus look well in rooms furnished in modern style.



X 1172 Fig. 15. Table clock for battery supply.

## Battery Clocks.

Clocks for use in homes and offices are generally small and have a low current consumption.

The Société des Téléphones Ericsson, Colombes, manufactures various types of such clocks, differing only in outward appearance, as may be seen in Fig. 13, 14, 15, 16 and 17.

All these clocks have the same type of movement driven by an electro-magnetic winding device which is fed from a pocket lamp battery

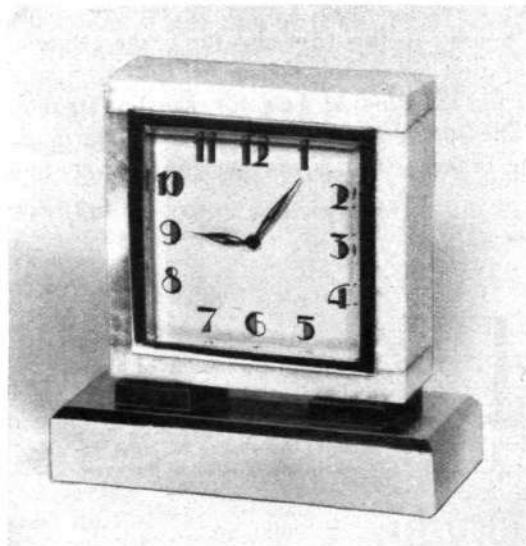


Fig. 13, 14. Table clocks for battery supply.

X 1169

X 1170

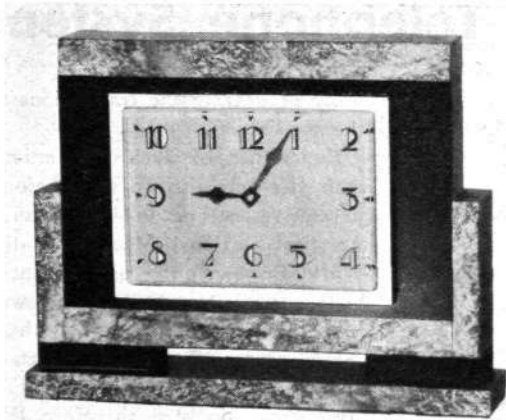


Fig. 16, 17. Table clocks for battery supply.

X 1168

X 1173

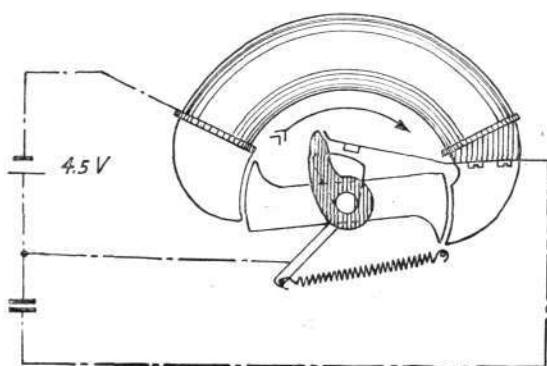


Fig. 18. Winding by means of a battery.

X 1174

During the winding the armature moves in the direction of the arrow and winds the cylindrical spring; the spring having run down the contact closes the current through the electro-magnet, which performs the winding anew.

of 4.5 V. The battery is placed inside the base of the clock and has a life-time of about one year. The life of the battery is limited solely by the polarization of the battery and not by the current consumption of the winding mechanism. The automatic winding is performed by means of an electro-magnet and a rotating armature, Fig. 18, which strengthens a cylindrical spring replacing the usual spiral spring.

The special design of the various parts gives the clockwork a constant torque as long as the clock is running; the winding lasts 4 minutes.

We trust that by this description of some of the clocks manufactured by Société des Téléphones Ericsson, Colombes, we have been able to give an indication of the present stage of this modern branch of the electric clock technics.

# The Ericsson Conference Telephone System



By  
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and  
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bility of hearing the translations of the speeches.

Experience of such installations with wired circuits proved therefore, in some respects not to be favourable. At the Sectional Meeting of the World Power Conference in Stockholm 1933, a new system was sought, which would avoid these disadvantages; the general secretary of the Sectional Meeting, Mr. Edy Velander, suggested therefore that wireless transmission should be used, and Telefonaktiebolaget L. M. Ericsson was asked to design such a system.

In large halls difficulty is often experienced in hearing speeches with sufficient clearness, owing to the distance and to bad acoustic properties of the halls. If the speaker's voice is so weak that the speech does not carry all over the hall, it may, of course, be amplified by means of loudspeakers, but, since the microphone and the loudspeaker must be close together, there is always the risk that the loudspeaker may start to sing when amplification is sufficiently great, owing to acoustic reaction between them. Further, at the present stage of technical progress the speech from a loudspeaker is not always of a satisfactory quality. If the acoustics of the hall are bad amplification of the speech may make it still harder to follow owing to echo in the hall. The only way to solve this problem is to transport the source of the sound right to the ears of the listeners and thus avoid the disturbance in the intervening space. This can be done by means of a microphone at the speaker's desk and a special receiver for each listener. This system has been practised for a long time in large halls used for meetings, certain spots being fitted with receivers for persons who have a difficulty in hearing.

In the recent years similar appliances have been used in order to eliminate the difficulty caused by the use of different languages at great international conferences. At such

conferences several languages are often used for speeches and discussions, and, consequently, interpretation from one language to another is necessary in order to enable all members to follow the proceedings. However, this repetition of the speeches takes up a great deal of time, and, further, it is tiresome for the audience, who, naturally, need only hear each speech in the language they understand best.

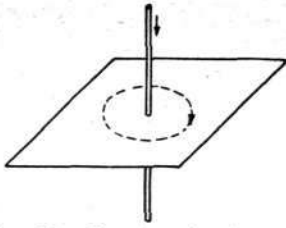
At the World Power Conference in Berlin 1930 attempts were made to avoid this trouble by installing lines from the interpreters to each member's seat, the lines terminating in several jacks. The original speech and the translations were sent out simultaneously, and each member had only to plug his receiver into the jack connected with the language he wanted. By this arrangement a deal of time was saved at the meetings, but on the other hand the system involved great disadvantages. The complicated line network required takes time to install and is expensive so that such a system is not suitable for conferences that are not permanent. The greatest disadvantage, however, is that the receiver cords prevent the members from moving about freely, and will easily get entangled. Owing to the cords a member arriving late will moreover have difficulty in reaching an unoccupied seat and, if all seats should be taken up, he has no possi-

## The Development of the Conference Telephone System.

Several ways of solving the problem suggested themselves and the advantages and disadvantages of all of them were carefully considered.

One of these suggestions was based on the use of electrostatic transmission. The very weak voice frequency currents from the microphone were to be amplified to a high degree and fed to a network of wires in the ceiling of the conference hall and to another network below the flooring. The members would thus be in the electrostatic field of the condenser formed by these two networks. The receiver set was to be fitted with two metal plates at different heights, and the terminals of the telephone were to be connected to these plates. Between these plates a certain tension would be produced, and this tension would drive a current through the telephone, the current being proportional to the voice frequency currents in the microphone. The sounds collected by the microphone could thus be heard in the telephone.

These metal plates would have made the receiver set rather cumbersome and the listener would have had to carry them parallel to the



X 3107 Fig. 1. An electric current flowing through a conductor will produce a magnetic field around and in a plane perpendicular to the conductor.

floor and at the greatest possible distance from each other, *e. g.*, one on the head and the other under one foot, this in order to obtain a sufficient tension between the receiver terminals. The tension between the networks would in addition have had to be so great that there might have been danger for the people in the hall.

It proved to be far simpler to solve the problem by using electromagnetic transmission, and the principles of such a system are described below.

## Fundamental Principles.

An electric current flowing through a conductor will produce a magnetic field around and in a plane perpendicular to the conductor; the intensity of this field will be proportional to the current in the conductor, and the direction of the field will be in accordance with the screw rule (see Fig. 1). An AC through the conductor will thus produce a field of which the intensity and direction will vary in accordance with the current.

If the conductor be bent to a loop, the field will be composed of the

fields produced by all the sides of the loop, see Fig. 2.

In another loop *II*, placed so that the field from loop *I* is at an angle to the plane of loop *II*, a current will be produced which is proportional to the intensity and the frequency of the current in loop *I*.

The amplified current from the microphone fed to a loop hung along the walls of the conference hall could thus, by electromagnetic induction, be transferred to a smaller loop or coil on the receiver. However, difficulties would occur since the low frequencies in the voice range would not be transmitted so well as the high ones, with the result that the speech would be hard to follow.

It would therefore be more convenient to move the speech band higher up in the frequency range, which can easily be done by modulating a very high frequency, the carrier frequency, with the voice frequency, as is the case in ordinary transmitters for wireless telephony, *i. e.*, to make the high frequency,

current vary in time with the voice frequency. On account of this modulation, two frequency bands one on each side of the carrier frequency and both of the same width as the speech band would be transmitted in addition to the carrier frequency. The width of the frequency band thus transmitted would be proportionately small. The whole frequency range transmitted would be transferred with almost uniform intensity, while at the same time the use of a high frequency would offer considerable practical advantages, *e. g.*, fewer windings in transmitter and receiver loops, etc.

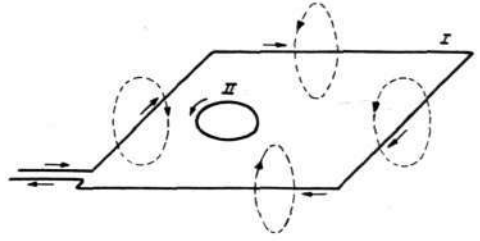
By rectification of the modulated current in the receiver loop it would be a simple matter to eliminate the carrier frequency and regain the voice frequency.

## Design.

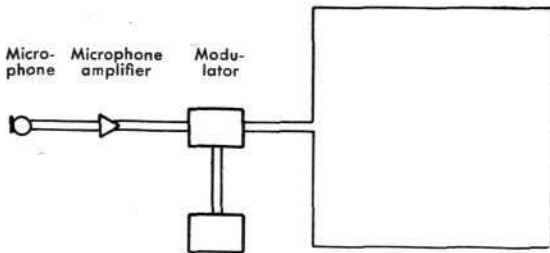
The transmitter is thus designed according to the principles shown in Fig. 3.

The speech current from the microphone is amplified in a microphone amplifier, and in a modulator it is mixed with the carrier frequency generated in an oscillator; the modulated carrier frequency is then fed to the transmitter loop.

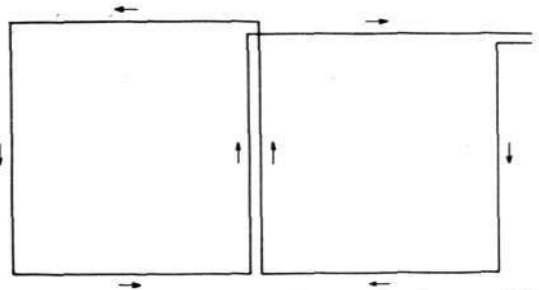
A large modern conference hall is generally built with steel supporting



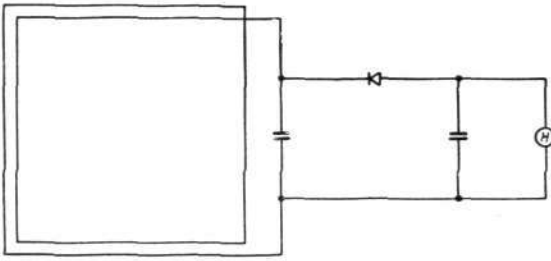
X 1176



X 1179 Fig. 3. Diagram of the transmitter.



X 1178 Fig. 4. The transmitter loop in the Concert Hall was given the shape of an 8.



X 1177 Fig. 5. Diagram of the receiver.

girders, and in these girders currents will be induced from the transmitter loop. These girders can thus form short-circuited loops which will disturb the field, and consequently, it is hardly possible to calculate beforehand the shape of the field, so the most suitable manner of placing the transmitter loop must be found out by experiment.

In an extreme case, such as where the floor contains so much metal that it can be considered as a conductor, it will act as an electric mirror for the transmitter loop. The image of the loop will have the same influence as a loop as far below the floor as the real transmitter loop is above it, but the current in the image will have the opposite direction to that of the original loop. The component of the magnetic field perpendicularly to the floor will therefore be attenuated by the combination of the real loop and its image and in the middle of the hall, where the field is vertical,

a high degree of attenuation will occur.

For this reason the transmitter loop at the Sectional Meeting of the World Power Conference in Stockholm had to be arranged in the shape of a figure eight, Fig. 4. In this way the field was more evenly distributed over the hall than with a loop hung along the walls.

The principle of the receiver set is very simple, see Fig. 5 being very similar to that of a wireless crystal set.

The receiver loop is tuned with a condenser to the carrier frequency. The rectification of the modulated current is carried out in a special permanent detector and the voice frequency oscillations, regained at the rectification, are led through the telephone, while the carrier frequency is separated by the condenser in parallel with the telephone.

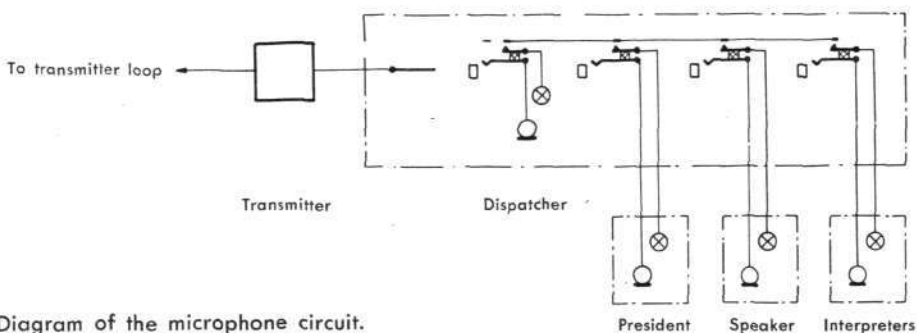
The receiver loop consists of several strands of wire, twisted to



X 1199 Fig. 6. The interpreters of the Sectional Meeting of the World Power Conference in Stockholm.

form a cord which is carried over the shoulder, Fig. 6. This cord supports a small box containing the detector and the condensers, to which the telephone cords is connected. The receiver set is moreover very light and does not hinder the movements of the user.

In order to obtain the loudest possible reproduction in the receiver telephone loop must be placed so that it covers the greatest possible amount of the field from the transmitter loop. Since the direction of the field varies in different parts of the hall, the best position of the receiver loop will also vary. Immediately below one of the wires of the transmitter loop the plane of the receiver loop should be vertical and parallel to the wire. In other places it will be more convenient if the plane of the loop is more or less horizontal. A few trials, however, soon show the position of the receiver loop that gives the best reception.



X 5052 Fig. 7. Diagram of the microphone circuit.

## The Conference Telephone System at the Sectional Meeting of the World Power Conference in Stockholm.

The proceedings of the Sectional Meeting were held simultaneously in the two halls of the Stockholm Concert Hall and both these halls were provided with conference telephone equipment. In order to prevent disturbance between the two halls, which are not far from each other, the installations were operated with different carrier frequencies, 375 000 cycles in one hall and 500 000 cycles in the other, corresponding to the wave-lengths of 800 and 600 m respectively. The receiver sets, being made with fixed tuning, were consequently of two different types.

The transmitter power was small; about 10 W proving sufficient for the larger hall, the size of which is 20×30 m.

Four microphones could be connected to the transmitter: one at the speakers' rostrum, one in front of the chairman, one at the interpreters' table and one for the dispatcher who was to connect the different microphones to the transmitter by means of a small switchboard. When a microphone was switched on, a red signal lamp glowed, indicating that the connection was established. The arrangements are shown in Fig. 7.

During the original speech the microphone in front of the speaker was generally in circuit. The speech could be heard direct as well as in the receivers, and the installation thus served to amplify the speech. It proved much easier to follow the

speeches through the conference telephone than direct, especially for those members listening to a speech in another language than their own.

Immediately afterwards the interpretation was made, transmitted through the conference telephone only. During the interpretation those who had understood the original speech could move about in the hall and converse with each other without disturbing those who wished to listen to the interpretation.

In certain cases the interpretation into another language was transmitted at the same time as the original speech was being delivered from the platform. This was the case with the speech of the general reporter at the beginning of each discussion.

During the Sectional Meeting the new wireless conference telephone system proved to answer fully the purpose required of it, and from the start it was highly appreciated by the members, Fig. 8. In the Swedish and foreign press the system aroused great interest.

## The Possibilities of the System.

The Ericsson conference telephone provides international conferences with an important new technical appliance and, owing to its simple design, the system can easily be made to suit any special requirements. There is no reason why the system should not be arranged for the simultaneous transmission of several languages. In this case each language would have its own transmitter and the receiver would be fitted with switches by means of which each listener could select the language he preferred.

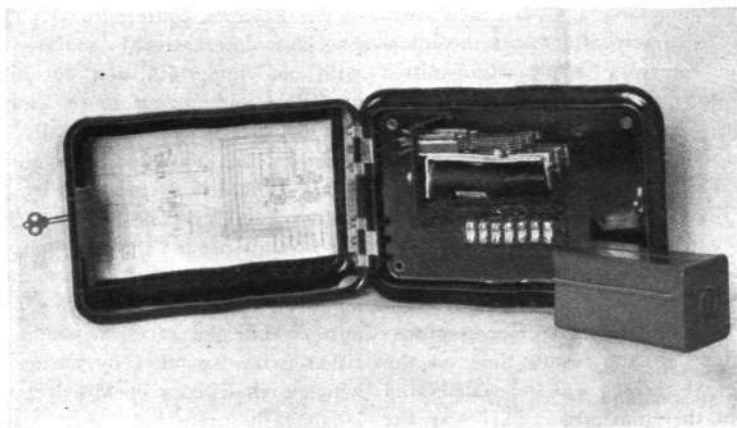
The transmitter loop can easily be extended to adjoining rooms, the cost of extension consequently being very moderate compared with that of a telephone system with ordinary wired circuits.

As has been mentioned above, the conference telephone system can with advantage be used for the amplification of speech in large conference halls, churches etc.



x 5077 Fig. 8. The conference telephone in service during the Sectional Meeting of the World Power Conference in Stockholm.

# Party Line Telephones in Hungary



X 5053

Fig. 1. Relay box for twin lines,

to be mounted where the lines to the two instruments part. The relays connect the instrument engaged in a call and break the connection to the other one.

The main requirements of the Hungarian Post Office in respect of party line systems were: selective calling, secret calls and separate counting for each subscriber. Primitive, non-secret party line systems, such as are commonly used in the U. S. A., were thus out of question.

The first selective calling party line installations to fulfil the demand for secrecy and individual counting, were those which have been in service in the Swiss telephone system since 1932; by agreement with the Ericsson group the manufacturer, Hasler A.-G., Bern, builds stations with types of relays and selectors similar to those of Ericsson.

Having been asked by the Hungarian Post Office to furnish proposals for the automatization of certain types of stations and the rearrangement of the rural line system for service night and day, Ericsson Magyar Villamossági R. T. got into communication with Hasler A.-G. At this time the Swiss Board of Telephones had arrived at the following different systems, which together provided a satisfactory solution of the problem: one secret party line system for two subscribers, «twin connections»; one selective calling system for several subscribers; and one rural exchange system for 10 to 200 subscribers.

Up to the end of 1932, Hasler A.-G. had delivered to the Swiss Board of Telephones 8 500 twin connections, 4 800 selective calling apparatus and 237 automatic rural exchanges.

The Hasler system was modified by Ericsson Magyar Villamossági R. T. to suit Hungarian conditions, and proposals were submitted to the Hungarian Post Office, though at the time no contracts were placed.

In recent years the problem has been very much to the fore and a great deal of development work has been carried out, the results of which are to be found in the systems described below.

For twin lines the systems proposed to the Post Office were that worked out by Hasler A.-G. and one evolved by Ericsson, Stockholm; the latter had been employed for automatic exchanges delivered by this firm. As a basis for solving the Hungarian problem the Post Office selected the system of Ericsson, Stockholm.

The principles of this system, which was intended for CB exchanges, are as follows:

The subscribers' telephone instruments are of the ordinary CB type. At the point where the lines to the two instruments diverge there is a box, Fig. 1, containing two relays for connecting the two conductors to

the instrument engaged in a call and breaking the connection to the other instrument. At the exchange the twin line is connected to calling lamps, individual for each subscriber. The selection of the instrument wanted is performed by plugging into the corresponding jack; thus the recording does not depart from the usual practice and is performed in the same way as for the lines of two separate subscribers. This connection of the CB exchange does not call for any additional arrangements at the exchange. If these principles are to be used for LB exchanges, however, extra equipment is required at the exchange, consisting of one choke coil and the replacement of two jacks per twin line, two condensers per cord circuit, and for each exchange one battery which may conveniently consist of a number of dry cells.

The LB system can be used for all LB exchanges in Hungary since each line has one jack only, serving for both local and interurban traffic. In the Hungarian CB exchanges a certain amount of additional equipment was found to be necessary owing to the special treatment of interurban calls. For party lines the rule that a local call can always be cut off without warning may be followed only in the case of the subscriber actually wanted for an interurban call.

For a CB exchange this condition can be fulfilled by simple additional devices at the exchange, so that the operator will get the local engaged signal when testing on the jack sleeve of the subscriber engaged in a local call; this signal need not be considered by the operator. When testing on the other subscriber the operator will receive a buzzer signal, indicating engaged by interurban call. This arrangement is made so that the interurban operator can plug into jacks indicated engaged in this way without disturbing the local call.

When transforming old LB-exchanges to the CB system, which has been done partly with material from the old Western exchange taken down after the automatization of Buda-

pest, modern cord circuits in which breaking of the calls, ringing and counting are automatic have been introduced. These circuits, which must be adapted to the parts available, have been designed in different ways for different exchanges, with the result that the conditions for the introduction of twin lines are not uniform. For example at automatic ringing the ring signal sometimes emerges from the minus pole and does not pass the same cord wire in all exchanges.

The Post Office has once and for all eliminated all these complications by inserting condensers in the two speech wires, whereby the connection becomes independent of the type of cord circuit.

In this manner a uniform method of connections for all exchanges was obtained. This method further carries with it the great advantage that the range covered is independent of the sensibility of the cord control relays; such single, twin lines as are particularly long can thus be equipped with more sensitive line relays or be fed with higher tension.

In accordance with the requirements of the Post Office this type of connection has been developed in order to make use of relays taken down in Budapest. The whole relay group is built together as one unit which is inserted between the multiple field and the line. A relay group of this kind has been fitted as a trial in the exchange at Kecskemét and has functioned perfectly.

Another twin line equipment, connected to the Krisztina automatic exchange in Budapest, has functioned without fault for five months.

The relay boxes, fitted where the lines to the instruments diverge are the same for LB, CB and automatic systems.

By these methods the problem of connecting two instruments to the same line has been solved in a uniform way for all the systems existing in Hungary. The parts required are either in store at the Post Office, or, if not, the Ericsson factory is able to undertake their manufacture. It thus depends on the decision of the

Fig. 2.  
Selective calling  
telephone  
instrument,  
for connection to LB  
or CB systems



X 1189

Post Office, as to, when the Hungarian public will be able to benefit by the advantages of twin lines. In order to give an indication of the savings to be derived from the twin line system, it might be mentioned that the economic calculations of the Swiss Board of Telephones, published in »Technische Mitteilungen» Nr. 5, 1926, show that the average annual saving in Switzerland due to one twin line connection is Sw. Frs. 83:— . Of this amount Sw. Frs. 56:— is to the advantage of the Board of Telephones and Sw. Frs. 27:— to that of the subscriber. In Hungary, however, all the savings are to be used for reducing subscription rates.

At present the Hungarian Post Office is having tests made with two different systems of party lines for more than two subscribers: in the capital a centralized system for big houses and in rural districts a decentralized selective calling system. Both systems can be extended to serve 10 subscribers.

The district where the house system is to be used is the capital where there is a high density of po-

pulation, while the selective calling system is more suited for rural districts where the density is very low. The selective calling system is, therefore, more interesting from an economical point of view, since the lines on which it is to be used are generally longer and thus the savings, due to their common utilization, greater. From a technical point of view as well the selective calling system is superior, communication between subscribers on the same line being possible, which is not the case with twin lines and house systems. In the house system this may not be necessary in most cases, the system being designed for subscribers living on the same premises. A disadvantage of the selective calling system is the fact that ordinary telephone instruments cannot be used, and that local current supply to the microphone is required even when connected to CB exchanges.

The house system comprises an additional line device at the exchange and an external automatic selector device installed at the house where the subscriber is to be found. Both devices contain rotating selectors,

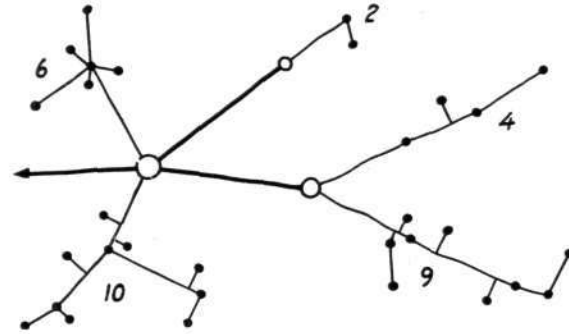
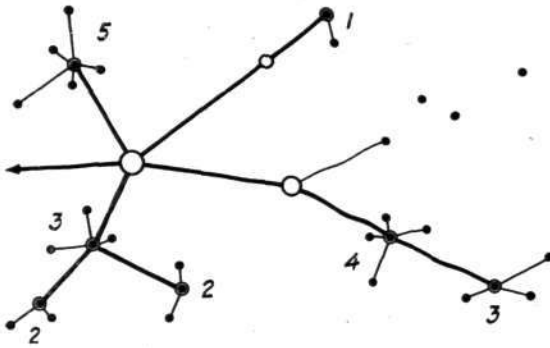


Fig. 3.  
Line system,  
above without, and  
below with party  
lines.

X 1193

which drive each other mutually. The external selector connects the calling or called instrument to the main line, and the station selector connects the individual counter. For outgoing calls the line selector at the automatic exchange first moves to the number in question — if the automatic system does not permit through selecting — and the two selectors of the party line then move synchronously. The Hungarian Ericsson company has delivered 5 automatic central devices for such house plants.

In the selective calling system also the station wanted is selected by a rotating selector. In this case each instrument contains a selective calling device. This device has been designed and developed by Hasler A.-G., and manufacturing rights have been acquired by Ericsson Magyar Villamossági R. T. These selectors consist mainly of a counter mounted on an Ericsson twin relay. The reliability of the selective calling device in question has been demonstrated during tests extending over more than 8 months in Hungary.

Fig. 2 shows a selective calling instrument that can be connected to both CB and LB exchanges.

The station equipment for the selective calling system will be somewhat different for LB and CB systems. Receipt of a call or the insertion of a plug will cause all selectors to move from home position, and further calls can then not be made. Outgoing calls or connections between the subscribers on the same line are made by the operator by means of the dial. A plant on this system installed on trial in the Kaposvár exchange and put into service in May 1932, on a line of 4 km length with 5 subscribers in the village Toponár, has functioned without fault during 8 months of test.

The Post Office has now to decide whether the equipment of this plant is to be made definite, and whether this system is to be used for other exchanges as well. At Kaposvár this would involve the fitting of dials and cords for these lines at 6 local and 6 interurban positions as well as the multiplication of jacks in the whole multiple field. The cost of this as

also that of a certain amount of selecting work could be saved if the selective calling system were reconstructed so that, instead of the special party line equipment, each party line subscriber became his own ordinary calling and multiple equipment and could thus be treated as an ordinary subscriber. The increased number of lamps and jacks needed would involve no increase in cost, since great reserves of both lamps and jacks are connected at every exchange.

This idea has been realized by a new system of connection the installation costs of which are negligible compared to the savings in costs of fitting and operation. The alteration of the subscriber's instrument has been made so that, when connected to small exchanges where the original system may be more economic, it can be adapted to dial systems by changing single wires. The principle of the new connection is that in the exchange one selector is used, the lines of which correspond to the subscribers' instruments, as is the case in the house system.

The selective calling system above described is suited for connection to the system recommended by the Post Office for the automatization of the rural districts.

Automatic rural exchanges, such as are already in use in the Swiss and other foreign systems will probably not be used in Hungary owing to the lack of lines and the high cost of buying automatic time-zone counters. Instead small stations will be equipped with selector devices operated from manual main exchanges. The big exchanges only will be equipped with automatic apparatus for local traffic. It will, however, be a long time before the whole of the rural LB exchanges numbering more than 1 000 have been automatized.

Fig. 3 shows how rational recording, longer operating time, improved speech transmission and increased number of subscribers — which might all be realized by the semi-automatization of the small rural exchanges — could in many cases be attained at less cost, and therefore

sooner by the introduction of selective calling systems.

In cases where the traffic does not require more than one conversation facility, an automatic rural exchange could to advantage be replaced by a party line plant. A village of 5 subscribers might perhaps be an extreme case. A house plant might be used here, but, since the subscribers would wish to be able to call the local post office at least, a selective calling plant for 6 subscribers, the local post office included, would probably be more suitable. Such a plant would probably be far cheaper than an automatic rural exchange.

There are local line plants that include only the local post office and

one subscriber. If these instruments need not communicate a twin line might be used, otherwise a selective calling line might be better. In both cases the cost would be far less than that of a rural exchange. Line systems at present containing less than 10 instruments connected to 2 or 3 exchanges are specially suited for party line systems.

The diagram, Fig. 3, shows such a case which on automatization would require five rural exchanges, which would be much more expensive than selective calling systems. Further, the decentralized shunting of the lines used for selective calling systems involves considerable savings.

The selective calling system is especially suitable for collecting new subscribers living at remote places. Each of the prospective subscribers shown in the figure cannot be expected to pay the installation cost of lines 10—20 km long, but they would probably not object to pay a fair share of the cost of extending an existing subscriber's line, especially if the low rates stated for party line subscribers are used.

From this example it is evident that the party line systems, and especially the selective calling systems, are well suited for rural exchange systems of the type that will probably be introduced in Hungary.

## Rural Exchanges in Norway

In the beginning of 1931 the Norwegian Board of Telegraphs ordered from Telefonaktiebolaget L. M. Ericsson, through Elektrisk Bureau, two automatic exchanges for Skryta and Algarheim as part of the automatization of certain rural districts north of Oslo.

The exchanges were delivered towards the end of 1931, and by March 1932 they had been completely installed. On March 12 they were put into service, and since then they have operated in a very satisfactory way.

The automatization of rural districts being at present much to the

fore, a brief description of these exchanges may be of interest.

The exchanges are entirely automatic and operate without local supervision. They have been installed by the Norwegian Board of Telegraphs in cubicles of special design, Fig. 1. In the winter the temperature in the cubicles is kept above freezing point by means of small electric heaters.

The traffic between the two automatic exchanges at Skryta and Algarheim is led over 3 two-way junctions, and communication with the rest of the line plant is led over 4

two-way junctions from Algarheim to the nearest, manual LB-exchange in Jessheim, Fig. 2. The distance between the automatic exchanges is about 4 km and that between Algarheim and Jessheim slightly greater. Junction as well as subscribers' circuits are overhead lines of iron wire, partly with unsoldered splices.

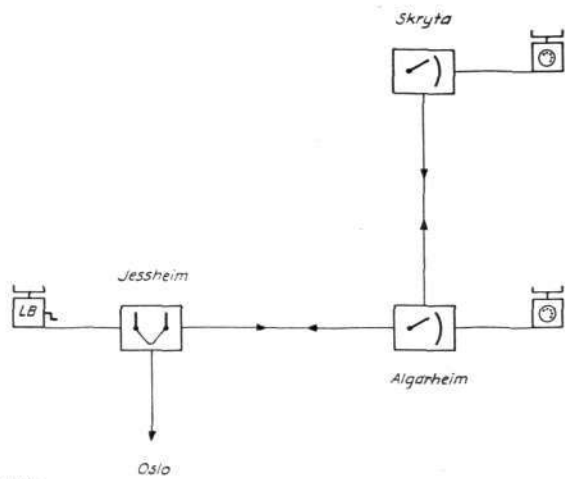
When the exchange was planned the Ericsson exchange, Type OL 1020, was selected as being the most suitable for the plant in question. The lines are taken in over main distribution frames with lightning arresters and fuses. The power supply consists of a storage



x 1196

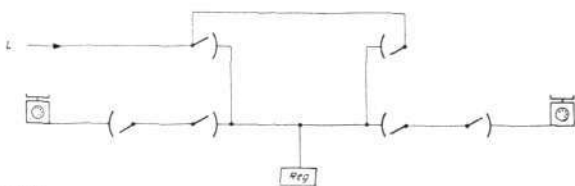
Fig. 1. The automatic exchange, at Algarheim to the left, and Skryta to the right.

x 1197



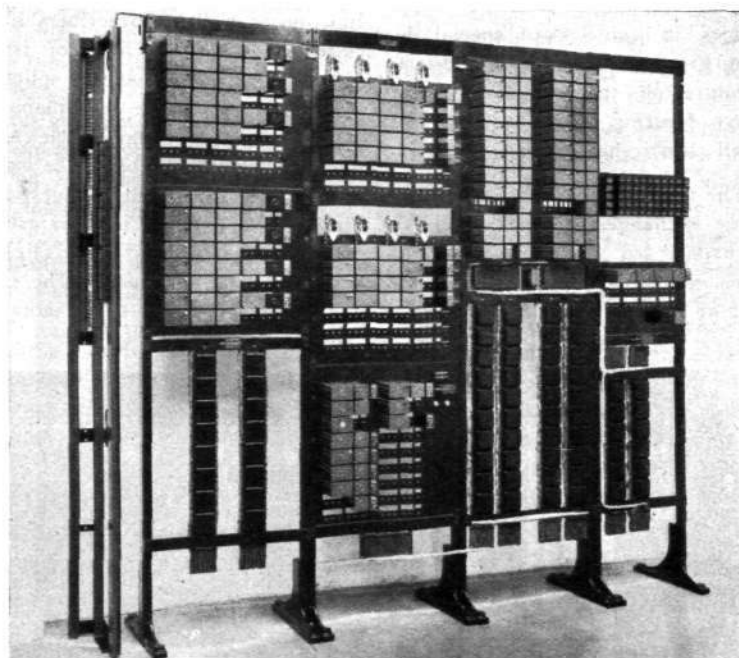
X 1195

Fig. 2.  
Diagram of the connections between the automatic exchanges and the rest of the line system.



X 1198

Fig. 3.  
Diagram of the automatic exchange.  
L junction line



X 5055

Fig. 4. The automatic exchange

From left to right the panels contain junction equipment, cord circuits, registers and alarm equipment, subscriber's line relays and selectors, and finally meters and interurban line equipment.

battery which is automatically charged from the AC mains under control of a special charging plant.

This type of exchange operates by means of registers. All selectors are of the rotating 25-line type. The subscribers' lines are divided into groups of 25. The number of simultaneous calls possible is 7 at Algarheim and 5 at Skryta.

Fig. 3 shows a simplified diagram and Fig. 4 the exterior of the exchange. The four panels of the rack contain junction equipment, cord circuits, registers and alarm apparatus, subscriber's line relays and selectors, and, finally, counters and interurban line equipment.

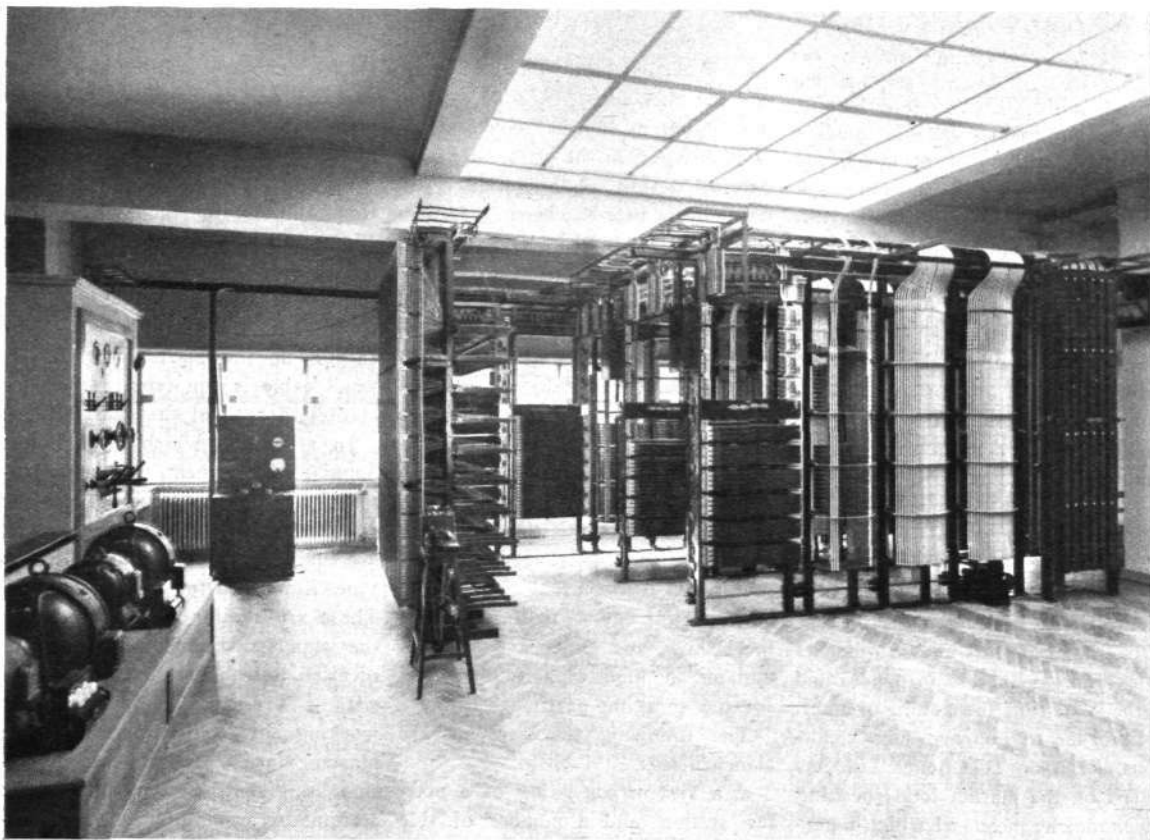
In both exchanges the numbers for the local traffic are composed of 3 digits. For the communication between subscribers and the two exchanges an open direction number is used, *i. e.*, the subscriber, having received a dialling tone from the local exchange, sets up the direction number and is then connected to the other exchange. He has then to wait for a new dialling tone before he can set up the number wanted. Counting is performed when the call is finished.

Interurban traffic from the manual exchange in Jessheim is carried on by means of special interurban call devices, which make possible the cutting of local calls when interurban calls arrive. This traffic is directed over the same junctions as the local traffic.

Since the exchanges operate without supervision they are fitted with alarm apparatus so that faults occurring shall be instantly reported for repair to the station master. As soon as a fault occurs on a subscriber's line or in the exchange this apparatus gives alarm to the manual exchange at Jessheim. An important fault can there be distinguished from faults of minor importance, *e. g.*, a short-circuited subscriber's line.

The fault statistics shows that the exchanges operate in a very reliable way, and that they have fulfilled all expectations.

# The Automatic Telephone Exchange in Arendal



X 7031

Interior view of the Arendal telephone exchange.

From left to right: charging equipment and distribution panel, the test desk, main distribution frames, and register, selector and line-relay bays.

The automatic exchange on the Ericsson system built by A/S Elektrisk Bureau, Oslo, for Arendals Telefonselskap was put in service during the night of September 10. The switching-over was carefully prepared and passed without any disturbances.

Arendals Telefonselskap was established in 1882 and is thus one of the oldest telephone companies in Norway. From the beginning it has had relations with Elektrisk Bureau, and the oldest parts of

the manual exchange that has now been replaced by automatic equipment were delivered by Ericsson as long ago as 1899.

The automatic exchange is installed in a large hall with sky light in the new building of the company: it is equipped at present for 1 500 lines and has a total capacity of 6 000 lines.

The illustration shows a view of the interior of the hall with the attractive and well-arranged exchange.

Arendals Telefonselskap has always recognised the necessity of keeping pace with technical progress, and during recent years it has under the direction of the manager, Mr. Alb. Petersen replaced its overhead line system by cables. The automatic exchange, the practical arrangement of the new building and the provision of new bakelite telephones make the Arendal telephone exchange one of the most modern and best equipped in Norway.

# Loud Speaking Intercom. Telephones

*After exhaustive experimental work, Ericsson Telephones Ltd. has designed a series of instruments for loud speaking intercom. installations.*

*The following article, reprinted by courtesy of the publication of this society, the Ericsson Bulletin, gives a description of this new group of material.*

Present day progress demands that persons holding important executive positions should not be required to waste valuable time doing needless operations, and at all times they should have full access to records, files or important papers. The inter-departmental type of telephone has done much to improve the administration of a business and has proved itself an indispensable item in an up-to-date office. Unfortunately, however, the use of the ordinary telephone limits the movements of the user. It necessitates the use of one hand at least and so prevents quick and easy access to papers and at the same time the making of notes.

In order to improve such conditions, Ericsson Telephones Ltd. has placed on the market loud speaking telephones by means of which a person is not required to engage either hand while telephoning, incoming speech being received on a loud speaker and outgoing speech picked up by means of a sensitive microphone. This means that after the single operation of a key it is possible

to move about in any average sized office and carry on a complete conversation with any desired extension. The essential qualities of such a scheme are, that the received speech shall be both loud and clear, and the microphone shall be capable of picking up normal conversation from any part of the office. By very careful design of the circuits and components this has been made possible to a degree which is considered superior to any similar system on the market. In a quiet office the cone type speaker, which is noted for its clearness, can be heard 30 to 40 feet away, and the microphone will pick up at this distance without difficulty.

From the point of view of initial cost and future maintenance it is not desirable to use any type of valve amplifier, and the Ericsson system requires only the usual type of dry batteries for the signalling part of the system, and either a 6 V accumulator or high capacity dry cells for the speaking part.

The following three systems are standardised:

a. a system consisting of a master station and a number of side stations with communication only between master and side stations.

b. a system consisting of a master station and a number of side stations with full intercommunication facilities between the side stations.

c. a system consisting of two or

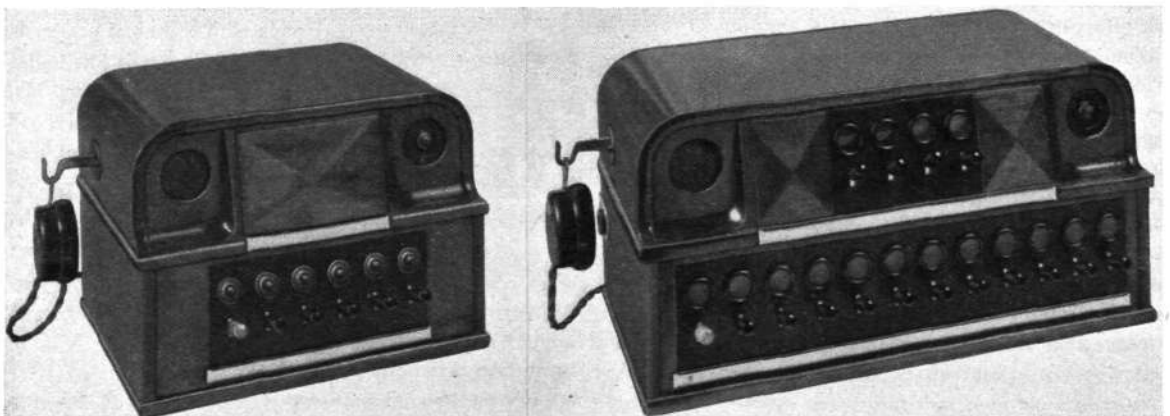
more master stations and a number of side stations with full intercommunication facilities between the side stations.

It should be noted that master station denotes a station with a loud speaker and microphone, and side station one with a standard bakelite micro-telephone.

System *a* consists of a master station similar to those shown in Fig. 1 and may be equipped with 11 or 16 lines. A side station, Fig. 2, consists of a bakelite table telephone fitted with a neat push button for calling up the master station. A small cable is run from the master station to each of the side stations.

In system *b*, which is the most popular arrangement, the master station is the same as for *a* but the side stations, which are shown in Fig. 3, are equipped with instruments of the types illustrated for 5, 10 or 15 lines. These are similar in appearance to the standard Ericsson intercommunication telephones but are fitted with a press button and lamp for working in conjunction with the master station. Direct communication is given between all the side stations by means of the local intercom buttons. The operation of a master station button gives direct communication with that master station, and other side stations cannot overhear.

In system *c* the same remarks apply as for system *b* but each side



X 7030

Fig. 1. Master stations for loud speaking telephone systems.



X 3108 Fig. 2. Side station for connection to one master station.

station must have a button and lamp fitted for each master station. Fig. 4 shows an instrument having 15 local buttons and two master-station buttons.

An extra condition which must be catered for is that of communication between the two master stations. There are many ways of doing this, but the particular requirements of each installation have to be carefully considered as it is not possible to give good loud speaker reception at one station when speaking at a distance from the microphone at the other station.

The following facilities are therefore provided:

1. one master station is equipped with a hand-micro which can be used when speaking to the other master station.
2. all master stations are fitted with handmics, arrangements being made that in all cases the station originating the call shall use the hand micro.
3. arrange that when »master» communicates with »master» each shall use the small watch receiver attached to the master station key-box.

The master station consists of a polished mahogany case-work, as shown in Fig. 1, the front of which is equipped with the necessary number of keys and lamps.

When a side station calls up, the lamp associated with it lights and indicates the number of the station calling. The lever key mounted immediately below this lamp is then operated and the speaking circuit is completed. An audible call is also given by a low pitched buzzer in order to attract attention.

The sensitive microphone is mounted in the top left hand corner



X 3109 Fig. 3. Side station for connection to one master station, 5 intercom. lines.



X 3110 Fig. 4. Side station for connection to two master stations, 15 intercom. lines.

and a warning lamp in the right hand corner. To guard against the leaving of a key in the operated position after the completion of a conversation, the warning lamp remains lit during the time that any key is in the operated position. A side station is called by depressing the appropriate key to its full extent or ringing position. On release the key takes up a middle or speaking position. If necessary, repeat rings can be given by further pressure on the key. When required, the loud speaker can be cut off by using the watch receiver provided.

For those who desire a really neat and inconspicuous arrangement, a three unit master station has been designed with the microphone and warning lamp fitted into a neat and pleasing inkstand, which is finished in oxidized silver and is both useful and ornamental. The key box may then be fitted in any convenient position within reach.

In all cases the loud speaker, Fig. 5, may be placed in any position in the room, the volume being such that it will be audible from all positions.

The intercommunication part of the side station instruments follows the standard

practice. When a call is received from the master station, the buzzer is operated in the usual way and a lamp is also lit in order to indicate that it is the master station calling. The removal of the hand-micro and pressing the master station button establishes the connection. Similarly, to call the master station the hand-micro is removed and the master station button depressed to its fullest extent. Should a side station be engaged when called by the master station the lamp at the side station will light and attract the attention of the user.

Conference facilities may be obtained by the master station throwing the appropriate keys. The stations thus selected can then speak and also hear what the other stations are saying.



Fig. 5. Loud speaker for master station.

X 1180

# Mining Telephones, Switchboards and Apparatus

*Pioneers in the field of telephone and signalling apparatus designed for use in the coal mining industry, Ericsson Telephones Ltd. have been well to the fore in the considerable advances of the past twenty years in this field. They have produced a complete range of equipment which is safe, fulfils its function with efficiency and convenience, is robust, and proof against malicious tampering. This equipment is described in the article below reprinted by courtesy of the Ericsson Bulletin.*

As an instance of attention to safety, it is interesting to note that the original DC mining bell with a short-circuited winding above and below each active winding as safety device, introduced over 20 years ago and certified in 1920, was almost as safe as the most modern bells.

Early in 1924 certification was obtained for an improved design of bell, and immediately afterwards a new certified relay was introduced which replaced the previous relay.

Ericsson telephone instruments were the first to obtain a certificate for magneto working and again for use on the battery call system, also at the present time their switchboards are the only ones for which a certificate has been issued.

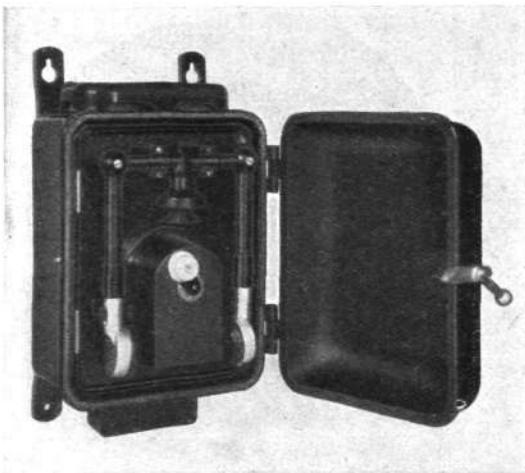
Telephones installations in mines have to conform to the appropriate sections of the Coal Mines Regulations. Until a few years ago the mining industry had to rely almost entirely on the manufacturer to ensure that signalling apparatus was safe. It will be readily understood that even where a manufacturer had the requisite equipment and personnel for safety tests such as were provided in the Ericsson laboratories, there was no generally recognised standard of safety. In 1919 the Mines Department commenced the test and certification of DC bells and relays for bare wire working, and in 1926 opened the Sheffield Testing Station for investigation of signalling problems and the test of commercial apparatus. Thus they have been enabled to formulate testing methods and indicate desirable features in apparatus. Ericsson Telephones Ltd. realised at the outset the value of this work and as testing

facilities became available they applied for test and certification of their apparatus, so that they now have a full range of equipment certified safe for use in fiery mines.

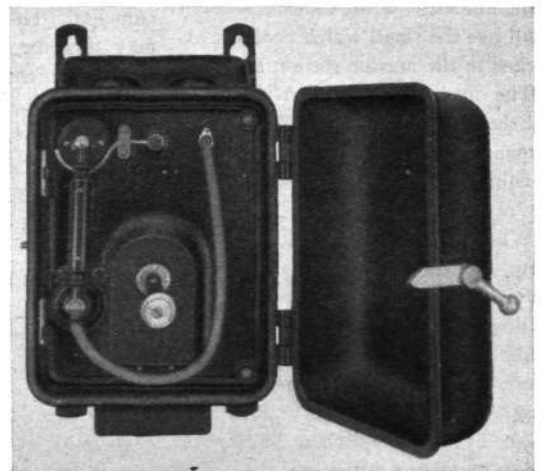
Apparatus may be divided into two groups, flameproof and intrinsically safe.

Flameproof apparatus depends upon its design and construction to ensure that if ignition of a mixture inside the case occurs, the resulting flame is so cooled on its passage to the exterior that it cannot produce any ignition of the surrounding methane atmosphere, however explosive the latter may be. The usual methods are, to provide wide machined flanges for cooling, to limit the unoccupied internal space and to pay special attention to strength of materials and construction. All apparatus associated must be flameproof and the lines fully insulated and well maintained, as a line fault immediately introduces the element of risk.

The alternative method is to design the electrical circuit so that if an electric spark occurs, inside or outside the apparatus, whether in normal working or as a result of any fault in the wiring system, such a



X 1182 Fig. 1. Mining telephone instrument, Type N2982, with swing-out microtelephone.



X 1183 Fig. 2. Mining telephone instrument, Type N2972, with hand microtelephone.



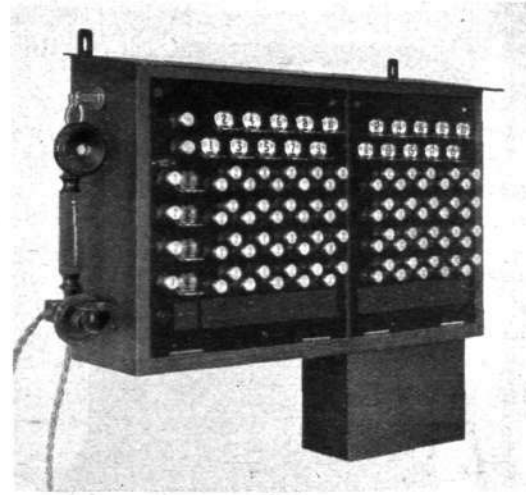
X 3121 Fig. 3. Mining switchboard, Type N 510, for 4 lines.

spark shall be incapable of igniting the most sensitive methane mixture. This »intrinsic safety» is doubtless the most satisfactory, as purely flameproof apparatus has always to contend with the ultimate possibility of a dangerous fault in the wiring. Good maintenance may make this improbable, it can never make it impossible.

Magneto telephones have a considerable application in mines and during the past fifteen years the original Ericsson design has received those additions and modifications which experience and research have shown to be of service. The present instruments, certified for parallel working, are available in two types. Type N2982, shown with door open for use, has a stout cast case with inner door on which are mounted the speaking equipment and generator. The ringer gongs are protected from damage by a cowling, and access to the interior is by special key. The inner door is waterproof including the generator crank gland. A protected water-proof transmitter inset is used. The outer door fastens with a slam catch and the rounded corners of the set are another feature of design. The case may be obtained cast in iron or aluminium. When the speaking unit is swung out for use the battery circuit for the transmitter is automatically switched on.

The other, Type N2972, is of similar design but is fitted with a hand microtelephone instead of the swing-out unit. Both instru-

Fig. 4. Mining switchboard, Type N550, for 20 lines.



X 1184

ments have the same electrical characteristics and are intrinsically safe for any number in parallel, and when used with Ericsson mining switchboards, Type N510, N515 and N550. These switchboards, certified for use with the telephones mentioned, are of very robust construction and simple to operate. Types N510 and N515 are pyramid boards for up to 5 circuits, while the connecting keys in the case of the board, Type N550, are arranged in horizontal rows and a hand micro-telephone and calling generator are provided for the operator. These keys are of plunger type with engraved metal tops. The smaller pyramid boards have no integral speaking and calling equipment, it being usual to fix the board adjacent to a telephone at which attendance is regular, thus there is no need to have duplicate equipment. Drop shutter indicators are used on these switchboards unless indicators with individual dust covers are desired, when a flap indicator is provided, which has a restoring button mounted under the indicator disc to release the mechanical holding device on the shutter. This latter indicator in a wood case and provided with contacts is available as an indicator-relay for providing a visual signal as additional to the telephone ringer.

Where a telephone, situated above ground, at the bank, in the winding house, in the offices, etc., is con-

nected, or may be connected by switchboard, to an underground circuit it is essential that it should be safe also. It is important that this point be appreciated. The same equipment can, of course, be used, but where a wood cased instrument is preferred, an instrument certified for surface use under cover is available, Type N2504, which has the same electrical circuit and equipment as the magneto telephones just described.

Battery operated bells, relays and telephones form another important section of communications in mines.

The Ericsson battery call mining telephone, Type N1150, is certified as intrinsically safe. The simple and robust cast case is waterproof and carries the waterproof inset transmitter inside the front, protected by a metal grid. A loud-speaking type of receiver is housed inside also; a flexible metallic tube with earpiece serves as listening tube and a thumb operated switch of substantial proportions controls the ringing and speaking. An external certified bell is used for calling and where a bare wire system is used the signalling battery must, of course, be of a certified type and common to all the telephones on the system.

By the addition of a condenser in the speaking circuit, any number of these instruments can be connected in parallel on a three-wire signalling circuit with a common battery. The



X 1185 Fig. 5. Telephone instrument, Type N2504, for surface use.



X 1186 Fig. 6. Waterproof mining telephone instrument, Type N1150, for battery call, with loudspeaking receiver.

condenser with strap is not normally fitted but can be readily added by a maintenance man, the drillings for the strap being provided.

The Ericsson DC bell, Type N3030, used for haulage roads, with telephones, or wherever a certified bell is required, is supplied in two resistances—20 ohm and 30 ohm. The 20 ohm bell finds favour for local working with say up to 12 V, while the 30 ohm bell is more used for the longer circuits with up to 25 V. Either is, of course, approved for use with any number in parallel up to the full 25 V permissible by regulations.

Where long distances have to be encountered or local battery working is preferable or more economical,

relays are used, closing the contact of a local bell circuit.

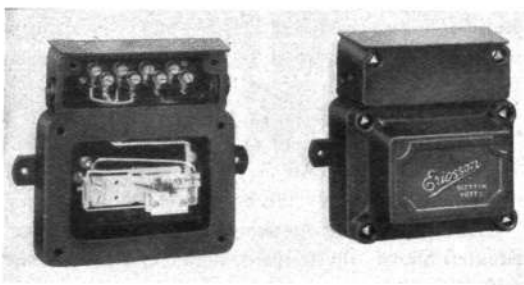
A new magneto-telephone relay, Type N7236, has been developed and is now available, which will operate in connection with Ericsson mining magneto telephones and switchboards, and provides one, two or three make contacts as desired. This relay, of unusual but highly efficient design, is housed in a stout cast case with both the relay and the terminal cover secured by tamper-proof screws.

The Ericsson DC relay, Type N7237A, certified in 1924, replaced the original certified relay, then discontinued. This relay, 100 ohm with an anti-spark winding of 500 ohm, and giving one make contact, is housed in a cast case with flanged

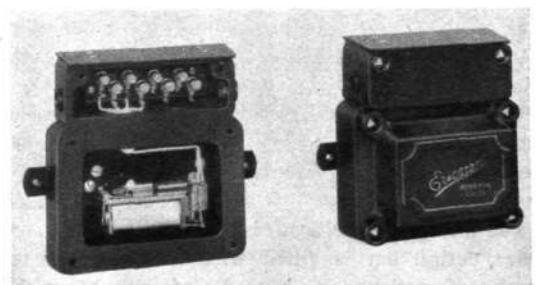
cover of the same general design as the bell.

In addition a new type of DC relay is now introduced, Type N7240, available with one, two or three make contacts as required, in a case of the same construction as the new magneto-telephone relay. This multicontact relay represents all that is most modern and desirable in a relay of this nature, incorporating as it does those features which have been proved in arduous service in telephone equipment all over the country, retaining for each purpose only the best in materials and design.

All DC bells, relays, etc., when used for parallel working on a bare wire system must use a common



X 1187 Fig. 7. Magneto-telephone relay, Type N7236.



X 1188 Fig. 8. DC relay, Type N7240.

battery of certified type as a source of energy. The Mines Department have made this ruling because, whatever the apparatus in circuit, it is highly desirable to limit the energy available to a safe maximum. In the case of a battery this can be effected by selecting a type which has an inherent internal resistance which is maintained at a suitable value under load, such as the 3-pint Leclanché cell. It will be seen that accumulator batteries are unsuitable by reason of their low internal resistance.

In connection with signalling sys-

tems a safety push and pull are available, both being certified by the Mines Department.

The certified push contains morse key contacts operated by a special drop handle, making accidental operation impossible. The stout cast case has a separate terminal chamber.

The certified pull, for such use as on haulage roads where wet or other conditions interfere with the satisfactory working of bare wire signalling, provides contacts in a cast

case with separate terminal chamber, the contacts being operated by pulling on stranded wire attached to the eye of the pull and carried on pulleys along the road to an anchorage at the end of the run.

No mention of coal mines equipment would be complete without reference to rescue work, and we are pleased to announce that, in co-operation with the leading manufacturer of rescue apparatus, we have designed and are commencing production of portable signalling equipment for this purpose.

## Alarm Receiver for Emergency Signals at Sea

The wireless service on board ships, especially the listening, has always been something of a problem. People who are used to active work find it wearisome to perform a service that consists merely of listening and waiting for something to happen. On the other hand it is evident that, without an effective wireless service on the greatest possible number of ships, the value of wireless for safety at sea will be little more than an illusion.

The provision of automatic receivers for distress signals seem therefore to be the only effective means of achieving this end. If reliable alarm receivers are in general use, it may be said that an ideal solution will have been reached and the value of wireless for ensuring safety at sea will have been increased a thousandfold.

Now that the provisions of the safety convention relating to listening service or automatic alarm apparatus have become law in most maritime countries, shipowners are faced with the problem of selecting the type of apparatus best suited for the purpose.

In the first place the apparatus must be absolutely reliable. It should not be liable to give false alarm, and its operation and upkeep should not entail unnecessary work or expense. Last but not least: the cost

of the apparatus itself must be reasonable.

In designing the auto-alarm apparatus these requisites have been kept constantly in view by A/S Elektrisk Bureau, and in this work they have had the cooperation of the Director of the Oslo Radio, Mr. Stavøstrand, who has been connected with automatic wireless appliances ever since their introduction.

The test requirements of the Norwegian Board of Telegraphs are in some respects more stringent than those of the English Board of Trade. The Elektrisk Bureau apparatus has passed the complete laboratory tests of the Board of Telegraphs without a single fault and without one single adjustment or regulation being necessary during 5 weeks' of test. Some of the more difficult tests allow a tolerance of 5 % but in these as in all others the efficiency of the apparatus has never fallen below 100 %.

In the laboratories of A/S Elektrisk Bureau and the Board of Telegraphs the apparatus has been subjected to more than 1 000 tests. For these tests an alarm signal was in each case transmitted with the minimum intensity of sound — *i.e.*, the intensity of a signal coming from an emergency transmitter operating at a distance of 100 sea miles. During about half the tests strong disturbances from two or

three other transmitters were made, for some of the tests the apparatus was heated to 45° C (every day during a fortnight), and in the course of others the apparatus was waggled and shaken. The apparatus did not fail once, but proved itself to possess complete reliability under all conditions.

The apparatus is of very sturdy construction so that no failure may be expected if it is treated with ordinary care. It is provided with a metal case designed for fixing to the wall of the wireless cabin.

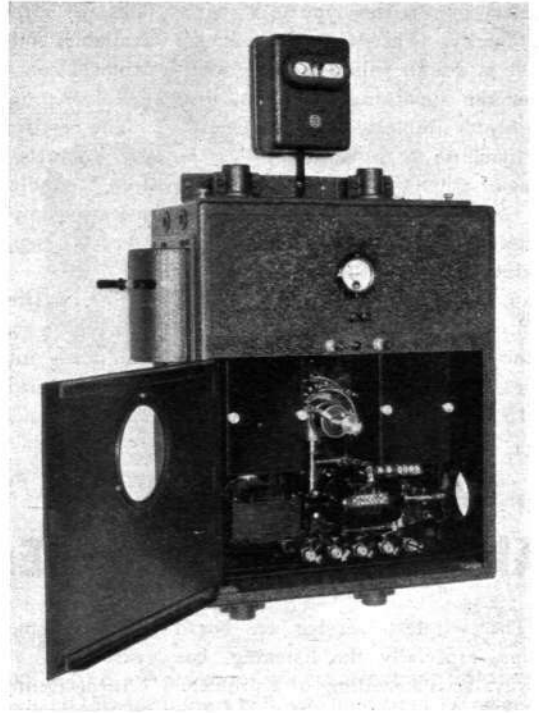
The apparatus is very simple to install and it can easily be fitted by the ship's wireless operator. The test oscillator of the apparatus is built as a wave meter for tuning to 600 m wavelength.

For steamers where the electric lighting generator is not generally in use during the day, a battery type is supplied, fitted with accumulator. In the case of ships where the lighting generator is always running a type for connection to the electric mains, without accumulator, is recommended.

The apparatus has a wireless receiver, consisting of a detector and two low frequency stages the second of which functions as a rectifier as well. Indirectly heated DC valves are used; these valves are of a sturdier construction and will give



X 1191



X 1190

**The alarm receiver.**

In the case, below the receiver, the motordriven auto-alarm device is seen, which connects the alarm bell after a series of three international emergency signals.

a longer life than ordinary valves. For testing the auto-alarm, a modulated valve oscillator is provided, giving the minimum input prescribed for the receiver with a wavelength of exactly 600 m. When the apparatus is being installed the final adjustment to the aerial of the ship can be made by means of this test oscillator.

The auto-alarm device proper con-

sists of a motor-driven selector which operates a set of contacts and relays so that the alarm bell starts ringing immediately three groups of international emergency signals are received. The motor runs in self-lubricating ballbearings and has a special regulating device of patented design, that will keep the number of revolutions constant even if the voltage varies as much

as 30 %. In other respects the principles and construction of the apparatus are similar to those in use in thousands of automatic telephone exchanges the world over.

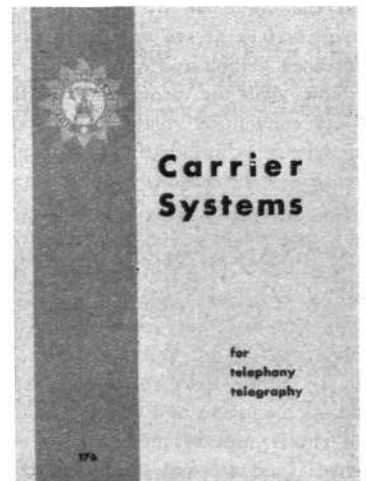
A/S Elektrisk Bureau have brought their great experience of automatic telephone construction to the work of designing an apparatus which shall fulfil all the technical demands that may be made on it.

# New Catalogue

catalogue of material for this system was being prepared. This catalogue has now been published, in English only, and entitled »Carrier Systems for Telephony and Telegraphy».

An article was published in the Ericsson Review Nr. 2, 1933, on the carrier telephone systems of Ericsson's design, and, in connection with this article, it was stated that a new

The above-mentioned article contained a complete description of this section of the Ericsson production and we therefore refer our readers to it.



# News from the Research and Development Department

## New Types of Measuring Instruments.



X 3120 Fig. 1. Capacity meter Type ZA 160.

Since the publication in the beginning of this year of Catalogue U 43 »Measuring Instruments for Line Measurements and Laboratory Use», some new measuring instruments have been developed by the Research and Development Department.

### Capacity Meter, Type ZA 160.

This capacity meter, Fig. 1, is designed as control and supervision instrument for cables and overhead lines, as well as for capacity measurements for the balancing of cables. By means of this instrument side circuit capacities between 0 and 0,111  $\mu\text{F}$  can be measured in steps of 100  $\mu\mu\text{F}$  and with an accuracy of about 3%. As is shown by the simplified diagram, Fig. 2, it consists of a Wheatstone bridge with

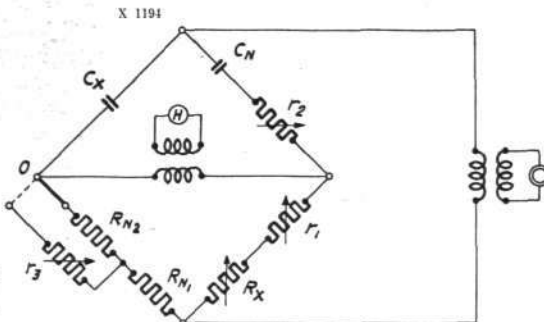


Fig. 2. Diagram of the capacity meter.

the necessary compensating devices for the loss resistance and the capacity of the connecting cables. Beside the usual switches for side and phantom circuits it is fitted with a switch for different ratios between side and phantom circuit capacities, which eliminates the great re-adjustment of the dials during measurements on one quad.

The input terminals are placed so that the instrument can be connected directly to the unbalance meter with auxiliary intermediate commutator as described below.

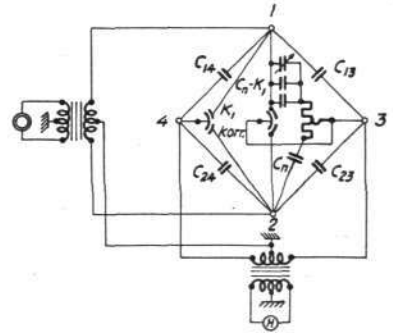
### Capacity Unbalance Meter, Type ZA 165, and Intermediate Commutator, Type ZA 170.

The capacity unbalance meter, Type ZA 165, Fig. 3, is a bridge for the direct measurement of the values of capacity unbalance, which determine cross-talk and noise level in long distance cables. All necessary switchings for measuring the six values of unbalance in a quad are made by a main switch with six positions, built into the instrument, and by means of a simple auxiliary device, the intermediate commutator, Type ZA 170, it is possible to measure the nine values of unbalance between two different quads.

The measuring range is 2 000—0—2 000  $\mu\mu\text{F}$  which is quite sufficient for modern types of cables. For the balancing of older types of cables, where greater values of unbalance are to be found, instruments



X 3112 Fig. 3. Capacity unbalance meter, Type ZA 165.



X 3116 Fig. 4. Diagram of the capacity unbalance meter.

of special design can be supplied on request.

The accuracy is, for unbalance values

- < 100  $\mu\mu\text{F}$  :< 2  $\mu\mu\text{F}$
- < 1 000  $\mu\mu\text{F}$  :< 4  $\mu\mu\text{F}$
- < 2 000  $\mu\mu\text{F}$  :< 6  $\mu\mu\text{F}$

A diagram is shown in Fig. 4. The unbalance to be measured is compensated in the bridge by means of a fixed condenser in parallel with one of the arms of the bridge and a variable condenser in parallel with the other. The instruments can therefore be of sturdier construction than would be the case if differen-

tial condensers were used, a great advantage for instruments for field use.

A characteristic property of the instrument is the use of balanced transformers between the oscillator on one side and the bridge and the receiver on the other. By means of these transformers the influence of secondary unbalances is eliminated, which cannot be done with the usual methods of splicing. When measuring the unbalances that determine the noise level and external fields, these condensers permit the elimination of those capacity unbalances that ought not to be included in the result obtained, *e. g.*, the unbalances to other quads in the same layer.

### Splicing Commutator, Type ZA 175.

This auxiliary instrument permits the rapid and convenient taking of the measurements corresponding to the eight different manners of splicing two quads. It comprises contact clips for the connection of the two quads and one switch with eight positions, and there is clear marking to give the manner of splicing in the different cases.

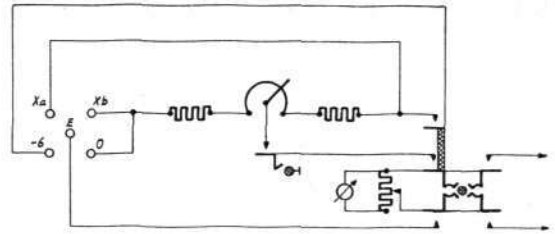
### Resistance Balance Meter, Type ZA 152.

Beside the summation, difference and ratio measurements of resistance



X 3113 Fig. 6. Insulation tester, Type ZB 300.

Fig. 5. Diagram of the resistance balance meter, Type ZA 152.



and capacity and the absolute and relative measurements of capacity, the resistance and capacity meter, described in Catalogue U 43, makes possible the measurement of the unbalance between the two branches of a telephone circuit. This type of connection has proved to be of such a great importance for control at cable installations as well as for the supervision of cable and overhead circuits that a special measuring instrument connected in this manner has been designed under the name of resistance balance meter. The diagram is shown in Fig. 5. The galvanometer built into the instrument can be used separately, *e. g.*, as an indicator for the resistance and capacity meter, Type ZA 150, or for other instruments which are not fitted with galvanometers.

The resistance balance can be read directly with an accuracy of 0,01 % in the range 0,5 %—0—0,5 %.

### Insulation Tester, Type ZB 300.

This instrument, Fig. 6, is designed for the measurement of the insulation resistance of cables up to 200 megohm. It comprises a galvanometer, a dry cell battery and a calibrating device which is connected by means of a switching key.

### Cross-talk Meter, Type ZB 256, (graduated in cross-talk units), and Type ZB 257, (graduated in nepers), with Auxiliary Apparatus.

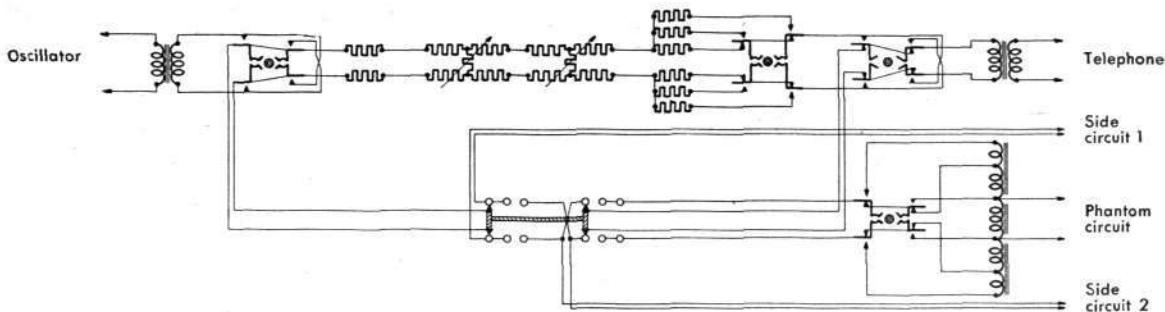
The basic principles of these cross-talk meters are in the main the same as those of the cross-talk meter, Type ZB 250, *i. e.*, a comparison between the intensity of the sound heard on the disturbed circuit and that heard through a variable attenu-

ation network fed from the same voice frequency oscillator; but the range of measurement is extended, from 11 neper for the old type, to 16 neper for Type ZB 257 and 1 cross-talk unit for Type ZB 256, Fig. 7. This has been possible owing to the design and the careful balancing by means of screens of the various parts. The internal cross-talk has thereby been reduced to a very small value compared to the measuring range.

As is shown in the diagram, Fig. 8, the connection of the oscillator and indicator is made through screened transformers with necessary switching keys, built into the instrument, and the three circuits of the quad are connected through a built-in switch with three positions, corresponding to the cross-talk measurements: side circuit 1 — side circuit 2, side circuit 1 — phantom circuit and side circuit 2 — phantom circuit. In order to make possible the measurement of the cross-talk between side circuit and phantom circuit as



X 3111 Fig. 7. Cross-talk meter, Type ZB 256.



X 9007

Fig. 8. Diagram of the cross-talk meter.

defined by the CCIF there is a special arrangement for transforming the characteristic impedance of the phantom circuit to the same value as that of the side circuit, if the ratio of these impedances is 1,6 or 2,0, which are the most common values.

The attenuation network of Type ZB 257 is adjustable between 5 and 16 neper in steps of 0,1 neper and that of Type ZB 256 between 110 and 1 cross-talk units in steps of 1 cross-talk unit.

The cross-talk meters can be used without auxiliary apparatus only when phantoming or termination of the quad is not necessary. In other cases one or more of the auxiliary instruments described below is required.

Two phantoming sets, Type ZB 266, are required for the measurement of near and far-end cross-talk in a quad. The phantoming is performed by means of balanced choke-coils, built into these sets, with an impedance balance better than 1:1000000. In both side circuits the capacity unbalance to earth is reduced to less than 1  $\mu\mu\text{F}$ . To the circuits that are to be terminated separate resistance units are connected; one set of such units with the characteristic impedance required is supplied with the set.

If both the near and far end of a quad are available, *e. g.*, at routine tests on loading coil cases etc., the measurements can be performed in a more rapid and convenient manner by means of an *auxiliary set for cross-talk meter*, Type ZB 270, which is chiefly composed of the same parts as two phantoming sets and two switches, and makes possible the mea-

surement of near and far-end cross-talk without any alteration of the external connections.

The measurement of near and far-end cross-talk *between* different quads is performed in the simplest way by means of two *inter-quad sets*, Type ZB 261. These instruments consist of choke-coils for the phantoming of the two quads, switches for feeding and listening on the different circuits, the arrangements for transforming the characteristic impedance of the phantom being of the same kind as in the cross-talk meter itself.

For measuring the far-end cross-talk the oscillator should be connected through a screened and balanced transformer; a suitable type is ZF 635.

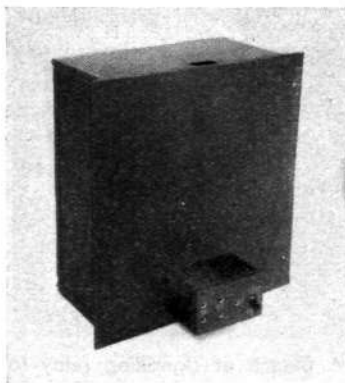
### Mains-connected Amplifier, Type ZF 555.

In the catalogue there is only one type of amplifier for laboratory use, Type ZF 550, which is fed from dry cell batteries built into the ins-

trument. Where AC is available this type can be replaced by a new type of amplifier for mains connection, Type ZF 555, Fig. 9.

This amplifier is designed for the same use as the old type, ZF 550, *i. e.*, all kinds of laboratory measurements, where an amplifier for a zero indicator is required. It comprises two valves with indirect heating, Marconi-Osram, Type MH 4, in a resistance-capacity connection, and as a standard it is made for connection to mains of 110 or 220 V and 50 cycles. Special designs for other voltages can be supplied on request. The amplification is continuously adjustable between 0 and 6 to 7 neper. The input and output impedances are 500 ohm. Owing to their design and the use of earth-connected screens in the input and output transformers risk of touching parts that are under dangerous tension is avoided.

The amplifier is designed so that it can be mounted on the under side of a laboratory table; the terminal block with the switch will then be accessible through a hole in the table.



X 3114 Fig. 9. Amplifier, Type ZF 555, for mains supply.

### Standard Attenuation Set, Type ZF 455—ZF 461.

These types are varieties of the standard attenuation set, Type ZF 450, described in the catalogue, and like the latter they can be used for DC as well as AC. Up to 50 000 cycles the error due to the frequency is very small.

The standard attenuation set, Type ZF 455, differs from Type ZF 450 in that the midpoints of the different attenuation networks are

connected to one terminal. It has a total attenuation of 12,1 neper, variable in steps of 0,01 neper, and an input impedance of 800 ohm.

Type ZF 456 is a corresponding instrument with an input impedance of 600 ohm.

These two instruments are terminated on the output side in similar way to Type ZF 450, and may thus be loaded only with a very high impedance, *e. g.*, a valve voltmeter. In certain cases, however, it may be desirable to use an attenuation set that is not terminated. This is the case with Types ZF 460 and ZF 461, the former of which has a characteristic impedance of 800 ohm and the latter one of 600 ohms. These attenuation sets are exclusively composed of H-connected attenuation networks. The total attenuation is 12 neper, variable in steps of 0,25 neper.

On request all the standard attenuation sets can be supplied with graduation in decibels instead of in neper.

Like Type ZF 450 all these types are symmetrical and carefully balanced and screened and they have the same high accuracy.

### Attenuation Box, Type ZF 401 and ZF 421.

A variety of the small attenuation box, Type ZF 400, with a lower accuracy described in the catalogue, has now been designed, graduated in decibels instead of in neper. The total attenuation is 63 db, variable in steps of 1 db. The characteristic impedance is 600 ohms for Type ZF 401 and 800 ohm for Type ZF 421.

### Voice Frequency Generator, Type ZD 110.

This generator has already been described in the Ericsson Review Nr. 2, 1933. It is a mains connected beat generator for 0—10 000 cycles with an output of about 200 mW at 2 % of harmonics. The adjustment of the frequency is performed by one dial without necessity for the alteration of any connections.

## Signalling Device for Small Exchanges.

For small exchanges operating without permanent supervision, an impulse generator is unsuitable on account of its high cost and the large amount of space it requires. Several methods of replacing the impulse generator have been suggested. The latest method of solving the difficulty is that provided by the new relay, designed in the Research and Development Department.

When the calling subscriber lifts his receiver and sets up the wanted number by means of the dial, the relay is energized and attracts, at the same time short-circuiting itself over the contact 1. The armature 2 under pressure from the spiral spring 3 then returns to left position so that the contact 1 is broken and the relay is attracted anew, and so on. In this way the relay is self interrupting. The spring 3 is placed around the shaft of the armature. The armature was formerly supported by holes in the bridge of the relay but this caused difficulty in manufacture, which has now been eliminated by placing the shaft 4 in an open slot 5 in the bridge 6 of the relay. The shaft 4 is fixed to the armature 2 by means of the spiral spring 3, both ends of which are fastened to the under side of the relay bridge 6. At the top of the armature 2 there is a ratchet 7 which, when the armature vibrates, drives a ratchet wheel 8 the shaft of which is fitted with a sector. As long as

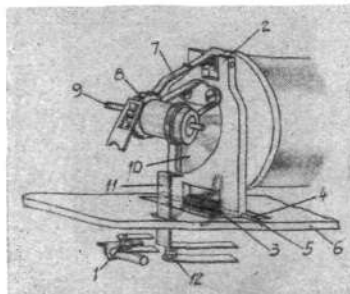
the subscriber keeps his receiver lifted and the call has not been answered, the sector 9 will rotate slowly, periodically pressing the contact spring 11, which is extended upwards through the bottom plate; each time the contact 12 is closed a signal is sent out.

## Mutiple Indicator.

By placing plugs of different colours in the jacks corresponding to the subscribers' numbers in manual telephone exchanges, *i. e.*, the multiple field, it has been possible in a simple way to keep operators posted with the changes in relation to subscribers' numbers, *e. g.*, »subscriber disconnected», »number changed», »no long-distance calls allowed», etc. The different colours of the indicating plugs, black, red, green, etc., in those cases have indicated the different categories.

For the smooth handling of traffic it is of great importance that this information should be available, and in automatic exchanges, where there is no operator, special arrangements are necessary for this purpose. Calls to any numbers subject to special conditions are generally put through to an information office, whose duty it is to give this information.

In this information office it is of importance for the staff to have registers that are easy to read. For this purpose the multiple indicator shown in the figure has been designed, the principle being the same as in manual exchanges. A metal sheet of the same appearance as an ordinary multiple field, *i. e.*, numbered in hundreds and tens, has a square for each number with a hole in the centre. For the numbers that are to be distinguished in one way or an other, pins with heads of different colours are inserted in the corresponding squares. A black pin may thus indicate: »subscriber disconnected», a red pin: »number changed» etc. The boards shown in the figure are 210×210 mm, and each side has space for 2 500 numbers. By using both sides of the



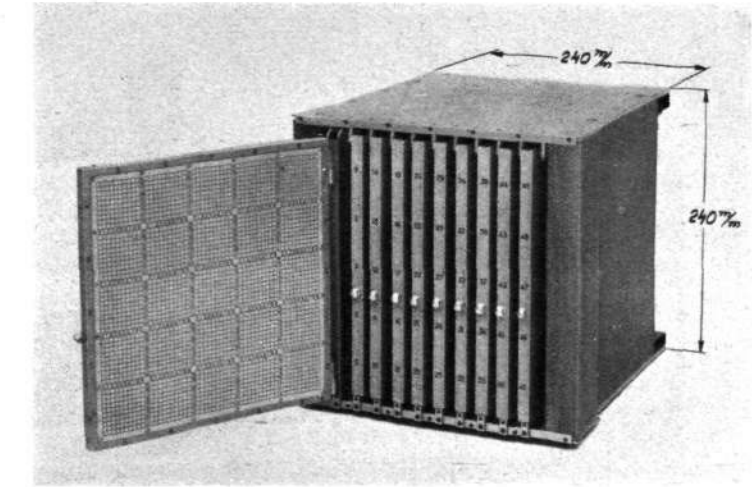
X 3115 Sketch of signalling relay for small exchanges.

The bearing stand for the shaft 9 has been left out in order not to screen the other parts.

boards the capacity is 5 000 numbers for each board, so that with ten double-sided boards a capacity of 50 000 numbers is obtained. The boards may be arranged in various ways, mobile or fixed, according to requirements. The type shown in the figure is intended for mounting in the multiple field of a switch-board.

For the indication of changed numbers the multiple indicator is supplemented by a card register on the multiple field principle. If a number in the multiple indicator is marked with the colour denoting change of number, the new number is to be found in the old one's place in the auxiliary register.

In addition to its employment in telephone exchanges, this multiple indicator can be used in other fields,



X 5054

Multiple indicator for 50,000 numbers, intended for mounting in the multiple field of a switchboard.

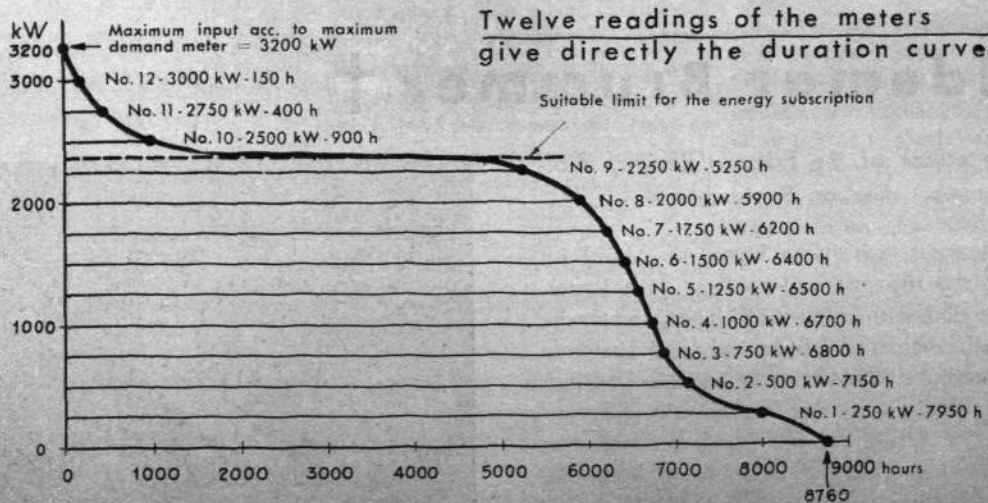
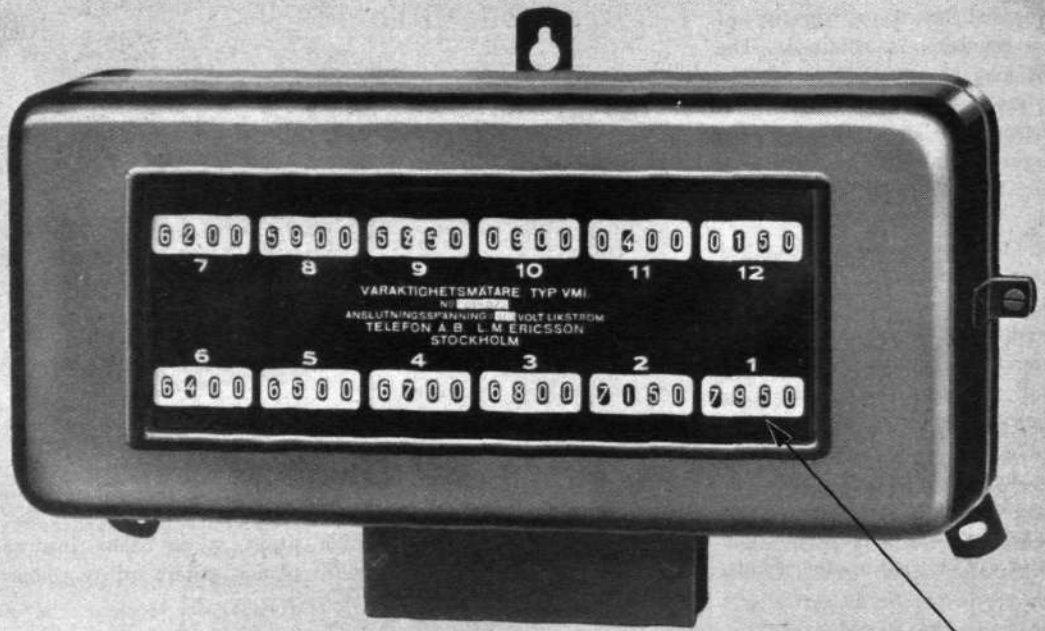
where the problem is to distinguish as, e. g., in banks, insurance companies, public utility companies etc.

## Woldemar Brummer †

*The late editor of the Ericsson Review, Woldemar Brummer, died on September 4.*

Mr. Brummer, who was born on Åland on September 21, 1871, served at first as a lieutenant in the Russian Imperial Guards. Later he studied at the Imperial Electrotechnical Institute in St. Petersburg, and in 1902 he obtained employment with the Svensk-Dansk-Ryska Telefonaktiebolaget, entering the service of the Ericsson telephone works in Leningrad in 1915. After the Russian revolution Mr. Brummer was transferred to Stockholm and in 1920 he was appointed director of the Ericsson works in Vienna. He remained there until 1926, when he returned to Stockholm to take over the editorship of the Ericsson Review. In 1932 he retired with a pension.



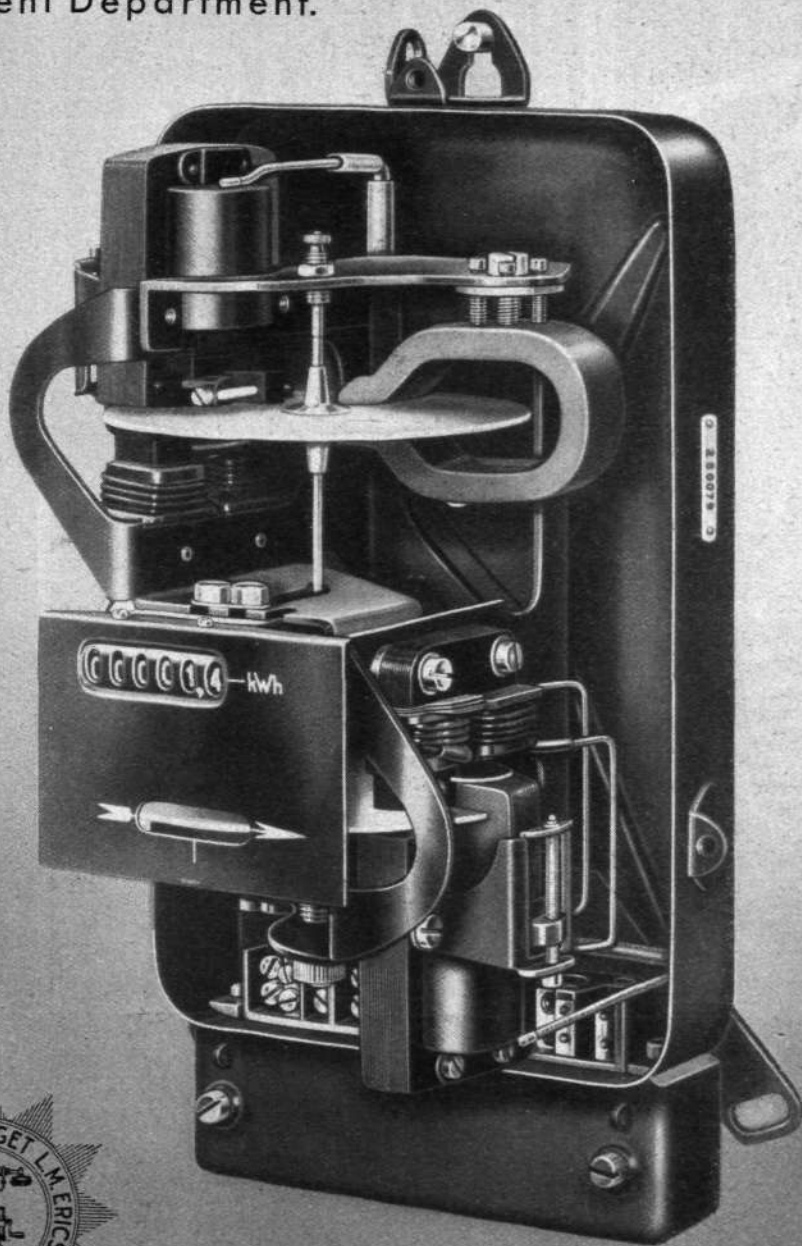


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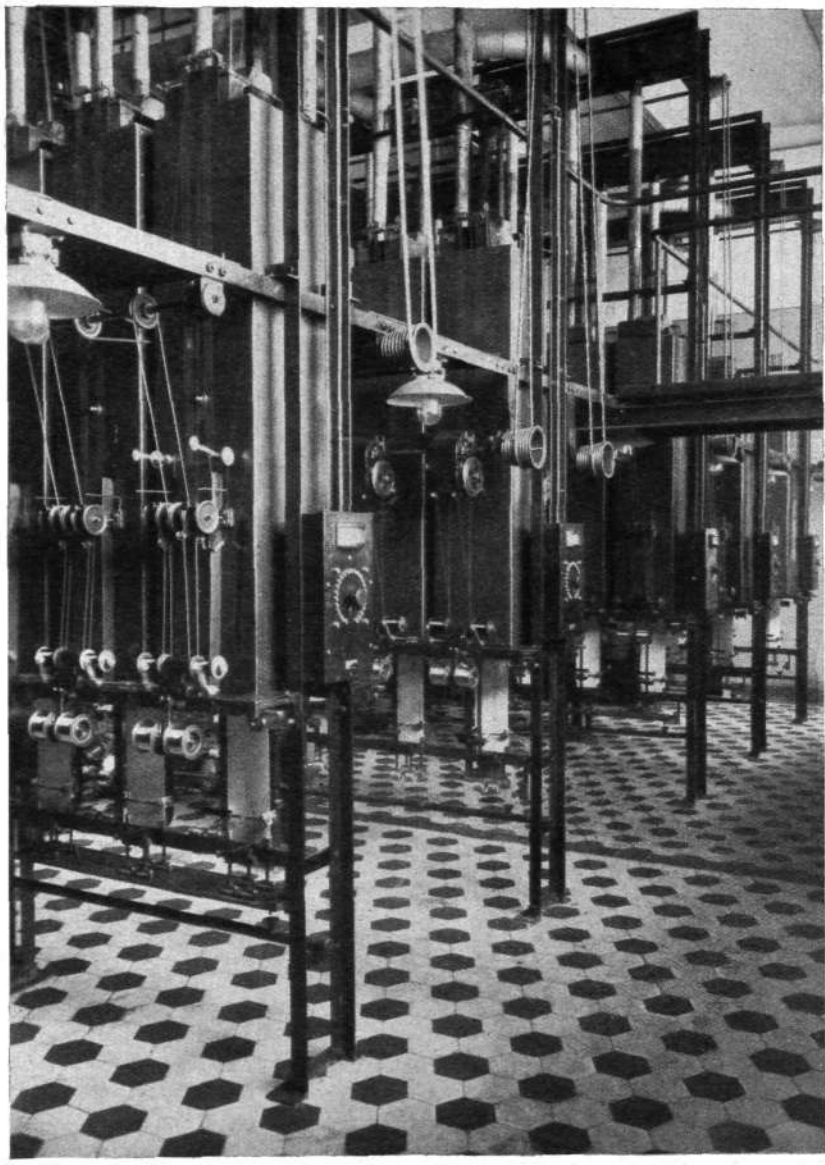


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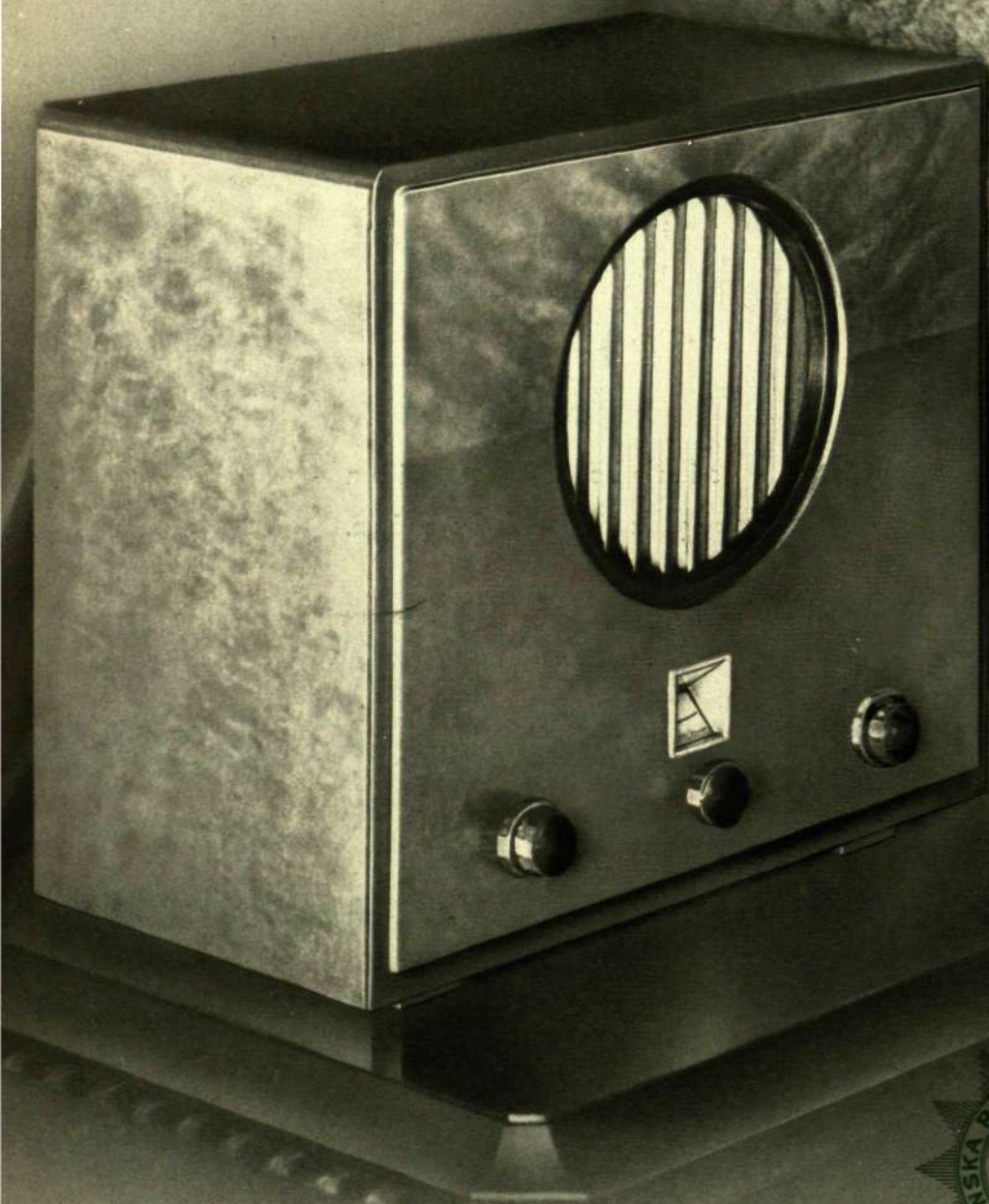
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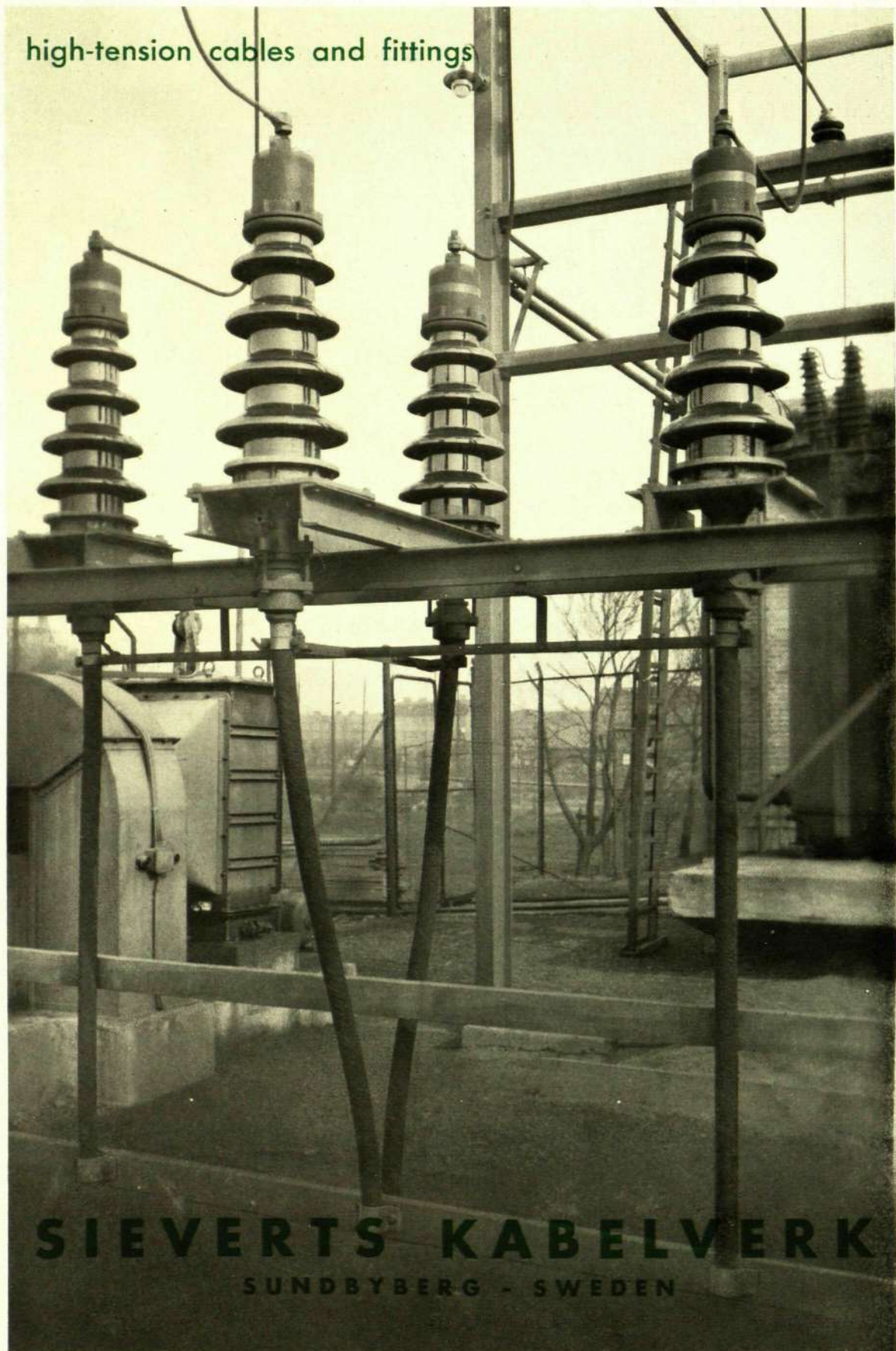
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1933 Nr. 4

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# Automatic Section Blocking on the New Subway in Stockholm

By  
R. GRIPE



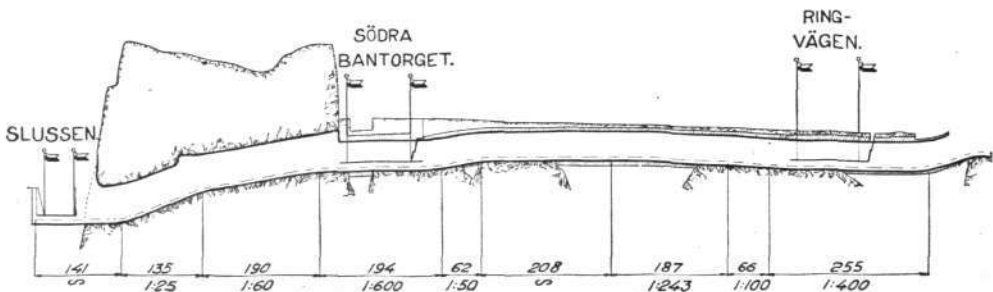
Signal engineer,  
Stockholm Tramway Company,  
Stockholm.

For a long time the difficult traffic conditions at Slussen, where the northern and southern parts of Stockholm meet, have called for a solution, and several different proposals of how to arrange the streets have been made. As early as 1875 a plan was drawn up for the building of a tunnel under part of southern Stockholm, Södermalm. Since then the situation has changed and on March 30, 1931, the Town Council of Stockholm decided to put in hand immediately the building of an underground tramway line under southern Stockholm. The Town Council entrusted the building of the tunnel, namely mining and concrete moulding, to the Street Commission and the building of the tramway with the necessary electric equipment, lighting, automatic section blocking system and complete station equipment to the Stockholm Tramway Company. The planning of the details of the technical installations, which to a certain extent were beyond the scope of the Stockholm Tramway Company, was handed over to specialist firms. Thus L. M. Ericssons Signalaktiebolag was asked to design the signalling system in co-operation with the Stockholm Tramway Company.



X 1235  
Aerial view of southern Stockholm.  
In the foreground, the opening of the tunnel at Skanstull is seen under construction.

The subway was built for two suburban lines, and the automatic section blocking system was at the beginning intended to include complete station blocking and complete section blocking even for single-track working. For this reason crossing points were planned at the terminal station of the subway and immediately north of the first subway station.



X 7038

Fig. 1. Profile of the Slussen-Skanstull tunnel.

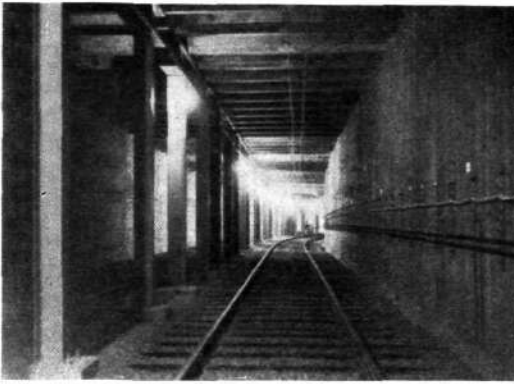


Fig. 2. Part of the concrete tunnel (left), and the rock tunnel.

X 1217

X 1216

This project proved, however, to be too expensive in consideration of actual demands, and the plant was finally designed for the blocking of all stations for double-track. The crossing points were replaced by a single point immediately inside the southern end of the tunnel.

The tunnel has been provided with an automatic section blocking system with electric light signals in order to ensure safety by regulation of traffic. Tramway and street traffic are regulated by means of signals all the way from a point between the tunnel track and the street track at the southern end to the terminal loop at the northern end.

The signals are operated by the trams as they pass the track circuits (block sections), insulated from each other, into which the track system has been divided. Insulation between two adjoining track circuits is obtained by means of fibre plates which insulate the joint irons from the rails and the rails from each other. Both rails being used as return for the tram current, impedance joints have been inserted at the ends of the track circuits. These joints allow DC from the tram to pass through the rails and back to the power source over a separate return, but at the same time they do not allow the signalling AC from the feeding transformers to pass from one track circuit to another.

The functioning of the signalling plant can be seen from Fig. 3. At the ends of the track cir-

cuits there are signals ( $A_3, A_4$  etc.), which show a green light if the next track circuit is unoccupied by trams. If the circuit is occupied by a tram the signal shows a red light. The signals and their position in the tunnel can be seen from Fig. 4, which shows a signal between two stations (home signal of a station) and Fig. 5, which shows a signal at the station (starting signal of the station). Fig. 6 gives an interior view of one of the signal cubicles used in the system.

As may be seen from Fig. 3, the track circuits  $S_1, S_2$  etc. form part of an electric network, composed of the feeding transformer  $TS_2$  and the two rails of the track between this transformer and the track relay  $RS_2$ . This relay is operated by the signalling current and operates the signal  $A_3$  by means of contacts. As soon as a tram has passed from track circuit  $S_2$  to circuit  $S_3$  the next tram can enter section  $S_2$ , if the first tram is protected from behind by a stop signal,  $A_4$ . If the stop signal does not function, for instance owing to the red lamp being faulty, the current

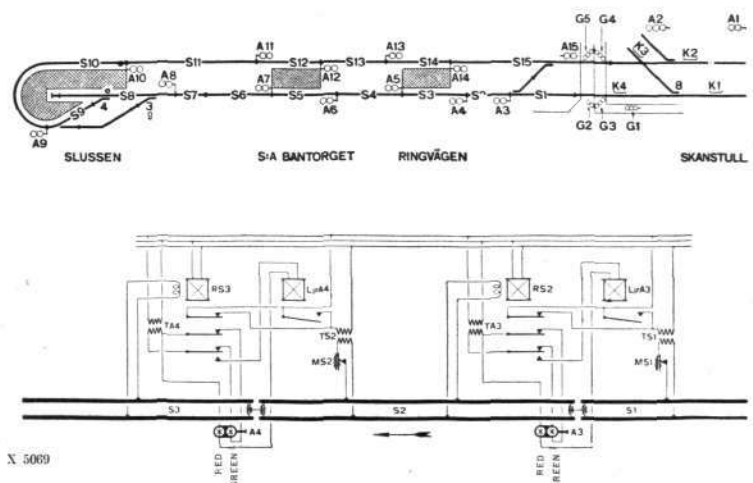
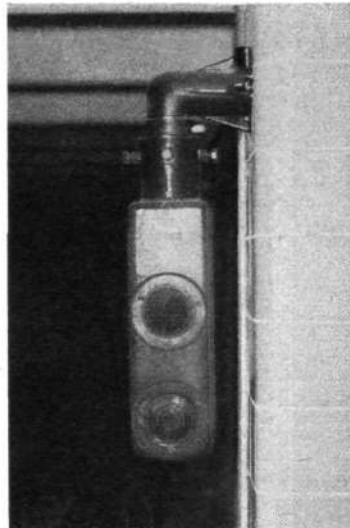
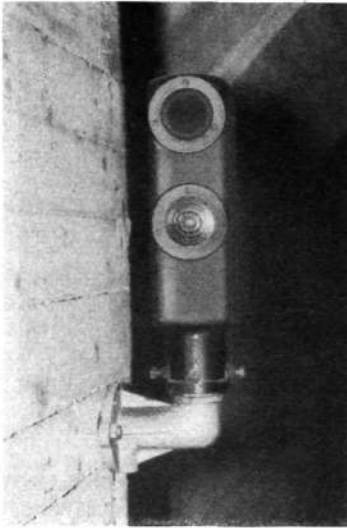


Fig. 3. Diagram of the signalling plant.

X 5069



X 3123

Fig. 4 and 5. Home signal (left) and starting signal.

X 3124

to the feeding transformer  $TS_2$  is interrupted by a contact on the relay  $Ljr A_4$ , which is connected in series with the red lamp of the signal  $A_4$ . This relay closes the current only when the red lamp glows. If  $A_4$  gives no stop signal the track relay  $RS_2$  receives no current. This relay keeps signal  $A_3$  in stop position and no tram can enter section  $S_2$ , as long as section  $S_3$  is occupied by a tram. Consequently there is no risk of a tram in the section being run into from behind by another tram which has passed the unlit stop signal  $A_4$ . When the tram in section  $S_3$  has proceeded to the next section, thus making section  $S_3$  free, the track relay  $RS_3$  closes the current to track circuit  $S_2$ , of which the relay  $RS_2$  is attracted and switches over signal  $A_3$  to green light.

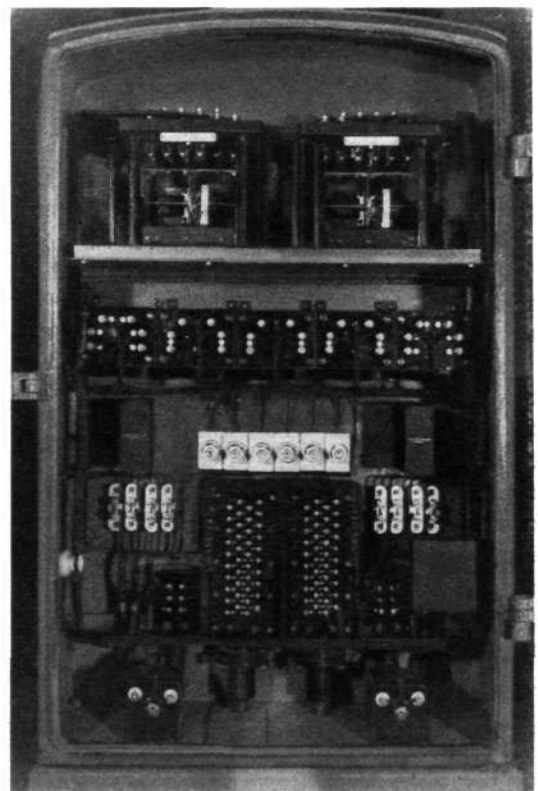
Signal  $A_1$  regulates the entering traffic from the southern side. This signal normally indicates clear, but is automatically switched over to stop when a tram has passed the contact  $K_1$  and remains in this position till the tram has entered track circuit  $S_1$ . Signal  $A_1$  can be set in stop position also from the control cabin at Slussen, if it should be necessary to stop traffic approaching the tunnel. On such occasions signal  $A_1$  will prevent a tram approaching the southern end of the sub-way from stopping in the street next to the tunnel entrance, where it would block the street traffic crossing the tracks at this point.

Street traffic is there regulated by the signals  $G_1—G_5$ . These signals show green light when there is no hindrance to street traffic. When an approaching tram arrives at a certain distance from the crossing, the signals show a yellow

light for a few seconds, thus warning the street traffic of a coming change of signals. This green-yellow signal is followed by a red light. When the tram passes the crossing, yellow light is shown together with the red, and when the street traffic is again free to cross the tracks, the signals  $G_1—G_5$  show a green light. The signal  $G_2$ , which is provided for pedestrians, shows a green or a red light only, without yellow warning light.

At the provisional terminal station at the northern end of the tunnel there are special signalling and safety arrangements for regulating the traffic on the main track, track circuits  $S_9$  and  $S_{10}$ .

As can be seen from Fig. 1, the section between the first subway station and the northern end of the tunnel has a gradient of 1 : 60 for about 190 m and a gradient of 1 : 25 for about 135 m. On account of local conditions the terminal loop at Slussen could only be given a radius of 16 m. In order to eliminate all risks the points 4 have

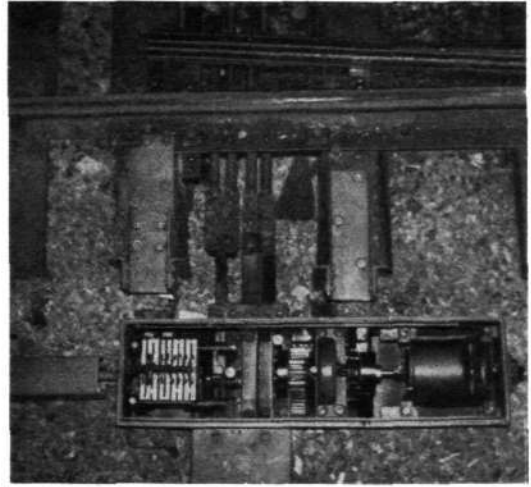


X 1248 \_ Fig. 6. Interior view of a signal cubicle.

been inserted in the main track *S9*. These points lead to a special safety catch-track with strong stop blocks, Fig. 7.

The points *4* are normally set for the safety track. By means of an electric driving device, Fig. 8, the points are automatically thrown over to the main track a certain time after a tram has entered track circuit *S6*. This time is fixed in relation to the tram speed permitted in this section. If the tram is running at a higher speed the point will not have been thrown over when the tram arrives, and if the tram cannot stop at the points, for one reason or another, it will be diverted to the safety track. If on the other hand the tram is running at normal speed the points are thrown over for the main track, and signal *A8* indicates clear if track circuit *S9* (the main track) is unoccupied. As long as the tram remains on track circuit *S8* the points cannot be moved, but after it has passed *S8* the points automatically return to normal position, see Fig. 7.

It has thus been ensured that the points cannot be thrown over while a tram is passing over them. The points can also be operated from the control cabin of the station or locally, if necessary, by means of a special contact device, Fig. 9, which is easy for the driver to reach by means of an ordinary point iron. Such local operation



X 1219

Fig. 8. Electric driving device.

is required when a tram has not covered the distance from the last station in proper time, and, for this reason, the signal *A8* indicates stop, the points *4* not being set for the main track. The tram is then stopped on track circuit *S7*, which is necessary for it to be possible to move the points locally by means of point iron.

In addition to the above-mentioned block signals there is one signal, *A2*, which indicates the position of the points *8* between the subway track and the street track. The signal shows one green light when the points are set for the subway track and two green lights when they are set for the street track. If the points are in an intermediate position the signal shows a red light.

## Auxiliary arrangements.

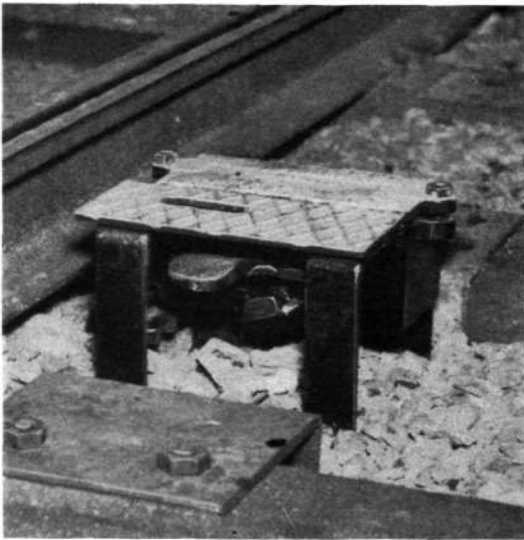
Special arrangements are provided, which are connected to and operated by the section blocking system. These arrangements give information in advance of the arrivals of trams and their destinations. This information is given by means of illuminated boards as shown in Fig. 10.

For instance, when a tram approaching from the southern end enters track circuit *S1*, the illuminated board at the first station is



X 5060

Fig. 7. Safety points and catch-track.  
In the foreground, the contact device for throwing over the points.



x 1220 Fig. 9. Contact device for throwing over the safety points.

lit up and thus indicates that a north-bound tram is approaching. When the tram departs and enters track circuit *S4* the illuminated board is switched off, but a similar board is lit up at the next station.

For south-bound trams there are two illuminated boards in the two tunnel stations, one for each of the two lines that pass through the subway. In the control cabin there is a press-button for the illuminated boards of each line. If a tram is to start on one of the suburban lines, the corresponding press-button is pressed in good time before the departure. At the same time the starting signal *A10* is set in clear position. When the tram has departed and entered track circuit *S11*, signal *A10* is set in stop position. The current

impulse from the press-button in the control cabin is repeated automatically to the illuminated board of the first subway station. This board is then lit up, indicating that a tram on the suburban line in question has left the terminal station. When the tram leaves the first subway station, the illuminated board of this station is switched off, and the corresponding board at the next station lights up.

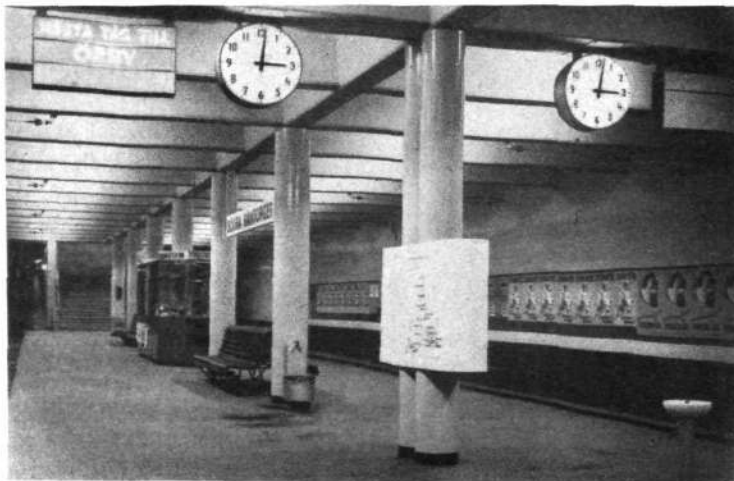
In the control cabin at Slussen there is an illuminated track diagram, Fig. 11, which gives a complete view of all track circuits. Each track circuit is represented by a lamp, which glows only when that track circuit is clear.

The necessary power for the operation of the signalling system is supplied as  $3 \times 220$  V, 50 cycles, AC from the Stockholm Electricity Works to the lighting central at the first subway station.

An important auxiliary to the signalling system is the local telephone system, by means of which the staff can communicate during service. The telephone instruments, connected to the line system have been installed at the following places: in the control cabin at Slussen, at point 3, in the power station of the subway, in the ticket collectors' boxes and in the lighting centrals of the two subway stations, at the emergency exit, at the southern end of the tunnel and at signal *A1*. The automatic telephone exchange is installed in the signal cabin at Slussen.

The section blocking and signalling systems have been planned and built by Signalbolaget in cooperation with the Stockholm Tramway Company.

The work of installation was commenced in June, 1933, and was completed and definitely



x 5061

Fig. 10. Södra Bantorget station.

tested before the opening of the tunnel to traffic on October 1st, 1933.

The installation of the system has required the following staff: 1 fitter, sometimes 2, from Signalbolaget and 2 fitters and on the average 10 workmen from the Stockholm Tramway Company.

As regards operation and maintenance as well as the expense of the signalling system it is difficult to make any statement, conditions differing from those of other systems with which comparison might have been made. We are, however, convinced that all expectations in regard to efficiency and economy of operation will be fulfilled.

X 5062

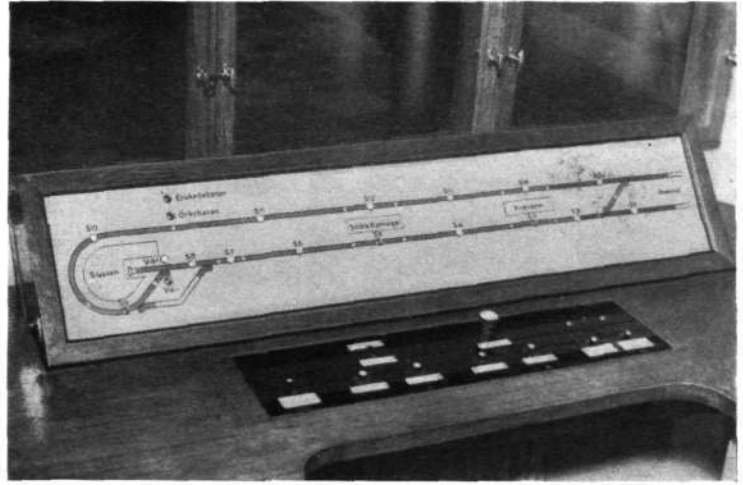


Fig. 11. Illuminated track diagram.

## Automatic Telephone Exchanges for LB-Systems

*The first automatic telephone exchange in the world to work on the LB-system without DC-signalling on the subscribers' lines has recently been delivered by Ericsson to the Royal Board of Telegraphs in Sweden.*

*We publish below a short description of this installation, in anticipation of the detailed description of the Ericsson rural automatic system that will be published in a coming issue of the Ericsson Review.*

New automatic exchanges are as a rule on the CB-system. This, however, necessitates in cases where there are already manual LB-exchanges,

*the providing of new instruments for the subscribers', as well as, to a great extent, an alteration to the subscribers' lines, as the CB-system makes demands on the insulation of the lines heavier than can generally be met by lines built for the magneto-call system. The cost of these replacements as a matter of fact weighs very heavily on automatization.*

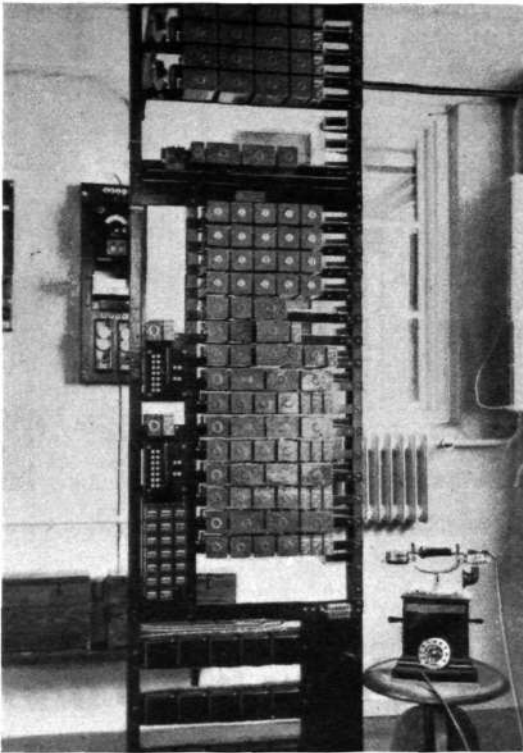
The automatization of a telephone network on the LB-system aims at conserving the existing telephone instruments as well as the existing lines. In order to obtain automatic service the instruments require to be fitted with a dial; this is only an addition to the instrument, which otherwise remains unaltered.

The automatic exchange is built in principle like an ordinary CB automatic exchange, but 50 cycles AC instead of DC is emitted on the subscriber's line by turning his magneto in the ordinary way when he calls the exchange. This AC is emitted by a cord circuit, or a register, and is heard by the calling subscriber as a dialling tone. The subscriber then dials the number desired and, on account of the changes brought about at this mo-



X 5080

View of Kärå near Gothenburg.



X 1233 Automatic telephone exchange for LB-systems.

ment in the impedance of the line, a relay in the cord circuit (or the register) is actuated in time with the breaks of the dial. In this manner the selectors are operated according to known principles. The relays and selectors are driven with DC of, *e. g.*, 24 V.

The wanted subscriber is called by a *periodic ringing signal*; when he answers the ringing is interrupted, a relay in the ringing circuit being put in action by the impedance alteration brought about when the hand microtelephone is lifted. This arrangement permits also the automatic *counting of communications actually made* which is not possible in normal LB-systems.

After the end of the communication the subscribers turn their magnetos, and release follows immediately.

To avoid a call remaining connected a long time when the subscribers have replaced their hand microtelephones but not turned their magnetos, the following arrangement has been provid-

ed: at certain intervals, *e. g.*, once a minute, an AC impulse is emitted over line of the calling subscriber. As long as the microtelephone of this subscriber is still lifted nothing happens, but if it has been replaced a relay in the cord circuit is operated and effects the release. In this manner no connection may remain established longer than one minute after the calling subscriber has replaced his microtelephone, even if he forgets to turn his magneto.

If the subscriber required is engaged, the calling subscriber receives a busy-tone. He has then only to replace his microtelephone and the release takes place without his having to turn the magneto.

If a calling subscriber by replacing the microtelephone interrupts a connection already begun, the release is effected immediately without his having to turn the magneto.

All impulsing and signalling is thus carried out by AC, and *DC is not emitted at any time over the subscribers' lines.*

Exchanges of the LB central-AC type may be equipped with junction lines for the traffic to manual main exchanges or to other automatic exchanges in rural networks.

The system allows for the transformation and phantoming of the subscribers' lines.

Tests carried out up to now have proved that the system is able to work on lines having a resistance of up to 2 000 ohm, with an insulation as bad as 5 000 ohm leakage resistance value.

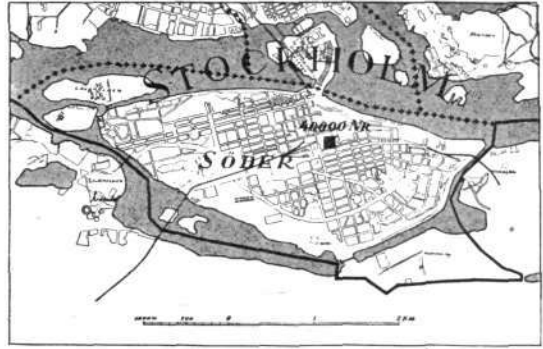
The system with local microphonic-feed battery gives better transmission than the CB-system. In addition, the extra attenuation due to reduced microphonic feed through increase in line resistance, always a draw-back of the CB-system, is avoided. It is thus easier to comply with the prescriptions of the CCIF concerning transmission.

An automatic telephone exchange of the system described above has been installed at Kärra-Hisings 13 km from Gothenburg and in direct communication with this town. The exchange is for a maximum of 20 subscribers' lines, and was opened on October 1st this year. It is the first automatic telephone exchange in the world installed to work on the LB-system without DC signalling on the subscribers' lines.

# Traffic Supervision and Maintenance of the »Söder» Automatic Exchange in Stockholm

By A. LIGNELL, Director of Telephones, Stockholm.

About 102 000 of the 116 000 telephone subscribers of Stockholm are at present connected to automatic exchanges. The subscribers are connected to 6 exchanges, of which the "Söder" exchange is the biggest. As it may be of interest to see how operation is carried on at an automatic exchange of this size on the Ericsson 500-lines selector system, information regarding reliability, operation cost, supervision and maintenance work is given below.



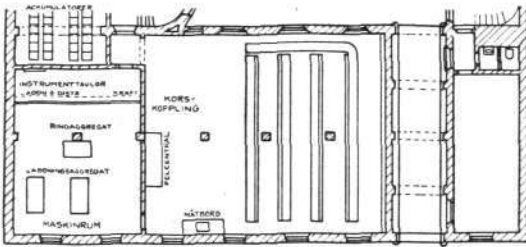
X 1231 Fig. 1. The »Söder» exchange area.

The »Söder» exchange, which was put into service on July 1st, 1931, is provided with racks and multiples for 40 000 lines and with connecting devices for 30 000 lines; in the existing building it can be extended to take 20 000 additional lines or a total of 60 000 subscribers' lines.

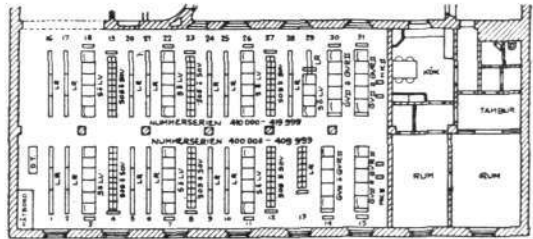
The exchange area may be seen from Fig. 1 and has natural boundaries of water. In addition,

the subscribers of a few minor exchanges immediately outside this area are to be connected direct to the exchange, and, moreover, the subscribers of several exchanges outside the area — collected in automatized line systems — are also to be included in the Stockholm number series.

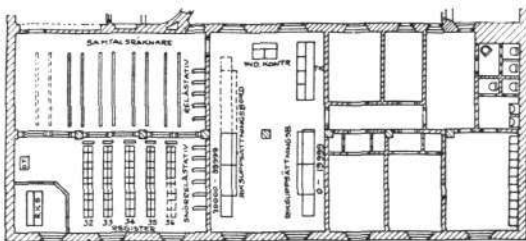
The arrangement of the equipment in the building may be seen from the following 5 plans:



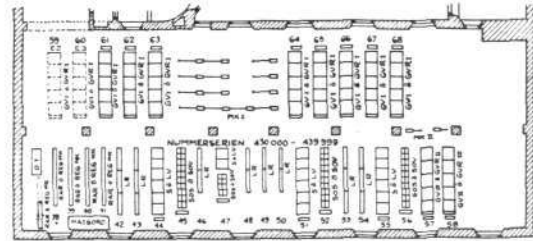
X 1207 Upper basement houses main distribution frame, fault office and power central.



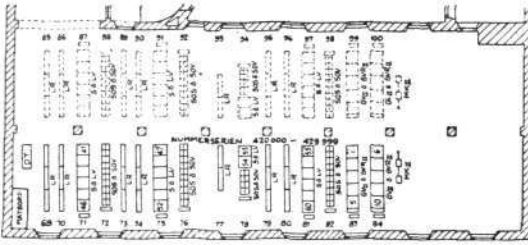
X 1208 Ground floor houses line relays, line selectors, final selectors and group selectors for 20 000 subscribers.



X 1209 First floor houses separate rooms for all registers of the exchange and for the meters of the subscribers, trunk positions for long-distance calls which also serve as information and vacancy positions etc., as well as positions for reliability supervision and individual supervision positions. This floor also contains some of the staff rooms.



X 1211 Second floor houses line relays, line selectors, final selectors and group selectors II for 10 000 subscribers (and has room for similar equipment for 10 000 additional numbers) and group selectors I for 40 000 subscribers (with room for group selectors I for 10 000 additional subscribers).



Third floor

houses line relays, line selectors, final selectors and group selectors II for 10 000 subscribers (with room for similar equipment for 10 000 additional subscribers and group selectors I for 10 000 more subscribers).



The following *connecting devices* are installed to deal with the present number of subscribers:

line selectors with sequence switches	1 506
registers	250
group selectors I	1 506
group selectors II	1 446
final selectors with sequence switches	1 502

The number of junction routes to and from other exchanges and departments is 69, with 2 164 junction circuits and 31 order wires for connection to the trunk positions, for long-distance calls, for local and long-distance file, for telephoning of telegrams and for the Telephone Commission's Office. The number of junction routes in the exchange is 7 with 485 circuits.

The *number of subscribers and traffic intensity* are given below:

number of subscribers connected 18/4,	
1933	25 799
outgoing local calls per day	157 643
outgoing and incoming long-distance calls per day	4 463
outgoing calls per subscriber per day	6.1
outgoing calls per subscriber per busy hour	0.65

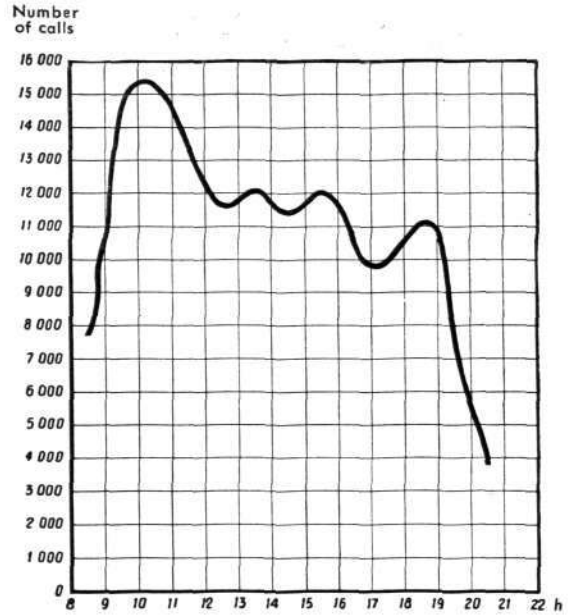


Fig. 2. Number of calls per hour.

The intensity of the outgoing traffic between 8 a. m. and 9 p. m. may be seen from the diagram, Fig. 2.

## Reliability.

Of 187 319 calls checked in the period 1/1 1932—30/6 1933 there were:

- 97.40 % faultless calls,
- 2.38 % fault of subscriber,
- 0.06 % fault of operator in manual exchange,
- 0.16 % faults in the technical equipment (automatic and manual systems, lines and instruments).

During the first six months of 1933 the corresponding figures for 71 405 calls were

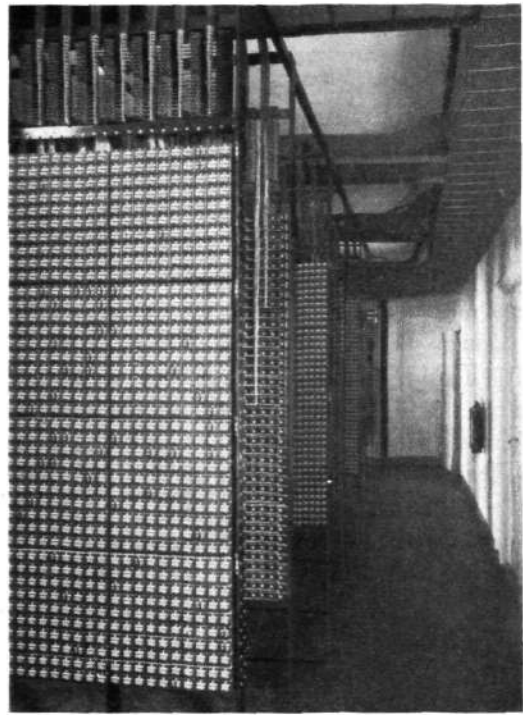
- 98.16 % faultless calls,
- 1.71 % fault of subscriber,

## Reliability Supervision 1/1 1932—30/6 1933.

	total number of calls checked	faultless calls					faults by subscribers	faults by operators	faults in the technical equipment					grand total
		calls put through	number changed, vacant or cut off	no reply	engaged	total			located				not located	
									home exchange	other exchange	line or instrument	total		
1/1—31/12 1932 %	115 914 100	91 897 79.28	728 0.63	9 561 8.25	10 180 8.78	112 366 96.94	3 236 2.79	71 0.06	131 0.11	31 0.03	—	162 0.14	79 0.07	241 0.21
1/1—30/6 1933 %	71 405 100	57 858 81.03	440 0.62	4 872 6.82	6 917 9.69	70 087 98.16	1 221 1.71	43 0.06	28 0.04	7 0.01	3 —	38 0.05	16 0.02	54 0.07
1/1 1932— 30/6 1933 %	187 319 100	149 755 79.95	1 168 0.62	14 433 7.70	17 097 9.13	182 453 97.40	4 457 2.38	114 0.06	159 0.09	38 0.02	3 —	200 0.11	95 0.05	295 0.16



X 2115 Fig. 3. The apparatus room, 2nd floor.



X 2113 Fig. 4. Call-meter bays.

0.06 % fault of operator,  
0.07 % faults in the technical equipment.

Faults due to subscribers have decreased from 2.38 % to 1.71 % and faults in the technical equipment from 0.16 % to 0.07 %.

For all automatic exchanges, in service from 1924, 1928, 1929, 1931 och 1932 respectively, the corresponding percentages for 413 806 calls checked during 1932 were:

97.09 % faultless calls,  
2.66 % fault of subscriber,  
0.04 % fault of operator,  
0.21 % faults in the technical equipment,

and during the first six months of 1933 for 254 730 calls checked:

97.95 % faultless calls,

1.84 % fault of subscriber,  
0.04 % fault of operator,  
0.17 % faults in the technical equipment.

As may be seen reliability is extremely good and subject to very small variations. The factor that varies most is faulty operation by the subscribers, and this variation goes the right way *i. e.*, the number of faults decreases.

### Fault statistics.

The number of cleared faults in the automatic equipment in 1932 was 0.41 per 10 000 calls. This figure decreased during the first six months of 1933 to 0.33, which corresponds to 4 to 5 cleared faults per day.

#### Fault Statistics $\frac{1}{1}$ 1932— $\frac{30}{6}$ 1933.

	average number of subscribers' lines	number of calls	number of faults cleared						
			in the automatic equipment			in exchange equipment outside the automatic system			
			total	per 10 000 calls	per subscriber's line	per day	total	per subscriber's line	per day
$\frac{1}{1}$ — $\frac{31}{12}$ 1932	25 911	47 450 109	1 960	0,41	0,08	5,4	872	0,03	2,4
$\frac{1}{1}$ — $\frac{30}{6}$ 1933	25 854	23 656 274	787	0,33	0,03	4,3	313	0,01	1,7

In exchange equipment outside the automatic system (main distribution frame, fuses, multiple and equipment of the trunk-position) the number of cleared faults per connected subscriber's line was 0.03 during 1932 and 0.01 during the first six months of 1933, which corresponds to 2.4 and 1.7 cleared faults per day respectively.

For all automatic exchanges the number of faults in the automatic system per 10 000 calls was 0.363 during 1932 and 0.368 during the first six months of 1933.

The number of faults per connected subscriber's line in exchange equipment outside the automatic system was 0.039 during 1932 and 0.014 during the first six months of 1933. The number of faults is thus remarkably small.

In 1932 there were 131 faults cleared in the Söder exchange by the supervision of current traffic and 637 faults by the cutting-in of the supervisory staff when the supervisory lamps of the registers glowed, or altogether 768 faults in the home exchange, which corresponds to 39.2 % of the total number of faults cleared during the year.

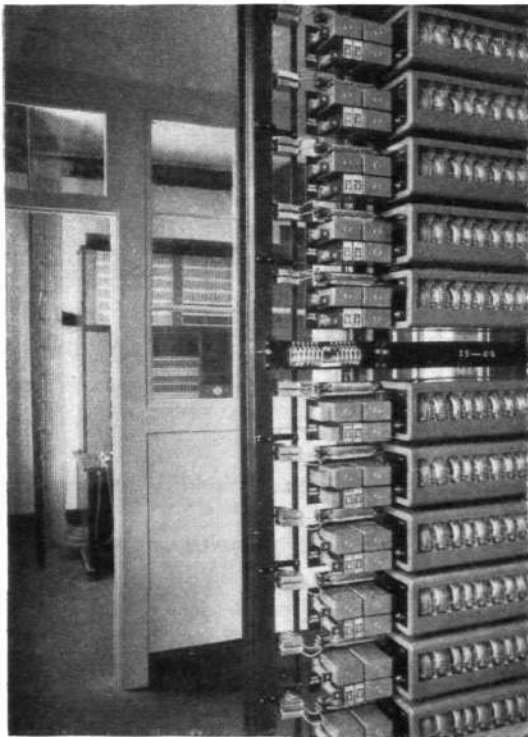
The great importance of traffic supervision even in respect of maintenance is thus evident.

## Maintenance.

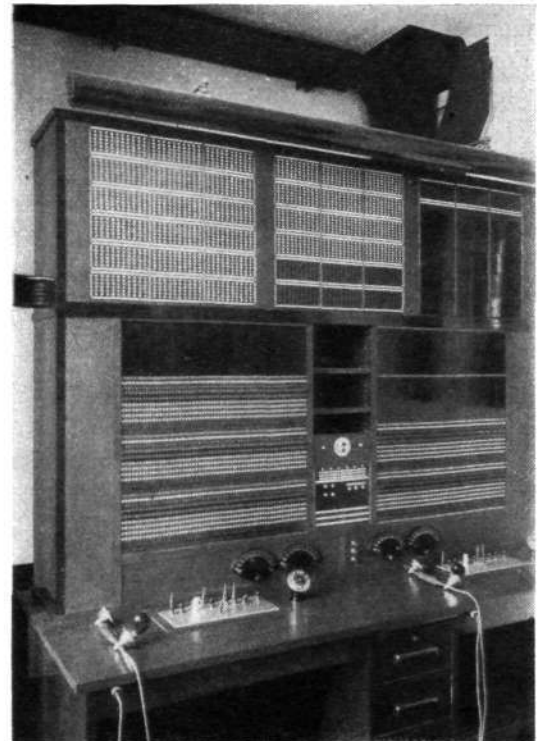
### Maintenance Cost $\frac{1}{1}$ 1932— $\frac{3}{6}$ 1933.

	staff		maintenance cost per connected subscriber				
	male	female	working hours	cost of labour	cost of material		total
					auto- matic equip- ment	outside the auto- matic equip- ment	
Sw. Kr.	Sw. Kr.	Sw. Kr.	Sw. Kr.	Sw. Kr.	Sw. Kr.	Sw. Kr.	
$\frac{1}{1}$ — $\frac{3}{12}$ 1932	14	5	1,81	2,57	0,07	0,23	2,87
$\frac{1}{1}$ — $\frac{3}{6}$ 1933	14	5	0,90	1,26	0,04	0,05	1,35

The maintenance cost—cost of labour and material—per connected subscriber was Sw. Kr. 2:87 for 1932 and Sw. Kr. 1:35 for the first six months of 1933. The average cost of all automatic exchanges, with call frequencies varying between 5.25 and 13.17 calls per subscriber and working day (8 a. m. to 9 p. m.), was Sw. Kr. 3:29 for 1932 and Sw. Kr. 1:56 for the first six months of 1933. The cost of labour and material at the »Söder» exchange per 100 calls



X 1212 Fig. 5. Register bay and register-control room.



X 1214 Fig. 6. Register-control table.

was Sw. Kr. 0:157 for 1932 and Sw. Kr. 0:148 for the first six months of 1933.

The cost of the traffic supervision per 100 calls was Sw. Kr. 0:03 for 1932 and Sw. Kr. 0:03 for the first six months of 1933.

The total maintenance cost per 100 calls was Sw. Kr. 0:187 for 1932 and Sw. Kr. 0:178 for the first six months of 1933.

In 1932 the power consumption per connected subscriber's line was

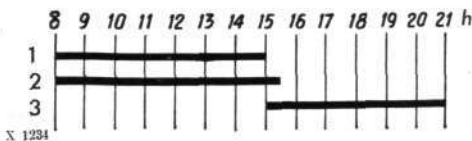
for motors . . . . . 0.83 kWh,  
for charging of batteries . . . . . 2.85 kWh,  
together making a cost of Sw. Kr. 0:179.

## Supervision and maintenance.

*Supervision work* consists partly in the reliability supervision proper by means of which a reliable view of the traffic is obtained and at the same time faults detected are repaired, partly in cutting into connections when the supervisory lamps of the registers light up. This will occur when the subscriber dials a number that does not exist in the system, when faults occur in the connection or when a register is occupied for more than 20 seconds. The subscriber will then receive assistance. When faults occur the connection is locked and the fault is reported to the fault office for immediate clearing.

(How the supervision is carried out is described in the Ericsson Review Nr. 4—6, 1929.)

In addition to supervision the supervising staff, consisting of 3 female employees, has to answer calls concerning the service and to do various statistical and registration work. This staff works according to the schedule shown below:

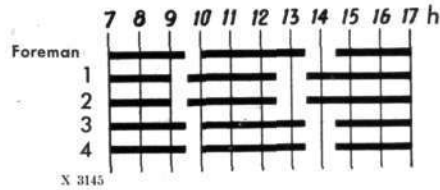


*Maintenance work* requires 19 workers consisting of:

- 1 foreman,
- 13 male fitters,
- 3 female cleaners for connecting devices,
- 2 female floor cleaners.

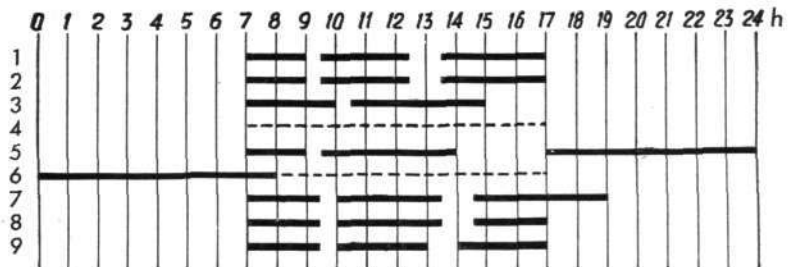
Four of the fitters are allotted to the main distribution frame and the fault office and the other nine alternate in standing by and working in the equipment rooms.

The staff of the main distribution frames and the fault office serves according to the schedule shown below:



The staff performs the following work: service in the fault office and keeping of fault journals; service of the workers on outdoor lines; switching over required by the Telephone Commission's Office; connection, disconnection and re-connection of subscribers' lines, and operation of the power central.

The staff of the equipment rooms serve according to the following schedule:



X 5082 The dotted lines indicate: free times following and preceding night-duty.

This staff performs the following work: watching for and clearing faults in the equipment rooms; regular testing during periods of low traffic intensity, partly by routine tests; inspection of shafts and rack motors as well as lubrication of bearings.

All female workers for cleaning connecting devices and floors are in service  $8\frac{1}{2}$  hours per working day, between 7 a. m. and 5 p. m.

# Synchronous Clocks

By  
S. FRIBERG



Sales Department,  
Telefon A.-B. L. M, Ericsson,  
Stockholm.

*In the Ericsson Review Nr. 3, 1933, an article was published regarding some new types of electric clocks for connection to DC or AC mains or use with batteries, the spring in those cases being wound by electricity.*

*The type of clock described below, the synchronous clock which is designed for connection only to AC mains, follows a perfectly new line, the driving device consisting of an electric motor so that the ordinary clockwork movement is not required.*

*The clock having been connected to the mains and set to the right time indicates the correct time day after day without requiring any adjustment or supervision. On account of their simplicity, reliability, and inexpensiveness, synchronous clocks have recently gained much ground.*

A synchronous motor connected to AC mains rotates at a speed absolutely determined by the frequency of the AC and the number of poles in the motor. These principles have already been applied in case of synchronous motors for power. If the frequency of the AC is kept constant, synchronous motors may be used for the indication of time by gearing to clock hands in a suitable manner.

The use of synchronous motors for driving clocks is made possible by the precision of power distribution nowadays. Thanks to practical arrangements and the cooperation of various power producers in great systems, break-downs in the mains are very rare.

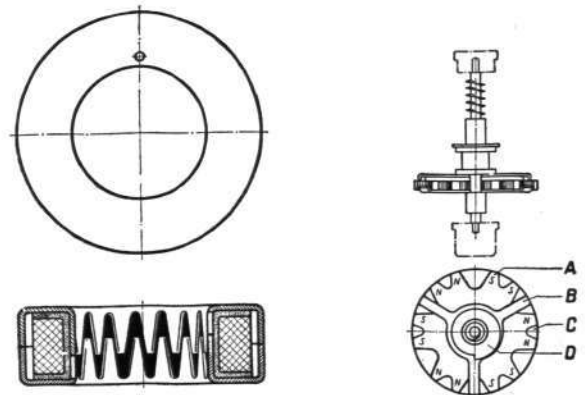
The frequency is kept constant by the power stations where are installed control clocks which

indicate with high precision the difference in time between a synchronous clock fed from the mains and a precision pendulum clock adjusted by comparison with official time signals. By the cooperation of power stations over wide areas, maintenance of the frequency is considerably simplified and the supervision of such an area can be performed from one point.

From the point of view of power suppliers the synchronous clocks provide the advantage that consumers can be offered a further facility, namely correct time. Just as it is now natural to get uninterrupted light and power supply from the mains so it will in future be the natural thing always to get correct time from the mains.

In countries where synchronous clocks have been introduced they have immediately won the approval of the public. For instance, half the number of clocks sold at present in the U. S. are synchronous clocks. The advantages are evident. The clocks need only be connected to the mains and from then they need neither be set nor wound nor do they require any batteries. They operate in a perfect manner unaffected by changes in temperature and position and are practically silent. Power consumption is very small; the Ericsson synchronous clocks consume about 1.5 W at 220 V.

The requirements to be fulfilled by synchronous motors for driving clocks are that their dimensions must be small, yet the torque should be sufficiently great; they should be noiseless, and finally they should run without requiring any supervision.



X 1223

Fig. 1 and 2. Section of the synchronous motor: left the stator, right the rotor.

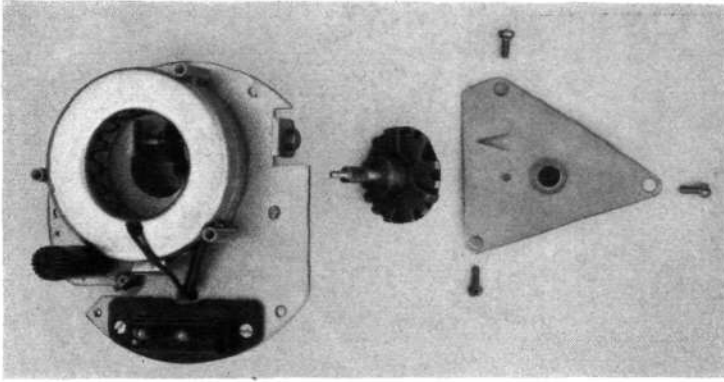


Fig. 3. The clock movement dismantled, extreme right the stator, middle the rotor.

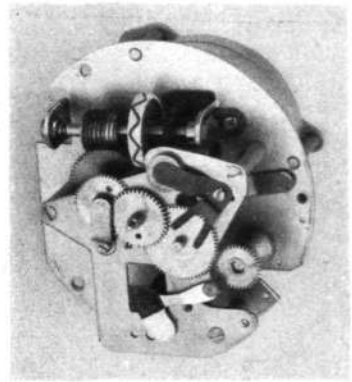


Fig. 4. The clock movement, from the face side.

X 5063

X 3125

## Design.

The design of the Ericsson synchronous clocks may be seen from Fig. 1 and 2.

The stator, Fig. 1, is made of a hollow ring of rectangular cross-section. Its outer diameter is 55 mm, and the inner diameter is 30 mm. The ring is divided in halves, each half having 15 teeth on the inside. When the halves are joined the teeth fit together so that an air-gap is left, where the winding is placed. In this way a stator of 30 poles is obtained, and the synchronous speed of the motor will consequently be 200 r. p. m. at 50 cycles.

The rotor, Fig. 2, is made of three discs. The disc *A* forms the armature of the motor and is made of steel with a high cobalt content. The pole-pitch is the same as in the stator, but for reasons of construction there are only 12 poles. These poles are of the same polarity two by two. The disc *B* of soft iron has three arms and is fixed to the disc *A* by means of the magnetically neutral brass disc *C*.

The disc *B* causes the motor to start as soon as it is connected to AC of sufficiently high voltage. On the rotor shaft the disc *D* is fixed, serving as a friction ratchet. This arrangement prevents the clock from starting in the wrong direction.

The magnetic material of the rotor has been selected with great care. This ensures that the armature is not demagnetized even after running a long time, which would render the clock less reliable. The rotor shaft is carried on bearings of canvas-bakelite. On account of the type of

bearing and the relatively low speed of the motor, no regular supervision for lubrication etc., is required.

The motion is transferred from the rotor shaft to the clock hands by tooth gears and worm gears. A drum is fixed on one of the shafts of the gearing. On this drum there is a wavy line visible through a hole in the pointer dial, so that it can at once be seen whether the clock is running or not.

Fig. 3 shows the movement from behind, especially the details of the motor, and Fig. 4 shows the movement from the face.

As has been stated the Ericsson synchronous clocks are self starting, *i. e.*, if a break-down should occur in the mains the motor will start as soon as the voltage comes back.

Experience has shown that most interruptions of the voltage are caused by switchings in switch plants etc. and consequently of a very short duration. In order to indicate that an interruption of the voltage has taken place, *i. e.*, that the clock may indicate the wrong time, a red warning flag becomes visible through a hole in the face immediately an interruption occurs. This signal remains even after the motor has started again.

For the setting of the hands there is a button at the back of the clock, which when pressed gears to the shaft of the minute hand; normally the button is out of gear and when it is pressed, *i. e.*, when the clock is set to right time, the red signal vanishes. The setting of the hands does not interfere with the motion of the motor, a friction clutch being inserted in the gearing.



X 1237 Fig. 5. Synchronous table clock.



Fig. 6. Synchronous wall clock. X 1236

The movement is enclosed in a dust-proof case of bakelite, and all parts under tension are thus protected against being touched accidentally.

The movement can be built into clock cases of various designs. On account of the great torque of the synchronous motor it can even be used for driving the relatively long hands of ordinary wall clocks. The same movement can thus be used both for small table clocks and wall clocks and it can thus be manufactured in a rational manner by mass production.

Fig. 5, 6, 7 and 8 show some types of synchronous clocks.

These small synchronous motors may be used for other purposes than for driving clocks. Their small dimensions, great reliability and small power consumption make synchronous motors suitable for driving various instruments which require to be regulated by time with great precision, as for instance recording instruments, two-rate meters, time recorders, form-stamps, switching clocks, etc.



X 1238

Fig. 7 and 8. Synchronous table clocks.

X 1239

# Automatization of the Telephone System in Venice

*Telefonaktiebolaget L. M. Ericsson has during recent years supplied automatic telephone equipment to several Italian cities. The automatization of the Venice telephone system now completed includes several interesting technical arrangements, which are described in the following article.*



X 5069

Panorama of Venice.

In 1929 Società Telefonica delle Venezie, TELVE, ordered from Telefonaktiebolaget L. M. Ericsson automatic telephone equipment; the new long-distance exchanges were put into service in 1931 and the new automatic exchanges in Venice in April this year.

No other city presents such peculiar topographic features as Venice, built as it is on more than hundred

islands nearly 3 miles from the mainland. These conditions of course influence the design of the telephone system of the city. The telephone lines can not be laid in underground concrete conduits, as is usual in

great cities, but must be laid either direct in bridges and streets or else as submarine cables. Extension of the line system being very expensive under these conditions the existing circuits had on automatization to be utilized in the best way. On account of this fact the junctions between the automatic exchanges consist of two wires only instead of three as is mostly the case for traffic between automatic exchanges in a city.

The construction of the automatic telephone system in Venice was carried out in several stages. Towards the end of 1931 and in the beginning of 1932 the new long-distance exchange and the Mestre automatic exchange

were put into service. These two exchanges are situated on the mainland at a distance of 12,2 km. from the Central telephone exchange in Venice.

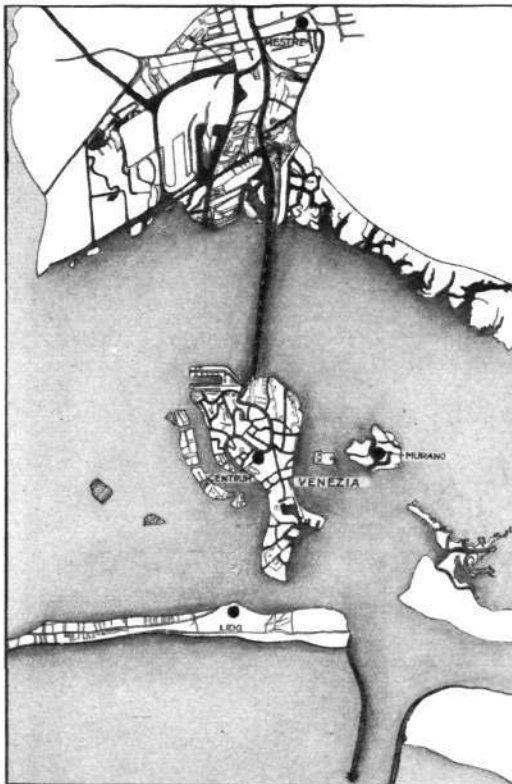
The Venice system formerly included two long-distance exchanges, namely the State exchange in Venice and the TELVE exchange at Mestre. These two exchanges have now been combined in the new exchange at Mestre, traffic thus being centralized. The long-distance exchange has 30 toll positions with a total of 120 long-distance lines. From this exchange all long-distance calls to exchanges in the Venice system are automatically established.

At present the Mestre automatic exchange is equipped for 1 000 lines.

On April 2nd this year, the following automatic exchanges were put into service: Centrum with 6 000 lines, Lido with 500 lines and Murano with 200 lines. The total number of automatized lines was then 7 700.

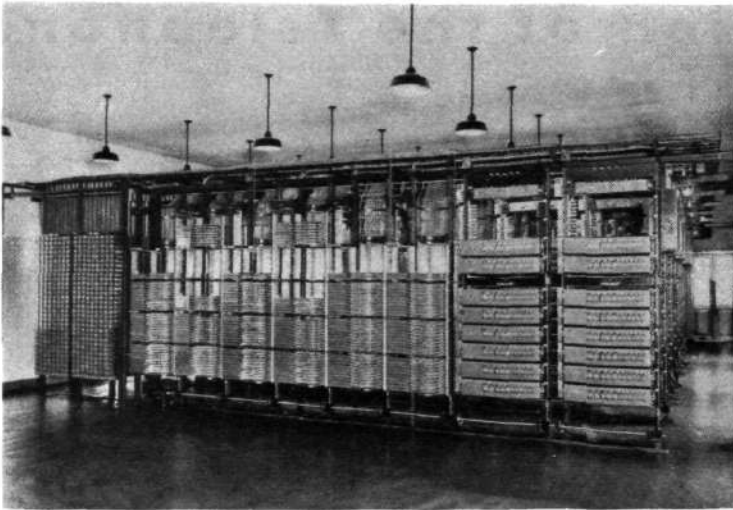
The Centrum exchange is situated in the heart of Venice near the famous Place of St. Marc in the same building as the old CB-exchange.

The Lido exchange is situated on an island in the gulf at a distance of 4,3 km. This exchange carries the traffic to the well-known bathing resort.



X 1222

Plan of Venice.



X 5064

Fig. 1. Unit row in Venice—Centrum.

The Murano exchange is also situated on an island in the Gulf of Venice at a distance of 2.4 km from Centrum.

## The Exchanges.

The Venice exchanges are built on the Ericsson unit system with 500-lines machine driven selectors and 24 V operating voltage.

The frames required for one group of 500 lines are joined to a unit row. In the Centrum and Mestre exchanges two groups of 1 000 lines in total have been built together as one row.

Fig. 1 shows a unit row in the Centrum exchange. The row is composed of 2 line relay panels for 1 000 line and cut-off relays, which may be seen to the left in the illustration. Next there are 6 panels for the selectors of the two 500-groups. The line selectors and final selectors of the first 500-group are placed next to the line relay frame. The fifth and sixth selector panels are fitted with the group selectors of the two 500-groups. To the right there are two panels with registers, one panel for each 500-group. On the back of the register panels the cord-circuit relay sets are mounted.

The selectors are operated by relays mounted on frames placed at the side of each selector.

All connecting devices are connected to the frames by means of jacks and plugs, and consequently the number of connecting devices required by the traffic can be fitted to each panel. A current distribution board with arrangements for the automatic starting of the frame motor as calls come in the row belongs to each row as well as a frame motor driven from the batteries. The motor has windings for generating dialling tone and ringing current for the unit row.

All exchanges except Murano have been equipped with line selectors, group selectors, final selectors and registers. In the Murano ex-

change registers have not been introduced the exchange being built for 200 lines only.

Each exchange has two storage batteries for the current supply. In the large exchanges they are charged by rotary converters. Fig. 2 shows charging machinery and switch-board for the current distribution in the Centrum exchange. Dry rectifiers are used instead of rotary converters for charging the storage batteries of the Murano exchange.

The subscribers' numbers have 5 digits, and the following series have been reserved for the different exchanges:

Centrum: 20 000—28 999

Mestre: 50 000—59 999

Lido: 60 000—69 999

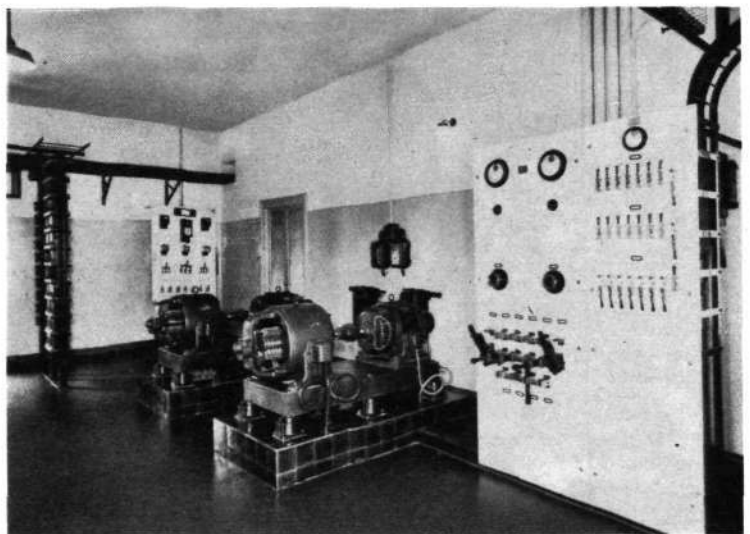
Murano: 29 000—29 999

The total capacity of the system is 60 000 lines.

The routing diagram of the exchanges can be seen from Fig. 3. The Centrum exchange is the centre of the whole system. The other exchanges are connected to it by two-wire single-direction junctions.

## Internal Traffic.

Each exchange may be considered as a separate unit, internal traffic being carried on inside the exchange without assistance from other exchanges.



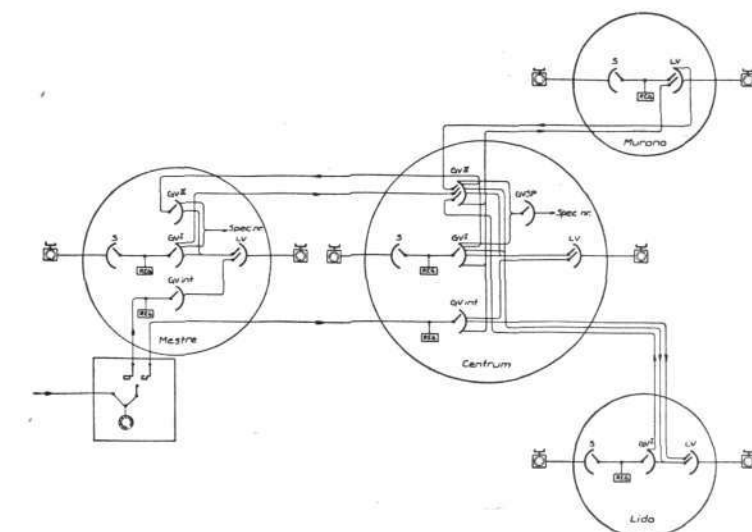
X 5065

Fig. 2. The power plant in Venice—Centrum.

When a subscriber lifts his micro-telephone a number of unoccupied line selectors are started. The first of these selectors to find the calling subscriber's line connects this line to the register. Having been connected to a register the subscriber hears a dialling tone advertising that he may start dialling the desired number. The register records the desired number, starts the group selector permanently connected to the line selector and controls its motions by means of the revertive impulses sent out from the selector to the register. The group selector then automatically selects an unoccupied final selector in the group of subscribers' lines in question. The final selector is started by the register and is directed in the same manner as the group selector to the subscriber's line in question.

If the line is clear an intermittent ring signal is sent out to the called subscriber, and this signal is heard also by the calling subscriber. When the subscriber answers the ringing is switched off and the conversation can take place.

If, on the other hand, the line is engaged an intermittent buzzer tone is sent out to the calling subscriber. After he has replaced his microtelephone all connecting devices return to home position.



X 5068 Fig. 3. Routing diagram of the Venice telephone system.

## External Traffic.

The traffic between the exchanges is directed over two-wire single-direction junctions. These circuits are supplied with repeaters by means of which feeding and ringing are repeated from one exchange to the other.

In the Mestre and Centrum exchanges these junctions terminate in a second group selector *GVII*. The Lido and Murano exchanges being built for 500 lines as a maximum are not at present fitted with such group selectors. In these exchanges

the junctions terminate in final selectors.

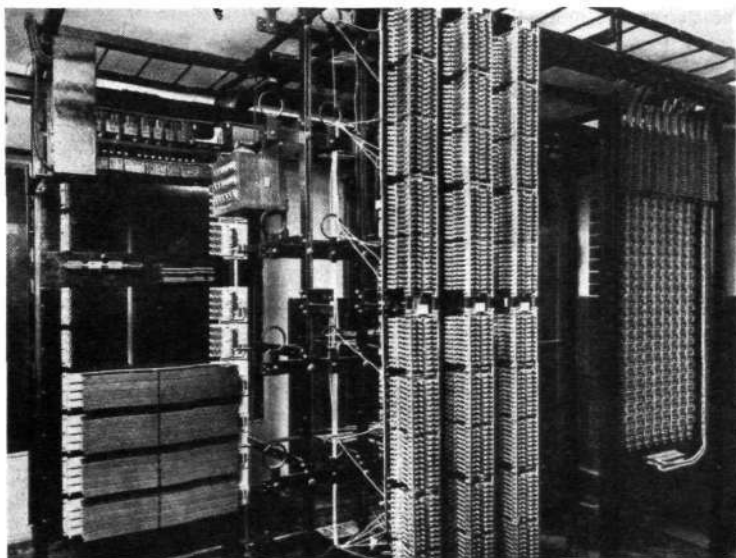
When a subscriber of the Mestre exchange has dialled the number of a subscriber of the Centrum exchange the first group selector at Mestre selects an unoccupied junction in the multiple frame of the junctions to Centrum. At Centrum the second group selector *GVII* and the final selector *LV* are directed by the register at Mestre.

In traffic from Mestre to Murano or Lido the second group selector *GVII* at Centrum is directed to the second multiple frame of the junctions to Murano or Lido respectively. The final selectors of these exchanges are then directed by the register at Mestre.

The first selector in the Murano exchange serves as a group selector for the outgoing traffic, no group selectors being supplied. It is directed to the first multiple frame if the register has received a subscriber's number belonging to another exchange.

## Traffic on Special Lines.

The traffic to the fire brigade, long-distance and rural recording offices, telephone commission's office, fault office etc. are directed over special lines, which are called by two-digit numbers, 00—09.



X 5068 Fig. 4. Interior view of the Murano exchange.

In the Centrum exchange special group selectors *GVSP* have been installed for this traffic. In the Mestre Exchange the special multiple frames are included in the ordinary group selector frames.

For the service of part of the special lines a special two-position switch-board has been installed at Centrum. During day-time the calls to the commission's office, fault office and telegram recording arrive at this switch-board. For night service part of these lines can be switched over to the long-distance exchange of Mestre.

The recording circuits for long-distance and rural calls are served by operators at Mestre.

## Long-Distance Traffic.

Long-distance traffic to all automatic exchanges is directed by the long-distance exchange at Mestre. Long-distance calls are established in a purely automatic manner.

The long-distance junctions are connected to jacks in the long-distance switch-boards and follow two directions. One terminates in the long-distance group selectors *GVint* of the Centrum exchange and the other in similar selectors in the Mestre exchange.

The 500-groups at Mestre, Centrum and Lido are fitted with special final selectors for long-distance traffic. At Murano combination final selectors are used for both local and long-distance traffic.

The long-distance operator selects a clear junction by pressing a selector button; the signal lamp of a clear circuit is then lit up. The operator plugs the local cord of the long-distance line into the corresponding line jack and dials the desired number.

The long-distance group and final selectors are directed by a register in the same way as for a local call.

If the called subscriber is engaged by a local call the operator is connected in parallel, and the end signal lamp of the cord circuit starts flashing. The operator can then break the local call in favour of the long-distance call.

## Different Classes of Subscribers.

The Venice exchanges are of such a design that not only ordinary subscribers but also duplex, multiplex and *PBX* subscribers can be connected to the system.

In each of the Centrum and Mestre exchanges one 500-group and in the Lido exchange 400 numbers are arranged for ordinary as well as *PBX* subscribers.

All lines of a *PBX* subscriber are situated behind each other in the final selector multiple frame. The subscribers' lines are called by a main call number. Having been directed to the call number in question, the final selector performs a hunting motion over the lines of the group and makes connection to the first clear line. If all lines be engaged the selector will arrive at a stopping line and busy-tone will then be sent out to the calling subscriber.

On calls from the long-distance exchange to such a number the final selector tests the lines as usual during inward motion. If all lines be engaged the selector stops at the stopping line and there it is switched over to reverse motion. During this motion the selector is testing for long-distance calls and makes connection to the first line in the group not engaged by long-distance call. If all lines be engaged by long-distance calls the backward motion is stopped when the selector arrives at the call number, and long-distance busy-tone is sent out to the operator.

The lines of a *PBX*-group can also be called by individual numbers. These numbers are chiefly used after closing hour when the subscriber connects the line in question to the desired instrument.

Centrum, Mestre and Lido have also equipment for the connection of *duplex* subscribers. Two subscribers are connected to one duplex line. They have individual call numbers



Fig. 5. Transport of material by gondola.

and are called selectively. During the conversation one of the duplex subscribers is disconnected from the line and can thus not overhear the conversation.

*Multiplex* lines can be connected to Centrum, Mestre and Lido. Such a line carries the traffic between the automatic main exchange and a group of up to 10 individual subscribers. The two-wire line is fitted with a multiplex exchange mounted in the centre of the subscribers' group.

The traffic to a multiplex subscriber from a subscriber in the automatic system is carried on in the ordinary way. The ring signal is sent out only to the called subscriber in the multiplex group. The calls are secret. Busy-tone is received after the last digit if the junction is engaged.

## Supervision and Alarm Arrangements.

In order to make possible the checking of the operation of the automatic exchanges and of the subscribers when dialling, the large exchanges Mestre and Centrum are provided with traffic-supervision boards and Murano and Lido with traffic-supervision boxes.

When the subscriber dials and the connection is established supervisory lamps are lit in the supervision table or box in order to show the progress of the connection. When the operation of the selectors takes longer time than usual an

alarm lamp lights up indicating that some fault has occurred. The supervision operator then cuts in in order to locate and clear the fault.

The traffic supervision position is not only intended as a central point for observing the traffic and the faults due to subscribers and connecting devices, but from this position there is the possibility of assisting subscribers not capable of handling their instruments or dials in the right way, which is of great

importance especially in new automatic systems.

The automatic exchanges are also provided with alarm arrangements, which report by optic or acoustic signals when faults occur in the exchange, *i. e.* when fuses melt, when motors do not start, if connecting devices do not return to home position etc. By means of these arrangements the staff can rapidly trace and clear faults occurring.

In the Murano exchange there is

usually no staff, but the exchange is controlled direct from Centrum in respect of the supervision of the traffic as well as the apparatus.

The subscribers are switched over automatically from the traffic supervision box at Murano to the traffic supervision position at Centrum if the dialling of the subscriber should take unusually long time. The supervising operator can then cut in and assist the subscriber if necessary.

## New Ericsson Exchanges during 1933

In 1933 the following automatic telephone exchanges on the Ericsson system with 500-line selectors have been put into service:

Date	Place	Exchange	Number of lines
7/1	Jyväskylä, Finland		900
20/1	Lidingö, Sweden	Lidingö Villastad	2 000
5/2	Durango, Mexico		1 000
11/2	Tripolis, Libya	Main exchange	1 000
		Sub-exchange	80
4/3	Paraná, Argentine		4 000
2/4	Venice, Italy	Venice-Centrum	6 000
		Lido	500
		Murano	200
11/4	Stockholm, Sweden	Östermalm	30 000
5/6	Oslo, Norway		400
2/7	Gothenburg, Sweden	Masthugget	12 000
10/9	Arendal, Norway		1 500
18/10	Warsaw, Poland	Zielna	18 000
27/10	Taranto, Italy		1 000
5/11	Fredriksstad, Norway	Main exchange	2 500
		Sub-exchange in Selbakk	200
18/11	Moss, Norway		1 500

In the same period the following exchanges built by Société des Téléphones Ericsson, Colombes, using the Rotary system, have been opened:

27/5	Paris	Opéra	10 000
16/12	Paris	Provence	10 000

Ericsson Telephones Ltd., London-Beeston, have supplied during the year the following exchanges, constructed on the Strowger system:

21/1	Birmingham	Priory	900
21/1	Birmingham	Acocks Green	1 800
18/2	Birmingham	Stechford	800
27/5	Manchester	Swinton	1 000
21/6	Birmingham	Birchfields	1 000
28/6	Crewe	Willaston	200
5/7	Birmingham	Marston Green	200
Dec.	London	Larkwood	1 700
Dec.	London	Stamford Hill	4 500



X 3145 The telephone exchange in Paraná, Argentine.



X 3144 The Zielna telephone exchange in Warsaw.

# The Automatization of the Suburban Telephone System of Stockholm

The automatization of the local telephone systems of Stockholm has brought to the fore the question of the automatization of the suburban exchanges around Stockholm in the suburban traffic area, i. e., the area within which the calls are not charged any special rate in addition to the ordinary charge recorded by the subscribers' meters.

As a first stage in this automatization the Swedish Board of Telegraphs ordered in 1932 from Telefonaktiebolaget L. M. Ericsson automatic equipment for the telephone exchanges at Lidingö, one of the largest suburbs of Stockholm. The order included three exchanges, Lidingö Villastad with 2000 numbers, Lidingö-Skärsåtra and Lidingö-Brevik with 500 lines each, together with equipment for automatic communication with the Stockholm exchanges. The first of the Lidingö exchanges was put in service in January this year, and the two others will be ready for service in January 1934.

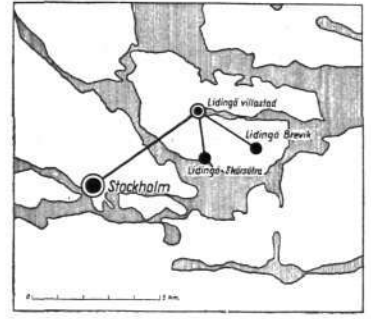
The automatic suburban exchanges will be connected to the Stockholm system in the same manner as are the local exchanges in the city proper. The subscribers will therefore have 6-digit numbers in the same number series as the Stockholm subscribers. A subscriber at Lidingö can therefore, in the same manner as the Stockholm subscribers, call a Stockholm subscriber or a

subscriber of the automatic suburban exchanges by means of his dial.

The Stockholm automatic exchanges, which are at present equipped for about 140 000 numbers, are built on the Ericsson system with 500-lines selectors and were provided with first and second group selectors only. In order to increase the capacity of the system in consequence of the automatization of the suburban exchanges a third group selector stage has been provided for the traffic to and from the suburbs. These group selectors have been placed in the local exchange in Stockholm through which the automatic suburban traffic — as well as the traffic until now dealt with manually — is directed. Fig. 2 shows a routing diagram of the connection between the Lidingö automatic group and the Stockholm exchanges.

The Lidingö exchanges are built on the newest Ericsson system with machine driven, relay operated 500-lines selectors and with all connecting devices for one 500-group of subscribers, joined to one row, i. e., subscriber's line equipment, registers and selectors with the necessary operating relays. The operating voltage is 24 V.

The Lidingö Villastad exchange has complete equipment with line relays, line selectors, registers, group selectors and final selectors. The Skärsåtra and Brevik exchanges on



X 3127 Fig. 1. The Lidingö exchange area.

the other hand are built as satellite exchanges of the Lidingö Villastad exchange. They are therefore only supplied with line relays, line selectors and final selectors while the necessary registers and group selectors are placed in the main exchange (see Fig. 2). Calls between two subscribers of the Skärsåtra or Brevik exchanges are thus directed over the main exchange.

All internal traffic on Lidingö passes one group selector stage only. The three exchanges can therefore be extended to 10 000 number together before a second group selector stage will be necessary. On account of the assembling of all group selectors in the main exchange, all junctions necessary for Stockholm traffic terminate in this exchange. Two traffic directions of 10 000 numbers each have been arranged as a reserve for short-cut traffic to adjoining suburbs.

The junctions between Lidingö Villastad and Skärsåtra and Brevik respectively are made as non-phantomized cable circuits; DC impulses can consequently be used. The circuits consist of three wires, of which the two speech wires are loaded and third wire provided for impulse transmission is unloaded. On account of this the DC in the loaded wires is reduced to less than 10 mA.

The junctions between the local exchange in Stockholm and the main exchange at Lidingö Villastad are single-direction loaded and phan-

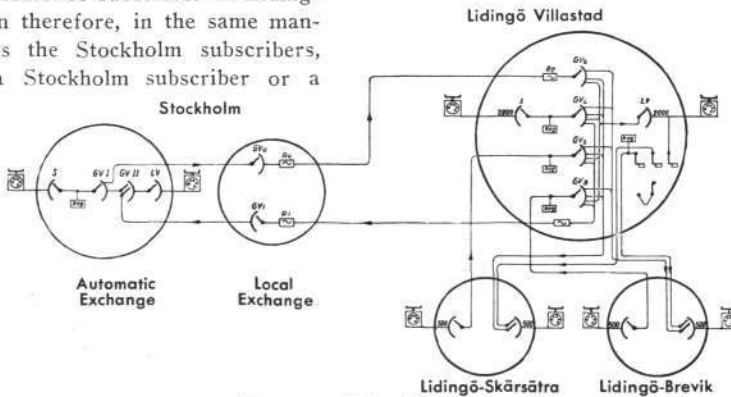
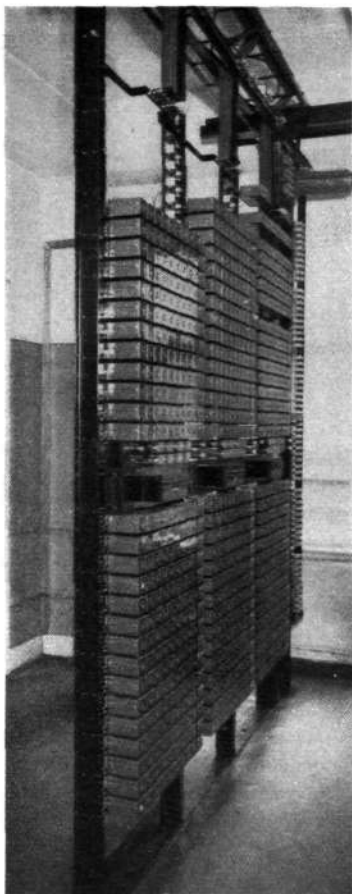


Fig. 2. Routing diagram of the Lidingö exchanges.

X 5081



X 3126 Fig. 3. Repeater bay, containing repeaters for 37 junction lines Stockholm-Lidingö.

tomized cable circuits. On these circuits impulse transmission can therefore be carried out with AC only. All impulse transmission for selectors over these junctions consists of revertive impulses from the selectors to the registers. At each end of the junctions revertive-impulse repeaters are inserted for transforming to AC impulses, which are transmitted over the junctions, the DC impulses produced by the selectors, and for re-transforming them on the register side to DC impulses for the registers. The starting and stopping of the selectors are based on a differential connection.

The revertive-impulse repeaters operate with 110 V AC, 50 cycles, taken direct from the mains at Lidingö Villastad, and in the Stockholm local exchange from the frame motors, which act as rotary converters.

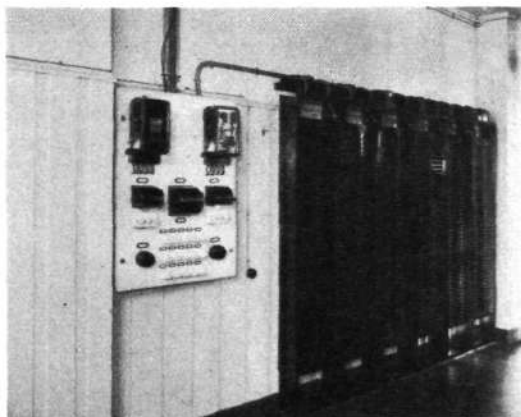
In addition to the selector impulses the necessary operation signals are transmitted as DC impulses over the junctions. For instance when during the setting up of a call from Stockholm to Lidingö, an outgoing group selector *GV II* in the local exchange has stopped on a clear junction the corresponding repeater, *RU*, transmits a short AC impulse as a test signal to the repeater *Ra* at the other end of the circuit in order to ensure that this repeater with the corresponding group selector *GVa* is clear for connection. If this is the case the latter repeater immediately transmits an answering impulse to the local exchange, at the same time as the selector is started. In other cases the group selector in the local exchange proceeds to the next clear junction. During the motion of the incoming group selector *GVa* revertive impulses are transmitted to the register *Reg* in the local exchange in Stockholm until the position determined by the dialled number is reached. The impedance of the repeater in the local exchange included in the circuits is then altered thus causing a polarized differential relay in the repeater at Lidingö Villastad to be actuated and stopping the selector. The final selector *LV* in one of the Lidingö exchanges is then operated in a corresponding manner. The ring signal to the called number is sent out from the local connecting devices and the feed comes from the repeater.

When the called subscriber lifts his microtelephone and replaces it at the end of the conversation, signals consisting of short AC impulses are transmitted over the junction; the signal relays of the cord circuit in the home exchange are then operated in the same manner as for local calls, and a double clearing signal is thus obtained even for junction calls. When both subscribers have replaced their

microtelephones a long AC impulse is transmitted from the repeater of the home exchange; the repeater of the called exchange is then released, and the subsequent selectors return to home position.

Trunk calls to and from the Lidingö subscribers are established by means of a manual switchboard in the main exchange at Lidingö Villastad. The subscribers' lines of the main exchange are entered into the multiple of this switchboard. By means of a dial in the switchboard and long distance final selectors at Skärsåtra and Brevik the operator can come automatically in connection with the subscribers of these exchanges. Special 3-digit registers being provided in the main exchange the operator need only dial the three last digits of the subscriber's number after having established connection with the satellite exchange.

The Lidingö Villastad exchange was to some extent to be regarded as an experiment in the automatization of the suburbs of Stockholm, partly for discovering to what extent the bare wire line systems of the manual exchanges could be utilized on automatization, partly for testing in service the Ericsson AC revertive-impulse repeaters on long junctions. During the time, nearly a year, the exchange has been in service it has been found to function in a satisfactory manner, and, on account of the low operating voltage, 24 V, no inconvenience due to the bare wire line system has been encountered.



X 1224 Fig. 4. Charging rectifier, consisting of two sets, each of one three-phase rectifier for 45 A.

# Greyhound Racecourse Totalisators

When the Betting Act became law in 1928 the first Ericsson totalisator was developed to cover the requirements of the Racecourse Betting Control Board (R.B.C.B.) of Great Britain. Subsequent experience with equipment manufactured, installed and maintained for the R.B.C.B., and the introduction of fully mechanized machines on greyhound racing tracks, led to the development of the Ericsson totalisator, Type C60. The system has been improved and simplified, while retaining the essential features and safeguards required by the R.B.C.B., and is now sufficiently flexible to co-

ver the requirements of the smallest of greyhound or the largest of horse racecourses.

The cardinal features of the Ericsson totalisator are:

it automatically displays to the public the exact accumulating amounts invested on each runner for win, place and totals;

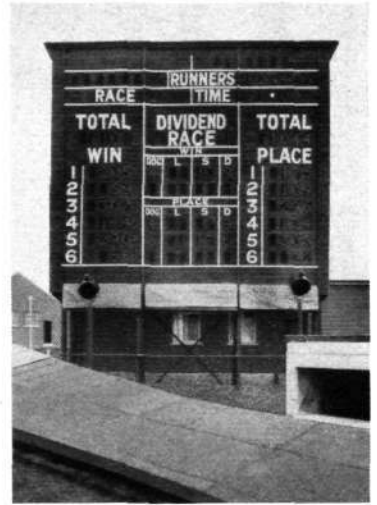
it is fraud and fool-proof, unfaillingly accurate, and more rapid in operation than any other totalisator.

The totalisator is described in the following article, which is reprinted by courtesy of the Ericsson Bulletin.

The functions of a totalisator are to issue a ticket, upon which details are printed to identify the runner, the stake value and whether win or place, the race and the race meeting, and to register the stake upon some recording device in strict accordance with the particulars printed upon the ticket. Preferably, the recording device should automatically display or control displays to the public to show the accumulating totals invested on each runner for each class of stake.

The totalisator must command the confidence of the public by its unfailling accuracy in recording and totalling the amounts wagered, in its freedom from breakdowns, and in the speed with which stakes are registered and queues at selling windows kept down.

In the Ericsson system the equipment is built up of items of apparatus, the soundness of design of which has been proved by years of public service in automatic telephone exchanges throughout the world. It



X 3128

Fig. 1. Indicator.

comprises, in the main, two standard components: the relay and the rotary line switch, built up into circuits which are designed to allow a liberal factor of safety for all operations. Every operation during the actual recording of the stake is checked, and an alarm is given should any portion of the equipment fail to function correctly and within a predetermined time. If for any reason the stake cannot be recorded the relative ticket is *not issued*, and the alarm conditions automatically set up indicate the trouble.

For every ticket issued, from any part of the track, an impulse is given to a rotary line switch in an adding machine appropriate to the runner and the class of stake selected. The adding machines are located at a central point, *viz.*, the control room, and rotary line switches forming the adding machines are provided for each denomination served by the ticket machines and for each digit displayed on the indicator; each adding machine serves one runner for one class of stake, *i. e.*, for win or for place. The runner and class of stake are selected on the ticket machine when the demand is made, and the stake impulse is thus routed to the appropriate adding machine.



X 5070

Fig. 2. Clubroom selling windows.



X 3129 Fig. 3. Control switchboard and miniature indicator.

Each ticket machine issues tickets of one value only, being permanently wired to a particular denominational common according to the requirements of the track. A machine issuing 2/- tickets can therefore impulse 2/- switches only; the appropriate switch in the adding machine is thus selected automatically.

Electrical linking arrangements are provided between the different denominational switches in any one adding machine, so that when a switch of lower denomination has been stepped ten steps by the issue of ten tickets of that value, the switch of next higher denomination is stepped one step by an impulse received from the switch of lower denomination in passing from its ninth to its tenth position. The whole arrangement provides an electrical counter, similar in effect to a standard »veeder« counter, except that it is not confined to unit impulses; the tens, hundreds etc., sections of the counter being capable of individually responding to impulses from appropriate ticket machines.

It will thus be seen that the position of the denominational switches of any one adding machine represents a measure of the number of tickets issued for the runner concerned. The switches do, in fact, register the number of unit stakes invested in the particular runner, and where the unit stake is 2/-, as is

usually the case, a direct reading is provided in pounds and tenths of a pound.

All indicators are controlled from the switches in the adding machines, being connected in parallel thereto and providing a visual indication in figures of the position of the adding machine switches. The figures on the public indicators are built up by illuminated lamps which change their formation with the varying positions of the switches, which in turn vary with the issue of tickets from the ticket machines. In addition to the public indicators, large and small miniature indicators are provided to display results in the club and in the control room respectively, the reading on each being shown by means of individual lamps lighting up figures.

Provision is made on the indicators for the display of winners, the dividend to be paid per unit stake on winning tickets, and miscellaneous signals with regard to racing results. The setting up of winners is directly under the control of some official of the racecourse, usually the judge, and suitable controlling equipment is provided for this purpose near the winning post. As soon as the winners have been declared, the control room staff work out the dividends and set them up provisionally on the miniature indicator in the control room. When these have been check-

ed by the totalisator manager or other responsible official, they are then displayed on the public indicators.

Safeguards are provided to ensure that tickets cannot be obtained from a ticket issuing machine for a race which has been run and thus upon a known winner. As soon as the race starts, all ticket machines are locked to prevent the further issue of tickets. In order to bring the machine into use again for the next race, each ticket seller has to operate a lever on the side of the machine, which automatically changes the race number printing drum, inside the machine, to the following race number. All tickets subsequently issued will bear this new number. The mechanical linking arrangement between the race number change and the electrical circuit of the machine ensures a really satisfactory control of ticket selling. The interior of a machine cannot be interfered with in any way by a ticket seller.

Ticket issuing machines are grouped in selling buildings situated in various enclosures round the track, and are looped together to one set of common conductors which are finally connected to the apparatus in the control room. The circuit arrangements are such, that for each group of ticket machines and class of stake only *one machine at a time* can use the common conductors, and

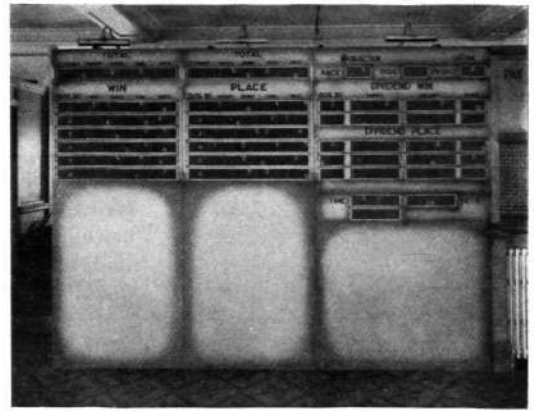


X 5071

Fig. 4. Inside of selling booth, showing ticket issuing machines.



X 1225 Fig. 5. Control-room apparatus.



X 1226 Fig. 6. Clubroom indicator.

a feature of the system is the chain relay control which permits this to be done with great speed and without any deterioration of the general accuracy level of the rest of the equipment. A full load ticket-issue speed of 60 to 75 tickets per minute can be obtained, even on heavily loaded groups, which is a particularly desirable feature when demands for multiple tickets are made and queues are forming at selling windows.

The chain relays are provided one per ticket machine, and form part of a relay set which is individual to a machine. If a group of machines are operated simultaneously, their relative chain relays set themselves in a queue and operate *one at a time* to allow each ticket machine in turn access to the common conductors over which the stakes are routed. A chain relay can operate only when its turn comes and when any relay previously operated has released. The chain relays of machines not initiating a stake operation at the moment, and of machines which have registered their stakes and are in the process of printing the relative tickets, form no part of the queue which is made up only of machines

initiating bets at approximately the same time. Ticket machines are cleared out of the queue at the rate of over 30 per second, and this speed, together with the small number of machines initiating a stake operation at approximately the same time, makes the waiting time in the queue negligible, even for a large group of machines. With a group of 100 machines, in one chain relay control, the ticket issue speed, with all machines serving the public in the last five minutes preceding the start of each race, varies between 60 and 75 tickets per minute per machine, as previously stated. Of course, this does not mean that 6 000 to 7 500 tickets are being issued to the public in any one minute; the lag of the backers forming queues at selling windows, the making of the demand for a particular runner, and the handling of cash, all slow down the actual issue of tickets to the public. The issue speed quoted above is the average speed at which any ticket is ejected from the machine.

It is desirable that the whole totalisator should be under full control throughout all stages, and the Ericsson totalisator being all electric

is particularly suitable from this point of view. The ticket machines are under constant control, the totalisator is started on stopped by electric contacts operated by a Yale lock, and all instructions to selling buildings are given by means of coloured lamps and hooters. Only the authorized person, equipped with the starting key, can operate the controls, all of which are conveniently grouped on the control switch-board. The possibility of accidental or malicious misoperation is thus reduced to one person who is under the direct supervision of the totalisator manager.

The following greyhound tracks have already been equipped with Ericsson totalisator, each of which fully justifies the claims made for this equipment:

- Dunmore Park, Belfast
- Perry Barr, Birmingham
- The Stadium, Sheffield
- Darnall, Sheffield
- Wimbledon Stadium, London
- White City, Glasgow
- Penny Cross Stadium, Plymouth
- Boundary Park, Norwich.

Other totalisators for track use are in course of construction.

# Paper-Paraffin-Insulated Condensers for Filter Circuits

*Ericsson Magyar Villamossági R. T. has recently delivered to the Budapest Suburban Tramway Company a battery of paper wound paraffin impregnated condensers, intended for use in filter circuits for the elimination of interference produced in telephone lines by the mercury rectifiers for the track propulsion current.*

*This delivery is specially interesting on account of the considerable size, 151  $\mu$ F, and high service voltage, 1200 V, of a battery of this construction.*

The World Jamboree held in August this year in Gödöllő was expected to involve such a great increase in the traffic on the suburban line between Budapest and Gödöllő that the Budapest Suburban Tramway Company had to enlarge its converter station in Gödöllő by the addition of one mercury rectifier. As the feeder and trolley lines of the track run parallel to the State telephone lines, and as the greater amplitudes and harmonics of the DC produced by the mercury rectifier induced a higher tension in the telephone line than that permitted by the Royal Hungarian Post Office, the tramway company had to insert a filter in the line at the converter station in order to eliminate the noise of interference. The mercury rectifier has six anodes and thus produces the disturbing frequencies corresponding to 50 cycles, *viz.*, 300, 600, 900 and 1200 cycles. These harmonics are eliminated by means of the filter which is composed of choke coils combined with condensers.

The condensers in the filter circuit were delivered by Ericsson Magyar Villamossági R. T., and manufactured as paper wound paraffin

impregnated condensers. These condensers had to comply with the following prescriptions: voltage test with 8000 V DC during 3 minutes; and, during a subsequent service test with a tension of 1200 V DC on which an alternative tension of about 15% of the DC tension was superposed, the heating should not exceed 40° C. Moreover, the loss angle was not to be greater than 30'.

With a view to these requirements, calculations were first made in order to ascertain the quantity and thickness of the paper, the most suitable capacity of the individual condenser elements, and the number of elements to be connected in series. It was found that the most suitable individual capacity would be 0.5  $\mu$ F, and that three such elements should be connected in series.

In order to ascertain the heating

of the condensers, four elements of the same dimensions as those to be used in the final construction were connected in series for the preliminary tests. The elements were put in a box in order to copy the actual cooling conditions as closely as possible. This test showed that the condenser elements could be loaded with 800 V, 50-cycles AC; at this load, which is 6 to 7 times greater than in service, the temperature after 9.5 hours had only risen to 38° C at an ambient temperature of 20° C.

The loss angle of the condenser elements was measured, both in Schering's bridge and according to Kellner's wattmeter method. In Schering's bridge the following results were obtained:

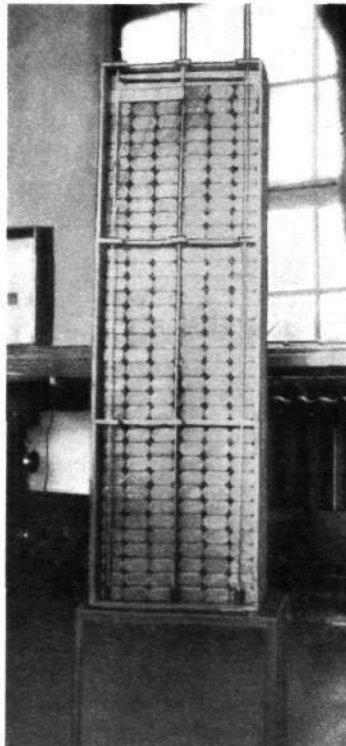
Alternative tension V	Loss angle min.
2 000	8.0
4 000	10.2
5 000	13.4

With the wattmeter method the following results were obtained:

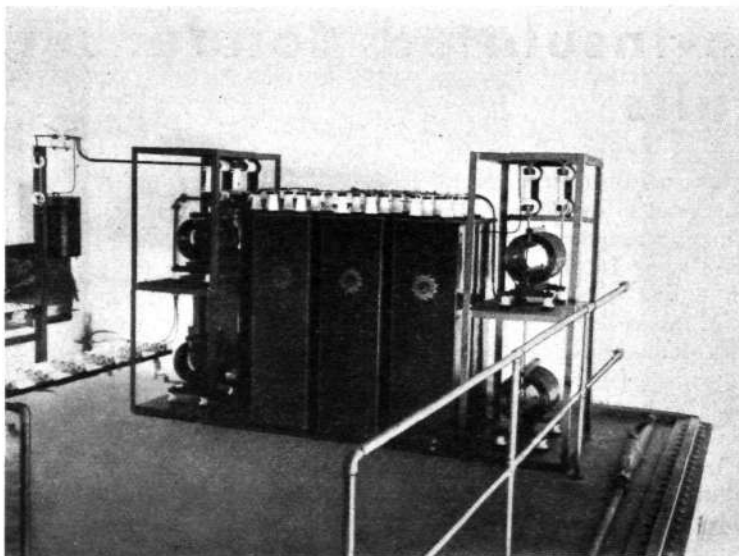
Alternative tension V	Loss angle min.
180	25.9
240	26.0
324	26.2
368	26.3
450	29.2
630	32.0

The higher degree of loss registered by the wattmeter method is because the vibration galvanometer used in the bridge measurements was adjusted for one frequency only (50 cycles), while with the wattmeter method the losses at all frequencies are measured.

The finished condensers were connected in parallel to form a battery, and the loss angle for the total capacity, 151  $\mu$ F; was measured to 33'.



X 3130 Fig. 1. Condenser in course of assembly.



X 5072 Fig. 2. Noise filter erected in the converter station.

## Design.

The battery consists of 13 condensers each of  $11.6 \mu\text{F}$  and has a total capacity of  $151 \mu\text{F}$ . Each condenser is composed of 70 groups connected in parallel with three elements connected in series each of  $0.5 \mu\text{F}$ .

The condenser elements were assembled in a metal box of oblong shape, in view of the better heat dissipation obtained with this shape. To

facilitate the mounting the elements were first assembled in a wooden frame, which was divided into three parts in order to equalize the load on account of the weight of the individual condenser packs. As according to the preliminary tests three elements were to be connected in series it proved most suitable to mount two groups of three elements in a row in order to allow for the soldering of the terminal wires of each element to the three busbars, see Fig. 1. The rows were separated

from each other by strips of insulating material to provide a more even support for the elements. When all packs had been mounted and the terminals soldered to the busbars all interstices and finally the whole frame were filled with paraffin. After a couple of days, when the capacity and insulation values had stabilized, the capacity and insulation of the condensers were accurately measured and the condenser was mounted in the metal box. The space between the box and the wooden frame was filled with paraffin through a hole in the lid. The 10 cm thick paraffin layer and the carefully tightened lid of the metal box ensure an hermetic sealing of the condenser, and all penetration of humidity in the condenser, which would be detrimental to the insulation, may be considered to be obviated.

The capacity of the individual filter groups, as well as the required inductances, were calculated by the customer. The filter circuit has satisfactorily eliminated completely all interference noise.

Fig. 2 shows the condenser battery erected in the converter station. The condensers have been in service since July 1933 and have functioned all along without trouble.

## New Catalogue

A detailed description of the Ericsson electric water level indicators and their application to various purposes was published in the previous issue of the Ericsson Review. A catalogue of this line of equipment has now been published in Swedish, English and Spanish.

In addition to a systematized description of the material, into which we need not enter as it will be sufficient to refer to the article in Nr.

3, the new catalogue contains a description of the extensive and interesting plant, built of Ericsson material, installed for control of the water level in the river Po in Italy. The need of a control system of this kind became evident at the disastrous floods of this river in 1926; the new installation has made possible a far more efficient utilization of the existing means of protection for preventing a repetition of the catastrophe.



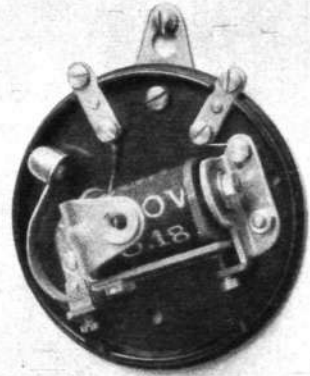
# New Designs of DC-Bells

*Telefonaktiebolaget L. M. Ericsson have in the recent years designed a number of bells for various purposes, which will be among the best in this line.*

*It is perhaps not correct to call these bells new though they are certainly new to our customers. The design is several years old and has for a long time been submitted to exacting tests both in practice and under exceptional circumstances in our laboratories until every detail has been proved to be perfect.*



X 3131



X 3132

Fig. 1 and 2. Bell, Type RA 510.

The bell mechanism has only one electromagnet coil, fitted on two supports. The left of these supports carries the mobile parts, namely the armature and the hammer shaft, in addition to the gong. The bearing point of these parts is situated as near the gong as possible. It is of great importance that the hammer bearing be placed in the right manner in bells with the mechanism built into the gong. The design of the hammer shaft is further of great importance.

This has been kept in view and consequently the bell has a remarkably clear and pure tone.

The self-interrupting spring fitted on the armature has two tongues pointing in opposite directions. One of them carries the self-interrupting contact and the other serves as a return spring for returning the armature and hammer to home positions.

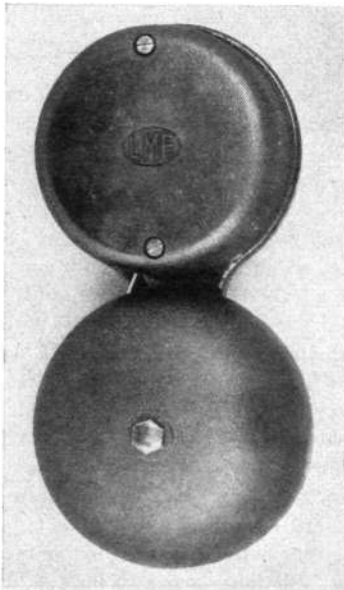
The two functions of the spring can be adjusted by means of two screws, one on each of the two sup-

ports. By means of the left screw the tension of the return spring is adjusted. The right one, fitted on the right support, is used for adjusting the self-interrupting contact. On account of this the right support must be insulated from the coil spool. This insulation is placed on the iron core of the coil and consists of two ebonite bushings.

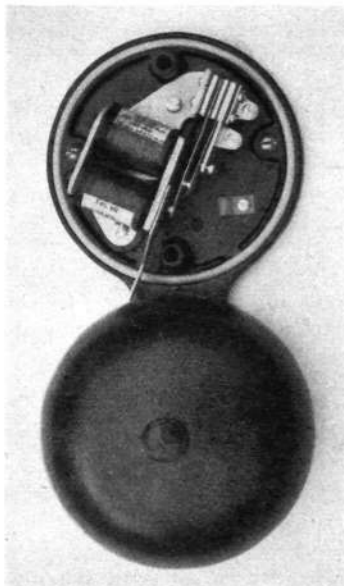
If desired, the mechanism described above can be used without bottom plate, for instance if it is to be built into an instrument, but in this case is should be fitted on an insulating base. As a standard it is mounted on a bottom plate of bakelite. In this bottom plate there are two openings for the adjusting screws, and on account of this the bell can be adjusted even during operation without being taken down. On the bakelite plate there is room for a suspension eye and two terminals for use when the bell is mounted separately. If the bell is to be fixed to the base the suspension eye and one of the terminals are left out. The wires are then connected to the terminal screw of the right support and the remaining terminal which is in this case placed inside the gong.

This bell has the designation, Type RA 610.

The bell can with advantage be used for tensions of up to 48 V DC and is intended for indoor use.



X 3133

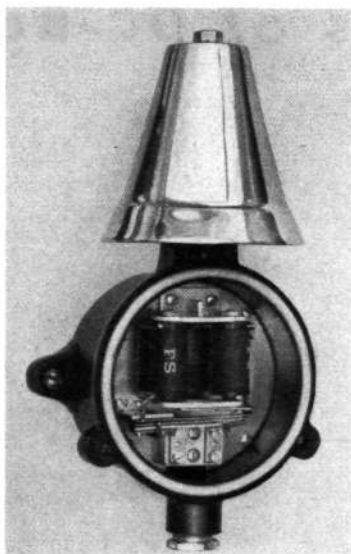


X 3134

Fig. 3 and 4. Bell, Type RA 910.



X 3135



X 3136

Fig. 5 and 6. Watertight bell.

The diameter of the bottom plate is 68 mm and the height of the bell is 36 mm. The weight is 170 g.

In cases where more powerful signals are wanted than those given by the type described above, bells with larger gongs and of sturdier construction should be used. Fig. 3 and 4 show such a bell, Type RA 910, designed for use as signalling bell in extensive signalling systems and in halls. Unlike the type of bell described above it has not been possible in this case to place the mechanism inside the gong, partly because the mechanism must be made larger in order to give sufficient power, and partly because the gong must be free from the attenuation which would be produced if the cover were placed immediately below the gong. The mechanism of this bell is enclosed in a case of cast iron. The case is watertight with the exception of a small hole in the bottom side, through which the hammer shaft projects. The design of the mechanism may be seen from Fig. 4. The cast-iron bottom plate supports a frame of soft iron fitted with two magnet coils, the armature and a spring assembly. The armature with the attached hammer shaft is attracted by the two magnet coils

simultaneously. It is supported only by the return spring. The self-interrupting contact is adjusted by means of the adjusting screw visible to the right in the continuation of the centre line of the upper magnet coil.

The two screws in the spring assembly above the adjusting screw are terminals for the line wires. The springs of the self-interrupting contact are insulated from the frame which consequently carries no current.

This bell can be used for tensions up to 48 V DC, and can be made so as to stand severe climatic conditions. It is designed for outdoor use also.

The dimensions of the bell are: length 297 mm, width 150 mm and height 90 mm. The weight is 3.1 kg.

## Watertight bell.

In addition, there are cases where even such a sturdy construction as the one described above is not sufficient, but a perfectly watertight bell is wanted. This is the case for instance on board ships, on light-

houses, piers and similar places, where the bells are used for alarm and signalling systems, ship's telephones, etc.

In order to meet these requirements the bell, Type RA 1200, has been designed. This bell, Fig. 5 and 6, is a diaphragm bell and is perfectly watertight. It can thus be immersed in water and will ring under water even for a long time without any water getting to the driving mechanism. The hammer shaft and the armature are fixed to each other on each side of a diaphragm. This diaphragm serves as a bearing for the mobile parts, but at the same time it closes perfectly the opening where it is fitted.

The bell is made of non-corrosive materials; e.g., the case is made of black-enamelled cast iron and the gong is of bronze.

The bell is designed to be mounted in a vertical position as shown by the illustration, for instance on a wall. The diaphragm is then turned towards the wall, and the hammer shaft is protected by the support of the gong. The front side of the bell can be removed, see Fig. 6. On account of this it is possible to connect the bell to the line and adjust it without it being necessary to take it down.

The two magnet coils operate a common armature fitted on the diaphragm, which also serves as return spring. Like the bell, Type RA 910, the armature operates a spring assembly for the self-interrupting contact which can be adjusted by means of a screw after the front side has been removed. Below this spring assembly there is a terminal strip for the incoming wires. These wires should be joined into a lead or rubber cable fitting into the packing of the cable inlet. The bell may be used for up to 48 V DC and can of course be used in any climate. It is especially designed for outdoor use. The dimensions of the bell are: length 269 mm, width 155 mm and height 98 mm. The weight is 2.5 kg.

## Alarm bell.

There has also been felt the need of a DC bell having as powerful a tone as it is possible to obtain with a moderate power consumption. The bell, Type RA 5000, Fig. 7, is of such a design. It is intended for use as alarm or signalling bell for, e.g., time signalling in large factories and for warning signals at railway crossings. In the latter case particularly, it is of greatest importance that the bell should give a powerful and piercing signal but at the same time have a small power consumption and be enduring and reliable.

Powerful signals are of course the most important of these qualities. In the first place, the signal must be so loud that it can be heard by persons in a sedan car in spite of the noise of the engine and at such a distance from the crossing that the car can be stopped in time. It should also be powerful enough to be heard above the noise of two trains. On double-track railways it may occur

that as one train is just passing the crossing another train is approaching. The second train may be hidden from the driver of the car by the train that is passing. In this case the warning signal from the bell must be heard above the noise produced by the two trains and the car engine.

Experiments have proved that a soft and harmonic tone is best heard above various kinds of noise. Further, such a tone is less disturbing and irritating for persons living near the crossing where such a loud bell is mounted. It is, however, not sufficient to supply a suitable gong in order to obtain the desired tone. The hammer and the mechanism must also be designed in a suitable manner which can be arrived at only after long and careful experiment. The bells of this type give such powerful signals that they can be heard at a distance of 3 km even if the listener is separated from the crossing by a wood.

Next to powerful signals, reliability is the most important quality.

During its life-time the bell must operate perfectly under all conditions. Even if a catastrophe does not always follow on faults in the signalling system, the risk is always there, and, consequently, it is natural that railway companies require above all a reliable signalling bell.

The most delicate part in such a bell is the spring assembly for the self-interrupting contact. These springs are therefore of a particularly sturdy construction. It may, however, happen that for some reason there may be an unsatisfactory contact between two springs, which might hazard the perfect functioning of the bell. The bell is therefore fitted with three pairs of contact springs, each pair independent of the others, and it will thus continue its operation even if one pair of springs is faulty. Owing to the continual motion and wear between the contact springs all deposits on the contact plate will soon wear off, and consequently the springs will be restored to normal condition if they have been faulty. This arrangement is of great importance for reliability and perfectly eliminates all failures which may be caused by contact faults.

In view of the need for reliability the power required cannot be taken from the mains available in country districts as these mains are often switched off for long or short periods. Operation of the bell from the mains by means of a floating storage battery will generally be too expensive. Use is generally made of a battery of dry cells having such a capacity that it need only be renewed once a year. Under such conditions the power consumption of the signalling bell will be of great importance. With this new type of bells the power consumption per crossing will be not more than half what it was previously.

In order to get an apparatus which will last, care has been taken to have as few points of friction and wear as possible. Thus the bell mechanism has only one bearing, *i. e.*, at the



Fig. 7. Alarm bell, dismantled.



X 3137 Fig. 8. Alarm bell, with protective roof.

point where the hammer shaft and the magnet armature are supported. This bearing is made as an edge bearing and is sturdy in construction. The

armature actuates the operating contact directly by means of an arm made for this purpose. This arm also actuates a locking spring which keeps the operating contact open during the return of the hammer after each hit. In addition to the parts mentioned, the bell mechanism consists only of a driving magnet, a cover and a terminal strip. The gong is, like that of a church bell, made of bronze.

In order to prevent snow and ice from being deposited on the gong the bell can be fitted with a protective roof made of galvanized sheet iron, Fig. 8. Deposits of this kind even in small quantities would weaken the signals considerably. The shape of the roof is such that it protects the bell perfectly under all circumstances. This may be seen in Fig. 9, where there is snow on the

roof while the gong is perfectly free from snow. In order to prevent the hammer from being injured from below a special protective net designed to be placed below the gong is manufactured.

The total length of the bell is 545 mm including the fixing irons. The gong diameter is 290 mm, the height 218 mm and the weight 10 kg. The total weight of the bell is about 15 kg.

With regard to the general qualities of the bell, Type RA 5 000, it may be mentioned that a great enterprise which was formerly against signalling bells of this type on principle has now ordered a large number of them after having tested a sample bell thoroughly over a long period.



X 1227 Fig. 9. Alarm bell, erected at a railway level-crossing.

# A New Midget Bakelite Telephone

The Ericsson 1931 bakelite telephone as described in the *Ericsson Review* Nr. 1, 1933, represents the standard type for ordinary subscribers' connections to public and private exchanges of manual or automatic systems.

As a complement to this type Ericsson has now introduced a reduced size of table instrument. The new type of instrument is destined for many different uses. In the present article, however, only those types are treated which can be used jointly with the standard instruments for connection to automatic or manual systems.

A sketch showing the comparative sizes of three Ericsson instruments is shown in Fig. 1. The shaded figure in the background with the high

switch hook and a hand microtelephone of old type represents the metal instrument, Type DE 502, and the standard bakelite instrument, Type DE 702, is shown in outline. The new instrument may be seen in the foreground. This last, Type DE 752, measures without the hand microtelephone 152 × 121.5 × 104.5 mm. The respective weights of the instruments are:

Type DE 502: 3.3 kg,  
Type DE 702: 2.5 kg,  
Type DE 752: 1.85 kg.

In Fig. 2 both bakelite instruments, the standard and the new, Type DE 702 and Type DE 752, are shown side by side. It will be observed that the distinctive form of the original model with its pure classic lines has been reproduced in the new. From the point of view of appearance both instruments may thus be considered equal.

The reduced dimensions have been rendered possible by substituting for the polarized ringer another built-

in calling device (Type DE 752), or as is the case with other types, by omitting the ringer entirely or mounting it separately.

## Design.

In the design of the midget instrument the same principles have been followed as those characterizing the standard model, *i. e.*, solid workmanship, standardization of the components and simplicity of adjustment and maintenance. The following components are the same as those used in the standard instruments:

- a dial with protecting case of Ericsson's standard type;
- b. induction coil with closed iron core consisting of laminations of high permeability iron;
- c. condenser, 1  $\mu$ F;
- d. switch with operating arm actuated by the hand microtelephone by means of two plungers gliding in two brass bearings inserted in the

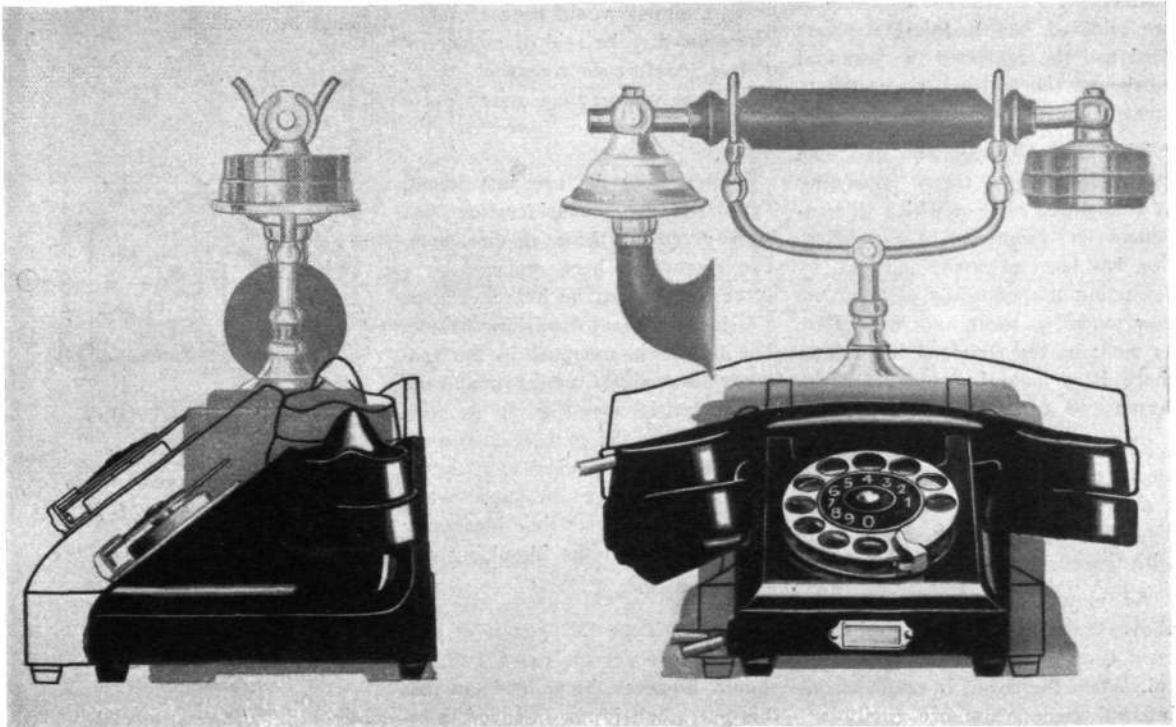


Fig. 1. Comparison between three Ericsson instruments.

In the background, the old metal instrument; in the middle, the standard bakelite instrument; in front, the new bakelite instrument.

X 703 9



X 7040

Fig. 2. Table instruments, Type DE 752 (left) and Type DE 702.

case; the dimensions of the operating arm differ somewhat from those of the original model, but the principle of the transmission of the movements is the same;

e. terminal strip of bakelite with combined screw and soldering connections;

f. terminal block of bakelite with moulded-in terminals and sheet-iron cover. All internal connections are soldered, but the microtelephone cord and the cables to the terminal block and the dial are connected to screw contacts.

The midjet instrument has, like its predecessor, a frame consisting of a mounting plate on which all components are assembled. A simplification has been effected, however, by arranging the mounting plate of the new model to serve as a base plate as well; in the standard instrument there is a mounting plate for the frame and a separate base plate.

The frame is fixed to the case by means of three captive screws. Fig. 3 shows a section of the instrument, Type DE 175, and fig. 4 the same with the cover lifted.

As may be inferred from the above, the design of the new instrument is extremely simple and practical. When the cover is removed, all internal components are easily accessible for maintenance and adjustment.

## Use as Main Instrument.

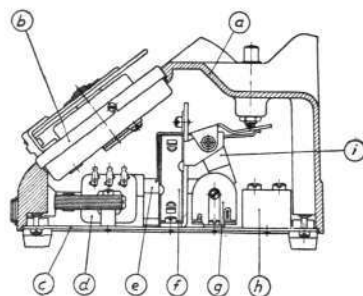
The standard instrument is provided with a polarized ringer having two powerful bell gongs. In offices where several instruments with numerous calls are in the same room, the sharp tone of this bell may be liable to disturb and irritate the occupants, and a less noisy though still distinct signal would be preferable. The same may be said of managers' offices, conference rooms et., *i. e.*, all places where unnecessary noise should be avoided.

In designing the new instrument, Type DE 752, consideration has been given to these requirements. The ringer has been replaced by a buzzer which can be heard even at a distance without disturbing people. The buzzer is mounted in the free space between the condenser and the terminal strip, (see Fig. 3). As with Type DE 702 the connection is antisidetone and has devices to attenuate the excess voltages produced when dialling, at the same time increasing the efficiency of the impulsing circuit.

As with Type DE 702 it is possible to connect an extra bell. It should, however, be pointed out that this extra bell is not intended to increase the volume of the signal but to repeat it in a place at a distance

from the instrument, in order to call the attention of another person in case the operator of the instrument is not present. The extra bell thus has the same function as when connected to an instrument having its own ringer.

It will be seen, therefore, that the new instrument, Type DE 752, is specially suitable for offices, banks etc., indeed all places where noise should be avoided.



X 3147 Fig. 3. Section of table instrument, Type DE 752.

- a case
- b dial
- c mounting and base plate
- d induction coil
- e switch
- f condenser
- g buzzer
- h terminal strip
- i operating arm of the switch

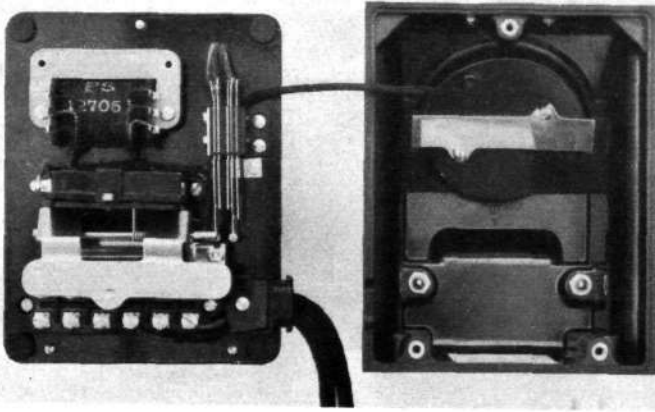
Communications may be carried out to and from both instruments, but not between them.

### Other Uses.

If the instruments are to be connected to manual CB-exchanges the dial is replaced by a blank of the same type as used in the standard instrument. An extra instrument, Type AC 1010, for use in combination with a main instrument connected to LB-systems is also manufactured; this instrument, however, may not be used for outgoing calls, as it has no magneto.

Without going further into details, it may be mentioned that the new midget instrument has other uses than those described above, *i. e.*,

in the new Ericsson selective calling system, in connection with the automatic exchanges, Type OL 12, in systems with DC-calling, etc.

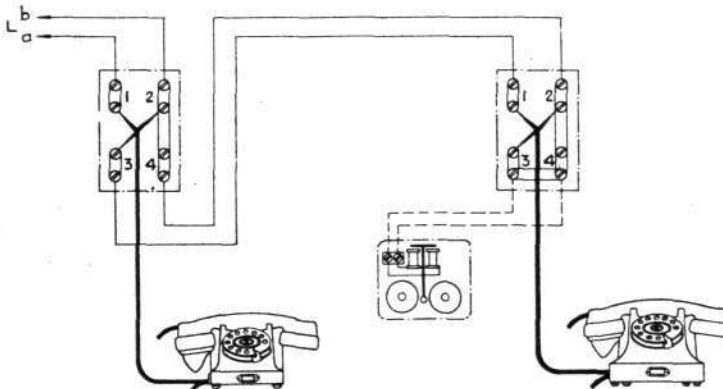


X 5075 Fig. 4. Table instrument, Type DE 752, with the case off.

### Use as Extra Instrument.

In many cases it is desirable to have two instruments connected to the same line. An instrument, Type DE 702 (or DE 200), is then combined with an extra instrument, Type DE 3010, as shown in Fig. 5. The

line is connected to the terminal block of the extra instrument and continues from there to the main instrument. If the distance between the instruments is considerable an extra bell may be connected so that the signal may be heard at both instruments, the extra instrument having no signalling device.



X 5076 Fig. 5. Diagram showing the connection of an extra instrument, Type DE 3010, to a main instrument, Type DE 702.

# Impulse Transmitter

The ordinary type of dial is nowadays commonly used, but, although it is sufficient where there is only a small number of calls per day, considerable inconvenience occurs when a great number of calls per day are to be recorded, as, *e. g.*, by operators controlling automatic selectors from manual switchboards.

The use of a dial thus involves a longer occupying of the registers, depending on the speed at which the operator dials the number, and a certain waste of time for the operator, who has to wait for the transmission of the impulses after each digit.

The use of a dial involves other inconveniences not less important. In addition to the difficulty of remembering the dialled number there is no possibility of keeping a check on it during or after the dialling, which may cause wrong calls.

With a view to eliminating this inconvenience Société des Téléphones Ericsson, Colombes, have designed an impulse transmitter that completely eliminates the disadvantages of the dial. This impulse transmitter is entirely mechanical, has small dimensions, requires no separate current supply and can easily be mounted on a switchboard instead of the dial. The Ericsson impulse transmitter has the following advantages:

1. the setting up of the digit and the transmission of the impulses are separate operations;

2. setting up is carried out by pressing the keys of a numbered keyboard in the same order as the digits of the number;

3. as the digits are set up they appear in a window above the keyboard so that the operator can always see that the number is correct;

4. in case of faults the digit may be cancelled by means of a lever placed to the right of the keyboard;

5. the line is always clear during the setting up and cancelling of the number;

6. when the number has been set up correctly the impulses are transmitted by pressing the key *D*;

7. the impulse transmission is carried out automatically without the aid of the operator, who can use the time for booking ordered calls, etc.;

8. the end of the impulse transmission is indicated in the apparatus by the set up number disappearing from the window. The operator then returns the apparatus to home position by pulling the same lever as used for cancelling, whereby the apparatus is wound at the same time.



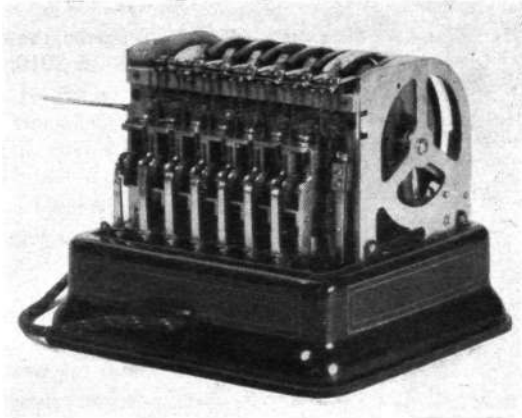
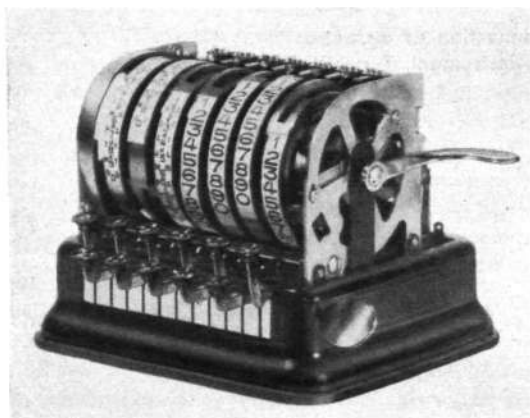
Fig. 1. Impulse transmitter.

## Design.

The exterior view of the apparatus may be seen from Fig. 1. The dimensions are  $175 \times 150 \times 150$ , and the weight, 5.2 kg.

The mechanism is protected by a metal cover with windows where the digits appear during the setting up. The keyboard consists of ten keys with numbers from 1 to 0 and an eleventh key *D*, for the transmission of the impulses. To the right at the top there is the winding lever and below it a support for the thumb which permits the operator to wind the apparatus without difficulty.

Fig. 2 shows the apparatus without cover. The mechanism is mounted on a bottom plate with rubber beneath to prevent slipping. The illustration shows the digit discs after the setting up and the apparatus ready for the transmis-



X 1229

Fig. 2 and 3. The impulse transmitter, without cover, seen from front (left) and rear.

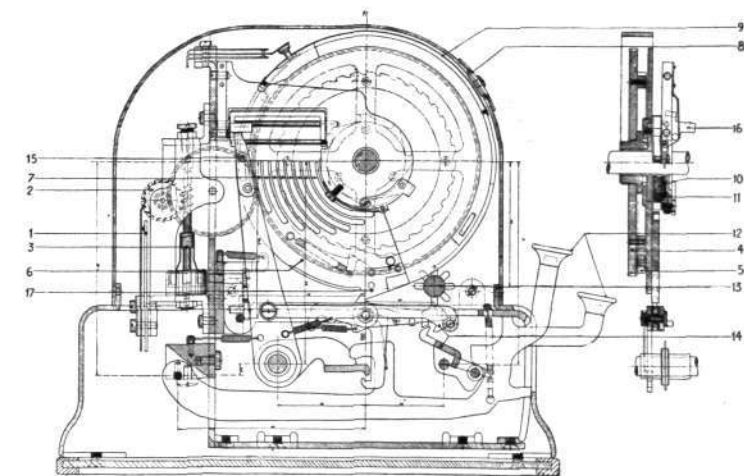
X 1230

sion of the set up number. Fig. 3 gives a back view of the apparatus.

The mechanism consists of two separate parts: the distributing part and the transmitting part. The distributing part has the function of setting the devices of the transmitting part in transmitting position.

In Fig. 4 the keys are indicated by 12. A lever system 14 moves a mobile stopper 15 in front of one of the channels in the disc 6. Each channel corresponds to a digit and the mobile stopper 15 stops in front of the channel corresponding to the pressed key. The disc is released from the ratchet 17 and moves until it touches the mobile stopper. The set up digit then appears in 8. The cam shaft 13 then sets the next disc in position for the setting up of the next digit. By this arrangement the seven discs are set in transmitting position one after the other.

The transmitting part is actuated when the key *D* is pressed. A pin then presses the flap 16 of the first disc, which releases the disc by releasing the mobile stop 15. This disc operates the group of contacts 1 by means of the gear wheel 4 and the cam 2, and the group of contacts then transmits the number of impulses corresponding to the digit recorded by the disc. The speed of the impulses is controlled by the regulator 3. After the im-



X 5077

Fig. 4. Section of impulse transmitter.

pulses have been transmitted the disc continues to rotate for 3/10 of a second and the different series of impulses are thus separated from each other. When the disc stops it lifts the flap of the next disc, which then transmits the next digit. This is repeated until the last digit has been transmitted, after which the digits disappear from the window 8. The apparatus can then be wound again.

The facility with which the operator sets, controls and transmits the number eliminates all risks of faulty operation. In order to ensure the carrying out of all operations the keyboard is automatically locked when the number has been set,

and when the transmission has been carried out and the apparatus requires to be rewound. By this arrangement the operator, finding the keyboard locked, is made to observe either that the apparatus contains a number registered but not transmitted or else it that has not been rewound after the transmission of the previous number.

The apparatus was thoroughly tested at the works and was then delivered to the French Telephone Administration, where it was installed on a switchboard and tested in actual service for one year. It was then submitted to the technical commission of this administration, which has approved of it for use on the state telephone systems.

## News from the Research and Development Department

### Special Designs of Dials.

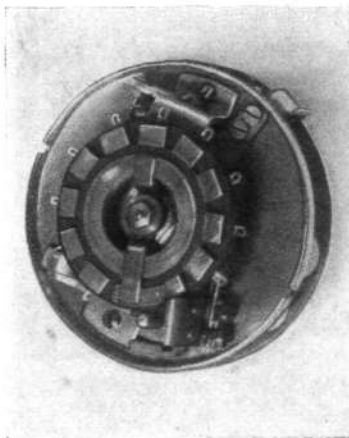
Société des Téléphones Ericsson, Colombes, have introduced some new designs of dials for use as selecting device in small intercom. plants.

The first of the dials described below is intended for intercom. plants of 10 lines and the second for plants of 10 local lines and one exchange line.

As may be seen in Fig. 1 the exterior does not differ from that of the usual type. The design can be seen in Fig. 2.

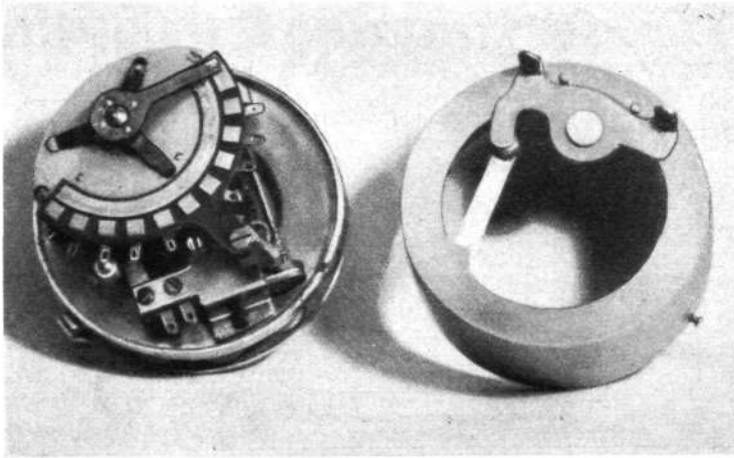


X 3138



X 3139

Fig. 1 and 2. Dial for 10-line intercom. plant.



X 5078 Fig. 3. Dial for 10-line intercom. plant with one exchange line.

By means of this dial it is possible to select one of the ten instruments without using switches or keys. The figure wheel is mechanically connected with a brush arm, which moves along a sector with ten contacts, one for each line. When the microtelephone is lifted the figure wheel is, by means of a locking device, locked in the position where it has been set. The ring signal is transmitted when the finger touches the finger stopper, which is mobile and connected with the ringing contacts. When the microtelephone is replaced the release device on the back of the dial is released, and the figure wheel returns to home position.

10-line intercom. telephone instruments may be equipped with this type of dial and their operation will then be very similar to that of automatic telephones.

The second dial permits the calling of local instruments as described above, and, in addition, calls in the ordinary way to an exchange line connected to an automatic exchange. For this purpose the dial, Fig. 3, has been provided with a mechanical locking device placed on the back of the dial, which is operated by means of press buttons mounted on the instrument. One of these buttons, marked *P*, is used for the connection of the instrument to the local plant and the other one, marked *R*, for the connection of the instrument to the exchange line.

When the subscriber lifts the microtelephone and presses the button *R* he is connected to the automatic exchange and can then set up the desired number in the usual way by means of the dial.

When he presses the button *P* the figure wheel will be mechanically connected with a brush arm, which moves over ten contacts mounted on the back of the dial. Each of these contacts corresponds to a local line. When the finger touches the finger stopper a ring signal will be sent out to the called subscriber.

When the figure wheel is released it returns to home position without bringing the brush arm with it. This arm is not returned to home position until the microtelephone has been replaced after the call has been finished or the button *R* has been pressed anew.

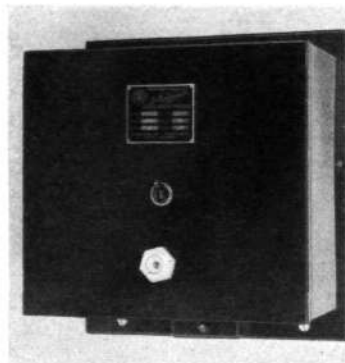
This dial thus permits all combinations previously established by means of an intercom. plant for 10 local and one exchange lines. It has the same appearance as the ordinary dial and the dimensions are the same except that the depth is about 50 mm.

## Mains-Connection Equipment for Small Automatic Exchanges.

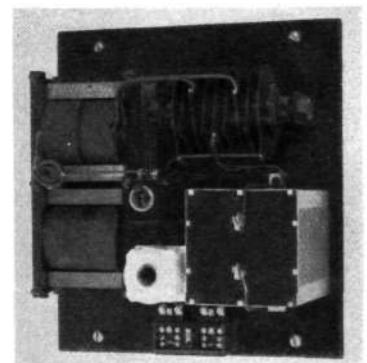
The Research and Development Department has evolved an apparatus for connection to AC mains of small automatic exchanges, for instance the 10-line automatic exchange, Type OL 12, described in the Ericsson Review Nr. 2, 1933. The apparatus can thus be used to replace batteries for the operation of the exchanges.

Fig. 1 and 2 show the apparatus with and without cover. It consists of a transformer for bringing down the mains voltage to a suitable value, a Westinghouse copper rectifier, a choke coil and an electrolytic condenser for smoothing the rectified current, a fuse and a two-pole switch in the high tension circuit, and a terminal strip. All parts except the terminal strip are protected by a black enamelled cover which is partly perforated to allow for ventilation. The switch and the fuse are accessible from the front without removing the cover.

At present the apparatus is available for 50-cycle AC and can be



X 3140



X 3141

Fig. 1 and 2. Mains-connection equipment. The picture to the right shows, left, the main transformer and choke coil; top right, the copper-oxide rectifier, with the switch, fuse and condenser below, and the terminal strip at the bottom.

switched over for 127 and 220 V. The power consumption is 2 W without load and 6 W during calls.

The dimensions are 290 × 260 × 172 mm and the weight is 10.2 kg.

## Toll Repeater.

It is often required to introduce a small amplification (0.5 à 1.0 neper) in certain long toll lines as well as in toll lines of inferior quality. On account of the special conditions under which this kind of repeater operates it was necessary to develop a special type of two-wire repeaters, the toll repeater. In the design reliability, simplicity of operation and inexpensiveness have been kept in view.

In the new Ericsson toll repeater, Type LOD 733, all these requirements have been met as far as possible.

The main principles of the toll repeater can be seen in the diagram, Fig. 1. The line and the balance are connected to a differential device, consisting of two simple transformers, of which one, 1, serves as anode transformer for one direction and the other, 2, as grid transformer for the other direction. This differential de-

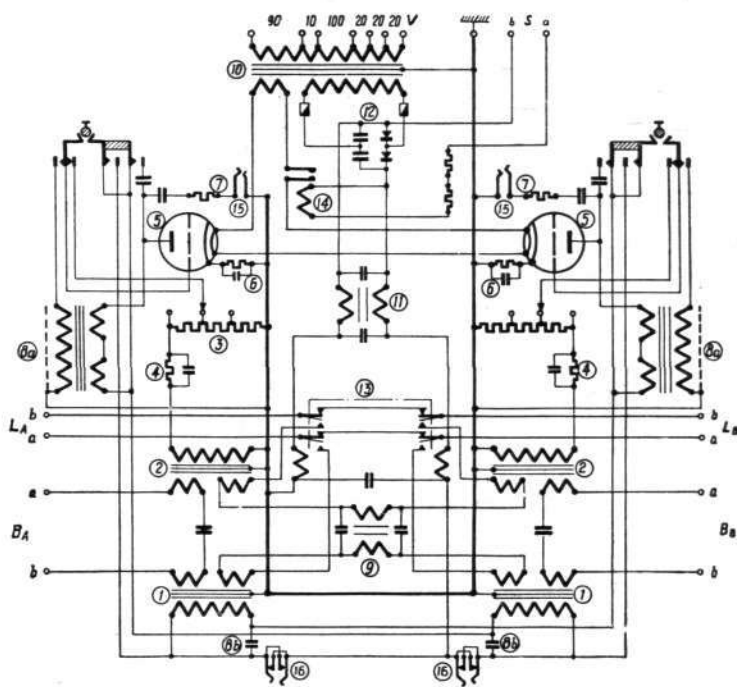


Fig. 1. Diagram of toll repeater.

vice is joined to a mechanical unit. The grid transformer is loaded with a potentiometer 3 with three tappings. By soldering the grid conductor to one of these tappings the gain can be adjusted to 0.6, 0.8 or 1.0 neper respectively. The potentiometer has further a simple attenuation equalizer 4.

The repeater valve 5 is of Type Marconi-Osram MH 4 with indirectly heated filament. The grid bias is produced automatically by the voltage drop of the anode current in the resistance 6 in the filament circuit. A high-resistance receiver can be connected between the anode and filament in series with the device 7

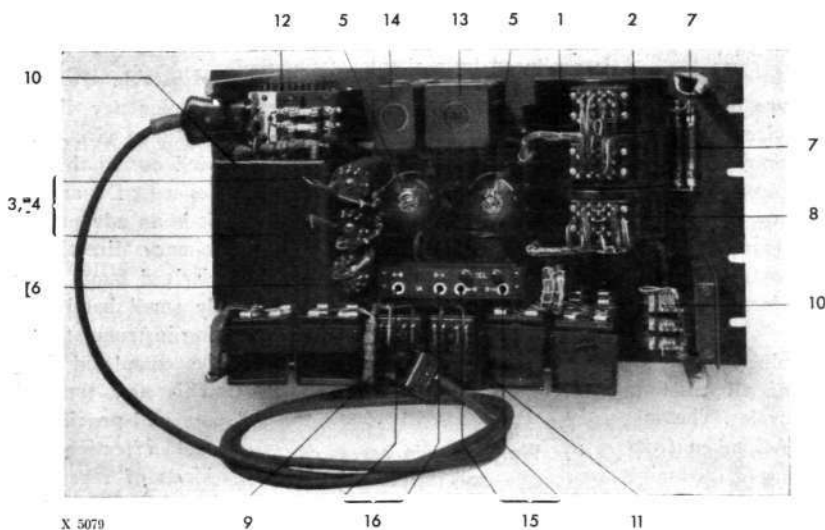
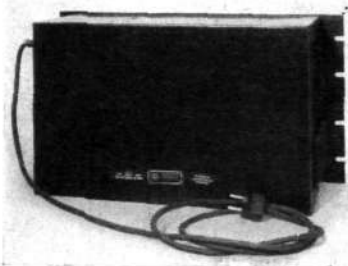


Fig. 2. Toll repeater, without cover.

- |                          |  |                                 |                                      |
|--------------------------|--|---------------------------------|--------------------------------------|
| 1, 2 differential device | 7 resistance                             | 11 coil for compensating filter | 15 listening jacks                   |
| 3, 4 grid potentiometer  | 8 coils for anode filter                 | 12 copper-oxide rectifier       | 16 measuring jacks for anode current |
| 5 repeater valve         | 9 filter coil for ringing-current bridge | 13 anode-current relay          | 17 connecting strips                 |
| 6 resistance set         | 10 mains transformer                     | 14 starting relay               |                                      |



X 3142 Fig. 3. Toll repeater.

consisting of a resistance and a condenser. In the anode circuit there is a low pass filter  $\delta a$  and  $b$  with a cut-off frequency of 2 500 cycles. This filter reduces gain at the high frequencies in order to facilitate the balancing of the lines. At high frequencies it will be difficult to balance the type of lines in question. By means of a press-button switch this filter can be changed to an anode circuit tuned to 600 cycles, the grid at the same time being connected to a feed-back winding on the filter coil. As long as the valve is usable it should start to sing, which is controlled by the receiver connected as has been described above. If this does not occur the gain of the valve has decreased so far, about 0.2 neper, that it must be replaced. This gain control is very simple and can be carried out by any person even without special training. The two filter coils  $\delta a$  are assembled to a constructive unit.

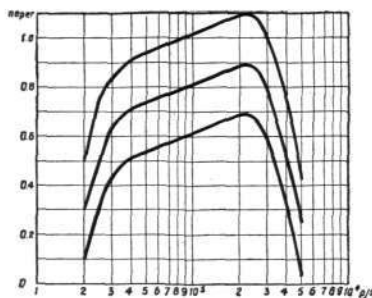
Between the mid points of the two line windings which are interrupted in the differential device there is a bridge connection  $g$  for ringing current passing the repeater. This bridge consists of a low pass filter with a cut-off frequency of 50 cycles. The ring repeater with its need for DC and AC feeding is thus avoided.

The repeater is made for connection to AC mains of all existing voltages and 25—60 cycles. The valves are heated with AC taken from the low tension winding of the mains

transformer 10. The anode voltage is taken through a compensating filter 11 from a copper-oxyde rectifier 12 in voltage-doubler connection. The anode current passes a two-cord relay 13 which separates the lines from the differential device and connects them directly if the mains voltage should suddenly fail. Thanks to this relay a call can be carried on, though without amplification, should the repeater be out of action. The repeater is switched on from the switch-board by means of the starting relay, 14, which attracts and thus lights the valves.

The mechanical design of the repeater may be seen in Fig. 2 and 3. It is designed so that it can if required be mounted on a bay. Single repeaters are usually mounted by means of cramp-irons on the wall near the switchboard of small toll exchanges. The parts are mounted on an iron panel  $266 \times 488 \times 3$  mm; the mounting is very concentrated and the space is well utilized. The mounting of the starting and anode relays is of special interest. These relays are fitted on a main frame and, when the valves have been removed, the relays can be swung down towards the valve sockets. On account of this the soldering tags of the relays are easily accessible.

Gain curves for the three tapings of the potentiometer are shown in Fig. 4. The gradient of the curves is produced by a simple attenuation



X 3146 Fig. 4. Gain curves of toll repeater.

equalizer, consisting of a resistance connected in parallel with a condenser. Other gradients can of course be obtained if these elements are given other values. The gain is given at 1 000 cycles and is 0.6 neper, 0.8 neper and 1.0 neper as has been stated above. Above 2 500 cycles gain decreases owing to the anode filter, and below 250 cycles it decreases because the transformer cannot transfer low frequencies.

The repeater has been tested in practice over a long period by the Swedish Board of Telegraphs and has given very satisfactory results.

The design described above, in spite of the fact that it includes not only the repeater proper but also the arrangements for current distribution, gain control etc., is simple, inexpensive and easy to operate. It constitutes a two-wire repeater which will certainly fulfil other requirements in addition to those stated in the introduction.

## New Experience on Gain Measurements.

As will be known a patented connection has been used for gain measurements on the Ericsson telephone repeaters. The amplifier (in two-wire repeaters both amplifiers of a communication) is fed back over an adjustable attenuation network with a frequency directing device (filter or tuned circuit). Investigation carried out in the Research and Development Department has shown that it is an advantage to design the frequency directing device as an  $m$ -derived band filter with a relatively small band width. Gain measuring instruments with such filters will be completed in the near future. This new type of gain measuring set will provide a means of simple and effective supervision of all kinds of repeaters.

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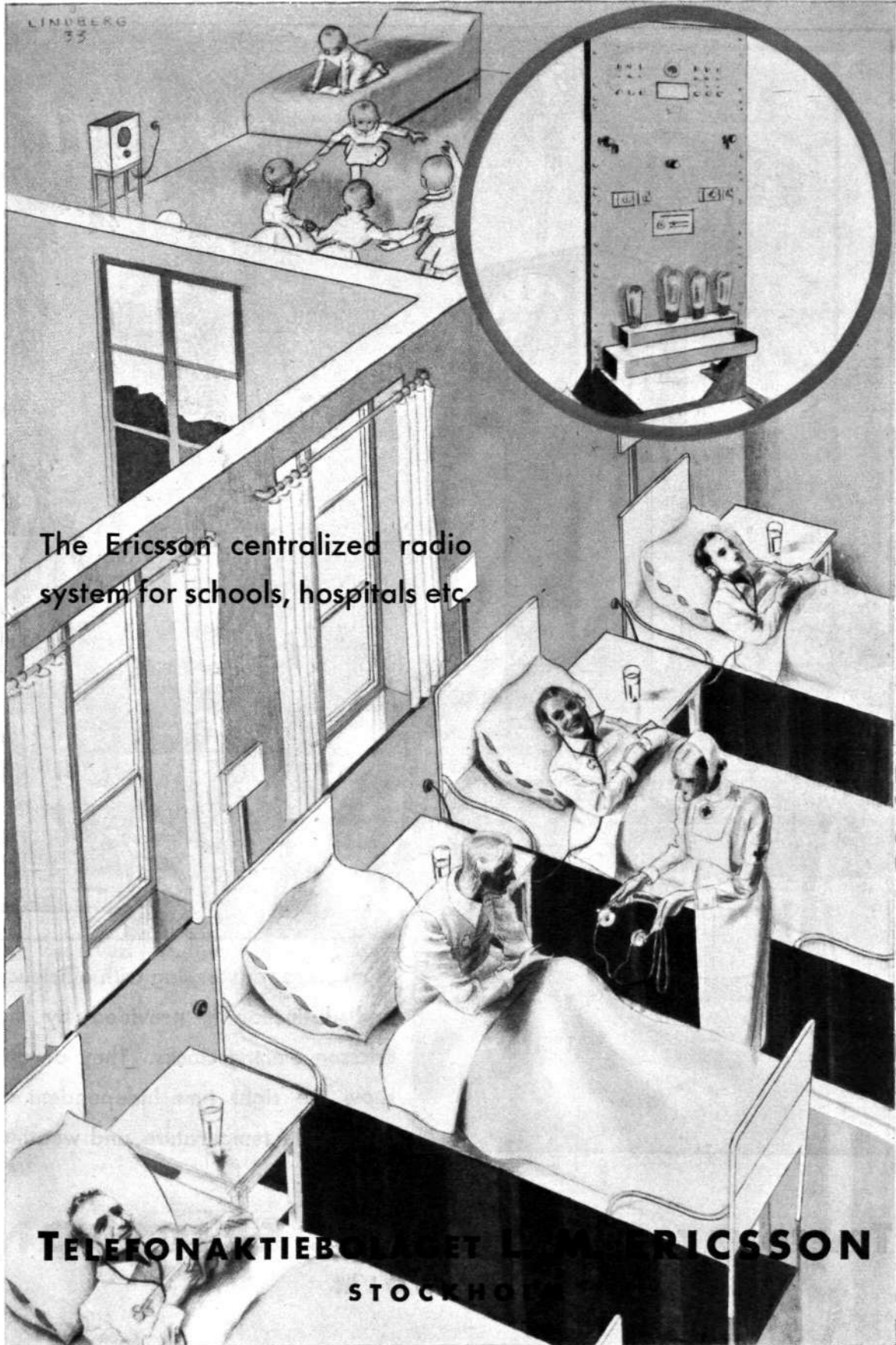
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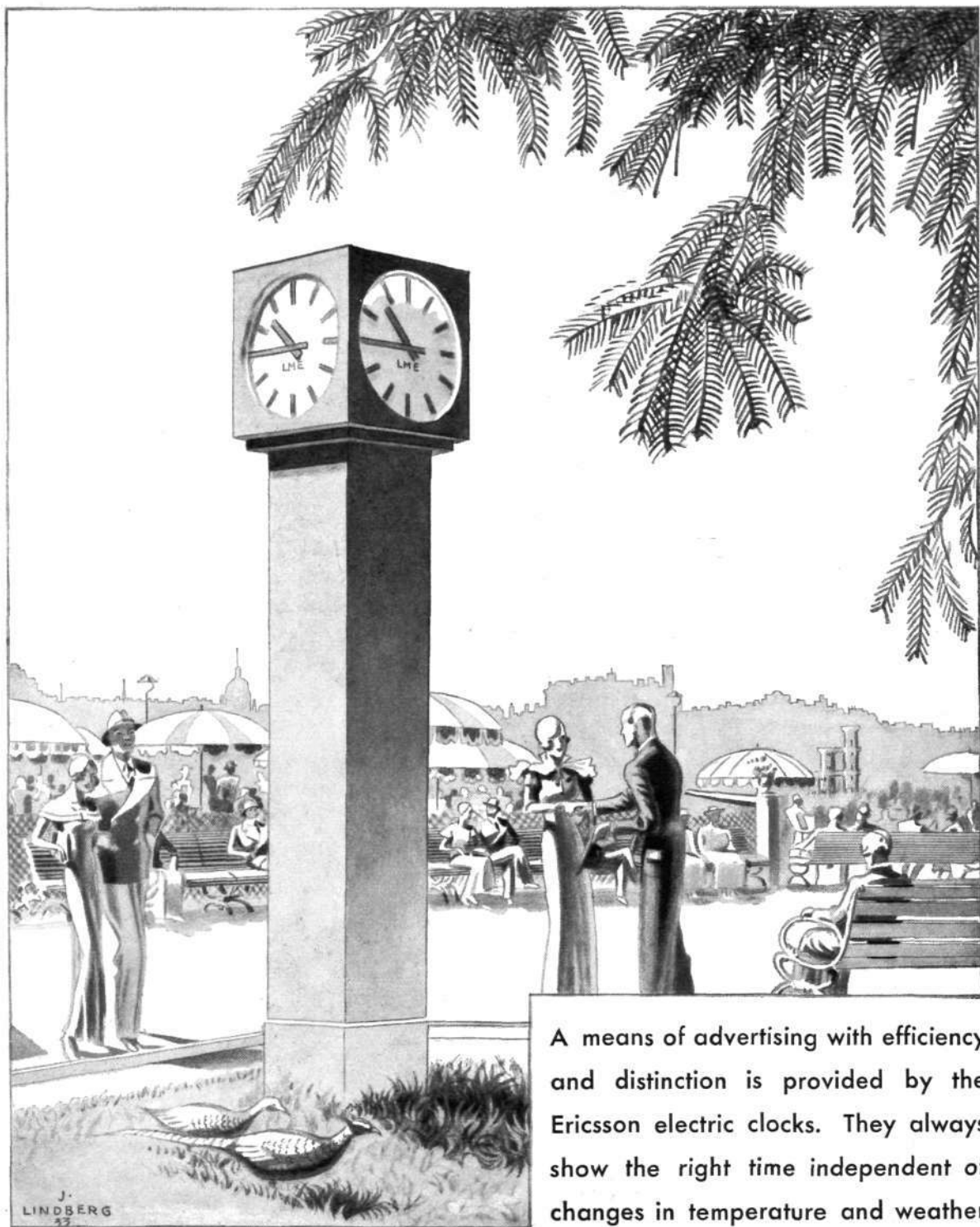
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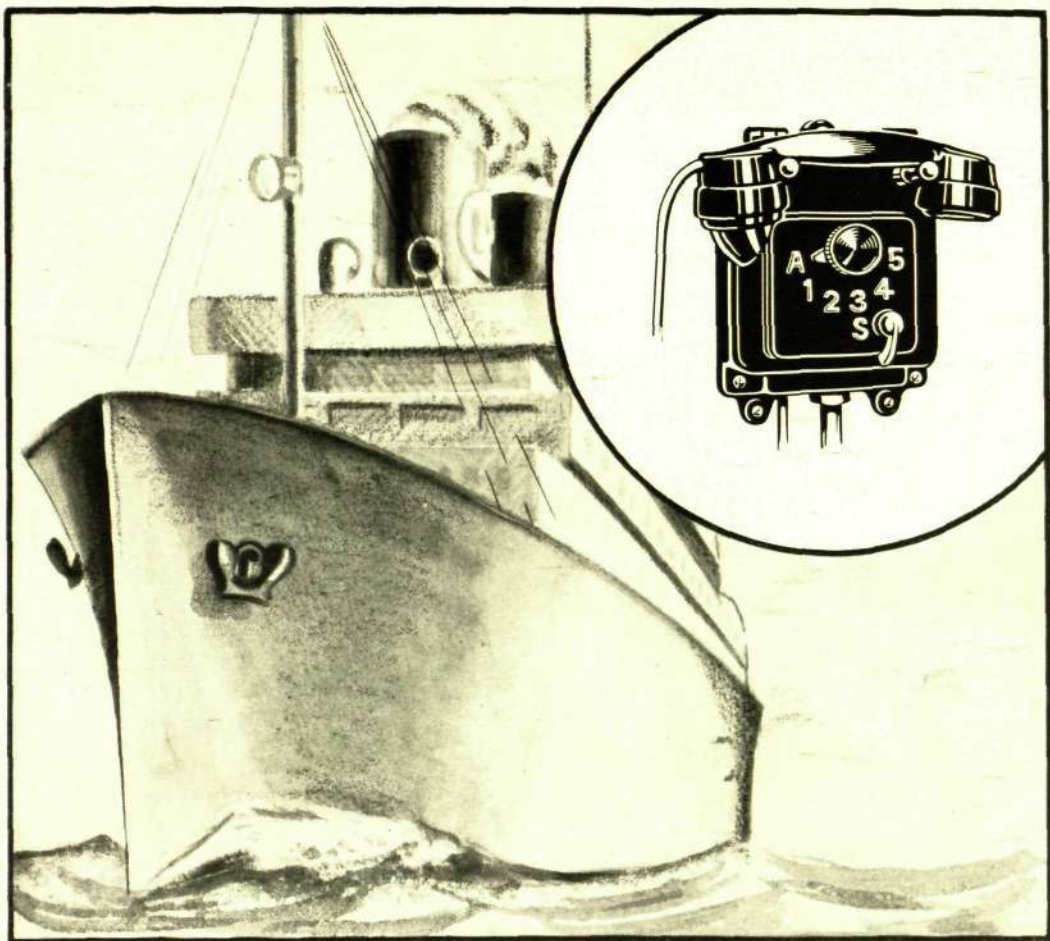
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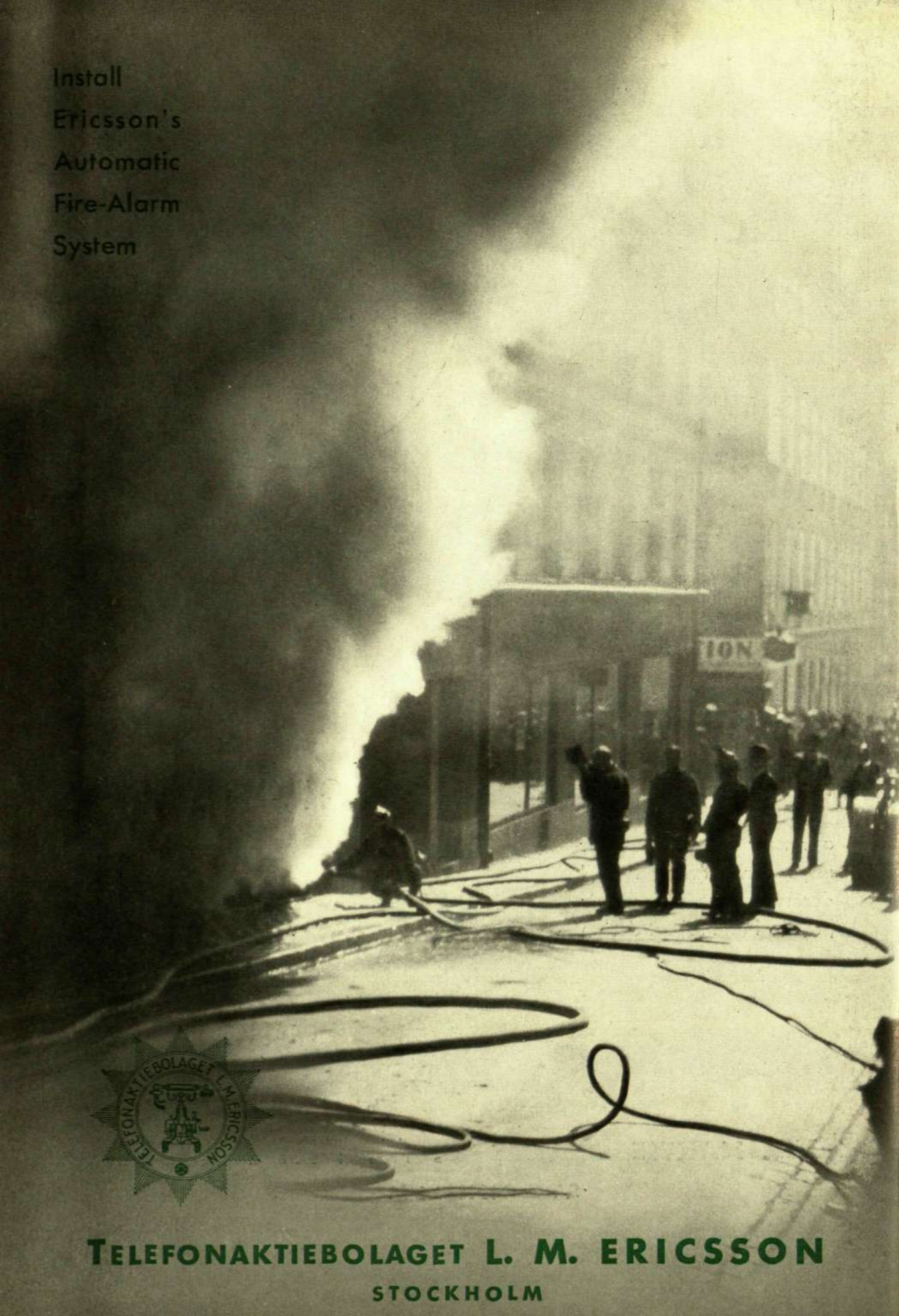
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