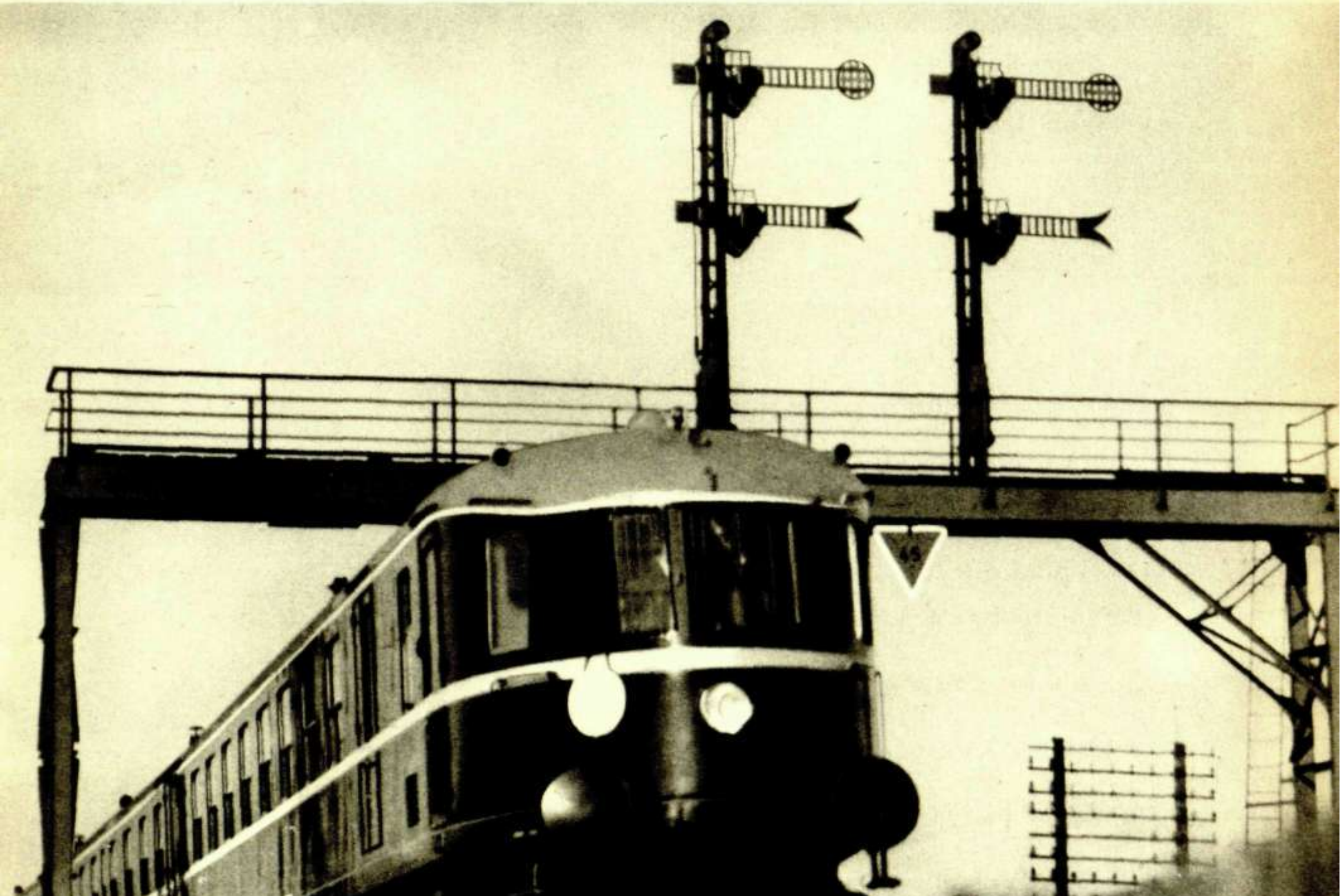
Ericsson Review



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ERICSSON REVIEW

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Field Telephone Instruments

A. ÖMAN, ELECTRICAL ENGINEER, ROYAL FORTIFICATIONS, STOCKHOLM

The equipment of a modern army comprises a multitude of technical auxiliary material, including signalling material of which the great importance only came to be fully recognised during the World War. While wireless above all was developed enormously during the war, this means of signalling can only replace wire transmission to a limited extent.

For that reason, side by side with the general development which has taken place during the last decade in telephone and telegraph practice, military signalling material has also been brought up-to-date and telephone instruments, telephone exchanges, line material, equipment for the construction of lines, etc., have to a large degree been redesigned. Severe demands are placed on telephone instruments for field operation. As the electrical data for a telephone instrument are governed to a certain extent by the conditions under which it is to work, a general survey of the special operating conditions in the field may be of interest.

Field Telephone Cables

At the beginning of the World War single-wire circuits came to be used most extensively at the front. Such a circuit possesses many advantages over a two-wire circuit, as for example the smaller weight and volume of the material (which is important from the transport point of view), smaller amount of material employed, more rapid construction of lines, simpler repair and smaller distortion. On the other hand the single-wire circuit is burdened with many serious disadvantages. Cross-talk often occurs, not only in lines drawn parallel but also between other lines connected in the vicinity of each other, principally due to the fact that the earthing to provide return circuit is bad. Moreover there is the risk of overhearing by the enemy, which can easily be carried out with the aid of a conveniently laid loop with an amplifier set connected. The requisite earthing is in many cases difficult, not to say impossible, to arrange, as for example in dry ground or on rocks. Disturbance from power cables may even be expected to arise; though as a rule these are out of operation at the front.

In view of these disadvantages two-wire circuits are as a rule used for the higher troop formations. For the smaller formations single-wire circuits must still be used to a very great extent, for reasons which should be clear in view of the advantages stated above.

There are several main types of conductors. *Bare-wire conductors* most nearly correspond to the bare conductors employed in permanent nets. The line is usually built as a quad, that is 4 iron cables (even iron wire), 2 or 3 mm in diameter, are laid on porcelain insulators which are fixed to spindles, screwed in to trees or on tube supports born by light poles. Transposition is used instead of twisting, mainly because of the greater speed of laying the line that way. The quads terminate in line transformers, so that a phantom circuit is obtained on the two main circuits, whereby with additional mid-point tapping a telegraph circuit with earth as return circuit is arranged in certain cases. This type of line is used for communication between head-quarters of higher commands.

For the construction of lines required urgently and for laying in the battle area *insulated double wire* is employed. This consists of a core of copper wires cabled with iron wire to take up the mechanical stresses. The core is rubber insulated and braided. The braiding is impregnated with a mixture of ceresin, paraffin etc., which approximates to the impregnation of tarred wood. Two cable parts are twisted for a double conductor.

Two-wire cables are used to a great extent by field telegraph units. According as conditions permit the cable is laid along the ground or where possible on the branches of trees, at a height which allows of persons passing beneath without risk of them being pulled down. As attenuation is considerable (about 0.2 neper/km) the range of telephony obtained is not greater than 15—20 km. The cable is therefore replaced later by a bare-wire cable, as soon as that can be done. The cable is moreover altogether too expensive and difficult of replacement to be allowed to remain exposed for any length of time. The insulation is delicate and quickly deteriorates from rubbing against the branches of trees or other injury.

Single-wire cables are of the same construction as a part making up a double-wire cable. The speed of line laying is considerably higher, as for the same length of laid line the weight and volume are only the half. Single-wire circuits are laid in the same way as double-wire conductors. Earthing to provide return current is done by means of an earthing spike or maybe a bayonet. In exceptional cases a double circuit is made of two single conductors laid about 0.5 m apart. In such case the laying of the line takes a longer time than when double cable is used.

In the front lines, in conjunction with the single-wire cable, *enamelled wire* is employed this being light in weight and cheap to manufacture. It consists of a 0.6 mm annealed iron wire with an insulating enamel coat. Such a line can be laid rapidly, as the wire only weighs 2.2 kg/km, and it is as a rule left lying when it has served its purpose. In rain or damp its insulation is rather unsatisfactory and leakage easily arises if the insulation is damaged which generally happens when laid against branches and the like, *i. e.,* in the place least desirable for it. When the wire is laid on the ground, leakage is considerable. The range of telephony which can be obtained is in general some few kilometres, and in favourable cases, that is when the line is well laid and the weather is dry, up to 5—8 km.

The circuits of a more permanent nature which may be employed in the field are not dealt with here, nor are the cables used at the front in trench warfare, these being more or less of the same design as those in permanent systems. From the point of view of the troops, it is principally the telephony range to be obtained with the different types of conductors which is of interest. In designing the field telephone instruments the properties of the conductors are of interest as there may be considerable variations in one and the same conductor according to different degrees of humidity and dependent on how the line is built. For that reason it is a particularly difficult matter to fix a »normal» characteristic and the limits of variation must be decided by experience with lines actually laid, leaving out of account cases which are particularly abnormal.

The comparatively primitive circuits used in the field and the special operating conditions arising must naturally be taken into consideration in the design of a field telephone instrument.

X 3425

Field Telephone Instruments

A military telephone instrument designed for use on patrol service is anything but a fixture. It is transported without special packing, often at the bottom of a load under a mass of other material, on lorries, carts and springless vehicles, but frequently it is borne by an infantryman who during an advance must continually be throwing himself to the ground. Less importance is therefore laid on an attractive outward appearance than in its ability without deformation to withstand severe mechanical strains. The various parts of the set should remain firm after violent jars or continued shaking. The contacts and leads must be secured so that they do not come loose. In damp weather, pouring rain and driving snow the insulation must not deteriorate. The operation of instrument must be as good at $-30°$ as at $+50°$ C. A cold instrument taken into a warm room becomes covered with moisture but this must have no detrimental effect on the insulation.

When the instrument is designed for carrying, the requirements in respect of light weight and small volume are severe. A signaller, *e. g.*, attached to the infantry, has a considerable equipment to bear, and the telephone instrument which is carried by a strap over the shoulder shares space with haversack, gasmask, waterbottle, revolver, compass, map-holder, report case etc. It should not therefore inconvenience its bearer to any extent.

As regards the method of operation of the instrument with different troop units, the requirements may vary considerably. If all these requirements were taken into account the instrument would have different weights and volumes for the different cases, according to the special parts needed. A microtelephone, an induction coil and a battery together with a suitable case must be considered as a minimum; to these must be added, at least if the instrument is to be connected to an exchange of ordinary type, a magneto generator and a bell. If the instrument is not equipped with a magneto, a buzzer is used for signalling.

Great difference of opinion exists as to whether a field instrument should be equipped with a buzzer or not. The presence of a buzzer is an inducement to employ voice-frequency telegraphy when speech is defective or on account of disturbance is difficult to hear. The risk of overhearing by the enemy is many times greater with voice-frequency telegraphy than with telephony, but even the use of speech is risky for the above reason. The notice on the German field instruments »beware, the enemy hears with you» is well known. In the German and the Norwegian instruments the buzzer is made as a separate accessory, by which better supervision of its use is obtained. In this connection it should be mentioned that during the World War, the ordinary telephone instruments, at least for the first line troops, were to a great extent replaced by what is called the fullerphone. Such an instrument consists, as regards transmission, of a DC telegraph instrument equipped with a low-pass filter which scrambles the outgoing Morse code impulses. Certainly the acoustics obtained through cross-talk (at the beginning and end of the sign) with DC Morse sending make it difficult to distinguish the Morse signs, but the filter must also be used for the reason that disturbances arise in the line itself. DC impulses coming to the instrument are broken up by a buzzer with the aid of an extra contact and the voice frequency thus obtained is heard in the earphone. An ordinary microtelephone can be connected to the instrument for speech communication and conversation can go on at the same time as DC telegraphy. For testing, the buzzer can be connected in such a way that it delivers voice-frequency current direct to the line. A French instruction says that the microtelephone belonging to the instrument must be in charge of an officer or a non-commissioned officer and used only on specified occasions. The question arises whether an LB field instrument can be used on a CB or an automatic net. It is comparatively easy to arrange an LB instrument for connection to a CB net. In principle all that is required is a block condenser for normal position. For use on an automatic system a dial is also required.

A switch-hook or the like is most often less desirable with field instruments, partly on account of weight and space and partly because there is often negligence in replacing the microtelephone. In some instances field instruments have switch-hooks, *e. g.*, in the German army, but in general one is content with an instrument in which the transition from normal to speech position simply consists in closing the microphone current by means of a key in the handle of the microtelephone. The instrument should, without switch-hook or a corresponding switch, function with good effect both at ringing frequency and at speech frequency, 250—2 500 c/s, the instrument in the latter case being dimensioned for 800 c/s. On giving ringing current, disconnection of the instrument circuit can be obtained by means of one of the switches actuated by the magneto generator so that all the output is delivered to the line. In normal position the generator is disconnected, by which the armature as a rule is short-circuited so that it does not weaken incoming ring-signal or speech. In addition separation of the circuit for the frequencies 20 and 800 c/s is done by suitable adjustment of the impedances of the various parts of the instrument.

The dimensioning of the instrument's impedance, calculated between the terminals for connection to the line, is rather difficult in view of the varying quality of the conductors. The characteristic impedance of the conductors varies in strength and phase angle within wide limits, if indeed one can speak of characteristic impedance in the proper sense of the word for the unhomogenous field lines existing in practice, where characteristic impedances of some hundreds to a couple of thousand of ohms must be counted on, and a phase angle of between 0 and —45°. In the first place when deciding on the instrument's impedance, the nature of the conductors must be kept in view, as it is desirable above all things to add to the range of telephony. It has therefore been found desirable to reckon with a characteristic impedance of 700 (—40°) ohm.

With certain kinds of circuits the distance over which signalling can be done is not so favourable as the conditions regarding speech distance. It is therefore better that a field telephone instrument, within the limits governing the weight and volume, should be provided with a magneto generator of comparatively high capacity. The magneto should, on 3 000 ohm actual load, deliver a tension to the terminals of the instrument of 60 V at 20 c/s. In practice the characteristic impedance of the circuit for this frequency is often appreciably less than 3 000 ohm, but in view of the design of the generator this delivers all the same a greater effect.

The sensitivity of the bell is of greater importance than its ability to give great acoustic output. As a general rule it should have a relatively high impedance, around 1 500—2 500 ohm, and with such a sensitivity it should function for 2 mA at 20 c/s.

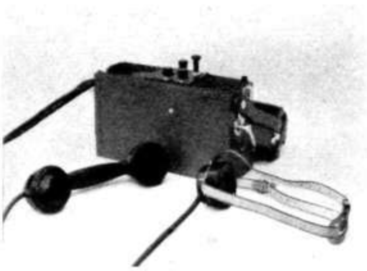
New Field Telephone Instruments

S. WERNER, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

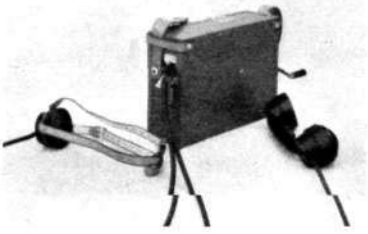
Field telephones do not constitute a standard article to the same extent as ordinary subscriber's instruments do, but are to be found in various designs according to the special purpose which the instrument is required to serve. Thus the requirements on a portable telephone instrument for military service may vary considerably both on account of the nature of military unit which is to carry and use the instrument and on account of local conditions.

The types of instrument described below are designed on quite different lines for the armies of different countries, but all the instruments are made with a view to the great demands of the present day for transmission properties and range, while at the same time fulfilling the highest requirements in respect of serviceable construction.

X 3427



X 3428



X 3429

Fig. 1, 2 and 3
Field telephone from Ericsson, Stockholm
above, closed for transport
middle, open for use
below, lid shut for use in bad weather

Field Telephone Instrument from Ericsson, Stockholm

In the manufacture of Telefonaktiebolaget L. M. Ericsson's new field instrument great care has been directed to the production of an instrument which shall be suitable for service conditions and have a high degree of electrical efficiency.

The instrument is designed in the first place for connection to one-wire or two-wire field telephone networks on the LB system and is provided with arrangement for voice-frequency telegraphy. The instrument is also made for connecting to CB systems. It is normally supplied with magneto generator, but in certain cases this is left out, when the instruments is required to be particularly light in weight. The instrument can then only be used for calling by voice-frequency telegraphy and for connection to a CB network. When the instrument is to be used solely as a troop telephone the bell also is left off as well as the arrangement for connection to CB systems.

From Fig. 1 it will be seen that the instrument is so shaped as to be easily and comfortably carried. It is 185 mm in height, 255 mm in length and 80 mm wide. The weight of the instrument completely fitted is about 4.5 kg. Fig. 2 shows the instrument opened out and ready for use. For stationary service the lid may be completely detached from the case. When employed outdoors in bad weather the instrument may be used with the lid on, see Fig. 3. In that case the key for voice-frequency telegraphy is operated through a hole in the lid.

The telephone instrument consists of an instrument inset, dry battery, hand microtelephone and extra receiver, all enclosed in a case with carrying strap, see Fig. 4.

The *case* is made of hardened masonite panels fastened together with dove-tails and glue. In addition all corners and edges are provided with rivetted metal mountings which still further reinforce the case while at the same time protecting it against shocks. The case is cellulose painted inside and out and is practically watertight. Tests carried out have proved that the case is very durable in spite of its small weight.

The lid has two snap locks, one at each end. One of these can be let down to disclose an opening in the case through which the line wires and the cords for the handset and extra receiver can be inserted. The lid cannot be locked until the opening in question has been closed. In the upper part of the lid there is a leather-covered hole through which the buzzer key immediately below can be operated. The leather, which is set in two metal rings, is easily replaceable.

The carrying strap is adjustable and is fixed to the two ends of the case by buttons. The strap goes through leather runners at each end of the lid. The lid thus cannot be mislaid, though if required it may be completely detached from the case by taking off the strap. One of the buttons holding the strap to the case is bored through and lined with insulation material. Through this hole an enamelled wire for a simple troop circuit may be inserted in the instrument.

Construction

The instrument inset is fixed in the case by three screws which can be loosened from outside the case. The nuts on the inset have a certain sideways play which avoids an accurate fitting of the inset in the case. Part of the space in the case is designed for housing the extra receiver.

The various parts of the *telephone inset,* see Fig. 4, are mounted on a metal frame and form a unit which can be tested and adjusted separately before being put in the case. The inset consists of magneto generator, bell, induction coil, condenser, buzzer, switch for change-over from normal to speech position on connecting to CB network, together with key for voice-frequency telegraphy. The upper part of the frame consists of an insulated plate on which are mounted two contact clips for connecting up the circuit. In addition there are on the plate the buzzer key mentioned above and the CB key. Below the insulated plate lies a three-pole jack for connecting up the handset.

The *buzzer* is fitted under the plate on a little carriage which may be drawn out sideways. The buzzer is made easily accessible to allow of inspection and necessary adjustment.

The *magneto generator* is of an entirely new type which while having larger capacity is smaller in size and weight than those hitherto used in field instruments. The generator is described more fully in a special article in this number.

The polarised *bell* is of standard type, see Ericsson Review No 1, 1933. The gongs are designed to suit the small amount of space available. The bell has a loud tone and rings with less than 2 mA between 16 and 20 c/s.

The *induction coil* is likewise of standard type. It has a closed metal core of alloy sheet and is anti-sidetone connected.

The *hand microtelephone* is of the bakelite standard type, see Ericsson Review No 1, 1933. At the same time it is fitted with key to close the microphone current. The design of this key is dealt with elsewhere in this number.

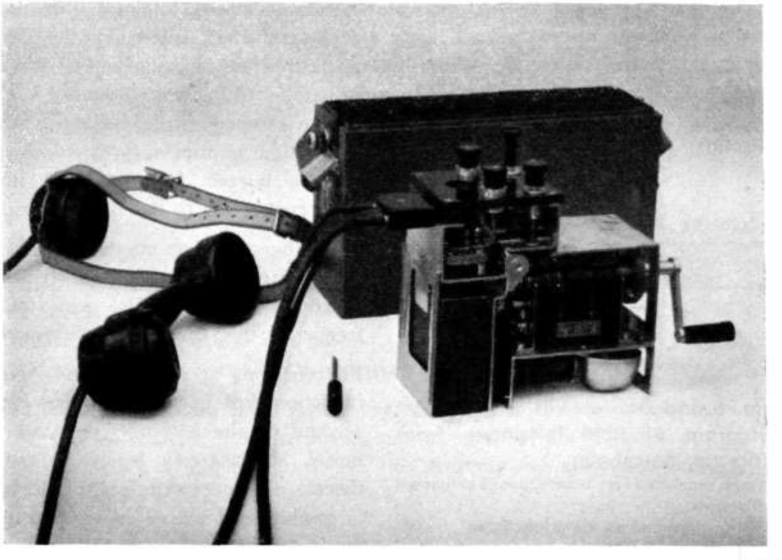


Fig. 4 X 5211
Field telephone from Ericsson, Stockholm
with inset taken out for inspection

As regards transmission properties, the handset is superior to former models used for field telephone instruments. It is provided with three-wire cord made as a rubber cable with round section. Connection to the instrument is by means of a three-pole plug which must be taken out of the jack fixed to the plate of the instrument when a move is to be made. This provides an extra precaution against continuous current wastage in case the key of the handset should get pressed in when packing. In addition it gives the advantage that the handset is easily replaced in case of fault.

The extra receiver is likewise made of bakelite and its casing is similar in construction to that of the handset. It is used in certain cases to supplement the handset and also if a second person requires to hear the conversation. For that reason it is provided with headpiece to hold it against the ear. The receiver has a rubber cord with two wires which branch off at the connecting end, each terminating in a plug. The branches and plugs are vulcanised together with the round rubber cord thus increasing the strength of the cord. The plugs fit in to jacks mounted on the three-pole plug of the handset. When setting up enamelled wire lines the extra receiver is used for supervison of the line, in which case it is plugged in to jacks on the cable drums.

The *dry battery* has an EMF of 3 V, and a capacity which in normal service does not go below 3 Ah. The battery consists of two series coupled rod cells built togther in a case measuring $36 \times 68 \times 85$ mm.

The battery can be changed without the need of taking the telephone set from the case. The battery is put in place by laying it in the compartment for the extra receiver and inserting it from the side. It is locked with a slide held in place by a milled nut. Electrical connection between battery and telephone set is obtained by a pair of stud contacts on the battery against which press a pair of flat springs in the set. This connection arrangement allows of rapid replacement of the battery and gives a more certain contact than with a cord screwed on to the battery.

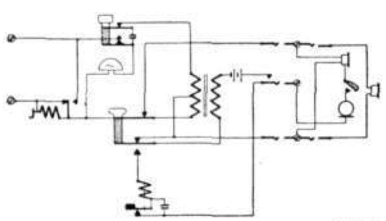
Operation

The apparatus, a diagram of which is given in Fig. 5, is, as stated earlier, designed for connection to both LB and manual CB systems. When the instrument is to be used only as a troop telephone the connection is according to the diagram, Fig. 6.

When connected to *LB system* (field lines) the instrument remains normally in inactive position, and speach position is only obtained when the local circuit is closed by means of the handset key. Incoming ringing current actuates the bell, whereupon the current passes by the magneto generator which is short-circuited in normal position. The speaking current circuit is connected in parallel to the bell through a 1 μF condenser. The reduction in the strength of the ringing current due to this is of no practical importance. Parallel connection is necessary when the instrument is called by voice frequency from a buzzer. For outgoing ringing current the magneto generator is connected direct to the line whereupon the speaking set is short-circuited.

Incoming speaking current passes through the condenser which is coupled in series to the anti-sidetone coupled speaking current circuit. The bell which is connected in parallel with this has such a high impedance at speech frequency that the shunting through same is of no importance.

For outgoing speech the local circuit, consisting of battery, microphone and induction coil is closed through the contact of the key on the handset. On account of the anti-sidetone coupling outgoing speech and other extraneous noises are scarcely heard in the earphone. This method of coupling is therefore of exceedingly great importance for a field instrument which often is employed at places exposed to noises of all kinds.



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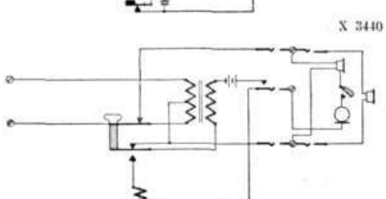


Fig. 5 and 6 X 3441

Diagram of field telephone from Ericsson, Stockholm

above, connected for connection to LB or manual CB system

below, connected as troop telephone

Voice-frequency telegraphy is carried out by means of a key which when pressed disconnects the receiver and closes the local buzzer circuit which consists of the battery, induction coil and buzzer with condenser 0.1 μF. The disconnection of the receiver is due to the need to protect the ear from the loud buzzer signals in the instrument. The buzzer is employed, as already stated, instead of the magneto generator in certain cases. It is used for telegraphy when speech is difficult to get intelligible, but must be used with caution in view of the greater danger of being overheard.

When connected to manual *CB system*, the CB switch which can be locked in pressed-down position, connects the condenser series with the bell. The instrument is then blocked for DC but incoming ringing current passes through the condenser and the bell. By unlocking the press button the instrument is brought into speaking position (LB position). The attraction and holding of the relays at the CB exchange is done by reconnecting the 1 μF condenser so that the bell in speaking position lets through the CB current. If on account of the length of the circuit the relay should not be able to attract, the resistance may be reduced so that it is lower than that of the bell by giving the generator handle a quarter turn which, as already stated, causes the bell to be entirely passed by, or in the worst eventuality it may be done by short-circuiting the line circuit.

X 3430

Transmission Properties

As is known the CCIF has introduced certain norms for measuring the efficiency of telephone instruments, which are expressed in relation to the international standard SFERT. Tests carried out give the following figures for transmission in relation to the SFERT:

when sending: — 0.3 neper,

when receiving, with one receiver connected: — 0.1 neper,

when receiving, with two receivers connected: — 0.4 neper for each receiver.

X 3431

Field Telephone Instrument from Elektrisk Bureau, Oslo

The field telephone instrument constructed by A/S Elektrisk Bureau, Oslo, is designed for connection to one or two-wire telephone networks on the LB system. For connection to CB or automatic systems, the instrument requires additional equipment in the form of a special set mounted on top of the instrument case. This equipment comprises condenser, holding coil, switch and dial. A set for voice-frequency telegraphy can likewise be mounted on the top of the instrument case. The instrument is equipped with a parallel jack and a series jack as well as a connecting cord with plug at either end so that two instruments at an intermediate station may be connected either in parallel or in series.

X 3432

Fig. 7, 8 and 9
Field telephone from Elektrisk Bureau, Oslo
above, closed for transport
middle, open for use
below, lid shut for use in bad weather

Construction

The instrument, Fig. 7, is fitted in a *case* of oak provided with adjustable carrying strap. All corners of the case are iron-shod and the bottom is completely covered with aluminium plate 1 mm thick. The generator crank fits in one end of the case and can be quickly pulled out for use in one operation. Height of the instrument is 289 mm, length 287 mm and width 125 mm; it weighs with all fittings about 7.8 kg.

The front of the case is let down, Fig. 8, to bring the instrument into service. In bad weather the instrument may be used in the closed case, Fig. 9. The circuit wires and the cords for the speaking set then pass through an opening in the front.

X 3433

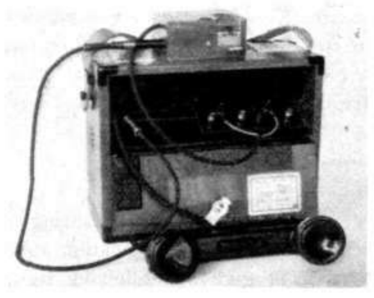


Fig. 10 and 11 X 3434
Field telephone from Elektrisk Bureau, Oslo
above, with se for connection to CB or automatic network
below, with equipment for voice-frequency telegraphy

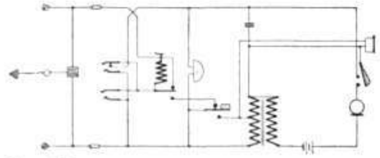


Fig. 12 X 3438
Diagram of field telephone from Elektrisk Bureau, Oslo

The case is divided along its length into two compartments by an aluminium partition. The handset is placed in the front compartment. During transport it is held between the lid and two spring clips. In addition a bakelite plate is fitted with two contact clips for connecting the line, one contact clip for earth and a press button. Connecting jacks for handset and extra receiver as well as jacks for a plug cord are fitted on another bakelite plate. A special division has been arranged for taking the extra receiver and accessories.

In the rear compartment there are the magneto generator, induction coil and a condenser. On the inner side of the back which also can be let down, the bell and the lightning conductor are placed. There is a special compartment for the batteries, which holds two dry cells $60 \times 60 \times 120$ mm, each having an EMF of 1.5 V.

On top of the instrument case there is a fitting for inserting a set for connecting the apparatus to CB or automatic networks, Fig. 10, or a set for voice-frequency telegraphy, Fig. 11.

The *hand microtelephone,* which is particularly strongly made, is cast in aluminium alloy. The distance between centres of receiver and microphone is about 180 mm. The receiver has two coils with a total resistance of 120 ohm. The microphone has a resistance of 40 ohm and is made as an interchangeable watertight inset. The handset is provided with key for closing the battery current. The microtelephone cord has four wires and connection to the instrument is by a four-pole ebonite plug.

The *extra receiver* is of the same design as that in the handset and is provided with headpiece for holding firm to the ear. The cord is two-wire but otherwise is of the same construction as the handset cord and it is connected to the instrument by means of a two-pole ebonite plug.

The *magneto generator* has four wolfram-steel magnets with 6×20 mm area. On no load the generator gives a tension of about 95 V at 200 v/m. Loaded with 1 000 ohm resistance the tension does not fall below 50 V. The generator crank is coupled to the generator both when the instrument is in use and when it is being carried.

The *bell* has two coils with a total resistance af 1 000 ohm and has two permanent magnets with 3×12 mm area. The gongs, which are made of brass, are 62 mm in diameter. The bell rings with 2 mA.

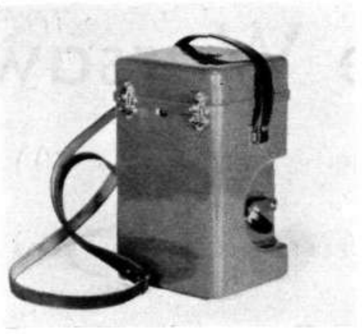
The *induction coil*, anti-sidetone connected, has closed metal core of alloy steel.

The *lightning protector* one in each branch consists of rare-gas tubes and fuses.

The equipment of the instrument also includes a cord with two plugs for the connection in parallel or in series of several instruments. An earthing rod is attached to the carrying strap and wire for earthing is to be found in the accessory compartment which also contains various tools.

Operation

The connection of the instrument is shown by the diagram, Fig. 12. When ringing current flows from the instrument no current passes through the instrument's bell and when the test button is pressed the bell rings for its own ringing current if the circuit connected to the instrument is closed. When the cord is plugged in to the parallel jack of the instrument, the instrument is connected in parallel to the connected circuit, and when the cord is plugged in to the series jack the instrument is disconnected from the circuit. By pressing the key in the hand microtelephone the microphone current is connected whereupon the condenser is short-circuited.



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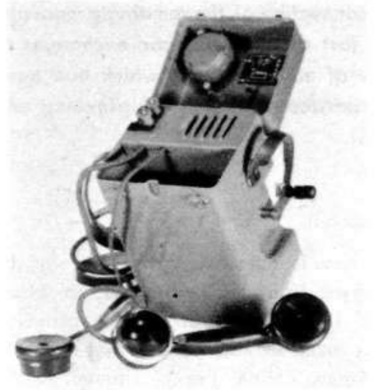
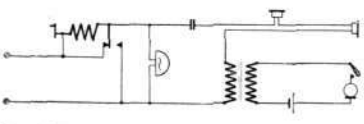


X 3437

Fig. 13 and 14
Field telephone from Ericsson, Colombes
above, closed for transport
below, open for use



X 3439

Fig. 15
Diagram of field telephone from Ericsson, Colombes

Field Telephone Instrument from Ericsson, Colombes

The field telephone instrument constructed by Société des Téléphones Ericsson, Colombes, Fig. 13, is a portable LB instrument fitted in a *case* of parkerised sheet steel, painted with three coats of enamel. The upper part of the case forms a lid which is closed by two snap locks. The instrument is carried by an adjustable strap. The height of the instrument is 260 mm, width 160 mm and depth 140 mm. Weight with all fittings is about 6 kg.

All parts of the instrument are mounted on an inset of sheet steel which is held firm by a snap lock. The generator crank which is placed at the right hand side of the instrument is jointed and goes into a recess in the case so as not to project during transport. For inspection of the instrument all that requires to be done is to twist out the generator crank, loosen the locking spring and draw the inset out upwards. All parts are then easily accessible. The case is provided with openings for taking the circuit wires and the cords to the speaking mechanism when the case is shut, thus permitting the instrument to be used in bad weather.

A special place in the form of a box is divided up to take the battery. This place has a ventilation pipe to allow gas from the battery to escape easily. The battery is easy to connect by means of special screw terminals.

The *hand microtelephone*, see Fig. 14, is made of bakelite and provided with key for closing the battery current. The handset is placed upright in the case and held in place by a pair of hooks. It is firmly attached to the instrument by means of a four-wire cord 1.2 m in length.

The *extra receiver*, which is of the same construction as the handset is placed inside the lid and held in place by a pair of spring hooks. The receiver is connected to the instrument by means of a two-wire cord of the same length as that for the handset.

The *magneto generator*, which is the model of the French Post Office, has three magnets of steel with 10 % cobalt.

The *bell* is fitted on the upper part of the inset and protected against shocks and humidity by a grating which allows free passage for the sound. The bell has two coils with a total resistance of 1 000 ohm and is provided with an aluminium gong 85 mm in diameter.

The *battery* consists of a dry cell 55 × 55 × 125 mm and has an EMF of 1.5 V. Special screw terminals ensure easy connection of the battery.

In addition the instrument has an *induction coil* with closed metal core of alloy sheet and a 2 μF condenser. All the terminals are mounted on bakelite bases and all apertures for wires and cords are lined with bakelite. Inside the lid there is a box holding two spare microphone insets. This box is held in place by a spring catch. The diagram of the instrument is seen in Fig. 15.

Automatisation of the Warsaw Telephone System

S. HÄGGBERG & H. ERIKSSON, POLSKA AKCYJNA SPÓŁKA TELEFONICZNA, WARSZAW

Fig. 1 X 3390
Zielna telephone exchange at Warsaw

During the month of September 1934 the full automatisation of the telephone system in Warsaw was completed by the connection of the remaining manually served subscribers, about 4 300, to the last of the automatic exchanges to be constructed. This terminated a work of automatisation which had been going on for about 5 years, and a brief description of the planning and execution of the work may be of interest.

The local telephone system in Warsaw city is owned and operated by the private concession company, Polska Akcyjna Spółka Telefoniczna, in which the Polish State and Telefonaktiebolaget L. M. Ericsson are the principal shareholders. The local telephone net was made in such a way that the subscribers were all served by a single exchange, Zielna, Fig. 1, situated in the centre of the city. The system was a manual distribution system with multiple switchboards, arranged for a capacity of 66 000. The multiple was connected in series in a special intermediate connecting frame to 3 halls, *A*, *B* and *C*. In halls *A* and *B* there were installed manual distribution positions with places for 25 000 and 20 000 local jacks respectively, Fig. 2. In hall *C* there was an automatic distribution system for 15 000. When automatisation began a multiple for 45 000 lines was laid to all the positions and about 44 200 subscribers were connected to the exchange. The number of subscribers connected in hall *A* was about 24 800 and in hall *B* about 19 400. There was a reserve hall *D*, similar in size to *B* and *C*. The State trunk exchange is housed in hall *C*. A new trunk exchange is in course of construction about 1.3 km from Zielna.

Planning

With the exception of hall *D* there was no place where a new automatic exchange could be fitted. It was decided, therefore, to take the load off the manual exchange by building three exchanges in other parts of the city: one in the south, Piękna, one in the north, Tłomacki, Fig. 3, and one on the eastern bank of the river Vistula, Praga. The buildings were designed and constructed for a capacity of 30 000, 30 000 and 10 000 lines respectively. Hall *D* was arranged as the transfer traffic exchange, to deal with traffic between manual and automatic exchanges during the period of transition.

In view of the fact that the whole cement conduit system with the primary and secondary cables belonging to it led in to Zielna, a distribution of the exchanges as set out above necessitated additions to parts of the conduit system as well as considerable re-laying in the primary net. On Fig. 4 can be seen the conduit net in Warsaw for primary cables; the conduits before automatisation together with the additions necessary to provide for the laying of primary cables and junction line cables for the new exchanges are shown.

When laying the cable net to the new exchanges the following main principles were applied: the primary cables which led from Zielna to a new exchange area, were divided up so that those parts of the cables which lay

Fig. 2 X 3391
Tłomackie automatic exchange

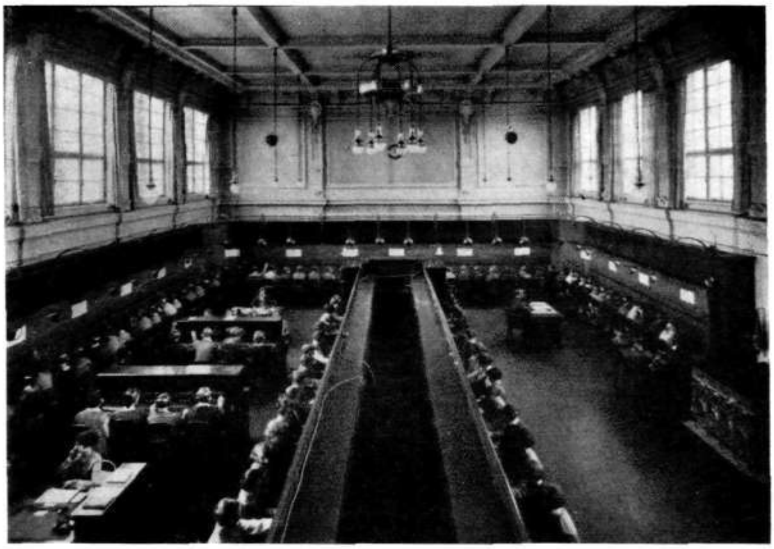


Fig. 3 X 5197
The old Zielna manual exchange, hall A

within the new area would as far as possible be used as primary cables for the new exchange, and those parts lying outside the new area would be extended and used at other places. By this means it would be necessary to furnish new cables for the work in the first new area dealt with, after which the cables outside this district from Zielna lying in its direction would be extended for laying when construction was done in the next district. A number of the primary cables which went out from Zielna to the new area and were drawn in the neighbourhood of the new exchange were to be used as junction lines. Naturally it also happened in a number of cases that it was necessary to lay primary cables in the new area in a direction quite different from the old.

The division of the Warsaw system into different exchange areas was also influenced by the fact that the city in the last decade had extended and taken in several new sections, with the result that the cost of subscribers' lines would become exceedingly high and the line resistance would in addition be inconveniently great, if only one exchange in the middle of the city were retained. In Warsaw 0.5 mm cable wire is pricipally used both in primary and secondary nets with the exception of cables leading to areas with long

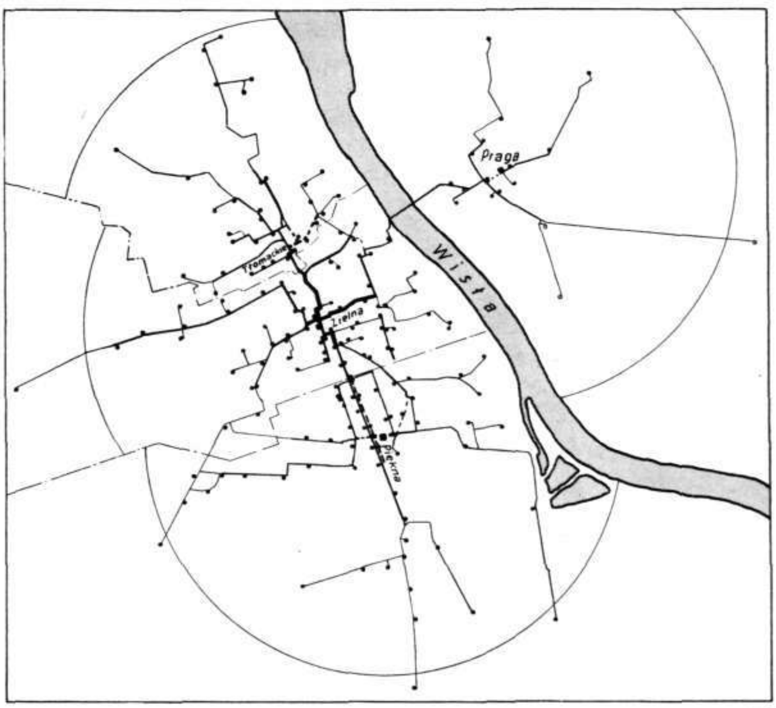


Fig. 4 X 5198
Primary cable network in Warsaw

subscribers' lines in the outer sections of the city, where 0.7 mm cable wire was used. A number of primary cables with 0.6 mm cable wires were in the net and these were as far as possible used as junction line cables between the different automatic exchanges. Junction cables with 0.7 mm wires were laid to the trunk exchange in course of construction from Zielna where the junction exchange between the new trunk exchange and all Warsaw's automatic exchanges is located.

In order that there should be as little need as possible for the provision of new cables for the relaying of the net in connection with automatisation it was necessary in accordance with the above that the automatisation and the reconstruction of the net should be done by stages. The first exchanges which it was thought advisable in view of this to construct were Piękna I, 10 000 numbers, and Praga, 3 000 numbers. At the same time as these exchanges the transfer traffic exchange at Zielna was also constructed; all these were put into service in October 1930, about 8 500 subscribers being connected to Piękna I in the period October 1930 to January 1931, and about 1 800 subscribers to Praga during October 1930. The next developed were Piękna II, 10 000 numbers, and Tłomacki, 15 000 numbers, the first 7 500 numbers at Piękna II being put into service during August—October 1931 by connection of about 4 200 subscribers and the remaining 2 500 numbers in June 1932 by about 1 400 subscribers being connected. Tłomacki was put into service during January and February 1932 about 8 300 subscribers being connected.

After the above-named exchanges had been put into service the manual exchange in hall *B* at Zielna could be taken away and the hall used for an automatic exchange. The great height of the hall made it possible to divide it into two floors. In the upper floor was installed an automatic exchange for 20 000 numbers, Zielna I and II, with the exception of the intermediate distribution and the metering, which were housed in the lower floor which also provided accommodation for the station engineer and the fitters. This exchange was taken into service during September and October 1933, about 15 400 subscribers being connected. In January 1934 about 700 additional subscribers were connected.

In hall *A* there remained at this stage about 4 300 manual subscribers who were to be automatised. While fitting was going on in Zielna I and II there were installed in the distribution room, with a view to freeing hall *A*, the old manual distribution frames for 5 000 subscribers. The multiples for these 4 300 subscribers were arranged in hall *C*, then partly taken up by the trunk exchange. A short time before Zielna I and II was put into service these subscribers were transfered from hall *A* to the provisional exchange referred to, so that hall *A* was available for reconstruction immediately Zielna I and II was put into operation. Hall *B* like hall *A* was divided into two stories. In the upper of these, place was arranged for an automatic exchange of 10 000 numbers (Zielna III). The metering for Zielna III was placed in the same room as the metering for Zielna I and II. The intermediate distribution frames were placed in the lower part of hall *A* where also the junction exchange for traffic between the new trunk exchange and the automatic exchanges was accomodated. Zielna I and II exchanges and Zielna III and IV, with a combined capacity of 40 000 numbers, by reason of the above-described reconstruction of halls *A* and *B* lie on the same level and communication is provided between them, which ensures effective supervision. The fitting of Zielna III was completed in August 1934 and the exchange was put in service in September, the above-mentioned manual subscribers, numbering about 4 300 being connected. This marked the completion of the automatisation.

Execution

The automatic telephone exchanges installed in Warsaw are on the Ericsson machine-driven system with 500-line selectors, and the necessary material has been manufactured at the factories of Telefonaktiebolaget L. M. Ericsson in Stockholm.

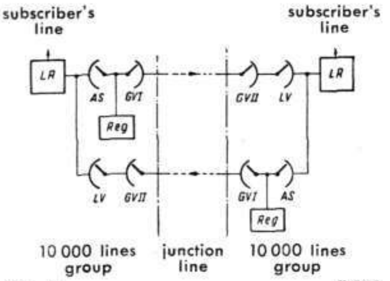


Fig. 5 X 3392

Routing diagram for automatic traffic

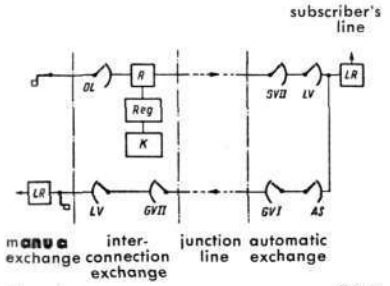


Fig. 6 X 3393

Diagram of interconnection between automatic and manual exchanges

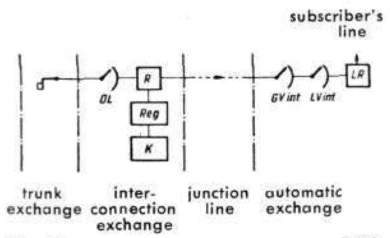


Fig. 7 X 3394

Diagram of interconnection between automatic exchanges and trunk and regional exchanges

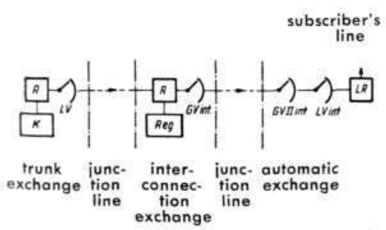


Fig. 8 X 3395

Diagram of interconnection between automatic exchanges and the new trunk exchange

for Fig. 5—8

AS	call finder
GVI	first group selector
GVII	second group selector
GVint	first trunk group selector
GVIIint	second trunk group selector
K	key set
LV	final selector
LVint	trunk final selector
LR	line relays
OL	25-step selector
Reg	register
R	relays

The telephone numbers have five or six figure in the number series 20 000—189 999, together with 10 special numbers in the series 01, 02—09, 00. The telephone system is divided into units of 10 000 lines each. A telephone exchange is made up of one or several such units. From a multiple in the first group selector, junction lines lead direct to a certain group of 10 000 numbers. These junction lines terminate in other group selectors which together with line selectors handle the incoming traffic to the 10 000 line group.

Fig. 5 shows a traffic distribution diagram for the purely automatic traffic. On automatisation the junction lines have been made three-wire, partly because they are short (only about 10 % of the present junction lines exceed 3.1 km in length), partly because conduits and cables formerly used for the manual subscriber's lines to Zielna could to a very large extent be utilised as junction lines, and partly because the exchange arrangements could thereby be simplified.

All the group selectors are operated by relay sets. The call finders and line selectors at Piękna, Praga and Tłomacki are operated by sequence switches, while at Zielna these apparatus are operated by relays. Both operating methods have given good results. The registers are connected direct to the cord lines.

Interconnection System

During the period of about 4 years when the manual exchange was in operation at the same time as the automatic exchanges, a system of combined traffic had to be organised, which in principle was arranged in accordance with Fig. 6. Junction line jacks to the automatic exchanges were mounted on the multiple of the manual exchange. Such a jack was arranged for each automatic 10 000 line group.

In accordance with instructions contained in the telephone directory the manual subscriber asked the operator at the manual exchange for the group to which the desired automatic subscriber belonged, *e. g.*, *8* for a subscriber with the number *8 22 31* and *11* for the subscribers' number *11 80 05*. The operator connected the subscriber to the 10 000 line group asked for, by one of the jacks referred to, to which was connected a 25 stage selector *OL* which automatically sought a free junction line which was connected to an operator with a free register with key set. The key-set operator replied giving her number, whereupon the subscriber gave the last four figures of the wanted number, thus *22 31* and *80 05* in the examples quoted above. The key-set operator pressed the number on the four figure button set and then the starting button, whereupon the second group selector *GVII* and the line selector *LV* at the automatic exchange were actuated and the automatic subscriber was called. The subscribers quickly learned the characteristic figures of the 10 000 line groups, and the dividing of the number into two parts never involved any difficulty but proved to be very simple.

Traffic from an automatic subscriber to a manual subscriber may be also seen from Fig. 6. This traffic was carried through in a simple way, the manual exchange multiple being connected to a line-selector multiple, the connection thus being obtained entirely automatically. In accordance with the diagram for the manual exchange this line-selector multiple had to be made two-wire.

Traffic from trunk and provincial exchanges was dealt with in accordance with Fig. 7. The connecting process was in principle the same as that described above for traffic from the manual exchange to the automatic exchanges. The trunk-line selectors *LVint* were in the same frame as the line selectors for local traffic and gave the trunk operator the facility of announcing a call, cutting off a local call and ringing the subscriber, if she so wished.

Traffic from the new trunk exchange under construction will be dealt with in accordance with Fig. 8. The trunk operator sets up the whole number on a one-line key set whereupon the whole connection is carried out automatically.

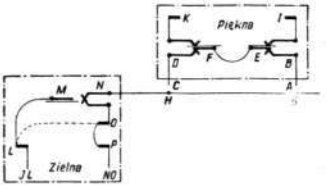


Fig. 9 X 3396
Diagram of transfer from Zielna to Piękna

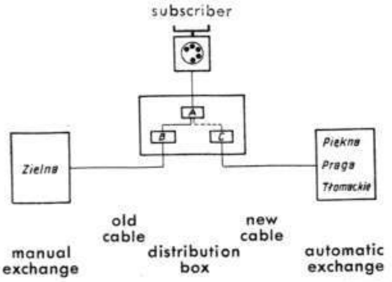


Fig. 10 X 3397
Diagram of transfer from old to new cables

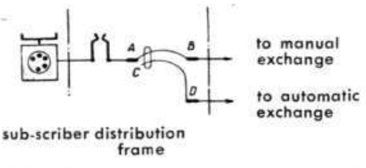


Fig. 11 X 3398
Diagram of transfer from manual exchange to automatic exchange at Zielna

Transfer

Three different methods were applied for the transfer of manual subscribers to automatic exchanges. The first two were used for transfers to Piękna, Praga and Tłomacki and the third for transfers to the automatic exchange at Zielna.

As an example of the first method, may be taken the first transfers to Piękna, *i. e.*, the first transfers in Warsaw, Fig. 9. A main route of cable with subscribers' lines went on the way from Zielna to not quite 100 m distance from Piękna exchange. When the main distribution frame at Piękna had been fitted and the conduits laid to the above-mentioned main route, the cables *AB* and *CD* were laid. In the distribution frame the lines in the cable *AB* were connected to the lines in cable *CD* by means of the jumpers *EF* and simple plugs *E* and *F* were inserted in the fuse-strip test jacks. Then the subscriber's cables in *G* and *H* were broken and the cable section *GH* was taken out. *A* was then connected to *G* and *C* to *H*. The subscribers' lines were then led over the distribution frame in Piękna to the manual exchange at Zielna. But the plugs *E* and *F* still insulated the lines from the automatic station. The contact *J* was transposed to the number determined for the respective subscriber in the automatic exchange and the contact *K* was so transposed that the line *DN* after the transfer could serve as a junction line between Piękna and Zielna. In Zielna the distribution wire *LM* was prepared with the plug *M*.

The actual transfer of the subscribers to the automatic exchange was carried out in one night which was announced in the newspapers. The transfer was simply carried out by taking out the plugs *E* and *F* from their jacks and putting the plug *M* in its jack. When *E* was taken out the subscribers were connected to the automatic exchange and when *F* was taken out and *M* inserted the junction line between Zielna and Piękna was ready. Later the distribution wire *OP* was cut and the distribution wire *OL* was laid instead of the provisional *ML*. In this way no special connection lines had to be drawn.

The second method was necessitated by the fact that it had been necessary to lay new primary cables to a great extent from Pięckna. For connecting the subscribers to these cables the method illustrated by Fig. 10 was employed. The subscriber had formerly been connected with the manual exchange through distribution wire *AB* in the distribution box. On the transfer, which was mainly carried out at night, the distribution wire was continued from *AB* to *AC*, on which the subscriber was connected to the automatic exchange.

In connection with the actual carrying out of the transfer, it should be mentioned that in those boxes where there was no spare place for the new terminal distributors *C* the terminals were connected to the cable and hung up provisionally at the box. When the transfer was to begin, the terminal *B* was unscrewed and the terminal *C* fitted in its proper place. While the special work was going on in the distribution boxes these were enclosed in a special protective casing of boards.

Transfer in one of the two ways above described was accompanied in each case by alteration of numbers for the subscribers. A new directory was issued on the first of a certain series of transfers. The subscribers first transferred had only their new numbers printed in the directory while those for whom transfer was to take place later had both their old and their new numbers printed, a letter being put between the two numbers. All subscribers who were to be transferred at one time had their numbers marked by the same letter. Immediately before a transfer was to take place it was announced in the newspapers, and all subscribers had to note on a special table on the title page of the directory that for this category of subscribers the new numbers were in force.

According to the third method the transfers from the manual exchange at Zielna took place in the distribution frames at Zielna, in accordance with Fig. 11. Between the line side of the distributor and the distributor strip for the automatic exchange a distribution wire *CD* was inserted. At *C* the

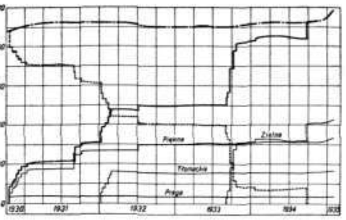


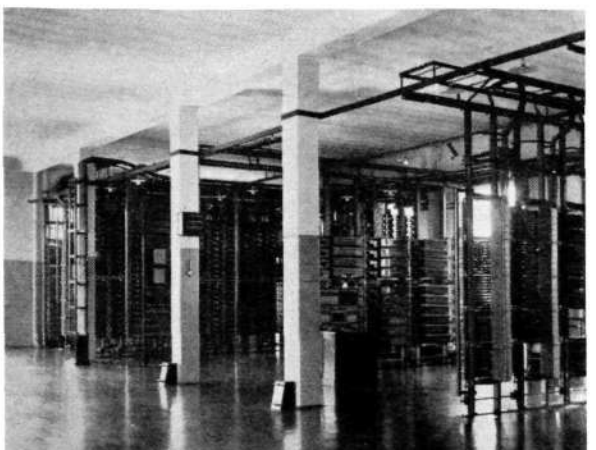
Fig. 12 X 3386
Progress of automatisation
— - — - — - — all subscribers
———————— automatic subscribers
·················· manual subscribers

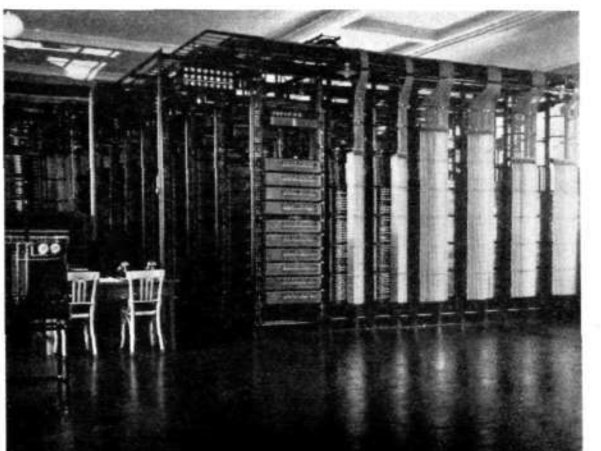
new distribution wire was firmly attached to the old distribution wire *AB* and at *D* it was soldered. The transfer, which took place at night, was done by detaching *A* and soldering *C* on the line side of the distribution frame.
In addition to the above three manners of transfer, yet another method was applied. It may further be pointed out in connection with the transfers that the combined traffic exchange and the junction lines were submitted to considerable changes to be able to deal with the altered conditions arising from the transfers. One example may be given: at the beginning of automatisation it was a case of leading traffic from a large manual station to two automatic 10 000 line groups. At a later stage it was the traffic from a small manual exchange which had to be led to seven automatic 10 000 automatic exchanges. The combined traffic exchange from first to last had to undergo great alterations, it had so to speak to live according to the work of automatisation. For these alterations the connecting arrangements had to be changed about time after time, and in this way the power of adaptability of the automatic system employed proved its worth.

Automatic Exchanges

One exchange with sequence switches, Praga, is shown on Fig. 13. Unlike the exchanges Piękna, Praga and Tłomacki there are in the exchanges Zielna I, II and III — as stated above — no sequence switches, the call finders and the selectors being operated by relay sets which are placed alongside the respective call finders and selectors and directly connected to these by means of plugs and jacks. The arrangement has been carried out in single rows for each 1 000 numbers, while the line relays for reasons of space have been placed in special rows. The back of such a row in Zielna III is shown on Fig. 14.
In Zielna II there are 3 500 lines made for PBX-subscribers and for these numbers the line relays are detachable and connected to their respective lines by means of special contact plugs. By this arrangement only as many line relays need to be connected as there are connected lines. This represents a great economy when many numbers have to be reserved for PBX-subscribers.
In all the exchanges except Zielna the battery and machine rooms are located in the cellars. The street cables naturally are led in to the cellars, from which the cables are taken and conducted in special concrete blocks to the distribution frames. The exchange rooms are usually situated higher up in the premises than the distributor frames. Call meters, one for each subscriber, are placed in special rooms to facilitate checking and photographing.
It should be mentioned that at the same time as automatisation was completed by the connecting up of Zielna III, automatic time signalling by means of the Ericsson photo-electric time signalling machine, as described in the Ericsson Review No 3, 1934, was introduced. This was the first of its type to be put into operation.

Fig. 13 and 14 X 7079
Automatic exchanges, Praga to left and Zielna III to right





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New System of Street-Lighting Control in Oslo

H. SKARPHAGEN, A/S ELEKTRISK BUREAU, OSLO

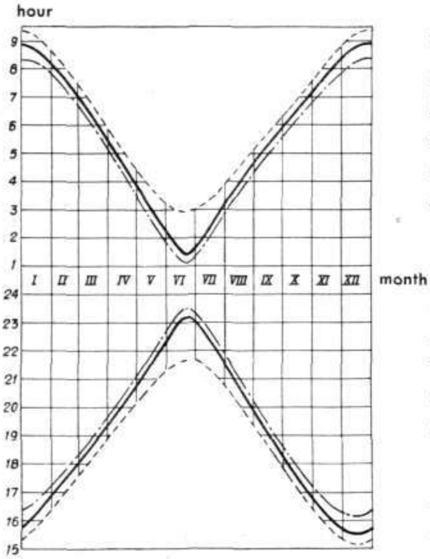


Fig. 1 X 3424
Curves for lighting and extinguishing of street lamps in Oslo

- - - - - - - - - sunrise or sunset
———— lighting or extinguishing
— - — - — - beginning of twilight

When a complete change-over to electric lighting of the streets of Oslo was made, the Oslo Electricity Works decided to introduce a system for centralised lighting, extinguishing and supervision of the street lamps. After several systems had been investigated, one designed by A/S Elektrisk Bureau was chosen. This system has now been in operation for 1 1/2 years and has given exceptionally good results.

Following the replacement of paraffin and gas by electricity for lighting the streets throughout, the necessity was felt for better control of the connections and the installation. At a time when only some of the streets were lit by electricity, the lighting and extinguishing of the street lamps presented no particular difficulty. Later, lighting boxes, as they were called, were set up at suitable points, and in these were fitted the safety devices for the connections and the time switches. The time switches could be set to light and extinguish the lamps at fixed times, and they were set each week in accordance with the curve of Fig. 1. This arrangement, similar to that in use in most towns, presents a number of drawbacks. Employees must constantly be going round to the different points to ensure that all is in order; faults can only be detected on the spot; on account of the rapid changes in the hours of sunrise and sunset in the spring and autumn months, 20 min/week according to Fig. 1, the street lamps may light up either too early or too late, according to the setting of the clocks.

In 1923, when it was decided to illuminate the streets by electricity alone, the Oslo Electricity Works prepared plans for a better and more centralised control of the street lighting. It would take too long to go into all the systems which were studied and tried out. That finally adopted was one worked out by A/S Elektrisk Bureau in collaboration with the Oslo Electricity Works and it has proved itself in operation to be satisfactory in all respects. The stipulations imposed were the following:

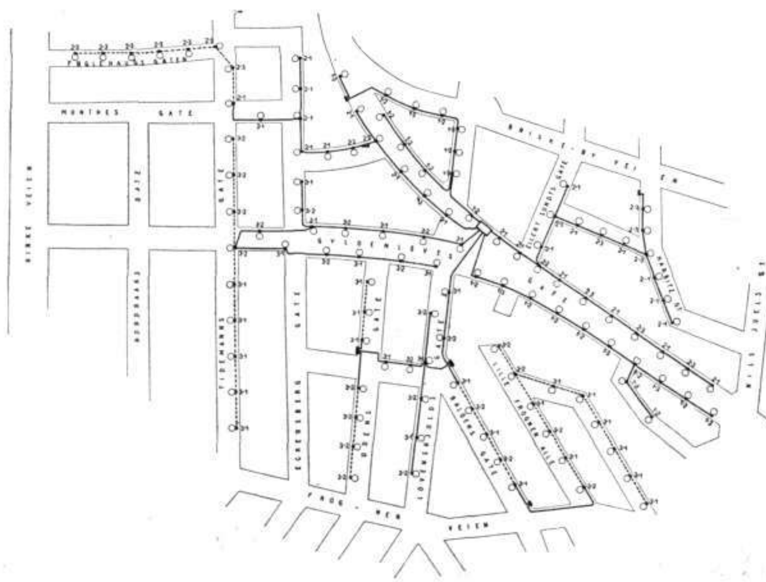


Fig. 2 X 5205
Sketch map showing lighting point with 6 cables

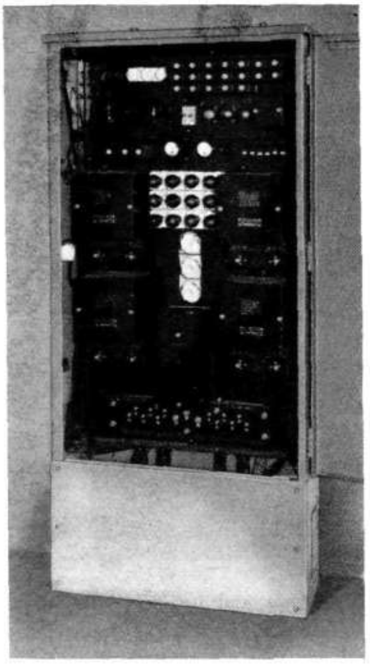


Fig. 3 X 3408
Lighting box

Using existing telephone lines it must be possible from a central telephone exchange

1. to light and extinguish the whole of the street lamps, with a return signal both visual and audible,

2. to receive warning signals automatically on fusing of the safety devices in the supply cables to the circuits from lighting boxes,

3. to receive a signal automatically when any lamp in no matter what part of the system fails,

4. to receive signal automatically when rupture or earthing occurs in the telephone circuit,

5. to make use of the telephone circuit for telephone communication between the central station and the lighting points.

As some indication of the extent of the problem it may be mentioned that there are in operation in Oslo city some 6 000 lamps with a total candle power of 4 200 000 and an energy consumption of 2 400 kW.

Arrangement

The new system may be divided into two parts, *viz.* lighting control and lighting boxes. When the system is fully developed there will be about 100 of the latter, located at suitable spots throughout the city. Where possible, transformer stations are chosen for the lighting boxes which are thus ensured a certain amount of protection and where in any case the temperature remains fairly uniform all the year round. From each lighting box are drawn cables for a maximum load of 10 kW/cable. The sketch map, Fig. 2, shows such a lighting point with 6 cables.

Each lighting box contains a motor switch for maximum 150 A, safety devices, telephone instrument, various auxiliary relays, keys, rectifier and differential relay. All parts are mounted on a frame which may be swung out, making both back and front easily accessible. When the frame is swung out all devices are deprived of current, as the feed cables and the outgoing cables are connected to the frame by knife contacts. Fig. 3 shows a lighting box with 4 lines. The differential relays referred to, Fig. 4, serve for signalling lamp failures and are so sensitive that they can detect down to 150 W lamps. The lamps are connected to the outgoing circuits in V form, *i. e.*, one phase is used as a fault circuit and the two others as outer circuits thus balancing as far as possible. The relays are both tension and temperature compensated and can stand an overload of up to 1 : 2. This excess is governed by choke regulation. The circuit safety devices are provided with special fuses so designed that on rupture of the fuse wire a special signal is transmitted to the central exchange. Each lighting box has a key for switching on and off the lamps connected to it.

Fig. 4 X 3409
Differential relays

The lighting central, Fig. 5, resembles in appearance the switchboard of a large power station. It is divided into three parts, each consisting of two line sections and two central sections, one of which acts as reserve. There are thus in all 36 sections. The line sections are marked with letters. A double telephone circuit leads from each line section, each circuit having up to 10 lighting boxes connected to it in series. The line sections are provided with

Fig. 5 X 5206
Lighting central at Oslo Electricity Works

the necessary devices for supervision of the lines and for receiving signals and fault warnings, such as milliammeter, red and green signal lamps, identification letter, together with a considerable number of relays and keys. For closer investigation of the condition of the line sections these must be connected over to the central section, which contains the necessary appliances for telephone communication with any one of the lighting boxes and for receiving signals, visual from signal lamps and audible from loud speakers. Above the central section is a board with 10 letters corresponding to the 10 line sections served by the central section, together with a number board for the 10 lighting boxes of the line section. Fig. 6 shows a part of the central desk with two line sections and one central section.

All the line sections can thus be connected to a control board, shown in a half-circle on Fig. 5, at which there is a switch by means of which the whole street lighting of the town can be lit or extinguished. It is also possible by means of the control board to transfer the lighting and extinguishing operation to whatever place the Electricity Works may decide, or to a photo-cell, thus making the street lighting dependent on daylight and darkness. In this connection it may be mentioned that the central worked with photo-cells for six weeks in the summer of 1934 without any supervision whatever.

Besides the above-named apparatus and equipment, there is also at the central a current-supply set which delivers 24 V DC for operating the relays, etc. in the central, plus and minus 100 V which is used for operating the respective relays in the lighting boxes, and plus and minus 240 V which can be employed for clearing and return signals.

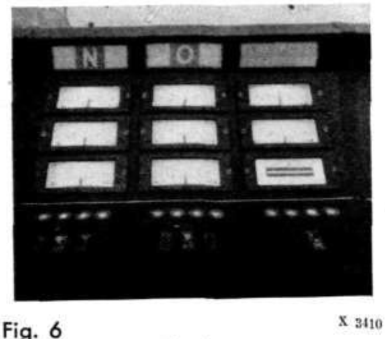


Fig. 6 X 3410
Part of central desk

Operation

Fig. 7 shows the diagram of a lighting box and Fig. 8 the diagram of a lighting central.

As stated, a telephone line leads out from each line section. One branch, *b*, is permanently earthed at the central. For *lighting the street lamps* the other branch, *a*, is fed with — 100 V, whereupon a polarised relay in each lighting box sets the switching motor in operation for connecting up the street lighting.

For *extinguishing the street lamps* the *a*-branch of the telephone line is changed over to + 100 V, on which another polarised relay in each lighting box sets the switching motor in operation for cutting off the street lighting.

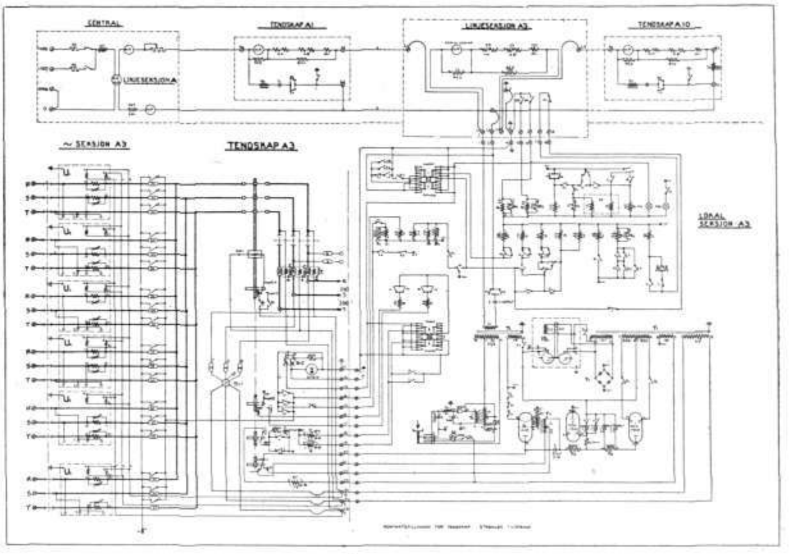


Fig. 7
Diagram of lighting box

X 5210

Both on lighting up and on extinguishing a red and a green lamp shine at the central. The green lamp goes out as soon as the motor switch reaches final position, but the red lamp must be disconnected manually by the operator at the central. It should be understood that a fault on the telephone line, for example a rupture or earthing, will have no influence on the polarised relays and thus cause no change in the position of the motor switch.

For *supervision and indication of faults from lighting boxes* a number of arrangements have been adopted. Any signal from one or other of the lighting boxes is announced in the central by a red indication lamp shining. This signal may mean the following:

1. fuse blown out,

2. lamp failure,

3. current to lamp circuit cut off,

4. a workman wishes to communicate with the central by telephone.

To find out what the incoming signal means, the central operator must transfer the line section of the red lamp to the corresponding central section. That the transfer has been properly done is indicated by the letter of

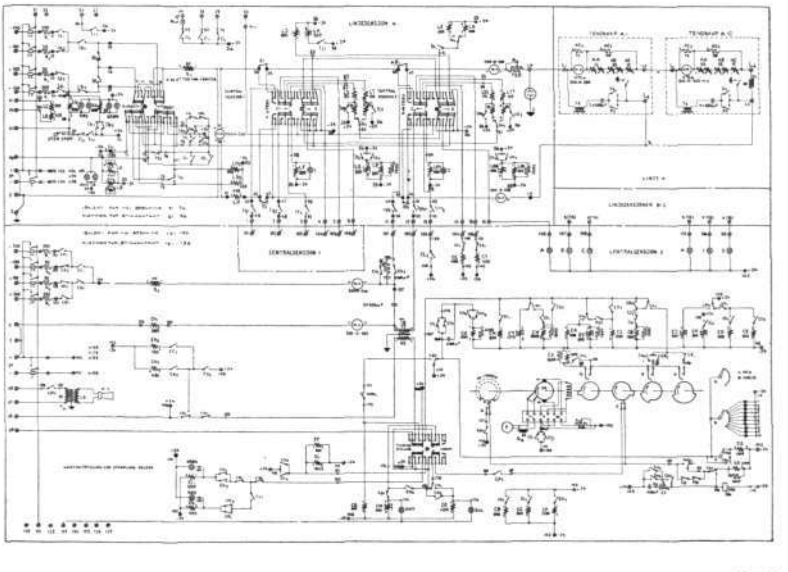


Fig. 8
Diagram of lighting central

X 5209

the line section concerned lighting up in the central section. Thereupon the central operator can get into communication with the different lighting boxes one after the other by sending out a series of current impulses. This is preceded by a preliminary long impulse, which constitutes fault call signal for all lighting boxes on the one line section. The call signal causes connection of the auxiliary relays in the lighting boxes, whereupon these send back acknowledgment signal to the central. There then follows automatically a series of short impulses of similar strength from a key sender, and these connect up each box in order of number, the box's number shining at the number board of the central section at the same time. Each box is connected long enough — about 3 seconds — for it to be able to send a tone signal to the central, where the operator hears it from a loud speaker. The impulse transmission can be stopped by the operator at any moment if he requires to listen to the tone signal of a particular box. The box in question continues to send first a long voice-frequency signal and then as many short ones as correspond to the number of the box, until the operator sets the impulse sender once more in operation or, by sending out a clearing signal, restores the relays of all the boxes. The clearing signal consists in raising the tension of the line for an instant from 100 to 240 V.

In each box there is a voice frequency generator for sending out the above-mentioned tone signals, the operation of which is to be seen by the simplified diagram, Fig. 9.

The voice-frequency generator can send out tones of four different frequencies according to the electric state of the box at the moment.

After the box has been connected to the central in the way described above, one the following signal may be received;

1. signal at 720 c/s, indicating that the motor switch in the box is connected and the street lamps lighted;

2. signal at 240 c/s, indicating that the motor switch is disconnected and the street lamps unlighted;

3. signal at 40 c/s, which indicates that a fuse has blown in the box;

4. signal at 10 c/s, indicating a lamp failure.

It is the duty of the central operator to test all the lighting boxes every morning after the street lamps have been switched off, and every evening after they have been switched on. If everything is in order he will in the former case receive a 240 c/s frequency tone and in the latter case a 720 c/s frequency tone. It is, however, easy to understand that the lamp failure signal comes in very frequently, when it is taken into account that the streets are lighted for about 3 600 hours and the average life of a lamp is only about 1 500 hours. Thus 30 to 40 lamps may require to be replaced per day.

The great advantage of learning speedily at what spots in the town the different lamps are burnt out, or which streets are in darkness because of the blowing out of a fuse is obvious. The central operator can immediately send out a workman to the lighting box concerned and have the fault put right. As soon as the work has been done, the workman calls up the central by means of a call key in the lighting box and lifts the microtelephone. The red lamp for the line section in question then lights up at the central. The central operator replies by transferring the line section to the central section after which the operator, by means of a key on the switchboard, can immediately get into communication with the workman. When it is a question of a telephone conference with one box or another, there is no necessity to send out the current impulses described above.

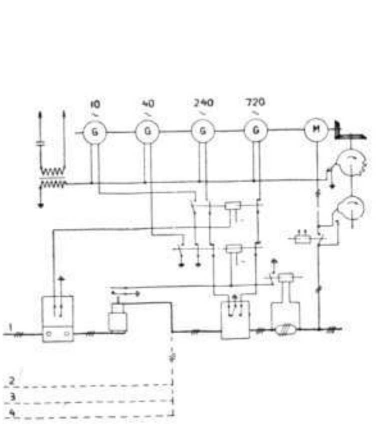


Fig. 9 X 3423
Diagram of voice-frequency generator

Finally the whole system is so designed that all important parts, such as motor switches, differential relays, relay plates, rectifiers, etc. can easily be replaced.

This new lighting system has now been in operation for about 1½ years and has all the time worked without a hitch.

Interlocking Plant at Aarhus Railway Station

H. SCHMEDES, SIGNAL INSPECTOR, DANISH STATE RAILWAYS, AARHUS

Fig. 1 X 3412
Map showing railway lines meeting at Aarhus

In connection with the establishment of a railway goods station at Mølleengen, Aarhus, and the reconstruction and extension of Aarhus H passenger station, the station has been provided with a new interlocking plant, supplied by L. M. Ericssons Signalaktiebolag. The new plant is noteworthy on account of its size and a number of special devices which are employed for the first time in Denmark.

Aarhus H constitutes a shunting station for the East Jutland main lines, *i. e.*, the line from Fredericia to Frederikshavn, see Fig. 1, seeing that the double track from Skanderborg (Fredericia) arrives at the same side as the line from Langaa (Frederikshavn), which latter line is also at the present time being made into a double track. Side by side with the double line from Skanderborg, the Odder line runs into Aarhus H, while the Grenaa line arrives by way of the eastern end of the station towards the harbour, proceeding thence to Aarhus Ø and Grenaa.

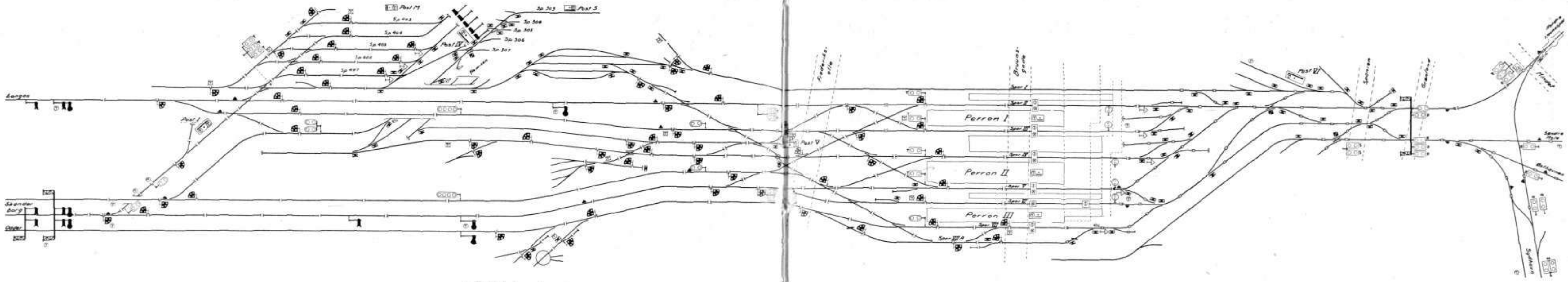
Planning

When studying and designing the new interlocking plant it was considered whether it was advisable to depart from the usual type of safety devices hitherto used in Denmark and introduce the system employed in America and England which, with modifications suited to the existing conditions, has been adopted at a number of Swedish stations, including Malmö, Gothenburg and Stockholm. This system not only handles train movements but also shunting operations within a considerable section of the signal-protected field, the shunting being controlled by dwarf signals.

A prior condition was that the new plant should be operated electrically, seeing that the numerous points and signals would involve an extremely complicated and costly installation as well as expensive upkeep of the wire system and moreover the great distances to several of the points and signals — the distance from Cabin I to the furthest point at Kongsvang is about 1 100 m and to the furthermost signal about 2 100 m — did not allow or could not be served by wire lines.

Since Aarhus main station, as mentioned above, is principally a reversing station, every through train whether single motorcoach or train consisting of motorcoach with attached coaches, but with controls at either end must reverse the motors, and moreover there is frequent coupling and uncoupling of coaches, as the lengths of trains are reduced or increased for the remainder of their run. In addition there are numbers of trains which terminate or start at the station. Besides arrivals and departures of trains there is considerable shunting from and to the passenger-coach depot and of locomotive traffic from and to the locomotive sheds. As a great deal of this shunting is regular, a plant with shunting tracks is consequently advisable, particularly as such a plant allows of light engines and motorcoaches running without conductors, for instance, from and to the sheds. It was therefore decided to use dwarf signals at the western end of the station.

At the eastern end of the station, towards the harbour, conditions are on the other hand somewhat different, as the space is considerably restricted and moreover shunting to and from the harbour is quite irregular so that it is not suited to a system in which the shunting is controlled from the signal-cabin. At this end of the station therefore the plant is made without dwarf signals.



distant signal
master signal
master signal
track signal
shunting signal
repetition signal
dwarf signal
signal at cabin crossing
entrance stop light

green repeater light for departure
blue repeater light for departure
insulated track section
boundary between area without track insulation (left) and with track insulation (right)
track insulation guarding against wrong operation
telephone with connection to signal-cabins
telephone connected to loudspeaker in nearest signal cabin
movable point-light
light at double crossing points
contact for local operation of points
scotch block
rail contact

Fig. 2 X 9022
Track signalling plan of Aarhus station

Fig. 2 shows a diagram of the new plant. There are 3 signal-cabins, namely: Cabin I, about 2 km to the west of the station buildings, where the lines from Skanderborg and Langaa run side by side,

Cabin V, which is the master cabin,

Cabin VI, at the eastern end of the station.

Further, there is connection with Cabin IV, at the departure grid for goods trains, and on the platforms there are entrance contacts for incoming trains. The following tracks are operated:

from Skanderborg to tracks IV and V, and thence to Langaa;

from Langaa to tracks II and III, and thence to Skanderborg;

from Grenaa and the harbour to tracks V and VI, and from track VI to Grenaa and the harbour;

from Odder to tracks VII and VII a, and from track VII to Odder;

from Skanderborg to goods-arr:val track at Cabin I and reverse, and from Langaa (goods trains) to tracks 405, 406 and 407;

to Skanderborg and to Langaa (goods trains) from tracks 303, 304, 305, 306 and 307.

Section blocking has been arranged between Aarhus and Hasselager, with intermediate block Cabin at Viby for south-going trains, and further section blocking between Aarhus and Brabrand has been arranged.

For running to and from the harbour, shunting signals have been put up, to allow of operation from Aarhus H to the north Harbour track, Søndre Mole, Østhavnen and Sydhavnen and reverse as well as from the north harbour track to Sydhavnen and reverse.

Fig. 3 X 3413
Signal-bridge with signals for trains from Skanderborg

Arrangement of Signals

The main entrance signals are made as semaphores, while the other signals are daylight signals. There are two kinds of the latter, namely *daylight signals* and *dwarf signals*. The daylight signals show red, green, yellow or blue light, while the dwarf signals are seen as pattern signals, the signal indications being formed by the positions of several white lights, Fig. 6.

In respect of signalling Mølleengen goods station is made a station in itself, seeing that passenger trains, both outgoing and incoming are shown »run through». Mølleengen is provided with the following pole signals operated

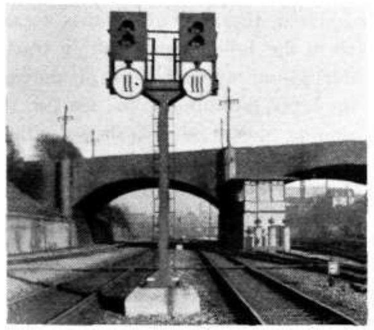


Fig. 4 X 3414
Daylight track signals for entrance on tracks II and III
In front of the bridge may be seen Cabin V (master cabin)

from Cabin I: for *trains from Skanderborg* over track on signal bridge seen in Fig. 3: two incoming semaphores with »run through» arms and daylight signal with requisite distant daylight signal for incoming from the goods track to the goods grid, and three daylight signals for entrance to the goods tracks;

for *trains from Langaa:* one entrance semaphore with »run through»arm, and three daylight signals for entrance to the goods tracks (the same three as mentioned above);

for *outgoing goods trains:* five track semaphores located at and operated from Cabin IV for outgoing to Skanderborg and Langaa, and two daylight signals for outgoing goods trains to Skanderborg and Langaa respectively; for *trains from the passenger station to Skanderborg and Langaa:* two daylight signals for »run through» to Skanderborg and Langaa respectively.

The passenger station has the following pole signals operated from Cabin V: for *trains from Odder:* one entrance semaphore;

for *trains from Skanderborg:* one entrance semaphore and two daylight track signals for entrance to tracks IV and V;

for *trains from Langaa:* one entrance semaphore and two daylight track signals for incoming to tracks II and III, see Fig. 4;

for *outgoing trains:* at the ends of the platforms 5 daylight signals: for trains to Odder from track VII, to Langaa from tracks IV and V and to Skanderborg from tracks II and III, with further out two starting signals for trains to Skanderborg and Langaa respectively.

Operated from Cabin VI are a number of daylight signals, *viz:*
for *incoming from Aarhus Ø and Harbour:* one entrance signal at the swing bridge over Aarhus river;

for *trains to Aarhus Ø (Grenaa) and Harbour:* one starting signal from track VI and several shunting signals with blue and yellow light for running from and to the various parts of the harbour.

Fig. 5 X 3415
Signal-bridge with signals for traffic with harbour

The signals for traffic with Aarhus Ø and the harbour are erected on the signal bridge shown in Fig. 5. The crossing at the east of the main building is protected with 5 small daylight signals with yellow and blue light. The starting signals are repeated in the platform hall with a green light for »clear», and the signals for incoming with a blue light in »clear» position. All the pole signals are automatically set at stop by trains passing them.

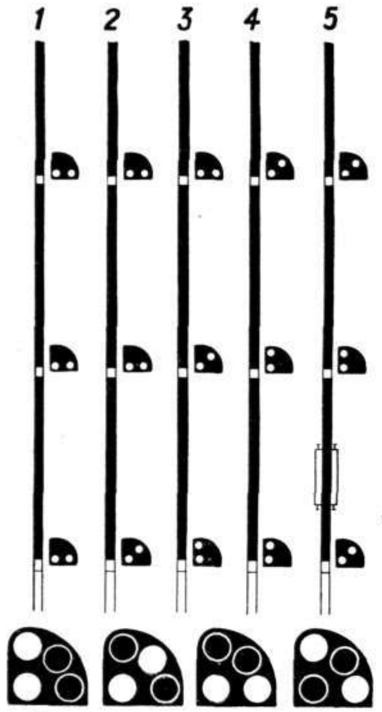


Fig. 6 X 3420
Cooperation of dwarf signals

Insulated Tracks, Dwarf Signals, Shunting Tracks

The train roads at the western end of the station (Cabins I and V) are provided with insulated track sections with track current. The track system is divided up into a fixed number of insulated sections and each section receives AC which operates a relay. When a coach, locomotive or the like is in a section the current leaks through the wheel axles and the relay armature falls. The signals are connected with contacts on these track relays so that clear signal cannot be shown while there is a coach, locomotive or the like in the train road. Thus there is automatic check whether a track is free before signal can be given.

Besides the above-mentioned principal train roads the field under Cabins I and V is also provided with shunting tracks which are equipped in similar way to the train roads. These require special signals in considerable numbers, as all movements allowed by the track system must be directed and controlled from the interlocking apparatus concerned. These signals are small low dwarf signals. The operation of the signals is by two white lights taking up different positions, see Fig. 6, which shows four signal patterns, *viz,* »stop», »caution», »clear» and »cancel», the last-named being utilisable to only a limited extent. The dwarf signals are set in connection with the points, hereunder covering points, and insulated track sections lying behind the signal. The train road from a dwarf signal to a following dwarf signal, the area of another signal cabin, a siding or the free line are indicated in the following: shunting track. When a shunting signal lever at the interlocking apparatus is at normal position the signal or signals belonging to the lever indicate »stop», see Fig. 1. If the lever is pulled down the corresponding dwarf signal shows either »clear» or »caution», as described below. If the lever operates more than one dwarf signal, the signal covering the track required shows one of the two »clear» signals, while the other signals indicate »stop».

If there be coaches, locomotives or the like on one or more of the insulated track sections (occupied tracks) behind a dwarf signal, that signal cannot give »clear» but only »stop» or »caution», no matter what may be the position of the next signal.

If the insulated track section behind a dwarf signal is free for coaches or the like (unoccupied track), the dwarf signal can show »clear», provided a following signal shows »clear» or »caution», and it cannot show »clear» but »caution» if the following signal indicates »stop». Where there is no following signal and vehicles enter a section which is not provided with dwarf signals, it is determined for each case according to the local circumstances whether such a dwarf signal with unoccupied or possibly uninsulated track behind may show »clear» or»caution».

When the lever of a shunting signal is thrown over, the points in the shunting track are locked. The connections between shunting signal lever and point lever, points, opposite shunting signal lever and train track lever are operated wholly electrically.

In those track sections which are divided into shunting tracks a number of these will come into the main train roads, and the shunting signals for these are so arranged that they indicate »clear» when the main track is required. The signal »clear» is shown until the front axle enters the first track section behind the dwarf signal.

The shunting signal levers are provided with lock for the position they are set at, though as a rule the lock operates only when the front axle enters the first insulated section behind the dwarf signal. So long as the section has not been entered the shunting signal lever — contrary to a main-track signal lever — can freely be returned to normal position, a facility which is made use of naturally in very few instances. Still for single shunting tracks

Fig. 7 X 3416
Dwarf signal

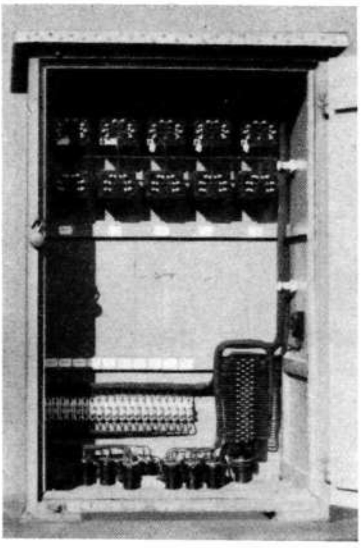


Fig. 8 X 3417

Transformer cubicle for five track sections

showing track transformers above and rectance coils below

it has been considered advisable to allow locking to take place immediately the lever is thrown over. The unblocking of shunting tracks takes place according to the circumstances at the spot, either when the whole track section is cleared or when a part of it has been passed by the last axle. In the latter case the remaining points in the track remain locked against changing, no matter whether the shunting signal lever is restored or not. These points can only be changed after the last rear-axle has left the insulated section of track belonging to them or, provided passage has not taken place, when the whole track is cleared.

The dwarf signals are in general similarly arranged for automatic change from »clear» or »caution» to »stop». If »clear» is showing this changes automatically to »caution» when the leading axle comes into the insulation behind the signal, and changes back to »clear» when the track is completely cleared, provided the lever is still in thrown position. If it shows »caution» no change occurs as a rule in the signal indication on entering the track.

A dwarf signal is placed immediately to the right of the track it refers to, and does not give indication backwards. A dwarf signal at »clear» or »caution» does not indicate which track is concerned, so that it is not possible to see from the signal which track is operated; there are in dwarf signals areas no point lights indicating this either. But since a signal cannot be set at »clear» for less than the track section to which it applies and at the same time the corresponding shunting track (or mutually dangerous shunting track) cannot be changed, all movements are protected, even the possibility of a wrong lever being pulled and causing an operated shunting track to lead in a different direction than was intended by the operating staff. A number of dwarf signals one behind the other work together as already described and as shown in Fig. 6.

While the track section under Cabins I and V are divided into insulated track sections, in the area under Cabin VI there is a single section beyond, which can be insulated for safety against untimely reversal of the central-operated points and locking of the track.

The insulation of the fish-plates and the intermediate plates is by layers of American fibre. The insulated rails are provided with insulation in both rail-ties with the exception of the rails insulated against untimely reversal and locking of the tracks under Cabin VI and of fairly simple sections under the other Cabins where insulation at one side is sufficient. Connection within the individual insulations is provided by double 5 mm copper wire attached to the insulation by conical spikes.

The insulated rails under Cabin VI are fed with 34 V DC while a single insulated section under Cabin VI and all the rest of the insulation are fed with 110 V AC in conjunction with the track tranformers and reactance poles. Thus the open track circuits are arranged for condenser feeding for continuous track current. Two-phase induction relays are used here. The current feed to the track-relay local phase is taken from the 110 V side of a $3 \times 220/3 \times 110$ V transformer placed in each signal-cabin, while the current supply over the insulated rails to the track phase of the relays is taken from the same transformers over a special track transformer for each single section. The track transformers and the reactance coils as well as the condensers are located in cubicles at the station, Fig. 8, and from these current is fed at low tension to the one end of the track section concerned. The two insulated railties then lead the current from and to the track relays (one relay for each section) introduced between the rail ties at the other end of the track section. The track relays and the greater part of the other relays are located in the under part of the signal cabin. The connecting wires are laid in armoured underground cables.

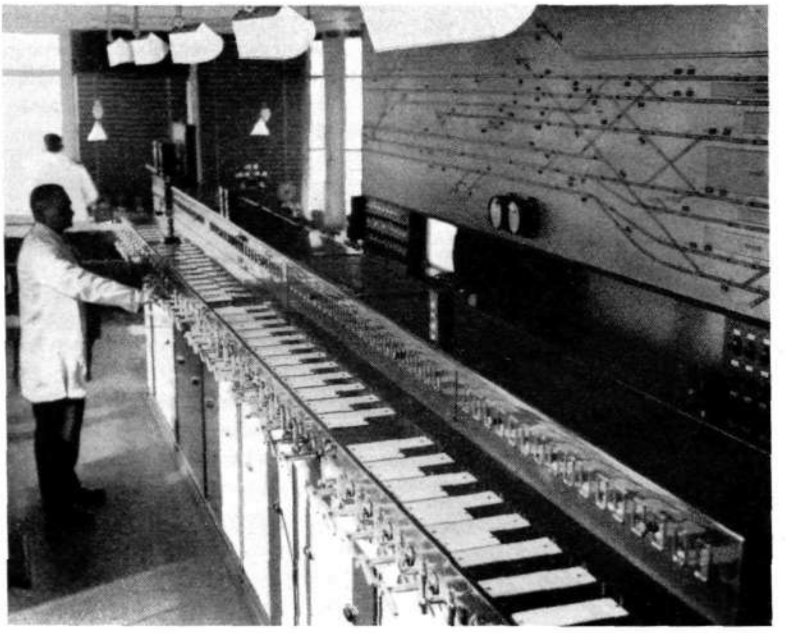


Fig. 9 X 5207
Interlocking apparatus and illuminated track diagram in Master Cabin

Operation of Points and Signals

The point drives are of Signalbolaget's newest type, some with and some without built-in lock according to whether the points have hook-lock or not. They are arranged for 220 V DC. The control of the position of the points is carried out in the Cabin I and Cabin V areas by means of three-way disc relays housed in the relay rooms, with local and indication phases for 110 V AC, 50 c/s.

In the field of Cabin VI the supervisory current is 34 V DC used in the ordinary way without special relays.

All the corresponding points in the tracks are control-locked and in addition the furthest points at Kongsvang, some 1 100 m from the signal-cabin are provided with special locking.

The insulation in all the individual operating locks is provided with double joints and in the control-locks with single joints.

The semaphores are operated with devices furnished by Signalbolaget arranged for 220 V DC and 34 V DC.

The daylight signals and the respective dwarf signals are operated by means of special DC relays located in the underpart of the signal cabins.

Fig. 10 X 3418
Cabin VI

Interlocking Apparatus, Relays, Signal-Boxes etc.

The interlocking apparatus in Cabins I and V are of Signalbolaget's latest type. The point levers each serve one or two points and in normal position lie over to the right, being over to the left when thrown. The angle traversed is 140°. The signal levers normally slope upwards and can be changed 70° to either side. Each lever can thus serve two train tracks, one at either side, while — as stated above — it can serve many shunting tracks, provided all the shunting tracks on the same lever are mutually opposed.

As concerns the main train roads there is also mechanical connection between the point levers and the signal levers, while for the shunting tracks there may be purely electrical connection, obtained partly at the lever magnet armatures and at contacts on the levers and partly by a considerable number of relays installed in the underpart of the cabin. The relays, of which there are both AC and DC, are for the most part provided with contacts enclosed in glass cases.

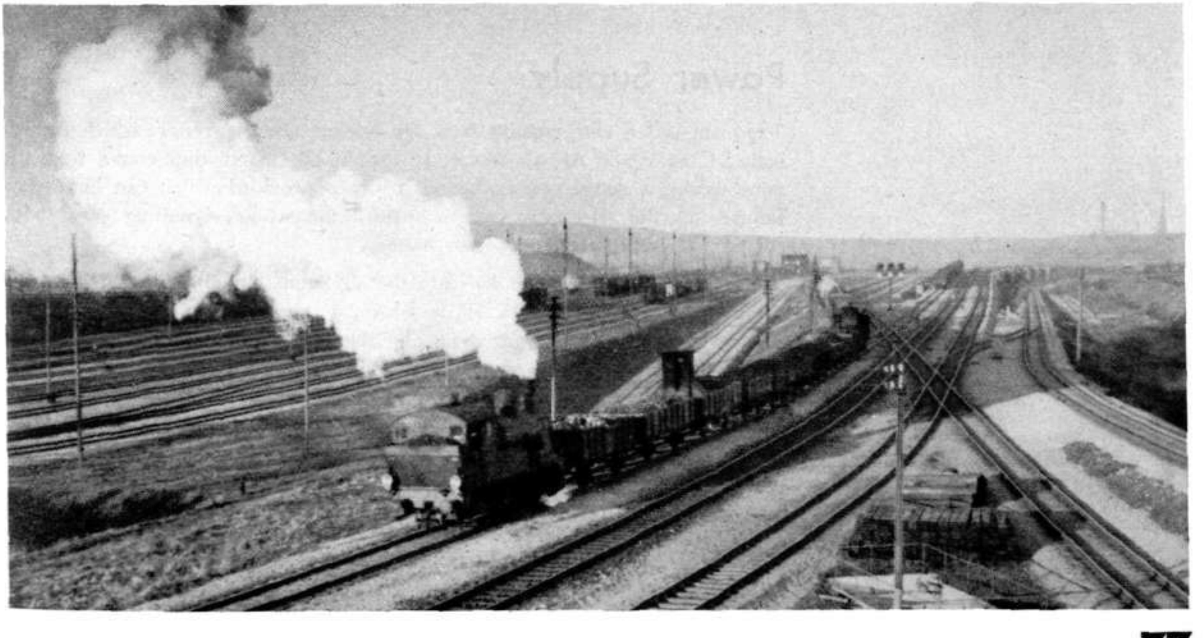
Fig. 9 shows the interlocking apparatus and the illuminated track diagram in Cabin V, the main cabin. Fig. 10 shows Cabin VI and Fig. 11 the view from Cabin I towards the main station. The illustration shows the double-track harbour line which runs under the main track at bridges.

The arrangement of the interlocking apparatus in Cabins V and I is substantially the same as described in Ericsson Review No 1—3, 1931. The interlocking apparatus in Cabin VI is of the Signalbolaget's normal type. An occupied track is locked automatically and cleared, also automatically, on the passage of the train. The traction track is protected, from Cabin V, by 5 daylight signals with 10 lights. The swing bridge over Aarhus river is blocked from Cabin VI in conjunction with the track section.

The table below gives for each central apparatus an idea of the levers, numbers of tracks, numbers of points operated, signals, dwarf signals, track insulations etc.

	Cabin I	CabinV	Cabin VI	total
fields in the central apparatus	40	80	48	168
point levers	18	32	20	70
signal or clearing levers	7	16	13	36
dwarf signal levers	11	25	—	36
spare sections	4	7	15	26
train roads	13	26	14	53
shunting tracks	51	147	—	198
centrally operated points	22	56	32	110
centrally operated scotch-blocks	—	1	1	2
semaphores	6	4	—	10
distant daylight signals	9	22	17	48
distant daylight signals on tractor track	—	5	—	5
dwarf signals	21	44	—	65
insulated track sections with lamp at track level	45	69	2	110
track insulation as precaution against wrong operation of points	—	—	28	28

Fig. 11 X 7081
View from Cabin I looking towards station buildings



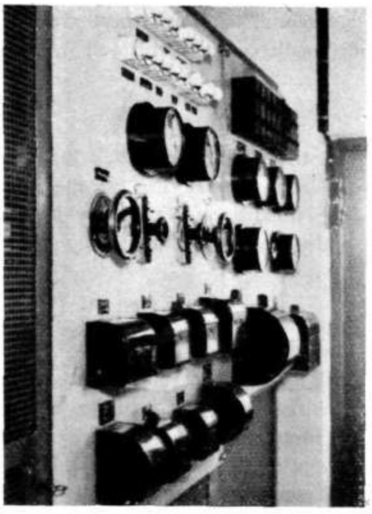


Fig. 12 X 3419
Instrument board in Cabin VI

Illuminated Track Diagram

As the shunting in the fields of Cabins I and V is to be controlled by and directed from the signal cabins it is necessary that the operating staff should be able easily to supervise and follow the individual movements and for that reason each of these cabins is provided with an illuminated track diagram for the track system concerned.

On these track diagrams, which are set up separately behind the interlocking apparatus, there are indicated, in addition to the tracks, the main signals (pole signals) and dwarf signals as well as the individual insulated track sections into which the track field is divided. The positions of the signals are repeated on the track diagram by separate coloured lights which show up as coloured lamps set behind windows and which indicate the signals. There is on the diagram one lamp for each insulated track section. The presence of a vehicle on a track section is marked by the corresponding lamp, set behind a window inserted in the track line, lighting up, and when the track is cleared the lamp is extinguished. Thus the lamps are out when a track is unoccupied and in this way very few of the lamps are lit up at one time. Momentary movements are thus noticeable earlier than with the contrary system: lamp out when occupied, lamp lit when unoccupied track. As a rule also the life of the lamps is longer and the changing of burnt out lamps more seldom necessary. All movements on the track system can be followed on the track diagram.

»Stop» at a dwarf signal is not repeated on the track diagram while »caution» is shown by a flame-yellow light and »clear» by a white light. »Cancelled» is indicated by flame-yellow light with a black cross. The various main signal positions are shown by red light for »stop» and green light for »clear», while the shunting signals are indicated by flame-yellow light for »shunting permitted» and blue light for »shunting forbidden».

The tractor line signals can be lit at the time of the trains and they are repeated with yellow or blue light on the track diagrams of Cabin V. Cabin VI has no track diagram of its own but there is a smaller diagram which by means of a couple of track insulations can show the position of main signals on much the same principle as described for Cabins I and V. The arrangement of the track diagram in the main cabin may be seen from Fig. 9.

In the direction of Skanderborg manual AC current line blocking has been installed while the same is intended for the Langaa direction and will be taken into service at the same time as the double track.

Power Supply

The plant is fed with current from the Aarhus Electric Works which furnish both DC 22 V and AC 3×380 V, 50 c/s. As all current thus comes from the same works, a petrol generating set has been provided which can in case of failure at the electricity works furnish the whole signalling plant with current. There is no accumulator battery.

The 220 V DC current is led into the different signal cabins direct from the mains, while the 380 V AC is taken by a special cable direct from the electricity works to the lower room of Cabin VI, which cabin is situated close to the electricity works. A petrol motor generating set is installed at Cabin VI. In normal conditions the current supply is utilised as follows:

220 V direct current is used in each of the cabins for: operating current for points and arm signals, lighting of arm signals, distant open-work signals etc., dwarf signals and point lights.

3×380 V alternating current is delivered to a transformer for 3×380/3×220 V at cabin VI, from which each of the cabins is fed with 3×220 AC, which through transformers and rectifiers supplies 34 V DC for the supervisory current etc., and further through transformers supplies $3\times220/3\times110$ V, 50 c/s, to track insulations and track relays (3×110 V, which at the track transformers gives 12—24 AC) and to the point relays local phase 110 V, and through transformers 110/110 V to the relays' indicating phases, and finally through transformers 110/14, 12, 11, 10 V for the lamps of the track diagrams.

Whenever DC in a cabin fails, 220 V DC can be obtained from the 220 V AC mains through a rotary converter. Should the AC supply fail or both AC and DC fail then the required current can be obtained for the whole plant from the petrol generating set referred to above.

Telephone Installation

The signalling plant is provided with a comprehensive telephone installation, since besides the customary connections between telegraph office, signal cabins, platform boxes etc. there is a considerable number of instruments at various spots, providing convenient communication with the signal cabin concerned, which is necessary in cases where shunting is controlled and directed from the signal cabins. The communication is carried out either with ordinary instruments or with loud-speaking instruments.

Under Cabin I there are 6 ordinary instruments at different places, two being at the incoming signals, and in addition 3 telephones connected to loud-speakers in the signal cabin. Under Cabin V there are 2 ordinary instruments at incoming signals, 3 at the platforms and 8 instruments at other spots connected to loud-speakers in the cabin. Under Cabin VI are 6 outside telephones.

As Aarhus H during the reconstruction period has for a part of a year been worked with purely provisional safety arrangements at Mølleengen — substantially the area under the present Cabin I — and for the areas now under Cabins V and VI without any safety arrangements, it is difficult to arrive at any estimate of the saving in staff due to the new installation, as there is no basis of comparison. It can however be stated that for safety and shunting service there are now employed 12 fewer men at Aarhus H than formerly. The new installation has thus, in addition to providing greater rapidity and safety in handling the trains at Aarhus H, also caused an economy of 12 men in comparison with formerly. A further saving of 1 or 2 men may be expected with some slight modifications in the plant.

Carrier-Frequency Channels on Selective-Calling Telephone Circuits

I. BILLING, ADMINISTRATIVE DIRECTOR, SWEDISH STATE RAILWAYS, STOCKHOLM

The need for an increased number of telephone circuits on the Vännäs—Ånge branch line in Norrland of the Swedish State railway has been met by the provision of carrier-frequency telephony on the existing circuit, where selective-calling telephony was already in operation.

Following the addition of the State Railways telephone cable Stockholm—Ånge which was constructed in conjunction with the electrification of the line, already described in Ericsson Review No 3, 1934, as well as for the reason that the State Railways had changed over to the use of telephony almost exclusively in place of telegraphy for long-distance service communications, the necessity arose for an increase of the number of circuits along the railway line north of Ånge. The need was particularly apparent on the 211 km stretch Långsele—Vännäs, the only section of the Ånge—Luleå line on which direct telephone circuits were lacking, though a selective-calling circuit was in operation. In this connection the proposal was made that, instead of putting up a new and expensive telephone circuit, a trial should be made with a carrier-frequency system which, by utilising the selective-calling telephone circuit mentioned, could be obtained for less than half the cost of new copper wire. This circuit has now been arranged and has been in trial operation since March 10th.

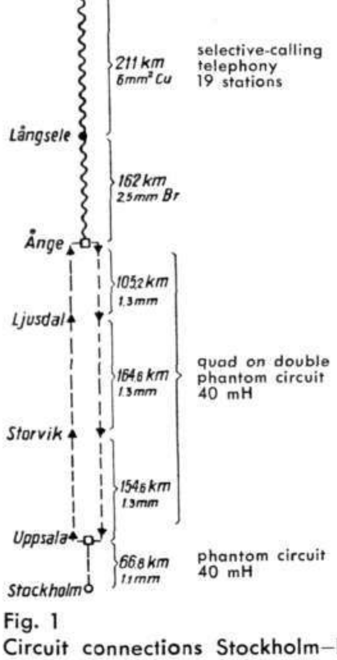


Fig. 1 X 3407

Circuit connections Stockholm—Luleå

Earlier Trials

Preparatory trials with the Ericsson carrier-frequency telephone system on selective-calling telephone circuits had previously been made by the State Railways. On the Södertälje S—Eskilstuna line trials had been carried out on an 82 km long overhead circuit of 3 mm copper conductor, which, however, was connected close to Södertälje with a 2 km stretch of 0.9 mm cable conductor. At the twelve intermediate stations and the two terminal stations, in which both selective-calling equipment and telephones were connected, suitable filters with a cut-off frequency of 2 400 c/s were mounted. Single channel racks were installed at both terminal stations.

On this trial it was apparent that certain minor modifications required to be made of the filters used, so that they should not adversely affect the ordinary voice-frequency conversation. Measurements of attenuation per unit length carried out on the line, with and without filters, gave the result that the additional attenuation through the fourteen filters amounted to 0.049 neper at 50 000 c/s and to 0.005 neper at 10 000 c/s, representing additional attenuation per filter of 0.0035 neper at 5 000 c/s and 0.00035 neper at 10 000 c/s. These measurements show that the shunting of the circuit, which each connection of a selective-calling apparatus causes, has only an insignificant influence on the properties of the line at carrier frequencies, if a filter of the above-mentioned design is inserted between the line and the selective-calling apparatus.

The lowering of the quality of the ordinary voice-frequency circuit arising from the insertion of the filters was later overcome in laboratory experiments, and the disturbances on this circuit caused by the carrier frequencies, 5 000 and 10 000 c/s, was found to be abolutely insignificant.

The problem of operating a single-channel carrier-frequency circuit over a selective-calling telephone circuit was now completely solved from a technical point of view.

Circuits

On working out the details for the provision of the carrier frequency circui. it was found advisable, for several reasons, to extend it to cover not only the Långsele—Vännäs line, but the whole line Ånge—Långsele—Vännäs. In this way was obtained a further telephone circuit also on the Ånge—Långsele line where the existing low-frequency circuit was very much occupied, and in this way the working of the different circuits could be concentrated at Ånge and Vännäs, a great advantage from the operating point of view.

Thus the carrier-frequency circuit has been connected on the 373 km line Ånge—Vännäs. For this are used a 162 km direct circuit Ånge—Långsele (—Sollefteå) of 2.5 mm bronze conductor and a 211 km long selector circuit Långsele—Vännäs of 6 mm² copper wire, to the latter of which are connected selective-calling equipment and telephone instruments, distributed over the two terminal stations and nineteen intermediate stations.

Outside the Ånge—Vännäs section the following low-frequency circuits among others, are used for through traffic:

to Luleå, a *323 km 3 mm copper circuit* (but only 6 mm² on the 143 km stretch Jörn—Boden),

to Östersund, a 101 km long 6 mm² copper conductor,

to Stockholm, a 491 km underground circuit, which normally consists on the Ånge—Upsala line of a four-wire circuit (two phantom circuits on 1.3 mm quads) and on the Upsala—Stockholm line of one phantom circuit on a 1.1 mm quad.

The voice-frequency and carrier circuits used for the 1 187 km long telephone communication between Stockholm and Luleå are shown in Fig. 1.

Arrangement of the Carrier System

The Ericsson carrier system and its use on selective-calling telephone circuits has already been described, in Ericsson Review No 2, 1933, among others. For the Ånge—Vännäs installation, the carrier frequency 5 000 c/s is used in the direction Ånge to Vännäs and 10 000 c/s from Vännäs to Ånge.

The plant comprises the following equipment:

at each terminal station, a terminal rack, Type ZL 200,

at the junction station, Långsele, between the direct circuit and the selective-calling circuit, a high-frequency shunt, Type ZL 611,

at every intermediate station on the Vännäs—Långsele line a selector filter, Type ZL 651,

at the Mellansel branch station, where the selective-calling telephone circuit branches off to Örnsköldsvik, a selector filter of the same type for the branch circuit.

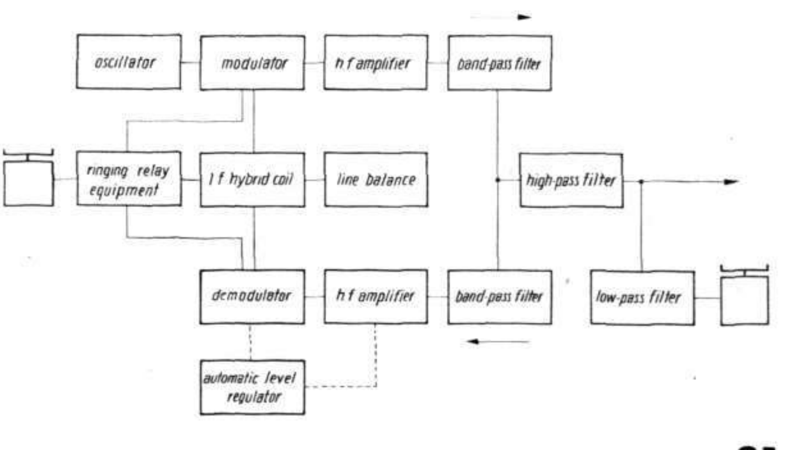


Fig. 2 X 5202
Diagram of terminal station equipment

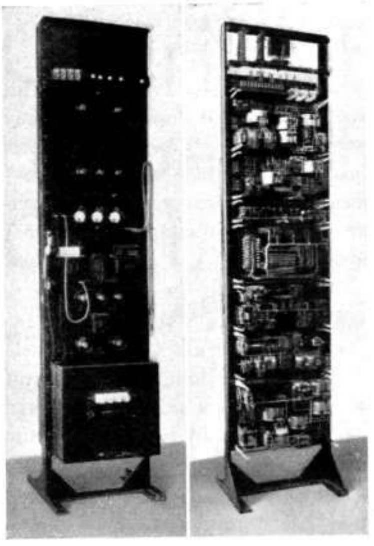


Fig. 3
Terminal station rack

X 3406

Each terminal station, see Fig. 2, comprises

a *low-pass filter* which separates the low-frequency currents for the selector with its telephone instrument, but allows the high frequency to pass on to

a *high-pass filter* which transmits the high frequency but cuts out the low frequency.

The incoming carrier frequency, modulated by speaking current, further passes through

a *band filter* which allows the incoming carrier frequency, 5 000 or 10 000 c/s, to pass together with the upper side band belonging to it but cuts out the frequencies of its own transmitter,

a *high-frequency amplifier* to

a *demodulator* which transforms the modulated high frequency to voice-frequency current which is then led through

a *differential transformer* with balancing network, which lets the incoming speach through to the telephone instrument but prevents it from going over to the transmitter side of the equipment.

The outgoing low-frequency speaking current first passes through the differential transformer, after which it goes to

an *oscillator and modulator* which changes the speaking current to modulated high frequency. This is amplified in

a *high-frequency amplifier* and continues through

a *band filter* which lets through the carrier frequency, 5 000 or 1 000 c/s, along with its sideband, but excludes the lower sideband, and so on through the high and low-pass filters mentioned to the selective-calling circuit.
There are 10 valves for the above described fittings of the terminal station equipment, of which 1 oscillator valve, 2 modulator valves and 2 amplifier valves are for the transmitter and 2 high-frequency amplifier valves and 2 demodulator valves for the receiver, while there is 1 valve for the automatic regulation of level. All the valves are of the Marconi company's type.

Outgoing ring signal actuates relays which connect the ringing current from the pole changer to the modulator. The signal thus passes to the circuit in the form of modulated high frequency. Incoming ring signal, which comes from the circuit as carrier frequency modulated by ringing current, passes from the demodulator to an AC relay which by means of other relays connects the pole changer to the telephone-instrument bell or to the drop indicator of the switchboard.

The above equipment for terminal stations is mounted on a rack, Fig. 3, which also contains a supervisory panel, with a supervisory telephone set as well as meters for checking the tensions and currents of all the valves, a current-distribution and a mains-supply panel, Fig. 4, for current supply from existing AC mains.

Current Supply

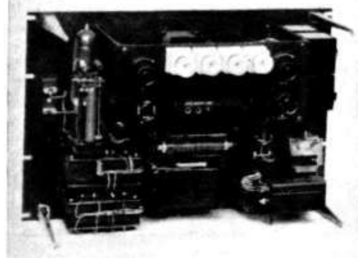


Fig. 4
Mains-supply panel

X 3403

For filament current to amplifier, oscillator and modulator valves, the filaments of which are connected four or two in series, 24 V is required. The anode tension is 120—130 V. Filament and anode current are taken each from separate metal rectifiers, mounted in the rack and connected to the AC mains, 220 V, 50 c/s. The total current consumption from the mains amounts to about 70 W. Grid tension is taken from the oscillator valve over a rectifier and the ring current comes from the existing pole changer.

As floating and reserve battery there is a 24 V accumulator of 100 Ah, which on interruption of the current from the mains delivers 24 V to the filament circuits and at the same time drives a small converter for anode current, mounted in the rack, which is started automatically. The current taken from

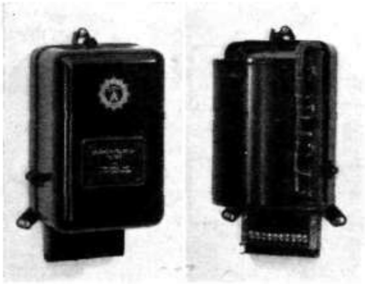


Fig. 5 X 3404
Selector filters

the battery for these purposes is 1.6 A, so that the battery is sufficient for about 60 hours reserve operation. The battery is charged automatically by the 24 V rectifier.

The *high-frequency shunt* at Långsele contains two low-pass filters, one in each of the two lines meeting in Långsele, which pass the voice-frequency currents to the switchboard, as well as one high-pass filter which allows the high frequency to pass without hindrance from one line to the other, but at the same time prevents the passage of low frequency between the circuits.

The *selector filters*, Fig. 7, are so designed that the high-frequency current continues unobstructed past the intermediate stations through a high-pass filter, while the low-frequency current either passes the station through a low-pass filter or is tapped for the selective-calling apparatus at the mid-point of the low-pass filter.

The attenuation properties of the filters at various frequencies have been measured. The result, see Fig. 6, shows that the through-circuit attenuation is very small for both low and high frequency, max. 0.020 neper at 2 500 c/s, and that the branch attenuation, *i. e.*, the attenuation from the line through the filter to the selective-calling telephone instrument, from being exceedingly low in the speech band, *e. g.*, 0.05 neper at 1 000 c/s, rises to 7.64 neper at 5 000 c/s, *i. e.*, the lowest frequency to be cut out.

Results

On trying out the carrier-frequency arrangements, after they had been fitted on the Ånge—Långsele—Vännäs line, it was found that they worked without hitch. However, while conversation was going on along the whole Stockholm—Luleå circuit there arose disturbing noise, and this on closer investigation was found to arise in that part of the Luleå—Boden section of the circuit which consists of overhead lines at a distance of 50 m and in parts only 15 m from the electrified railway line Luleå—Narvik. The induced tension of $16^2/_3$ c/s from this was actually sufficient to actuate the ring-signal relay on the carrier rack at Vännäs. By inserting at Vännäs and Boden telephone transformers without earthing these disturbances were eliminated so that the circuit worked perfectly.

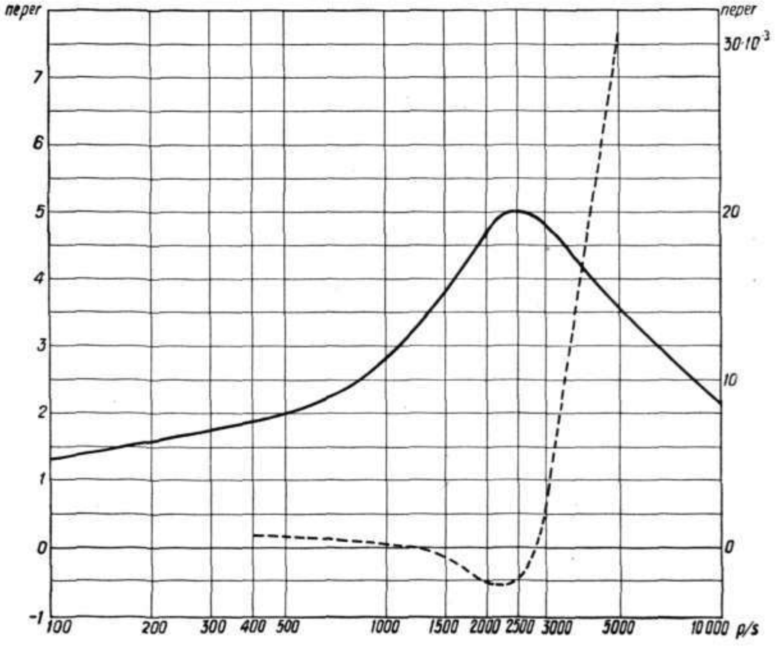


Fig. 6 X 5204
Attenuation curve for selector filters
——— overall attenuation
.... branch attenuation

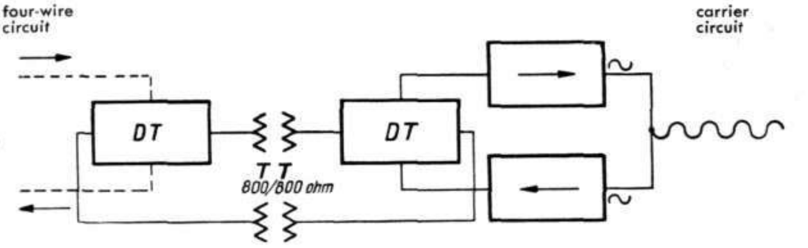


Fig. 7
Tail-to-tail connection
DT differential transformer
TT telephone transformer

X 5203

The *overall attenuation* on various circuits of which the Ånge—Vännäs carrier-frequency circuit formed a link was measured at a frequency of 800 c/s. These included the four-wire circuit Ånge—Upsala, together with the two-wire circuit Upsala—Stockholm, partly with normal connection at Ånge, *i. e.*, with four-wire terminal set and balance, in which case the circuit section Stockholm—Ånge had an overall attenuation of 0.8 neper, and partly with tail-to-tail connection at Ånge, *i. e.*, without balance but instead with connection over telephone transformers to the differential transformer of the carrier system, see Fig. 8.

From the results of these attenuation measurements it was seen that with normal connection at Ånge the attenuation on the Stockholm—Vännäs circuit amounted to about 0.9 neper, and the attenuation on the Stockholm—Luleå circuit when transmitting from Stockholm to Luleå was 1.7 neper and in the reverse direction 1.9 neper; with the tail-to-tail connection at Ånge the attenuation on the Stockholm—Luleå circuit attained 1.05 neper when transmitting from Stockholm to Luleå and 1.21 in the reverse direction.

The *automatic level adjustment* in the terminal station equipments was tested by transmitting from Ånge a carrier frequency of 5 000 c/s modulated with 1 000 c/s and measuring at Vännäs the demodulated tension, an artificial line with variable attenuation being connected in series with the circuit. On increase of this extra attenuation the following decreases in the demodulated 1 000 p/s tension occurred:

extra line attenuation, neper	0	0.4	0.8	1.2	1.6	2.0
low-frequency attenuation, neper	0	0	0.02	0.045	0.12	0.24

The Stockholm—Luleå circuit is thus of first-rate quality and especially with tail-to-tail connection remarkably good.

On the basis of the results thus obtained the new carrier-frequency circuit may be considered as completely fulfilling the guaranteed transmission qualities. It may therefore be anticipated that this new telephone circuit after continued test operation for about 3 months will show itself capable of meeting the demands made on it and thus become a permanent link in the telephone net of the State Railways.

With the increased traffic on this line which may be expected on complete change-over from telegraphy to telephony, there exist possibilities of replacing the new single-channel carrier-frequency circuit Ånge—Vännäs by a three-channel circuit, allowing on the circuit in question one low frequency and three high-frequency telephone conversations. The single-channel circuit could then be transferred to the Vännäs—Boden line, or if the three-channel system were also extended to this line, to some other line in Norrland where the need for it exists.

In this connection it should also be mentioned that Telefonaktiebolaget L. M. Ericsson, on the basis of the experience thus gained in Sweden, have contracted to apply carrier system to selective-calling telephone circuits on certain railway lines in Spain. Thus in the near future there will be fitted a single-channel carrier-frequency system for 5 000 and 10 000 c/s on the following three selective-calling circuits of 3 mm copper wire: Madrid—Venta de Banos, 285 km; Venta de Banos—Léon, 134 km; Venta de Banos—Miranda, 174 km, so that Madrid will be able, by means of a carrier system including a carrier amplifier at Venta de Banos, to communicate direct with Léon and Miranda, while at the same time selective-calling telephony will be utilised on these three circuits which are equipped with 33, 22 and 20 selector units respectively.

Electrical Listing Arrangement at the Helsingfors Exchange

O. HJELT, O/Y L. M. ERICSSON, SUOMESSA, HELSINGFORS

At the beginning of this year an electrical listing arrangement, constructed by Aktiebolaget L. M. Ericsson i Finland for the Helsingfors Exchange, was put into service. This installation is one of the first of its kind to be installed in the whole world — only in Stockholm Exchange is one like it to be found — so that the following description, reproduced from »Kraft och Ljus» No 2, 1935, may be of interest.

There are many spheres of daily life where procedure follows a certain routine which has grown up during many years. This routine process is so ingrained that it is often overlooked that modern technical practice may provide other means that permit the procedure to be carried out much more simply and effectively.

Transactions on stock exchanges are as a rule carried out verbally, a procedure which leads to much waste of time, besides entailing considerable strain, both physical and nervous, on officials as well as members. For this reason the Principal of the Stockholm Exchange began to consider the possibilities of another method of listing quotations than the verbal one and worked out a system which was introduced on the Stockholm Exchange 16 years ago and which has now been in use on the Helsingfors Exchange since the beginning of this year. This system makes possible a particularly rapid liquidation of stock transactions, thus enabling considerable time to be saved. As an example, it may be stated that it has happened that on the Stockholm Exchange a turnover of 20 million Kronor has been liquidated in a single call-over, *i. e.*, in a period of little more than an hour.

The introduction of such mechanical arrangements on a bourse is attended at the beginning with difficulty, as the old accustomed method is preferred. However, it does not take long for members to get accustomed to the new procedure and to recognise its great advantages. When the electrical listing system had been in operation on the Stockholm Exchange for 10 years, the members were given the opportunity to decide by referendum whether or not the system should be retained. The members voted unanimously for the retention of the system.

Below is a description of the listing installation of the Helsingfors Exchange, which is the same as the Stockholm equipment except as regards size.

Fig. 1 X 5208

Interior of Helsingfors Exchange

In the background, below the quotation board Principal's desk is seen in the foreground members' desks

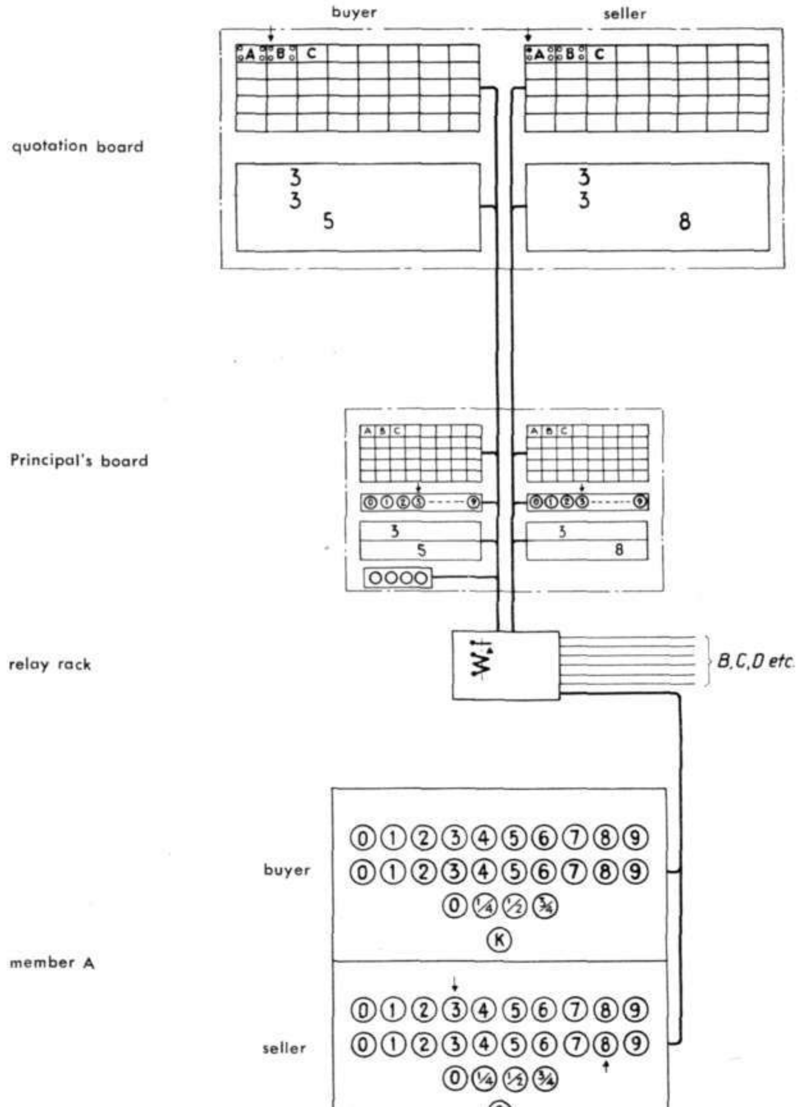


Fig 2 X 1464
Diagram of electric listing arrangement

Construction

The listing arrangement consists of a quotation board, a relay switchboard and the press-button sets of the members, see diagram, Fig. 2.
Inset in the desk-top of each broker are two sets of buttons for noting selling and buying prices respectively. Each set consists of 10 buttons for the unit figures, a like number for the tens and certain buttons with special functions. Possible further figures are not noted during the progress of negotiations for each quotation, but are inserted by the Principal of the Exchange.
Up above the Principal's platform and clearly visible over the whole hall is hung the large quotation board, Fig. 1. As may be seen from Fig. 3, the board also is divided into two simlar sections for purchases and sales. Each place in the hall corresponds to a compartment on the board marked with the initials of the owner of the place, on both purchase and sales section. In the corners of each compartment are mounted different coloured lamps. The lamp in the upper left-hand corner is green, that in the right-hand corner red, and so on.
The white sections under these initialled compartments are of ground glass covering figures cut out of brass plate which can be illuminated from behind by electric lamps. In the upper part of the section is a row of figures from 0 to 9 by means of which the Principal marks the hundreds figures for the stock or share that is being called at the time. The two rows below contain figures for the tens and units. At the bottom there is a row for marking frac-

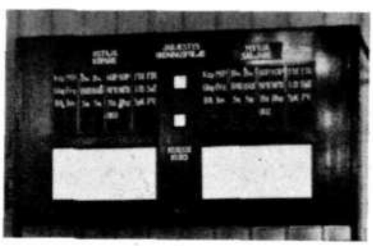


Fig. 3 X 3426
Main quotation board

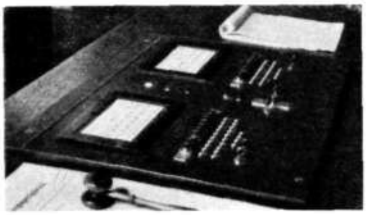


Fig. 4 X 3421
Principal's quotation board
with operating devices

tions. Between the sections with he initialled compartments there are two lamps one of which indicates that the system is connected up, while the other has the important function of marking when a conclusion has been arrived at.

The Principal, who sits with his back to the board and thus can hardly follow the marking on it, has a copy of the large board in miniature inset in the top of the desk in front of him, Fig. 4. This board contains in addition various switches, for starting etc., and buttons for marking the third (hundreds) figure.

In a room immediately adjoining the Exchange Hall the central organ of the installation, the relay exchange, Fig. 5, is housed. Here are registered all the connections of the buttons in the hall. The listings, which the exchange later connects to the board, depend thus not only on the offer given but also on the offers which have preceded it. The exchange contains no other connecting appliances except relays, and its working therefore is extremely rapid and silent. The wide section to the left holds all the relays which list a certain price, as well as the mechanism for clearing foregoing listing etc. In the two sections to the right each Exchange member's place is represented by a group of relays for purchase and a similar group for sales. These relays control the marking of all figures and the order in which offers are made, if several offers are made one after the other. The relay exchange and the other equipment are made for 26 members' places, with provision for extension by 14 further places. In the event of extension beyond this figure being necessary, this can be done by the installing of a further section.

An installation with such a responsible duty as this must naturally be absolutely free from faults in operation. Regular supervision is therefore advisable and to facilitate this there is in the relay exchange a small replica of the listing board and a button set. All the place equipment is connected to jacks in the test circuit and can be connected by plugs to the test arrangements. By means of this arrangement the tester can at the same time carry out test markings, follow their progress on the board and directly see the working of the relays.

Operation

The dealings in a certain security begins with the Principal calling the security, at the same time connecting up the system. The security in question has been listed the day before at, say, 357. The Principal connects the hundreds figure 3, which appears both on purchase and sales sides of the board in 8 cm high transparent print. Exchange member *A* wishes to buy at 332. He presses for an instant on buttons 3 and 2 of the tens and units rows respectively of the purchase section and on the board appears the complete purchase bid of 332. In member *A*'s compartment on the board a green lamp lights up at the same time, so that all may clearly see who has made the offer. The colour of the lamp indicates that *A* is the first to offer this price. Should other brokers also be disposed to purchase at this price, they make the same marking. In their compartments also lamps light up, but of different colours indicating the respective order in which the bids were made. For the one who immediately after *A* marked the same price a red lamp shows, and so on. Maybe a broker *B* wishes to sell, but at a higher rate, 339 for example. He presses the corresponding buttons in his sales group and his offer is marked on the board under the heading »seller».

Other brokers now join in the game with fresh offers, but in order that the dealings shall proceed rapidly the relay exchange is so constructed that bids on the purchase side cannot be lowered and sales offers cannot be raised; thus the board always lists the best prices noted for the security.

If, however, a member *C* lowers the sales price by marking 338 from his button set, the preceding sales price is erased, 338 shows up as the best sales price and a green lamp lights in *C*'s compartment on the sales side.

On the purchase side we had two brokers bidding 332. One or other of these, or perhaps a third broker, feels able to buy at 335 and notes this rate therefore by means of his buttons. Immediately all the markings noted in their order disappear and the new price appears on the board, while a green lamps indicates who has made the bid. In this way the prices and the

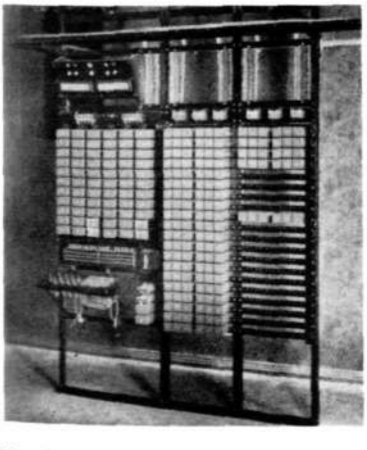


Fig. 5 X 3422
Relay exchange of listing arrangement

lamps indicating order of bids change in quick succession, while the rates on the purchase and sales sides approach nearer to one another. Finally the same rate is marked on purchase and sales sides. A conclusion has been arrived at and the security changes hands at the price listed. At the same time a bell rings, the conclusion lamp lights up and the markings are automatically locked. There is still possibility for other brokers to mark the same price and come up into second, third place, etc. If the Principal wishes to prevent this and stipulate that the transaction only applies to members whose bids are marked on the board, he presses on the barring lamp for a moment, whereupon all further markings are made impossible.

As will be seen from the above the Principal can without the least strain follow the bids and at any moment read the prices direct. For a conclusion with verbal dealings, particularly great vigilance is necessary on the part of the Principal in order to determine who bid first when bids where given at about the same instant.

As the prices are marked electrically, the Principal in all tranquility can follow the progress of the prices and wait for the bell to ring as indication that the transaction is concluded. The work of the members is also facilitated since they have the bids before their eyes all the time and have not to shout themselves hoarse to get their own bids heard.

In addition to the buttons referred to for the marking of tens and units, the button sets of the brokers contain buttons for marking fractions. Certain securities are listed in percentage and these prices are extended to fractions of per cent, thus 105¾ %. When such a security is called, the Principal presses on a special button which connects up the system for marking percentages. The fraction buttons can now be put into operation and the corresponding marking shows up in the lowest row of the marking part of the board.

In order to facilitate still further the work of the members there is in the purchase set a button for direct purchase and in the sales section a button for direct sale. Let us assume that a broker *D* for the moment is not interested in the security which is being called. He has not made a bid, but is on'y waiting for the next security to be called. Suddenly he finds, for example, that a sale price of 732 has fallen to 715. At such a price it will pay him to buy any circumstances. He must act quickly and *D* has no need to pick out the figures 1 and 5 to buy, he has simply to press his button for direct purchase. All earlier purchase prices and orders of bids are erased, 715 comes up on the purchase side, the conclusion bell rings and a green lamp in *D*'s compartment indicates that he has bought at 715. Brokers who are not bidding may thus for all eventualities during the negotiations sit with one finger on the purchase button and one finger on the sales button and watch out for a favourable price.

When the dealings in a security have been going on for a time and a number of conclusions arrived at, business is for the moment at an end and there is no more to be done. The purchase and sale bids then move away from each other. By pressing a special button the Principal fixes these prices which are the final prices of the day. The marking figures then change from white to red. The Principal proceeds to the next security. The final prices are binding on the bidders for a certain stipulated time.

In the manufacture of the listing arrangement elements standardised for telephone practice have principally been made use of. Thus the numerous relays in the exchange are of the type which make up the modern automatic exchange. The button sets, jacks, lamps etc. are as used in manual exchanges. The wiring has been carried out exclusively in lead sheathed cotton insulated and impregnated cable.

As the floor of the Exchange Hall is laid with parquet, direct'y embedded in concrete, the cables have been laid in channels sawn out of the parquet. As the parquet pieces are 20 mm thick, the channels can be covered with the same material in 10 mm thickness, so that the presence of the channels in the floor can hardly be detected. An idea of the extent of the wiring may be obtained from the fact that in certain of the channels 1 340 wires run side by side.

New Automatic Exchanges on the Ericsson System in Sweden

The Royal Swedish Board of Telegraphs has ordered from Telefonaktiebolaget L. M. Ericsson for the town of Borås an automatic telephone exchange on the Ericsson machine-drive system with 500-line selectors.

The exchange, which will consist of 7 000 numbers and be ready for traffic towards the close of the year 1937, is to be made so that time-zone-metering may be introduced when the surrounding rural district is automatised.

At the present time automatisation on the Ericsson system is being carried out in the suburbs and towns around Stockholm. Three exchanges on Lidingön with a total of 3 000 numbers were opened for traffic during 1933 and 1934. The Äppelviken exchange of 7 000 numbers is to be opened in January 1936 and the Enskede exchange with 6 000 numbers in January 1937.

New Automatic Exchanges on the Ericsson System in Czechoslovakia

The first automatic telephone exchange in Czechoslovakia on the Ericsson machine-drive system with 500-line selectors was opened on 30th March last at Nitra.

The Nitra exchange is at present developed for 420 subscribers and 4 special directions. There can be 20 local calls and 12 trunk calls going on at the same time. A manual trunk exchange, installed earlier by another maker, comprising 6 operator's positions and about 40 trunk circuits has, with very little modification, been arranged for automatic junction traffic over the new automatic exchange with the subscribers in Nitra. The installations will in the near future be supplemented by circuits for automatic setting up of connections from the trunk exchange at Bratislava, 90 km distant, where all arrangements for dealing with trunk calls will be located. By this arrangement it is considered that in course of time it will be possible to do without staff altogether at Nitra.

In addition, it is the intention to connect the automatic rural exchanges to the Nitra exchange in the near future.

The Czechoslovakian Ministry of Posts and Telegraphs which has already expressed its satisfaction with the new installations at Nitra, has ordered further plants of a similar kind.

X 3403

General post office at Nitra
where the new automatic exchange is housed

Police-Telephone System — Further Developments

J. R. H. STEVENS, ERICSSON TELEPHONES LTD, BEESTON

In the Ericsson Review No 2, 1933, a description was given of a new system of police telephones introduced by Ericsson Telephones Ltd, London—Beeston. Since that time the system has been in widespread use and experience obtained in practice has led to a number of improvements.

The general desire of police authorities for a modern telephone communication system has been met by the Ericsson police-telephone system, adopted as a standard by the British Post Office and described in the Ericsson Review No 2, 1933. This system provides a communication network interconnecting boxes and pillars in the streets, police sub-stations, police headquarters and the telephone exchanges. Line costs are reduced to a minimum by connecting more than one street point, *i. e.*, box or pillar, to each line. The public are permitted restricted use of the system: public calls being limited to communication between the street points and the police or fire stations. Speech from the police operator to the public is received at the street point through a loud-speaker.

The police authorities have not hesitated to take full advantage of the facilities offered by the police-telephone system and to remodel their organisation upon modern lines. The increasing importance of the system in police administration and the tendency of the public to use the services offered, even for other than strictly emergency calls, have necessitated further development of the system.

Thus there has been introduced an inward-signalling device which indicates, at the switchboard, which of the call points connected to a line is calling and also the class of caller, *i. e.*, police or public. This device is necessary for reliable supervision of police officers on beat. All officers report »on» and »off» from certain stipulated street boxes and also call up at regular intervals from other street points on their beats. Notices and routine reports are posted in the street boxes, distribution being by motor vehicles. In this way each street box becomes a police sub-station and it is rarely necessary for a beat police officer to report personally at headquarters, as he can maintain contact by means of the telephone system.

Fig. 1 X 3401
Signal mechanism for street point

The signalling device, Fig. 1, based upon an automatic-telephone dial mechanism, is operated automatically when the police handset is lifted, or the public panel is opened, and transmits to the line a train of pulses. These pulses operate relays at the switchboard and light a lamp display to give the required indication. In connection with this facility a certain amount of circuit development has been carried out to prevent lost calls, and to reduce to a minimum the possibility of false calls. If mutilation of the pulse train should occur due to extreme conditions, occurring but rarely in practice, the type of call is always shown correctly. The answering of a public call is thus never delayed because of an incorrect display.

Delay which may arise from other causes is eliminated by the fact that a public call display has preference in such a manner that, if a police call is displayed

Fig. 2 X 3402
Two-position operator's desk at police station

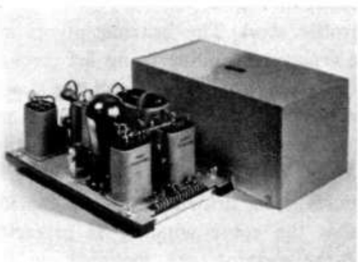


Fig. 3 X 3400
Amplifier with suppressor

and awaiting attention and a public call should originate on the same line, the display of the police call is cleared and the public call display substituted. A police call following a public call cannot, however, clear down the public call display.

Moreover a public call that originates on a line already in use by a police call is displayed irrespective of the destination of the police call, which may be extended to a police extension line, to another switchboard in the police area or to the public exchange.

Previously all public calls were answered by the operator who, by actuating certain keys, was connected to the line via an amplifier. Experience has shown that, generally, the operator is fully occupied with routine police calls, and the question of permitting, if necessary, the answering of public calls at some point remote from the switchboard has received consideration. The circuits have been redesigned so that the answering of public calls is effected by special cord circuits, thus allowing extension in a manner similar to that of a police call to certain selected extension lines, which may include those to the charge room, the superintendent's office, the ambulance, the fire-station etc. The operator may listen-in to an extended call; a facility of great value on fire calls.

The switchboards are each equipped with six of these special cord circuits and, since the answering of a public call requires amplified speech, an amplifier is associated with each cord circuit. The amplifiers are accommodated on the top of the switchboard as seen in Fig. 2. The plugs of the public-call cord circuits are located in the centre of the switchboard and are, therefore, accessible to both operators. Each amplifier employs one valve only, and is fitted with a suppressor using metal rectifiers for reducing to a comfortable level the strength of that part of the loud-speaker's output which is returned to the operator's telephone through the street point transmiter. Fig. 3 shows clearly the compact form of the amplifier and suppressor unit.

The public-call cord circuits are so arranged that any attempt to extend a public call to a line other than those assigned will cut off the amplifier and light the alarm lamp. This also occurs under any other condition of misuse or incorrect operation.

New Hand Magneto Generator

E. BERGHOLM, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

Telefonaktiebolaget L. M. Ericsson has worked out a new type of hand magneto generator specially designed for use where low weight and small size are necessary.

The great advances in recent years in the manufacture of permanent magnets has led to the solving of a problem which had for a long time been troubling the designers of telephone instruments, *i. e.,* the production of an efficient magneto generator of considerably reduced dimensions. While formerly wolfram alloy steel with a coercitive force of 60—80 ørsted had to be used for the construction of instruments with permanent magnets, there is now a whole range of different materials to select from with coercitive forces up to 600 ørsted.

The selection of the material depends naturally on what demands are placed on the design in respect of efficiency, dimensions and price. The magnet material in the generator described below is 35 % cobalt steel which has shown itself to be the most suitable to meet the requirements imposed.

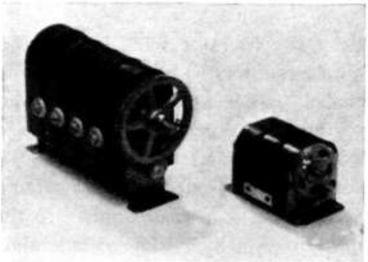


Fig. 1 X 3442
The new magneto
compared with magneto of older type

Fig. 1 shows the new magneto generator compared with one of an older type of comparable capacity. The reduction in the dimensions has been exceedingly great, as can be seen. The overall measurements of the new type are: height 66 mm, width 63 mm, length 100 m and weight 1 kg. The principal parts of the new generator may be seen in Fig. 2.

The *rotor* is made of silicious martin profile steel. The bearing pivots are bored through, the connecting wires to the armature winding being led through them. The winding is completely insulated both from the rotor and the stator. The *stator* is fully closed. The pole pieces, made of profile steel of the same composition as for the rotor, are rivetted to the pole plate, which in conjunction with the end plates form a completely closed rotor chamber.

This prevents dust and foreign metal particles being drawn in the air gap. At the same time it gives the advantage that the rotor winding is protected against damage. The spring group and the gearing are mounted on the end plates. The spring group normally effects a commutation, which is adequate for most telephone circuits. The gearing ratio between the crank axle and the rotor axle is 1 : 5.25.

The *magnets* are made of 35 % cobalt steel. Their dimensions are selected to give the highest possible efficiency and stability against demagnetising influences. The magnet area is 5×17 mm. With this area the output from three magnets is only slightly smaller than for magneto generators hitherto employed with five magnets. This output is quite sufficient for telephone instruments even under very severe conditions. The magneto generator is normally for three magnets, but in many cases two magnets should give a ringing output which is quite sufficient.

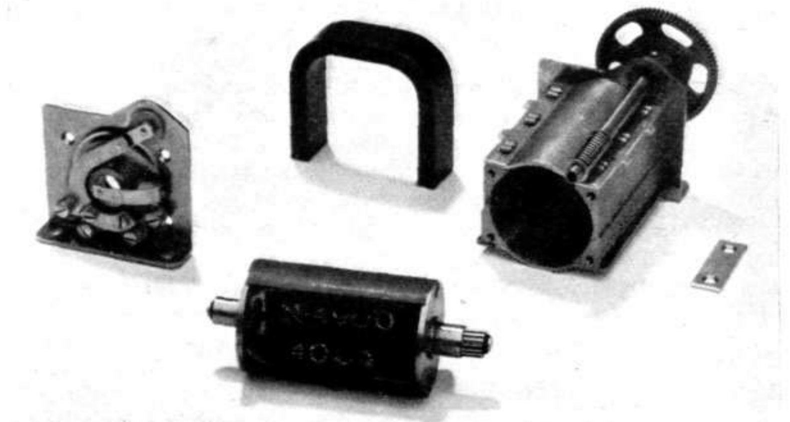


Fig. 2 X 5212
Magneto dismantled
left to right: spring set, rotor, a magnet and stator

Bakelite Handset with Key

S. WERNER, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

To permit of the use of the Ericsson standard handset in special instruments which have no special switch-hook, a press-button key has been constructed, which is fitted in the handle of the handset.

The bakelite handset has already been described in Ericsson Review No 1, 1933, and here will only be given a description of the press-button mechanism, Fig. 1, together with particulars of its function.

The press button is located on the inner side of the handle where its position is such that it can easily be pressed by the fingers with normal grip on the shaft. Only the part of the press button projecting is visible of the whole device. It is 8 mm in diameter and is made in insulated material of the same colour as the handle. There exist no projecting metal parts and the handset is thus made entirely of insulating material.

The press button acts on certain springs located inside the microphone case where they are easily accessible for inspection and adjustment. Pressure on the button is transmitted to the contact springs by way of a metal rod sliding freely inside the handle and which is inserted through the cord intake. The press button is fitted inside with a metal cone against which the point of the rod rests. The rod also tends to prevent the press button falling out and is itself held by a screw.

Pressure on the button pushes the rod in the direction of the microphone case and there actuates the contact springs. A spiral spring under the button restores it to initial position and the end of the rod is held against the conical surface of the button by the contact springs in the microphone case. The contact springs are located on the terminal block in the microphone case. One of them is connected to the contact spring of the microphone and the other to the connecting strap between the terminal block and the wire in the handle. The wire goes down in the handle and lies there pressed against the sliding rod.

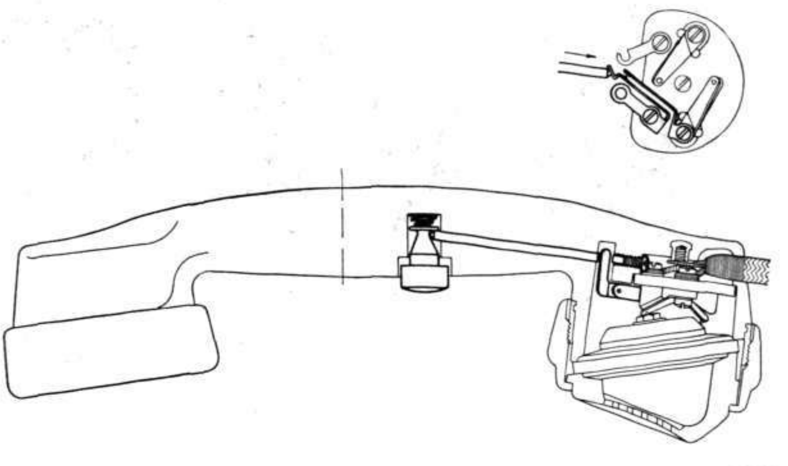


Fig. 1
Section of handset with key

X 5213

Operating Relays

E. LUNDGREN & G. BYRENIUS, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

Telefonaktiebolaget L. M. Ericsson has developed a series of operating relays the main point about which is their high reliability in service. They are therefore particularly suitable for automatic switching of operating apparatus, remote control, etc.

The technical man is constantly directing his efforts towards the rationalisation of operating and working processes, which in many instances can be carried so far as to make the processes entirely automatic. To ensure full reliability of working, not only the automatic control organ but also each and all of the relays which drive the operating devices must be free from failure. High quality in the relay is therefore a particular necessity, the more so as a slight increase in the price of the relays represents a very small percentage of the total cost. Telefonaktiebolaget L. M. Ericsson therefore in designing these operating relays has directed attention especially to meeting all requirements in regard to absolute reliability of working.

The operating relays are enclosed in black-enamelled sheet-iron cases, see Fig. 1, with terminals of safe construction for tensions up to 380 V. The magnet coils are of the same type as for the usual telephone relay, and the contacts are of different types, suitable for various break effects.

The first type, the *mercury contact,* Fig. 1 a, consists of a glass tube containing mercury and a rare gas. The mercury connects two or three electrodes fused into the tube. These contacts are made in three different sizes, with breaking capacities of 6, 12 or 30 A at a non-inductive load not exceeding 220 V.

The great usefulness of wolfram as a contact material has been utilised in the second type, the *wolfram contact,* Fig. 1 b. The breaking capacity is about 500 W on non-inductive load with a greatest tension of 380 V and a maximum current of 3 A.

The third contact is the *low-capacity type,* with silver contacts like those used in telephone practice. Compared with the preceding ones this contact has a relatively low breaking capacity, about 0.5 A for 24 V non-inductive load, but this is quite sufficient in many cases. The tension should be kept below 60 V, which does not constitute any drawback since AC may be used for operating and this can easily be transformed down to the required tension. The advantage of these contacts is that with them it is possible to obtain many and complicated contact combinations, see Fig. 1 c.

The relays are constructed for any desired working voltage. The standard figures are 24, 48, 110 and 220 V, DC or AC. The relays for AC are

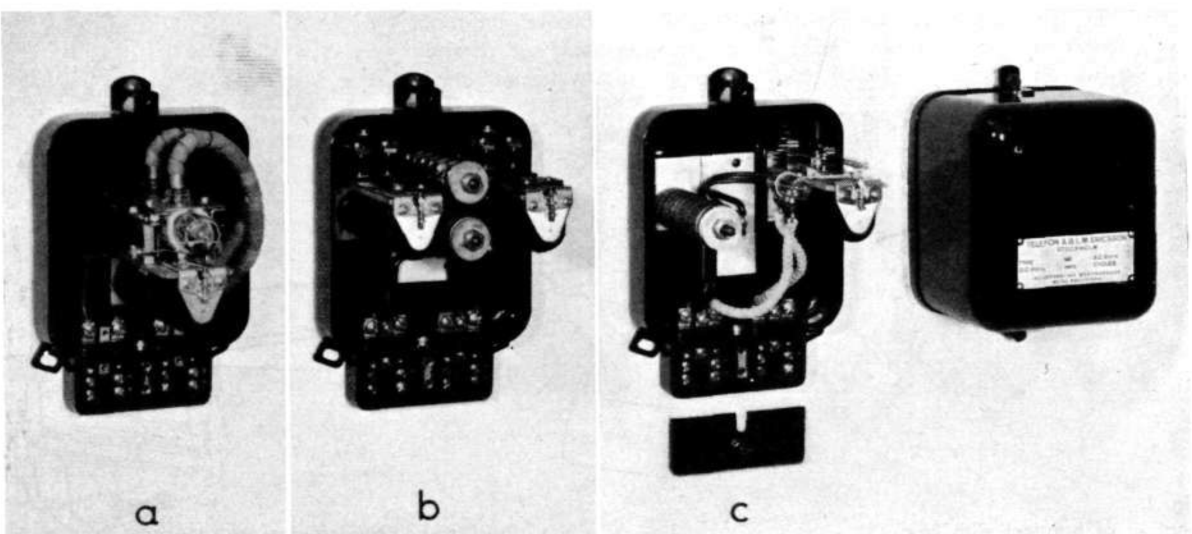


Fig. 1 X 7080
Operating relays of different types with
a mercury contact
b wolfram contact
c silver contact

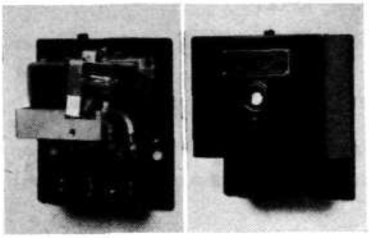


Fig. 2 X 3411
Operating relay with mercury contact and visual signalling

equipped with metal rectifiers so that they work noiselessly and without vibration. The energy consumption is low, keeping between 0.1 and 0.5 W for an operating voltage of 24 V DC.
The design is very flexible so that the relays may be used for various requirements. It should be mentioned that the different types of contact may be used on the same relay, that contacts for thermic release may be fitted, etc. The relays can also be provided with mechanical locking for manual or electrical restoring as well as visual signalling when the relay is in attracted position, Fig. 2.
A large number of Ericsson operating relays are in use for signal installations of various kinds, charging sets, time-control installations, for switching in motors, automatic oil-firing plants, etc.

Sand Cover to Protect Cables against Insects

In tropical and sub-tropical countries care is necessary to protect aerial cables against the ravages of insects. The lead-sheath is frequently attacked by beetles or bees which bore small holes in the cover with the object of depositing their eggs in the cable itself.
Several instances of damage done by the carpenter bee have been reported from Further India. This bee, one of the *apis* species, usually attains a length of 20 to 30 mm. It prefers dry trees, preferably dead wood, as depositories for its eggs where its larvæ may develop, and seldom makes use of bark or other rough surfaces. The hard, smooth surface of the cable seems to attract the bee as offering conditions similar to those of dry wood, and the manner in which the carpenter bee attacks the cable sheath may be seen from Fig. 1. The size of the hole was 7×7.5 mm, though the damage done to the paper covering was very small. No eggs were found inside the cable.
The fact that the carpenter bee avoids rough surface has led to the employment of a covering of sand as a means of protection, see Fig. 2, which shows such a cable as manufactured by Ericsson. The sand is made to adhere to the cable by means of a black compound of high melting point which is fused on to the cable and to which the sand is applied while the compound is still soft, the whole surface then being left to harden. Cables treated in this way have remained undamaged for several years, and it is considered that the rough sand cover has been effective in preventing the attacks of the insects and the influence of the climate.

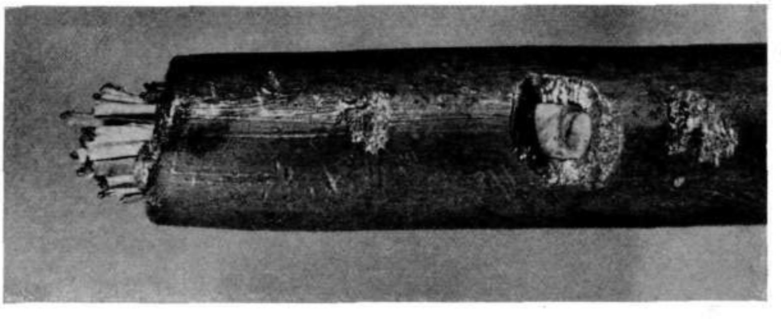


Fig. 1 X 5214
Cable attacked by insects

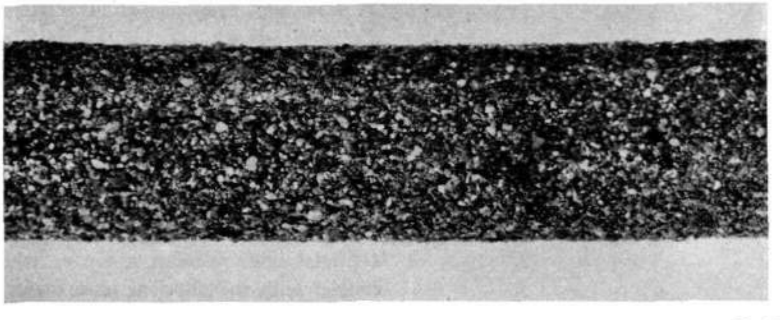


Fig. 2 X 5215
Sand-covered cable

New Catalogue

A catalogue dealing with the Ericsson systems for selective-calling telephony is now ready in the English language and will shortly be available in Swedish, German and Spanish.

The catalogue comprises, first, a general part which deals with the more important technical and constructional details of the systems and the possibility of using selective-calling lines for simultaneous carrier-frequency telephony, followed by a special section giving the practical arrangements and connections for the different systems; descriptions are also given of the designs, dimensions, etc. of the most important instruments and the necessary power plants for the operation of the installations. The text is supplemented by diagrams, photographs and tables.

The Ericsson selective-calling telephone systems are specially designed for railway requirements and the catalogue indicates all the numerous possibilities which the systems offer on account of their practical division into units and their adaptability, both in respect of reliability on the utilisation of the lines to full capacity and their suitability for combined operation with private exchanges etc.

The English edition of the catalogue bears the number 203.

Ericsson Technics

Ericsson Technics No 1, 1935.

R. Lundholm: The Influence of Condenser Protection on Ligthning Surges.

In the present article the characteristics of the functioning of condenser protectors, which have been used of late instead of resistance protectors for the overvoltage protection of power plants, are studied. On the basis of a numerical example, it is shown that the voltage surge is transformed by the condenser through the generation of a reflected wave which superimposes itself on the incoming wave. Further, the range of protection of the condenser in the line along which the wave comes is discussed. When the condenser protector is struck by a train of waves it is theoretically possible for high overvoltages due to resonance to arise. It is demonstrated however that in practice conditions are seldom or never liable to favour the occurrence of these overvoltages.

The influence of an inductance in series with the condenser is studied and it is evident therefrom that current transformers do not appreciably reduce the protective influence of the condenser against overvoltages.

Ericsson Technics No 2, 1935.

T. Laurent: Transformation fréquentielle des lignes artificielles correctrices d'affaiblissement.

The author demonstrated in Ericsson Technics No 5, 1934, how by means of frequency transformation of electrical filters it is possible to transform one type of filter into another. In the present paper these frequency transformations are treated in a more general manner together with their application to artificial lines used by Ericsson for attenuation correction. As in the case of electrical filters, the frequency transformations of attenuation-correcting artificial lines presents a theory which is very clear and stands in intimate contact with the physical phenomena.

The Ericsson Group

Associated Enterprises

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Československo Prchal, Ericsson a spol	*Praha 1*, Malé náměstí 1
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Eesti Tartu Telefoni Vabrik A/S	*Tartu*, Puiestee tänav 9—11
España Cía Española Ericsson, S. A.	*Getafe (Madrid)*
France Société des Téléphones Ericsson	*Colombes*, boulevard d'Achères
Great Britain Ericsson Telephones Ltd	*London WC 2*, Kingsway 67/73
The British Automatic Totalisator Ltd	*London WC 2*, Kingsway 56
Electric Totalisators Ltd	*London*
Production Control (Ericsson) Ltd	*London WC 2*, Kingsway 56
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Società Ericsson-Fatme	*Roma*, via Appia Nuova 572; C. P. 348
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Società Urbana Immobiliare	*Napoli*, Palazzo Telefoni, piazza Nolana; C. P. 274
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Magyarország Ericsson Magyar Villamossági R. T.	*Budapest 4*, Fehérvári-út 70; F. P. F. 282
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Österreich Ericsson Österreichische Elektrizitäts A. G.	*Wien XII*, Pottendorferstrasse 25/27
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Polska Akcyjna Spółka Telefoniczna	*Warszawa I*, Zielna 37/39
»Telsyg», Wytwórnia Telefonów i Sygnałów Kolejowych S. A.	*Wełnowiec-Katowice*, Św. Jadwigi 10
România Ericsson S. A. Română	*București*, strada Luterană 23
Suomi O. Y. L. M. Ericsson Suomessa	*Helsinki*, Neitsytpolku 1
Sverige Telefonaktiebolaget L. M. Ericsson	*Stockholm*, Döbelnsgatan 18
Svenska Radioaktiebolaget	*Stockholm*, Alströmergatan 12
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Aktiebolaget Alpha	*Sundbyberg*
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Fastighetsaktiebolaget L. M. Ericsson	*Stockholm*, Kungsgatan 33

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Nederlandsch Indie Ericsson Telefoon-Maatschappij N. V.	*Bandoeng*, Tamblongweg 11
Türkiye İzmir ve Civarı Telefon Türk A. S.	*İzmir*, Mitat Paşa Caddesi; P. K. 314

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Corp. Sudamericana de Teléfonos y Telégrafos S. A.	*Buenos Aires*, Bernardo de Irigoyen 330
Cía Argentina de Teléfonos S. A.	*Buenos Aires*, Bernardo de Irigoyen 330
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Brasil Sociedade Ericsson do Brasil, Ltda	*Rio de Janeiro*, rua General Camara 58
México Empresa de Teléfonos Ericsson S. A.	*México, D. F.*, 2:a calle Victoria 53/61; apart. 1396
Cía de Teléfonos y Bienes Raices	*México, D. F.*, 2:a calle Victoria 53/61; apart. 1396
Uruguay Cía Sudamericana de Teléfonos L. M. Ericsson S. A.	*Montevideo*, calle Mercedes 1262

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Australia Ericsson Telephone Mfg Co.	*Sydney*, Clarence Street 137/139

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Southern Rhodesia Rogers-Jenkins & Co., Ltd	*Bulawayo*, Fort Street 124; P. O. B. 355
Union of South Africa. Rogers-Jenkins & Co., Ltd	*Johannesburg*, Marshall and Nugget Streets; P. O. B. 654

AMERICA

Bolivia Cía S. K. F. de Bolivia	*la Paz*, avenida 12 de Julio 34; cas. 678
Chile Flaten, Royem, Anker & Cía, Ltda	*Santiago*, Estado 46; cas. 2168
Colombia Axel Bergstrom S. A.	*Bogotà*, calle 13 a, 16—80; apart. 916
Ecuador Cía Sudamericana S. K. F.	*Guayaquil*, 9 de Octubre 106; cas. 1317
Peru Cía Sudamericana S. K. F.	*Lima*, esq. Pando y Bejarano; cas. 2260
Venezuela Harry Gibson	*Caracas*, Edificio Principal 8; apart. 891

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