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On the cover: the Samaritaine Stores at Paris

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Modern Telephone Instruments

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Of late years almost incessant designing activity has been displayed in most branches of telephony. This has also been the case with subscriber's instruments and special instruments of various kinds. Telefonaktiebolaget L. M. Ericsson has contributed to these developments by a series of different types of instruments, all of which are distinguished by tasteful appearance and soundness of construction.

Many of the instruments are of entirely new design and only a few of them consist of older types brought up to date and improved.

Normal telephone instruments have already been described in the Ericsson Review No 1 and 4, 1933, and the transmission and technical properties were dealt with in the Ericsson Technics No 2, 1934.

This issue contains a brief review of a number of special instruments which are of more general interest: coin apparatus, extension instruments, stenographers' instruments and divers' instruments, while a special article is devoted to ship's telephones.

The next issue will contain descriptions of subscriber's extension stations, as also portable instruments.

Coin Apparatus

As the telephone has penetrated more and more into home and business life as an indispensable accessory, people have become accustomed to having telephone service constantly at hand, with the result that there is a demand for coin apparatus on the streets, in waiting-rooms, shops etc. To meet this demand Ericsson has recently completed new coin apparatuses, which are characterised by extreme simplicity in service and reliability of construction

Coin apparatus can, from the point of view of service, be divided into two different types: postpayment and prepayment instruments. By postpayment apparatus is meant an apparatus where the payment is made after the called subscriber answers and by prepayment apparatus is understood an apparatus in which the coin is first inserted and *is automatically collected* by the apparatus as soon as the communication is obtained.

It is possible, however, to make all postpayment apparatuses in such a way that the coin must be inserted before the apparatus can be used. By this they do not become prepayment apparatus, seeing that the real collection must all the same be done after an answer has been received.

In general it may be said that in principle the prepayment apparatus is the better. Yet up to now it has frequently had the disadvantage that its construction was too complicated and that it often required special supplementary equipment at the telephone exchange. Ericsson has, however, succeeded in designing such a coin apparatus, which meets all requirements in respect of simplicity and reliability both electrically and mechanically.

All the types described below are made as units which can be used with any type of telephone instrument. This ensures lower first cost and upkeep expenses for the telephone administration, while in construction they are stronger and simpler. For instance, with the coin apparatus for connection to automatic systems there is a further great simplification, seeing that the coin apparatus, which is more exposed to damage need not be provided with a dial and crutch. None of the types described below is fitted with special refund mechanism, and this enables an extremely simple construction mechanically to be used.

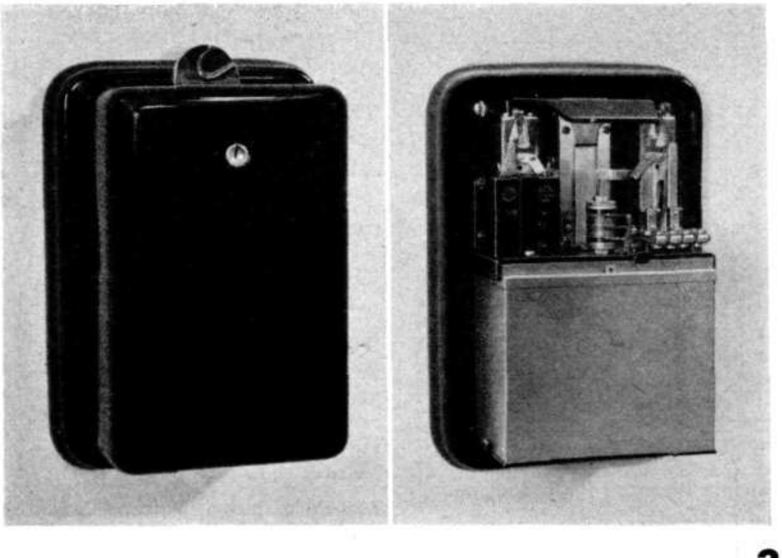


Fig. 1 X 5191
Coin box for one kind of coin, Type DU 100
Top, between relays, coin groove
bottom, coin box

Prepayment Coin Apparatus

The coin apparatus, Type DU 100, described below can be connected to any automatic or manual CB systems so made that a current inversion is obtained on the calling line when the called subscriber answers. Even if the system does not use normally a current inversion at the answer, such an inversion may generally be obtained on certain lines, to which the coin apparatus are then connected.

The apparatus is of the prepayment type, being therefore provided with a coin slot in which the coin inserted before the call is made. It remains in such a position that the caller may, *at any moment* before the conversation begins, take it out with his fingers. It is only when the called subscriber answers that the coin is made to fall automatically in the box. In this way all complicated refunding mechanism is avoided and the instructions to callers in regard to payment are of the simplest conceivable.

The apparatus can be used for both outgoing and incoming calls, payment not being necessary in the latter case.

The coin apparatus, Fig. 1, is particularly strongly made to answer the severe demands which may be made on such an apparatus. Special measures to ensure a thief-proof construction have been taken, the cover being made of 3 mm pressed steel, and the base is of hardened cast metal. In addition the cover is provided with a first quality lock.

The internal parts are also strong and simple. The whole mechanism is mounted on an angle steel plate to which the various parts are fitted. In this connection the coin groove is noteworthy, as on account of the design of the apparatus this can be made as a straight vertical groove. To prevent any fraudulent tampering with the machine, for instance by using a com attached to a string, the kroove is provided with a coin block which prevents a coin once it has reached the groove being drawn back through the slot. The blockage of speech if the required amount be not paid is complete, as both microphone and earphone are short-circuited.

The coin apparatus, see the diagram, Fig. 2, contains two operating relays, each of which acts on a flap in the coin groove as well as its own short-circuiting contact. Each relay is connected in parallel to a rectifier which is directed opposite to the line polarity. Both these relays connected in series are shunted by a condenser which reduces the impedance in the speech frequency. When a call is made the current direction is from *La* to *Lb* causing the relay *R2* to be so strongly shunted by the rectifier *Re2* that it cannot attract. Practically the whole line current thereupon flows through relay *R1*, as the rectifier *Re1* has high resistance to this current flow. The relay *R1* thus attracts and collects any coin which may remain in the coin groove from a previous call, at the same time short-circuiting relay *R2*.

The apparatus is now ready for the impulsing and there is no further change of any kind until the current change takes place on the line, *i. e.*, until the called subscriber answers. Thus it is possible without payment to carry on a conversation with the operator, use a special number and obtain a communication etc.

The requisite coin for payment can be inserted in the slot *at any moment whatever*, as it is prevented from falling into the apparatus by the flap operated by relay *R2*. If there is no reply or the number is engaged or impulsing has been broken off because a wrong figure had been dialled, the coin can be taken out of the position in which it was held by relay *R2*. Thus no extra arrangement in the shape of refunding mechanism or extra slot is required. On the other hand when there is a reply, a current flow takes place on the coin-apparatus line. Thereupon falls the relay *R1* which is unable to attract because of being connected in parallel with rectifier *Re1*. With the changed

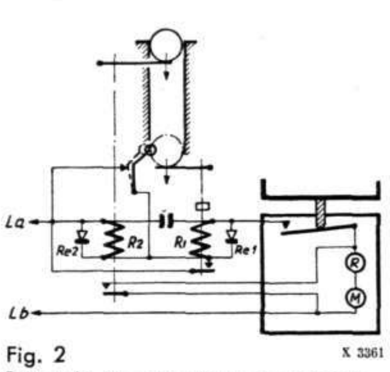


Fig. 2 X 3361
Principle diagram for prepayment coin apparatus

current direction relay $R2$ becomes magnetized and attracts its armature, so that the earphone and microphone of the telephone instrument are short-circuited. At the same the upper flap in the coin groove is influenced so that a coin can pass. A coin inserted in the slot thus falls into the coin groove and stops against the lower flap. In this position the coin influences a contact which short-circuits relay $R2$. This relay falls once more and the telephone instrument is set in operation so that a conversation can be held. Should there be no coin or should the coin used be faulty, for example too small, the contact referred to is not influenced; the relay $R2$ remains attracted and the telephone instrument is consequently out of operation until the communication is cut off. As may be seen from the foregoing, on an outgoing call there is no relay in series with the telphone instrument, as relay $R1$ is short-circuited by rectifier $Re1$ and relay $R2$ by the coin contact.

It should be noted that the block actuated by relay $R2$ is influenced *indirectly*, so that it is not possible to prevent relay $R2$ from short-circuiting the telephone instrument by hindering the operation of the flap. As the flap moreover covers the whole opening of the coin groove and as the flap and the relay operate in such a way that the former must cover the coin slot if the telephone is not to be short-circuited, it is apparent that the coin groove can be made extremely simple, as fraudulent manipulation is exceedingly difficult to carry out. The coin groove therefore consists only of a straight vertical piece extremely easy to make.

From the foregoing it can be seen that it is impossible to use the apparatus wrongly, while at the same time the instructions for those in charge of the apparatus may be of the most simple nature.

As the relays are both without current while conversation is going on, the apparatus is independent of the switch-hook, and it follows that the apparatus may be used for systems with single clearing signal and for systems with double clearing signal. Moreover a subsequent caller cannot lose a coin placed in the slot in readiness for his call if the previous call had not been disconnected, say after a trunk call.

An incoming call may be taken without the necessity of payment. The current direction in that case during the whole call is such that relay $R1$ is actuated but not relay $R2$, so that no short-circuiting of the speaking set can take place. It is also plain that such a coin apparatus can be arranged to take one or several coins, or coins of different denominations. If only one coin is to

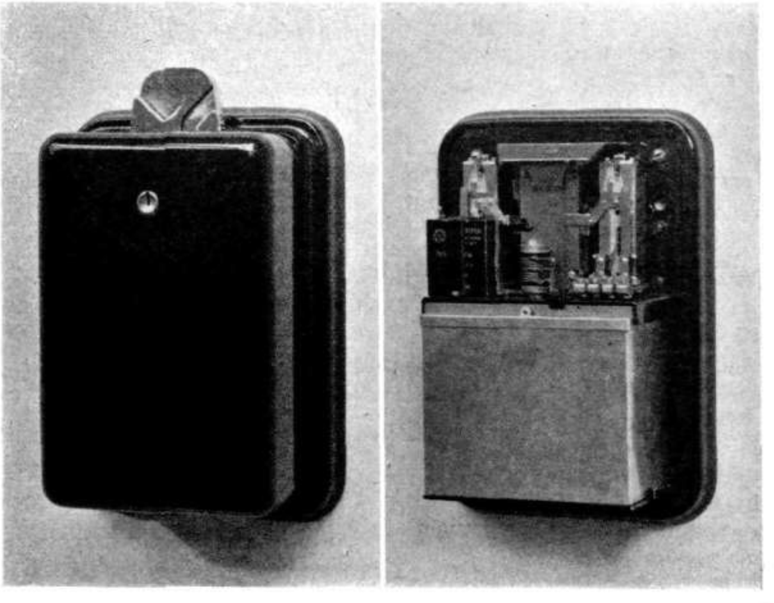


Fig. 3 X 5192

Coin box for two kinds of coin, Type DU 100

With the exception of the coin groove, the apparatus consists of the same parts as for a single kind of coin

be used then the coin contact is closed by this particular coin. If two coins must be inserted, the coin contact is so placed that it remains influenced only when the two coins lie one on the other. As the first coin passes there is a momentary release of relay *R2* but this is of no importance as the relay closes immediately and once more short-circuits the speech mechanism. If payment may be made either by one coin of high value or several coins of lower value, two coin contacts connected in parallel are fitted, these receiving their influence from the two separate coin grooves. If the payment is made up of one coin of one value and another coin of a different value then two coin contacts connected in series are arranged so that both must be down for the short-circuiting of relay *R2* to take place. How the slot should be arranged when two different coins are to be employed may be seen from Fig. 3.

Postpayment Coin Apparatus

While as a rule the prepayment type of apparatus is to be preferred, in certain cases it may occur that an apparatus of the postayment type is desirable. For this purpose Ericsson has produced the following two types of apparatus.

Coin apparatus with speech-block at the exchange

With all postpayment apparatus the caller can hear when the called subscriber replies but he himself cannot make use of his own instrument as transmitter. Usually this blocking of the speech in one direction is done in such a way that the microphone in the instrument is short-circuited. With Ericsson's coin apparatus, Type DU 200, the speech blocking takes place at the exchange instead. For this two different arrangements have been designed. In one an electronic valve is employed, which at the proper time is connected in the speech circuit, in such a way that the anode circuit is connected to the coin-apparatus side and the grid circuit to the called subscriber's side. Speech can then pass from the subscriber to the coin apparatus but not in the reverse direction. The electronic valve is fed exclusively from the exchange battery. By the other method the speech circuit is broken and a talking machine connected, which says to both caller and called, *e. g.*, »please pay» and »please wait». Naturally from the economic point of view such an arrangement can only be considered if the number of coin apparatuses is very large.

The greatest advantage of the system is that this coin apparatus may be made extremely simple without any parts working electro-magnetically. To give the necessary signal on payment to the exchange the coin groove is provided with a contact which on the passage of the coin is broken for a moment and thereby connects a high series resistance on the line, which signals the payment to the exchange, after which the electronic-valve block and the talking machine are disconnected and the speech connection completed. The apparatus can evidently be used for incoming calls when payment is not required.

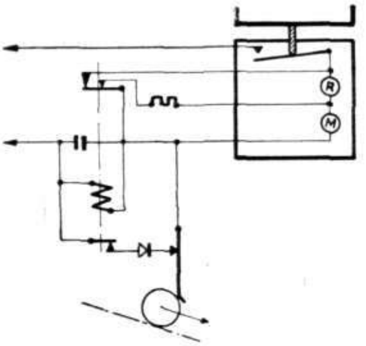


Fig. 4 X 3362
Principle diagram of postpayment coin apparatus
with speech block in the apparatus

Coin apparatus with speech-block in the instrument

This coin apparatus, Type DU 300, can be connected to any automatic or manual CB system.

With the automatic system it is necessary that current change occurs on the caller's line when the called subscriber replies. This current change cannot in general be obtained with the manual system. Instead the current change is obtained when the operator rings the subscriber.

On current change the speech connection is blocked in the one direction until payment has been made. The blocking in this case is done by a relay in the apparatus which short-circuits the microphone and at the same time connects the earphone with a resistance so that it cannot be used as transmitter. The apparatus can be used for incoming calls without payment being necessary. The method of operation can be seen by Fig. 4. The mechanism consists, in addition to the coin groove, of the above-mentioned relay which in closed position breaks the short-circuit of the microphone.

This relay is connected in parallel with a rectifier in series with a break contact in the coin groove as well as a break contact in the relay itself, by which the closing of the relay can be operated both by the current direction on the line and by a coin passing the contact in the groove.

When connected to a manual exchange the apparatus functions in the following way: on a call from the coin apparatus the current direction on the line is such that the relay is traversed by current, the rectifier having for this current direction such a high resistance that the relay is not short-circuited by the parallel current paths. Thus the relay attracts and the caller comes into speech communication with the telephone operator and can ask for the required number. The operator takes the order in the usual way and rings up the wanted subscriber. In a manual exchange the call is usually metered when this has been done. Here the same operation is used but to change the line polarity by means of a relay which is connected in the same way as the call counter. On this the relay falls in the coin apparatus and when this has happened the relay can no longer attract for the line current, as the parallel current path has now such a low resistance that the greater part of the current passes this way. The microphone is now held short-circuited and the earphone also is weakened by a parallel resistance. This last measure is taken to prevent the earphone being used as a transmitter.

When the called subscriber replies, the caller hears that and pays in a coin. On this the short-circuit current path to the relay is broken for a moment so that the relay once more attracts and itself breaks this current path, thus setting the speech mechanism in work so that conversation can take place.

Incoming calls to the coin apparatus can evidently be received without payment taking place and just in the normal way.

As may be seen the operator's work for a call from a coin apparatus of this kind is exactly the same as for a call from an ordinary instrument. She has no need to know that the call came from a coin apparatus, so that such an apparatus may be mixed up in any way with other apparatuses in number series and multiples. From the technical and especially from the economic points of view this has a great advantage making it the more profitable to install coin apparatuses.

From the foregoing it is apparent that this type of apparatus may be used in automatic systems. The current change then is obtained on reply from the called subscriber. In this case there is no necessity whatever for extra arrangements to be used at the exchange.

There are other cases in which the apparatus in question can be used however, though the manner of operation may not be completely satisfactory. In automatic systems which do not have current change on reply the coin apparatuses may be connected to the line-finder side and the final-selector side of the exchange respectively in such a way that different polarity is obtained on the line in the different cases.

Obviously in this way the result is that *incoming* calls — over the final selectors — do not need to be paid for, while *all outgoing* calls must be paid, thus also conversation with the operator, calls on special numbers and the like, which might at times be inconvenient.

Extension Telephones

By extension apparatus are understood the arrangements which are used, e. g., in offices, to connect two instruments to one and the same line when one instrument most often functions as an auxiliary instrument for the other or main instrument. Below are described a few ways, specially suitable for office purposes, in which two instruments may be connected to the same line.

It is characteristic of all extension apparatus described below that no alteration or extra fitting whatever is necessary to the central apparatus. The connection may be made to any type of line and only in the last case described does the station need to be provided with periodical ring signal.

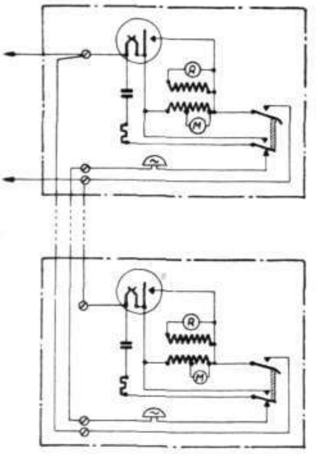


Fig. 1 X 3364
Wiring diagram of parallel extension

Parallel Extension

The simplest way to arrange an extension apparatus is merely to connect in parallel two ordinary instruments. This, however, carries with it the disadvantage that on dialling from one instrument the bell in the other instrument accompanies the impulses from the dial by giving a weak ring signal. This is particularly troublesome if the two instruments are in different rooms.

By means of a simple artifice this disadvantage can be overcome. The two instruments are connected according to Fig. 1, *i. e.,* the line branches are reversed between the two instruments and the terminals of the extra bell are connected together. The ring signal is then obtained through the bells in series; both bells are disconnected when either of the microtelephones is lifted. The speaking set, however, still remains connected in parallel with the line.

Series Extension

If both instruments are in the same room it is not desirable that a signal should be given by both bells. In that case it is better to make use of a special instrument designed for connection as a series instrument to an ordinary subscriber's instrument. This connection is referred to in Ericsson Review No 4, 1933. The line passes through the series instrument to the terminal instrument. When the microphone of the series instrument is lifted the line to the terminal instrument is broken, so that the latter is completely disconnected. The bell thus does not interfere with impulsing and a conversation cannot be heard in the terminal instrument. This is an advantage if the two instruments are in different rooms. In this case the series instrument should be provided with a bell connected as an extra bell to the terminal instrument, see Fig. 2.

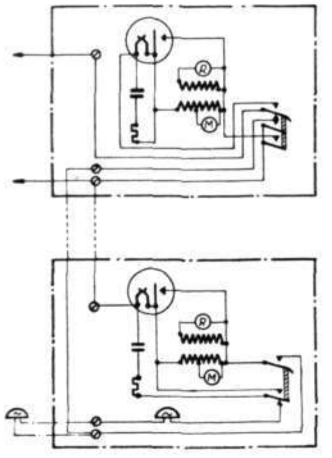


Fig. 2 X 3365
Wiring diagram of series extension

Extension with Two-Line Relay

Both the above types of extension apparatus are characterised by the fact that no extra fittings are required beyond the telephone instruments themselves. For reciprocal cut-off connection there is, however, required an accessory in the form of a two-line relay, Type RN 142 602, Fig. 3, which is mounted on a wall in the vicinity of one or other of the two instruments. All the same no alteration in the automatic exchange is necessary and connection may be made to any line.

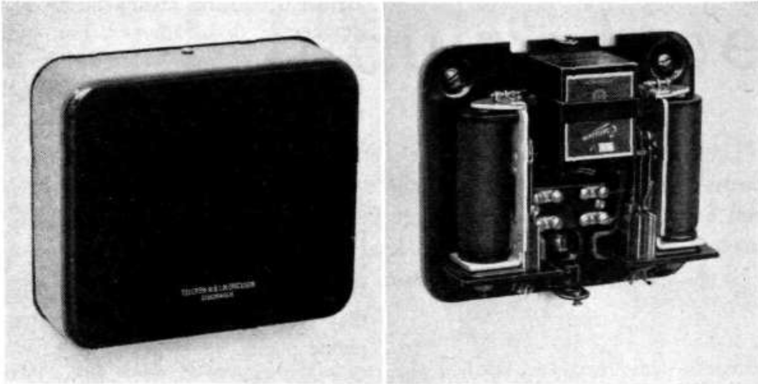


Fig. 3 X 5193
Two-line relay, Type RN 142 602

A two-line relay, Fig. 4, consists of two series relays, one in the line of each instrument. These relays have contacts either of which when closed disconnects the other line. The relays have delayed action and are connected in parallel with a condenser to allow impulsing from the dial as well as speech. Two instruments of any type may be connected to the two-line relay.

This arrangement is suitable when it is desired to have two instruments of equal standing connected to one line. The ring signal is received simultaneously in both instruments, but the person who first lifts the micro-telephone of one of the instruments receives the call, though naturally it can be transferred to the other instrument simply by replacing the micro-telephone.

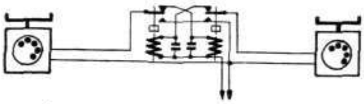


Fig. 4 X 3366
Diagram of extension with two-line relay

As regards operation, therefore, the arrangement resembles the above-mentioned series instrument if the latter is provided with an extra bell connected to the terminal instrument. The difference is that the series instrument has priority and can always take the line, even if the terminal instrument is engaged in conversation. If a two-line relay is used neither of the two instruments has preference over the other.

Extension with Call-Transfer Relay

By automatic extension instrument is here meant an arrangement which automatically passes a call which comes to a main instrument on to a subordinate instrument. Such an arrangement may be a useful facility for a person who is often obliged to be away from his place. The call is then passed on automatically to the subordinate instrument which can answer enquiries as to where the wanted person is, note the call etc.

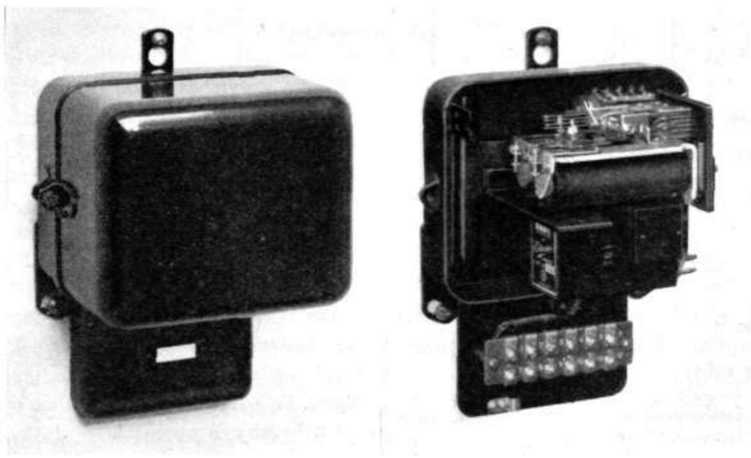


Fig. 5 X 5194
Call-transfer relay, Type RN 143 755

Hitherto existing arrangements for this purpose have suffered from quite a number of disadvantages. For example, it has as a rule been necessary to make use of manual restoring, local batteries for thermo-relays etc., and the arrangement was such that each call was only passed on after a certain delay, while it is desirable that this should take place only on the first ringing.

Ericsson has recently designed an arrangement, Type RN 143755 for this purpose which overcomes all the inconveniences mentioned. In the main the apparatus, Fig. 5, consists of a step mechanism with stepping relay and restoring relay for same. Both relays are built together so that in appearance they closely resemble a two-magnet selector of the type used in selector telephone plants.

The step mechanism is so constructed that it cannot take many steps after the contact is closed, as it is mechanically blocked in that position. The contact then remains closed until the restoring magnet operates. The magnet is constructed as a series relay to the main instrument and consequently receives current when the microtelephone of this instrument is lifted, whereupon the restoring magnet attracts its armature, interrupting the line to the extension instrument and returning the step mechanism to home position. After this has taken place the ring signal to the extension instrument is again delayed by a fixed number of signals, assumed above to be three. If connection has been made of a call and the main instrument does not reply, then the next ring goes without delay to the extension, which can then immediately deal with the call.

The extension may be connected in two different ways, Fig. 6:

A. the speech wire of the extension instrument is connected separately and the step mechanism is connected by a third conductor to the bell of the extension instrument; there is thus a three-wire connection between the main instrument and the extension. This method of connection gives the facility that the extension instrument can always be used for *outgoing* calls as well, provided the main instrument is not in use;

B. the extension instrument is connected to the main instrument over two wires only, one of which goes over the contact of the step mechanism. This method of connection only permits the use of the extension for outgoing calls on condition that connection has first been made, and this in its turn can only happen when the call brings forth no response from the main instrument.

From this it is evident that connection according to B is probably more suitable for use in offices where it is desired that the extension instrument shall be connected only when the person for the main instrument is not available.

In quite a number of other cases, *e. g.*, where the proprietor of a small shop has his residence in the same building as the shop, it may be convenient to have a main instrument in the business part and an extension instrument connected in the residential part on principle A. In such a case it would be desirable that, even at times, *i. e.*, in the daytime, when the main instrument was in use, the extension instrument could be used for outgoing calls. Incoming calls could be answered in the main instrument without disturbing the extension instrument which, however, after business hours would be automatically connected for the reception of calls also. As can be understood, the automatic extension instrument offers great possibilities for improving telephone service in a simple manner in a great number of instances. It should be particularly noted that operation is entirely automatic and that no extra battery is required.

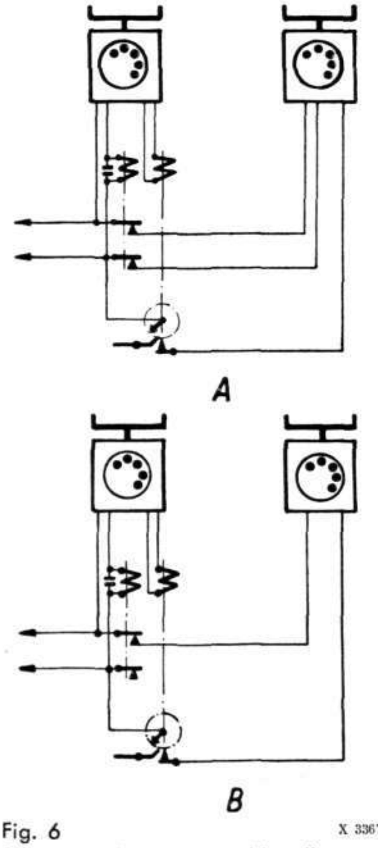


Fig. 6 X 3367

Diagram of extension with call-transfer relay

A extension permanently connected to line
B extension connected to line only after main instrument fails to answer

Telephone with Inquiry Line

In certain cases an office room is equipped with two telephone lines, viz., a town line and a local line. Both these lines may be connected when desired to a single special instrument instead of two normal instruments, and this constitutes a great advantage with improved working facilities. An instrument specially designed for this purpose is described below.

Fig. 1 X 3031
Telephone instrument with inquiry line

Modern automatic telephone exchanges for offices are most often designed for all traffic to and from a room to be handled by a single telephone instrument and a single telephone line. This applies even to transfer traffic with the public telephone system. The special demands which have lately been made regarding facilities for inquiry and transfer of main-line calls are also met by the newer local exchanges on business premises.

In spite of these facilities there still exists in a number of cases room for further improvement in the telephone service. For example, a person in authority has often in addition to the local line a separate direct exchange line. Naturally it is possible to have a telephone instrument for each line but that is not only inconvenient but carries with it a number of other disadvantages. For instance, if it is desired, during a call on one instrument, to make use of another instrument it is difficult to prevent the conversation in the second instrument being over-heard in the first and vice-versa.

For such requirements a telephone instrument with inquiry line, Type DF 220, has been designed, *i. e.*, an instrument equipped for two lines of which the one can conveniently be connected to the public exchange and the other — the inquiry line — to the private branch exchange. In appearance the instrument, Fig. 1, resembles the Ericsson standard telephone instrument of bakelite. It is, however, provided with two press buttons — red button for town system and white button for local line — as well as a larger wall fitting than the standard instrument and in this is placed the bell of one line.

The diagram of the design may be seen from Fig. 2. By means of the red button *Ka* the instrument is connected to the exchange line L_1 and by the white button to the local line L_2. When the instrument is connectd to one of the two lines, the bell of the other line remains connected so that signals may be sent to the instrument on the free line.

The difference in equipment of the two lines is to be found in the fact that line L_1 is provided with a resistance *Hc* which is connected if, when button *Ka* has been pressed, button *Kb* is subsequently pressed. That is the position when, during a call over the exchange line, an inquiry is to be made over the local line. In that case the resistance *Hc* is connected across line L_1 so that a call connected over this line is held during an inquiry and not disconnected. During the inquiry the conversation of line L_2 cannot be overheard on line L_1. When the inquiry call is completed the instrument is again connected to line L_1 by pressing button *Ka* right down to lowest position, whereupon button *Kb* is released and rises to rest position. While the inquiry is being made both the buttons *Ka* and *Kb* remain down so that there is clear indication that the exchange line is held. The holding is effected by a resistance and not by direct short-circuiting, as it is desirable that a trunk operator may be able, even while an inquiry is being made, to demand attention by ringing on the exchange line bell, and this would be impossible were the line completely short-circuited during the time it is held. When the microtelephone is replaced both the buttons pressed down are released.

Thus the above described telephone instrument meets all reasonable requirements; it completely replaces and in certain respects gives even better service than two separate instruments.

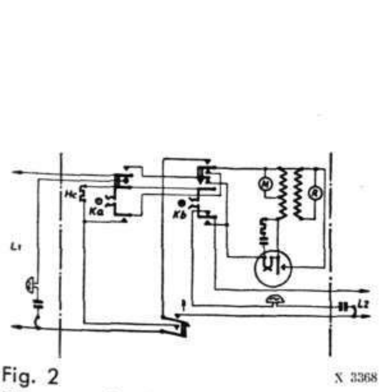


Fig. 2 X 3368
Diagram of telephone instrument with inquiry line

Stenographer's Telephone

To fulfil the need for a telephone instrument which while being used gives complete freedom of movement to both hands a new telephone instrument, the stenographer's instrument, has been designed.

Fig. 1 X 3371
Stenographer's instrument, Type DE 722

The instrument, Type DE 722, Fig. 1, has in addition to the customary hand microtelephone a double headphone which is connected to the instrument by a plug. In this respect it differs most favourably from older instruments of this nature which in most cases are equipped with special breastplate transmitter and the like. Such instruments are time-wasting to put on and take off and inconvenient on account of the numerous cords that were necessary. In the new instrument the ordinary microphone in the hand microtelephone is employed as sound collector. For this reason it is placed on the instrument in the position shown in Fig. 2. This special placing ensures that the microphone always takes up a vertical position, in which its efficieney is the highest possible, and that its mouthpiece is directed towards the speaker. Moreover the rubber feet of the instrument deaden jars on the table, so that disturbance on this account is considerably lessened. Finally all risk that the microtelephone may get hidden during a call under papers, books etc. is precluded, which would not be the case if it were directly placed on the table. At the close of a call the microtelephone is returned to its normal place on the instrument. The shaking it then gets prevents the carbon granules from packing thus enabling an ordinary carbon-granule microphone to be used. Only in special cases, when very great sensitivity is required, is a microphone with carbon pellets employed. Here it should be noted that increased sensitivity also applies to extraneous noises in the room.

No technical difficulty is encountered in constructing this instrument with a loudspeaker instead of earphones, by which means the speaker is completely free of the instrument. With such an arrangement, however, an echo suppressor would be necessary to prevent accoustic reaction. The arrangement selected, with double earphones, is advisable so that the instrument may be employed in places where several persons are at work, for example a stenographers' room. A loud speaker would interrupt the work of others, while at the same time intelligibility would be reduced by noises in the room, for instance the clatter of typewriters.

The instrument has anti-sidetone connection which prevents the sound from its own microphone being heard in the earphones. This arrangement serves a double purpose: it prevents the disagreeable shocks the listener would sustain on changing over to talking from listening when the ear is adapted to catch feeble sounds; and in addition their is no disturbance of the listener by noise and movement in the room. Direct noise is shut out by the double headphones and the anti-sidetone connection eliminates indirect noise from the microphone. In this way it is possible to take dictation without difficulty even in the midst of much noise.

The instrument is also particularly useful when an important telephone conversation must be stenographed during the call. In this case the stenographer has the headphones while the speaker uses the hand microtelephone in the ordinary way. The instrument is in this respect superior to an ordinary instrument with extra earphone, as the stenographer has both ears shut off from direct sound and can adjust both ears to the one tone, which is less tiring on long calls. Moreover she has both hands free for the work.

The instrument may also be used for other purposes. It is particularly suitable for theatre box offices, telephone-order business, information bureaux, dispatching rooms, newspaper printers for setting late news direct from telephone dictation etc.

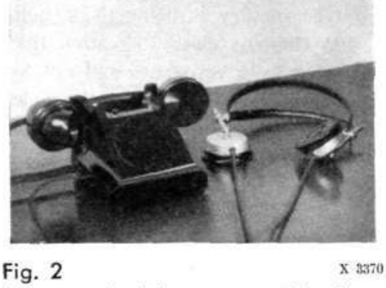


Fig. 2 X 3370
Stenographer's instrument with microtelephone in speaking position

Diver's Telephone

As early as the beginning of this century, Telefonaktiebolaget L. M. Ericsson had constructed a telephone equipment specially intended for divers. The equipment has lately been modernized and is described in its new shape here below.

Fig. 1 X 3369
Diving helmet with earphone and microphone

Formerly divers under water had no means of communicating their instructions to assistants on the surface except by a signal line. The limitations and uncertainty of such a system of communication are evident. In order to remedy this, Ericsson has designed a special diver's telephone.

Fig. 1 shows the fitting of the earphone and microphone inside the helmet. They are connected by a rubber insulated cable to apparatus with the assistants. The cable enters the helmet through a special watertight joint, and is attached to the airhose in a suitable manner.

Fig. 2 shows the equipment for a diving station. This equipment includes a breastplate transmitter together with double headphones. The microphone feed is provided by a dry battery kept in a case large enough to take the complete equipment. Connection to the apparatus is done by plug and jack in the case. The whole equipment is of watertight construction and the instruments are suited for the special requirements.

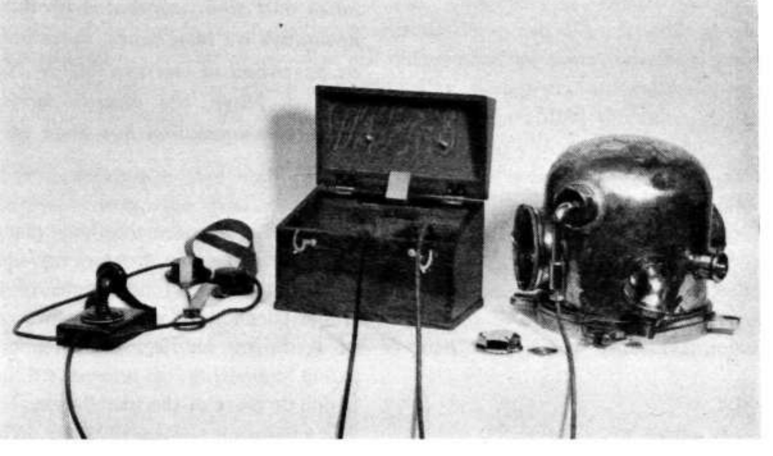


Fig. 2 X 5195
Equipment for diving post
Left to right, breast transmitter with headphone, carrying case, and diving helmet with telephone equipment

Telephone Installation on the Aircraft-Carrying Cruiser Gotland

V. SÖDERSTRÖM, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

Fig. 1 X 5181
Aircraft-Carrying Cruiser Gotland

For communication from one part of a ship to another, the old speaking tubes and other apparatus for the transmission of orders have been replaced nowadays by telephones, these being of special manufacture for the purpose, as described in Ericsson Review No 2, 1933. In the latest ship built for the Swedish Navy, the aircraft-carrying cruiser Gotland, this new means of ship's communication has been very widely employed.

When designing the telephone plant for the aircraft-carrying cruiser Gotland attention had to be directed not only to the technical side of the question but also to the special conditions of service on a war vessel. To prevent the whole telephone plant being thrown out of operation by injury to some part of it during gunfire, the telephones have been divided into groups, each group consisting of a separate installation fed by its own battery. Thus if one or more of the installations be damaged the others will not be affected.

The result is that the cruiser is equipped with no fewer than 29 telephone installations, 28 of which are on the loud-speaking system, *i. e.*, without induction coils; as the resistance of the cables is negligible, there is no attenuation of the speech volume such as the above-named factors might cause in an ordinary telephone system. These 28 installations are used for transmitting orders to the gun crews, the engineroom, the catapults etc., while the remaining installation is an automatic telephone installation for communication between the cabins and the like. This last, moreover, is connected to a manual board by means of which communication can be set up with the land when the ship is lying in port and there is connection to a telephone exchange.

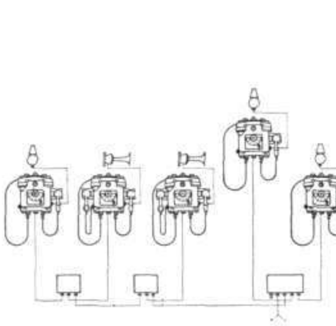


Fig. 2 X 3372
Diagram of ship's telephone installation
intercommunication system

Three types of loud-speaking telephone installations may be described. The first, Fig. 2, contains instruments with selector devices by which any one instrument can ring up and talk with any of the others. Thus the officer

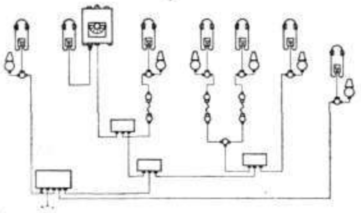


Fig. 3 X 3373
Diagram of ship's telephone installation
order system with operator's instruments

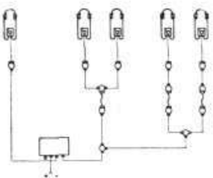


Fig. 4 X 3374
Diagram of ship's telephone installation
order system with permanently connected instruments

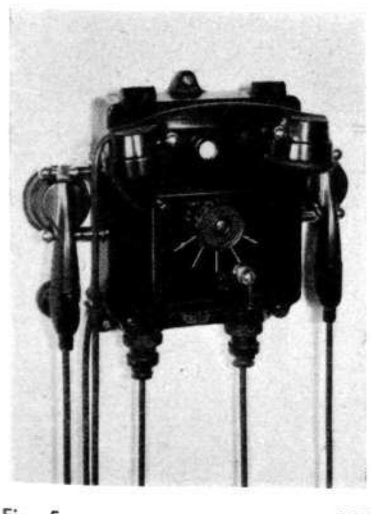


Fig. 5 X 3335
Watertight wall instrument

on the bridge can ring the aft turbine room to give an order or, as all instruments are connected in parallel, can ring both the fore and the aft turbine rooms to give an order meant for both.

The second type of installation is shown in Fig. 3. In this case one station is equipped with selector coupled to a breast microphone with double head telephones. The other stations have only one head telephone with breast microphone. By means of the selector all the other stations can be called, provided they have bells to receive the signal.

The third type of installation, Fig. 4, contains only speaking arrangement in the form of head telephone and breast microphone. In this case no call is necessary, as every man will be at his station when the installation is in use. The whole cable network is watertight and the connections have packings and are screwed.

The wall telephone instrument for loud-speaking, Fig. 5, as delivered to the cruiser Gotland differs from earlier types, both because the hand microtelephone and the extra earphone are connected to the instrument by means of watertight plugs and jacks and because on receipt of a signal a little white flap falls down behind a panel on the front of the instrument, thus giving an optical signal at the same time as the audible one.

A new suspension fitting, consisting of two turned metal pillars of the same type as used for fixing the hand microtelephone, one fixed and the other moveable, holds the extra earphone and the laryngotelephone firmly in place so that they cannot work loose when the ship is rolling.

It has been found necessary to provide optical signals in view of the division of the plant into several installations. This involves several instruments at one place connected to different installations, see Fig. 6, and to show which instrument has received a call there must be some indication on the instrument itself. The white indication flap disappears automatically when the hand microtelephone or the laryngotelephone is lifted to reply.

Laryngotelephones are used in places where the noise is great, such as the turbine rooms, the dynamo room, the stokehold etc. Ordinary microphones pick up and transmit all the noise of the machinery and fans, causing the speech to be mixed with all the local noise and making it difficult for the hearer to catch. All extraneous noise is eliminated by the laryngotelephone and only the speech is heard. When the cruiser is in port and the machinery is idle, the hand microtelephone can be used, this giving better transmission and being more convenient.

The selector has six positions; after the selector has been put in the desired connection the switch is thrown to the right, thus sending out the signal.
Each instrument has either a bell or a signal horn connected to it. The bells are watertight membrane or diaphragm bells, Type RA 1200, see Fig. 6, as described in Ericsson Review No 4, 1933.

The signal horns, see Fig. 7, are also of diaphragm type and watertight. These signal horns emit a rather low tone to be distinguishable from the noise of the engines. At a certain number of places, where the noise of the engines is so great that the horn signal is extremely difficult to catch a red lamp is connected in parallel as an extra optical signal.

The breast microphones and the head telephones, Fig. 8, are of watertight construction. The telephones are connected to the line over condensers and thus are always ready to receive speech. To connect the microphone there is on the breast microphone a switch with two positions, one self restoring —

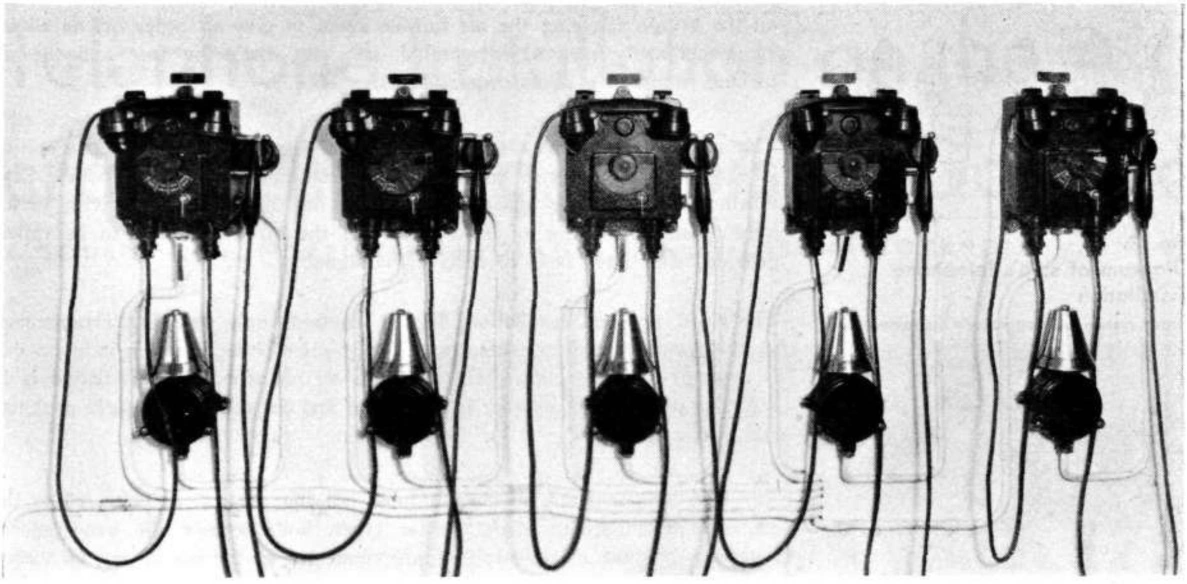


Fig. 6 X 7073
Wall instruments with diaphragm bells

to acknowledge that an order has been correctly received — and the other with a catch — for longer communications. During speech the microphone is connected in series with the telephone and the condenser has then no function.

The telephones are fixed to a leather band, one telephone being moveable, so that the correct position for the telephones may be maintained. Tightening is by means of a chin-strap with buckle. Connection is made by a three-pole jack to a contact box with a three-pole plug, Fig. 9.

There is an automatic telephone exchange for communication between the cabins, and this is combined with a manual exchange for use when there is connection with the land. The automatic exchange in its main features is like Type OL 45, see Ericsson Review No 2, 1933, but it has a spring mounting designed to overcome vibration due to the rolling of the ship

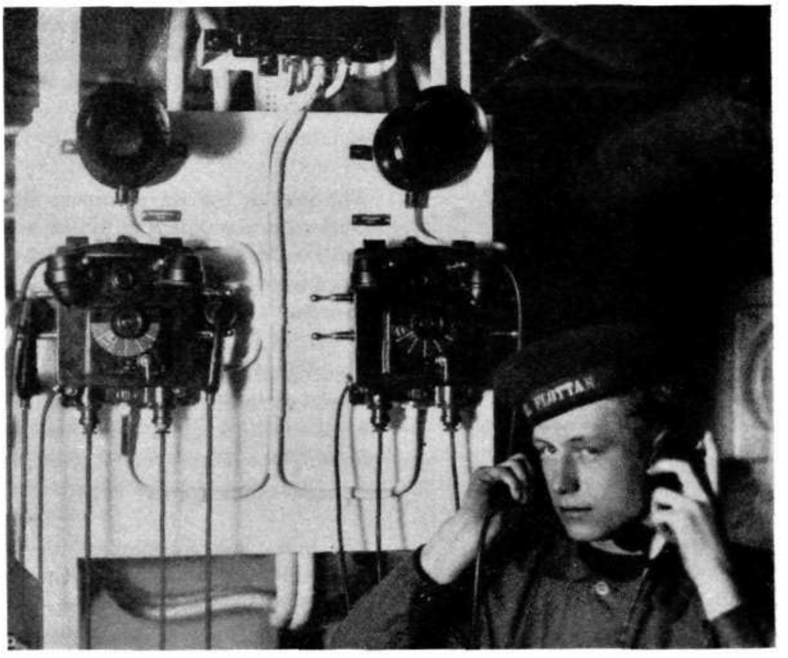


Fig. 7 X 5184
Wall instruments with signal horns

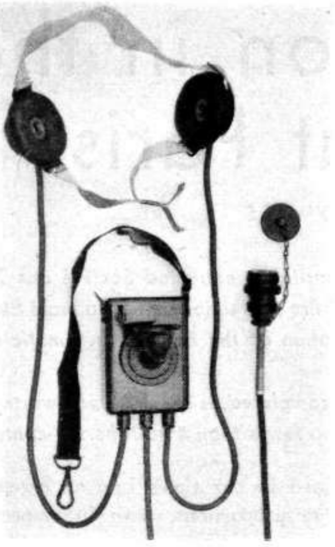


Fig. 8 X 3336
Breast microphone and headphone

Fig. 9 X 3337
Watertight contact box and three-pole jack

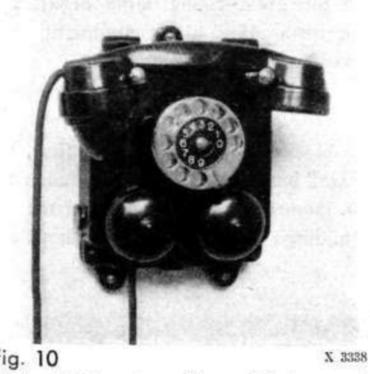


Fig. 10 X 3338
Watertight automatic wall instrument

and the firing of the guns. The exchange has 40 local lines and two order lines to the manual exchange.

The telephones connected are provided with dials. The wall instruments, Type DE 140, Fig. 10, have watertight leads for the cables. The hand microtelephone suspension is the same as for the loud-speaking instruments, so that they are not affected by the rolling and vibration of the vessel. Table sets are of normal construction, Type DE 702, but the ordinary wall attachment is replaced by a distribution box with three-pole plug and the connection of the cable fixed to the wall is by means of a watertight three-pole jack. When the instrument is disconnected a cover is screwed in instead of the jack, thus keeping the cable net protected and completely watertight. The instrument can be fixed to the table by special clamps should the rolling of the vessel make it necessary.

Communication between two telephones over the automatic exchange is obtained in the usual way by dialling the required number. The zero gives connection on one of the two order lines to the manual exchange, for use when the ship lies at anchor or at the quay and is connected to a telephone station on land. The required number is asked of the manual exchange after which the hand microtelephone is replaced. The operator at the exchange calls up the land exchange — by magnets if it is an LB station, by switch if it is a CB station or by direct dialling of the number if it is an automatic exchange. When the operator is in communication with the desired number on land, the instrument making the call is rung and then connected to the number asked for by means of a press-button switch. There are 20 such switches in the manual exchange, only half of the 40 instruments being intended to communicate with the land, the remainder being blocked. Of course, all can call up the exchange and ask for calls, but the instruments for which there is no connecting switch are blocked.

The whole network consist of flexible ship's cable, Type FVFF, composed of 1.5 mm^2 multiple strand cable, rubber insulated, lead-sheathed and armoured with steel wire. The area of the conductors has been calculated to give as little attenuation of the speech in the loud-speaking system as possible. The same cable has been used for the automatic system so as to have a uniform type of cable throughout. All the cable connections are to watertight boxes, with from 3 to 8 cable leads screwed in. The instrument boards for the charging of the batteries and throwing over from one battery to another are protected by covers, though these cannot be made watertight, as the charging is carried out by means of resistances from 110 V to 12 V DC. The resistances cannot be closed in, owing to the need for ventilation because of the heat generated.

Fire-Alarm Installation in the Samaritaine Stores at Paris

R. AUGERON, SOCIÉTÉ DES TÉLÉPHONES ERICSSON, COLOMBES

The great Paris department store Samaritaine entrusted Société des Téléphones, Colombes, with the provision of fire protection in its two main blocks of shops and warehouses, by the installation of the Ericsson automatic fire-alarm system.

This installation, which has recently been completed, is specially noteworthy on account of its size, in that it comprises no fewer than 4 600 thermo-contacts.

The modern department store has developed in our times into an extensive business undertaking of exceedingly large proportions, both in respect of the quantities of goods exposed and the numbers of customers who are attracted by them. In case of fire in such a store, indescribable panic cannot fail to arise, which may be of the greatest danger because of blind acts of desperation on the part of the public and because of the great difficulties caused to those whose duty it is to look after the safety of the premises. In such conditions any outbreak of fire may be fraught with disastrous consequences to life and property. Should it be the night when an outbreak occurs the material damage would be particularly great, with the result in most cases of serious temporary loss of employment for the staff.

Fortunately such catastrophes can in these days be prevented by employing to combat an outbreak of fire the most effective of modern fire-protection appliances: the automatic thermo-contact. This constitutes an invisible guardian which gives warning in an instant of any abnormal rise in temperature and closely restricts the area of an outbreak. Moreover the fire brigade receives the alarm in good time and is thus in a position to take speedy and effective measures without arousing too much sensation.

It was these considerations which guided the great Samaritaine department store in Paris when it decided upon the installation of an automatic fire-alarm installation in its extensive shop and warehouse premises.

Planning

The installation is spread over two huge blocks of buildings. The first, the Monnaie block, Fig. 1, situated on the right bank of the Seine contains the four Samaritaine shops; the other, the St Jaques block, Fig. 2, is on the left bank of the Seine and consists of three buildings which house workshops and warehouses.

Fig. 1 and 2
Samaritaine Stores, Paris
left, Monnaie block
right, St Jacques block

X 7074

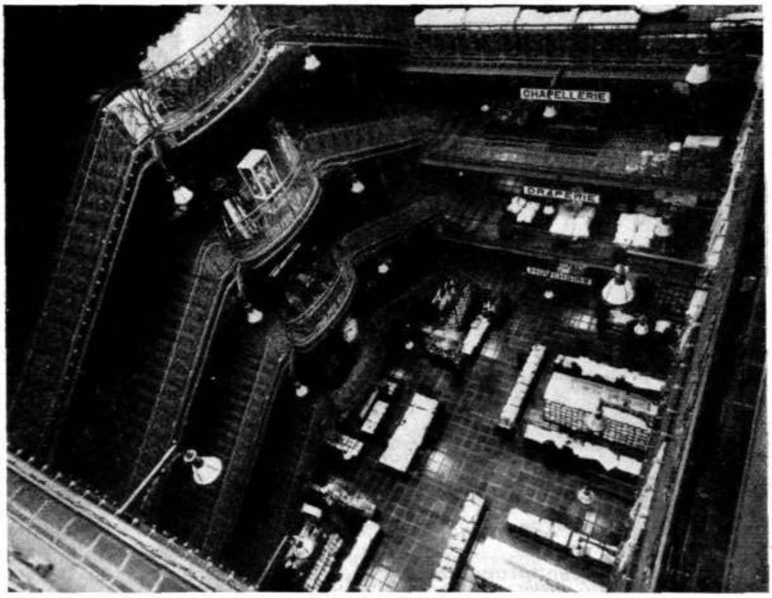


Fig. 3 X 5189
One of many light wells in the stores

The protection of this very large range of buildings presented a special problem in respect of the position of the thermo-contacts. For instance, it was apparent that it would in many cases be necessary to depart from the principle imposed by the French Fire-Insurance Central Association, which prescribes one thermo-contact for every room or part of room having 300 m³ volume.

In general these great shops did not contain separate rooms, as the departments on the 10 stories communicate directly one with another through the great centre wells, Fig. 3, some of which have 700 m² floor space, the moving staircases, the goods chutes, the lift shafts etc. All these openings produce currents of air which required to be taken into full consideration in order to ensure complete protection. Thus the direction of a current of warm air in the vicinity of a lift might be entirely changed by the opening of the lift door, and consequently a thermo-contact must be placed there to come into operation rapidly in case of fire. Investigations made in this connection made it clear that thermo-contacts should be placed alongside such openings and without exception around the large openings. Some of these openings are frequently the cause of sudden currents of warm air, the speed of which is often sufficient to set a differential thermo-contact in operation. However, this risk is eliminated by the use of the Ericsson differential thermo-contact, Fig. 4, which is easy to regulate to suit the conditions of the place where it is fitted. This quality has been more fully described in Ericsson Review No 1, 1934.

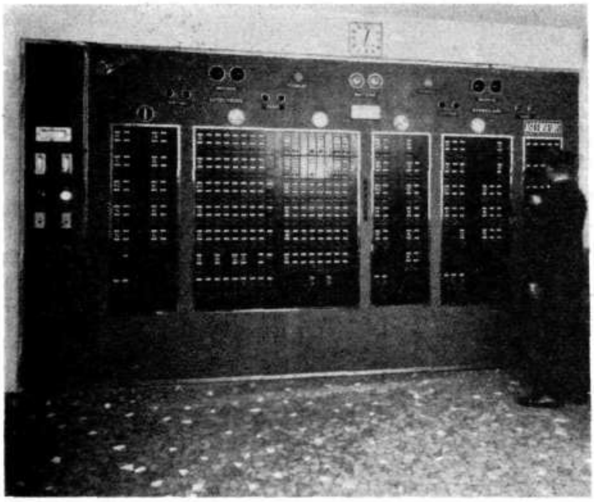
The heating plants were also the subject of special study and certain spots have had to be protected by maximum thermo-contacts because of the high local temperatures, frequently attaining 80 to 90° C.

In view of the fact that some portions of the shops were not exposed to sudden changes of temperature or sudden currents of hot air, the cubic air-space method could in these be applied, provided it did not frequently happen that goods were exposed on shelves or in show-cases. On the other hand, goods piled up on counters formed veritable walls which had the effect of dividing the salesrooms into corridors, each of which required special protective measures. In the same way account had to be taken of the regularly occurring large clearance sales which caused temporary accumulations of goods in certain sections of the salesrooms and warehouses.

Independent of the automatic fire-protection arrangements, consideration had to be given to the position of the manual fire-alarm boxes, to ensure that they would be as visible and accessible to the public as possible.

Fig. 4 X 3160
Differential thermo-contact

As soon as the placing had been determined on the basis of the foregoing, it was seen that the following numbers of alarm appliances were necessary:



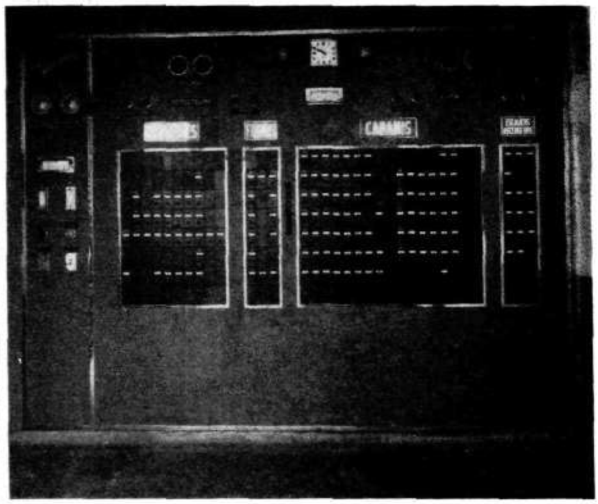


Fig. 5 and 6 X 7075

Left, Monnaie-block central apparatus right, St Jacques-block central apparatus

On each board the charging panel is mounted at the extreme left, the common signal arrangements at the top and the loop units in the centre

in the Monnaie block, 2 700 thermo-contacts and 240 manual fire-alarm boxes; in the St Jacques block, 1 900 thermo-contacts and 200 manual fire-alarm boxes.

The circuits to which the various appliances are connected are divided into several loops and these are connected to central apparatuses, Fig. 5 and 6, only the more important will be described here, *viz.*: the Monnaie-block installation.

Construction

Fig. 7 shows a plan of the four shops comprising the Monnaie block, which have a total floor space of 19 000 m². Each floor of a shop has been divided into regular sections, each section corresponding to a loop with thermo-contacts and auxiliary fire alarm boxes. Shop No 2, for example, is divided into 8 loops which come out at staircases which have been put in specially to provide ease of access to the different departments in case of fire; in addition to these loops on the different floors there are special loops for the passenger and goods lifts and for those stairways which are entirely closed in. In the Monnaie block the loops are distributed as follows: for the different floors, 156 loops, for the lifts 23 loops and for the stairways 4 loops.

The loops are connected with the central apparatus over connecting boxes and main distribution boxes of metal. The circuits between the connecting boxes and the appliances consist of lead cable, protected in some of the basements by steel piping. The distribution cables which constitute the supply cable and connection circuits between the different connecting boxes are in steel protective piping or watertight protective piping. The cables are two-wire with conductors of 0.9 mm tinned copper wire, double paper-insulated, single cotton-insulated, the whole paraffin impregnated and bound with metal tape. The conductors in the cable are surrounded by a paraffined tape and lastly by a lead sheath. The metal tapes around the conductors are joined together and connected to earth, which makes it possible to discover short-circuits between the conductors, warning of this being given by a signal similar to that for earth leakance.

The cables in the thermo-contact loops have a single tinned copper conductor 0.9 mm with double silk winding and single cotton winding and impregnated with paraffin. This has a protecting lead sheath which in its turn is protected by a plaited fireproof web.

The central apparatus, Fig. 5, is of metal. For each loop it gives the following signalling possibilities: fire, line rupture, short-circuit and earth leakance. These signals are supplemented by signals announcing interruption of current and excessive drop in the tension of the operating battery.

The central apparatus controls likewise the operation of the automatic sprinkler installation which has been installed by the French Fire-Insurance Union.

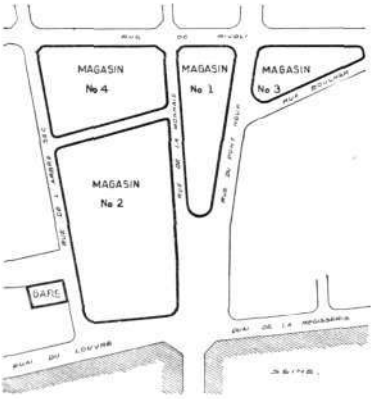


Fig. 7 X 3355

Plan of Samaritaine Stores, Monnaie block

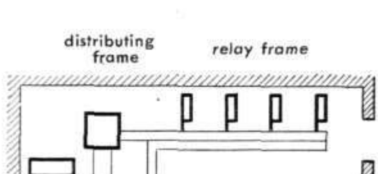


Fig. 8 X 3356

Plan of central apparatus

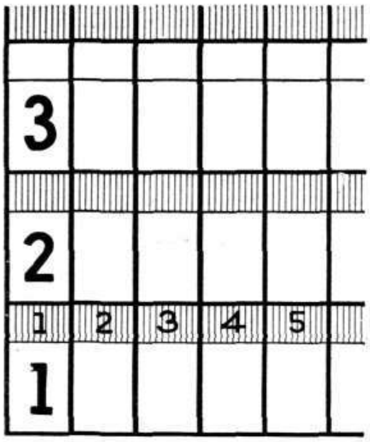


Fig. 9 X 3357
Detail of central-apparatus board
showing distribution of loops according to floors

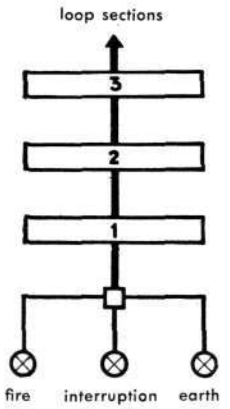


Fig. 10 X 3358
Diagram of connection of loop sections to common signalling arrangements

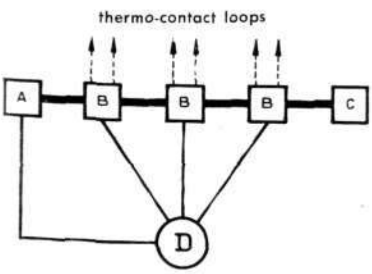


Fig. 11 X 3359
Diagram of loop section
A interruption-signal relay
B loop relay
C earth-signal relay
D fire-signal relay

This forms a net which follows the thermo-contact loops exactly and for which there are the same signalling possibilities.

The central apparatus is installed in the lower basement of shop No 2, in such a position that the firemen have speedy access to the other shops. A detachment of firemen in the service of the company keeps watch night and day over the safety of the premises. This detachment is accommodated in two large rooms, the larger of which houses the central apparatus. This room, Fig. 8, and the partition formed by the central apparatus contain the relay frames, distribution frames and the batteries. The central apparatus consists of a back wall divided into three panels, the largest of which holds all the press-buttons and the signal arrangements for the loops and the two others the main signals and the current-supply apparatus.

Immediately an alarm signal occurs it can be seen at a glance from the main signals whether it is fire or a fault which has caused the signal.

The signals for the loops are distributed over 5 sections corresponding to shops No 1, 2, 3 and 4 and to the lifts. The lenses in the upper part show in illuminated letters and figures which part of the building a section covers.

Each of the shop sections is systematically arranged in accordance with the position of the loops, so that the arrangement is simple to comprehend, thus making it easy to locate the place from which an alarm has come. With this object the signal lamps are arranged to correspond with the positions of the loops in the shops. The horizontal rows represent the loops on the different floors and the vertical rows the floors reading up and down, as shown by Fig. 9.

The final planning of the signal arrangements has necessitated the arrangements of the loops in each shop in a number of vertical sections which are all connected to a single main signal. One section comprises about 20 loops the signal arrangements of each being indepedent of those of the other loops.

Fig. 11 shows a diagram of the relays in a section. Each separate loop is connected to a relay *B* which operates in case of fire or line breakage. All the *B* relays in a section are controlled by three relays, the function of which is to indicate the nature of the signals by lighting the requisite signal lamp. Thus relay *A* signals breakage, relay *C* earth or short-circuiting and relay *D* fire.

The lamps operated by relays *A* and *C* are fitted to a special plate in the lower part of each section. These relays at the same time control the main signals for fault. The relay *D* is influenced directly by relay *B* and connects up the main signals for fire. All these main relays in their turn operate the working relays for the ring signal arrangements.

The signal arrangements for the sprinkler installation are identical with the above. For this reason the loop plates contain two annunciators and two signal buttons, see Fig. 12.

The annunciator consists of a cylindrical sector which shows its lower rest position when attracted by the armature of an electro-magnet actuated by a relay *B*. At the same time this relay lights a lamp behind the annunciator window. The annunciator has two rectangular parts, one white and one red, numbered according to the loop in which the annunciator is connected. As will be seen from Fig. 13, the white part is made up of transparent white and red parts, which has the following advantage: even if the lamp fails to operate, the annunciator lifts and shows the red part, thus giving an alarm signal; should, however, the annunciator fail to operate, the lamp is all the same connected to relay *B*, so that the transparent part is lit up and shows red instead of white.

Daily tests are carried out to check the working of the fire and fault relays. The tests for the relays *A*, *C* och *D* are made by sections, see Fig. 11, and in respect of relays B for each loop plate. For this purpose the lower part of each plate is provided with a three-way switch for testing the line-rupture and earth signals.

Tests of the fire signals are made for each loop by means of a special test switch fitted to each annunciator. This test switch has three positions, the centre being for normal operation and the upper one for testing relay *B*. The lower position is provided for disconnecting the loop in case of repair and

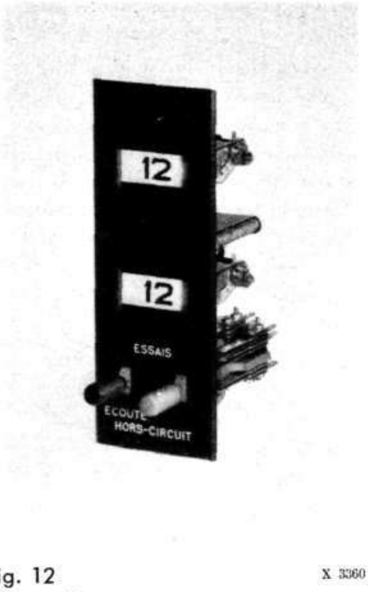


Fig. 12 X 3360
Loop unit
comprising an annunciator and a signal button for each of the thermo-contact and sprinkler loops

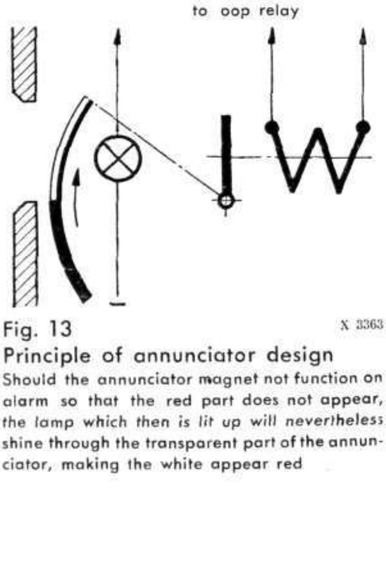


Fig. 13 X 3363
Principle of annunciator design
Should the annunciator magnet not function on alarm so that the red part does not appear, the lamp which then is lit up will nevertheless shine through the transparent part of the annunciator, making the white appear red

Fig. 14 X 5190
Fire-alarm box for manual alarm
On the underside of the box there is a jack for plugging in a portable telephone instrument

for telephonic communication between the central apparatus and the fire-alarm boxes of the section.

This last provision is made to facilitate the work when firemen are inspecting the fire alarm boxes set up in various spots, Fig. 14. After opening the box and sending out an alarm signal, the fireman connects a portable telephone by plugging into a jack fitted in the lower part of the box, after which he awaits a reply from the fireman on duty for that box. The latter in his turn puts in the plug of a microtelephone in the jack belonging to the section covering the loop from which the signal has come. This jack is in the lower part of the plate in each section, close to the test switch for fault signals.

When testing is not going on, the fireman can call up the central apparatus without giving alarm signal, by plugging his telephone into the alarm-box jack. The call is announced at the central apparatus by the annunciator of the loop and the lighting up of fault lamps.

All light signals are accompanied by audible signals from bells.

For greater safety there is no interruptor in the ring-signal circuits; only by the operation of a relay actuated by a switch with spring return is it possible to disconnect the bells after alarm signal has been given, *i. e.*, without extinguishing the light signals, this being only possible when the switch of the loop giving the alarm is thrown to disconnecting position.

The back of the central apparatus is hermetically sealed by large metal sliding doors which protect the signal annunciators from dust. At the side of the central apparatus are fitted all the signal relays together with distributing frame.

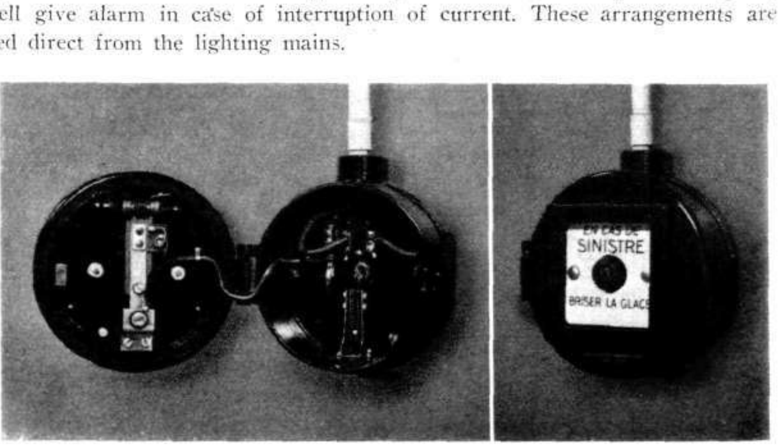
On the relay frames the section relays are arranged vertically in their order, which facilitates speedy testing and repair; each relay frame contains a number of safety devices with optical signalling by lamps in the upper part of the central apparatus.

The cables from outside come to the cross-connections through a metal box. In another connecting box the loops are connected to the connecting plates of a relay frame, and these are connected to the central apparatus through a separate box.

The installations of the Monnaie and the St Jacques blocks are each fed by an accumulator battery with cadmium-nickel elements which is charged over metal rectifiers. The Monnaie-block battery is of 72 Ah capacity and the St Jacques-block battery of 40 Ah capacity.

The battery of each block is controlled by a charging panel mounted on the front of the central apparatus to the left of the signal section. The panel holds a voltmeter, a charge ampèremeter and a discharge ampèremeter. In addition there are two switches for connecting and disconnecting charging and for disconnecting the current to the installation. These switches are supervised by two signal lamps which are lit by operation buttons.

As soon as the battery tension falls to the lowest limit permissible for the operation of the installation a signal is given. Two signal lamps and a special bell give alarm in case of interruption of current. These arrangements are fed direct from the lighting mains.



The Swedish Riksdag's Voting Machine

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

In 1927 Telefonaktiebolaget L. M. Ericsson constructed the first voting machine, this being installed in the Finnish Diet. The installation is described in Ericsson Review No 10—12, 1927, and was designed for secret voting. Last year the Swedish Riksdag ordered a similar installation for open voting and this has been put into service at the opening of this year's session.

The Swedish Riksdag or Parliament is an institution of ancient date. It reckons its ancestry back to the year 1435, when the peasant leader Engelbrekt called the gentry of Sweden to Arboga to join him and his supporters in deliberations concerning important matters of state. The Swedish Riksdag thus celebrates its 500th anniversary this year.

The traditions of past centuries usually have the power to keep alive old uses and customs, these being accepted as symbols of successful work carried out. If this way of thinking is allowed to hold complete sway there is a danger that form is preferred to performance, and then old traditions certainly cannot be upheld.

In a riksdag or parliment it is above all the question of voting where the struggle between tradition and efficiency lies. It is through the vote that the decisions of the riksdag are made known and the formal casting of the vote assumes for that reason a mantle of importance. Yet as a form of procedure the manner of casting the vote should, however, be judged only according to its efficiency.

That is the conception that has guided the Swedish Riksdag, for in spite of its ancient traditions it has not shrunk from changing its method of voting in order to adopt a method which enables the result of the vote to be speedily available. In 1925 the Riksdag modified its procedure by the introduction of the open vote, with the result that many questions could be voted on by a show of hands. This year the Riksdag has installed its voting machine, by which the vote by calling of names can be carried out exceedingly rapidly.

The votes in the Riksdag are cast in two ways. The most frequently occurring way is by *show of hands,* when the Riksdag members rise in their places for a few moments, first those whose vote is »aye» and then those whose vote is »no». The Speaker then estimates which is in the majority. Should he be doubtful or should anyone demand it, the count is made by the vote being carried out with *call of name, i. e.,* the name of each member is called and he announces orally the way he votes. On written demand made by at least one tenth of the members of the Chamber and handed in to the Speaker

Fig. 1 X 5187

Interior of First Chamber

On the wall: left, individual voting board; right, results board

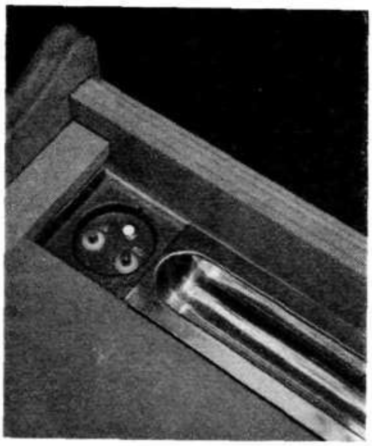


Fig. 2 X 3347
Riksdag member's desk
with voting buttons and signal lamp

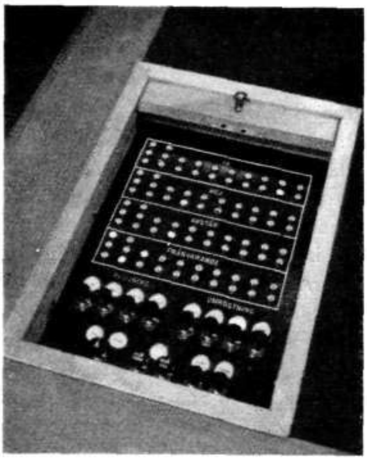


Fig. 3 X 3348
Speaker's operation board

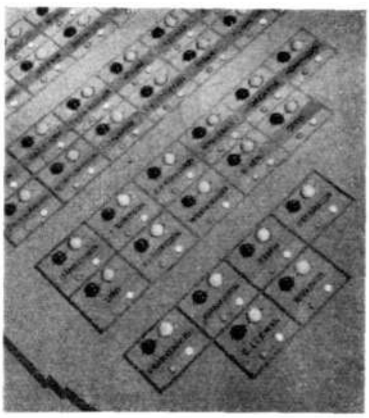


Fig. 4 X 3349
Detail of individual voting board

before the voting begins, the vote is taken by call of name, in which case the individual votes are recorded in the minutes of the Chamber. Naturally voting by call of names takes a considerable time and it is these votes which will in future be carried out by the voting machine.

With the machine the vote proceeds in the following manner: the Secretary reads the voting proposition, the Speaker then announces that the vote can take place and thereupon presses a button on his operation board.

In each Riksdag member's desk, Fig. 2, there are two buttons, one marked »aye» and the other »no». »Aye» and »no» votes are cast by pressing the respective buttons and »abstain» is indicated by pressing both buttons. The button only requires to be pressed for an instant for the vote to be registered. Once a button has been pressed the vote cannot be changed, except to »abstain».

When the members have cast their votes by pressing the requisite buttons, there appears immediately on a board on the wall of the Chamber an indication of their votes. When the Speaker is satisfied that all have cast their votes, he presses a button on his operation board, Fig. 3, and after that no further vote can be registered. A further button is then pressed which sets in motion the reckoning of the votes electrically. This is finished in about $^1/_3$ minute for the First Chamber and about $^1/_2$ minute for the Second Chamber. The totals of the different kinds of votes appear automatically in illuminated figures on two boards on the walls of the Chamber, one at each side. While the counting is going on a photograph can be taken of a smaller illuminated board, the record board, which is built into a cabinet. This photograph constitutes a record of the voting.

In addition to the press buttons mentioned above there is in each Riksdag member's desk a signal lamp which lights up immediately on pressing one or both of the buttons; thus the Riksdag member can see that his vote has been registered. The press buttons and the signal lamp are placed in the desk in such a way that they are covered by the lid when it is closed. Thus when the desk is locked the press buttons cannot be tampered with.

The Speaker's operation board holds for the carrying out of the voting four press buttons with indication lamp for each. These lamps indicate which button was last pressed. The buttons have the following functions: »ready for voting», »voting finished», »counting» and »restore».

In addition there is a test arrangement to test whether the lamps are in order, as well as a smaller board to give the result of the count. The whole apparatus is built into the Speaker's table and is protected by a wood shutter with lock.

The board for the individual vote results consists of two panels of the same kind of wood as is used for the other fittings of the Chamber. The wooden panels are provided with inlays of darker wood which form a plan of the Chamber. Each Riksdag member's place is represented by a square in which a nameplate and four small electric lamps are placed, see Fig. 4. The glass lenses which cover the lamps are of different colours and different sizes. The upper left-hand lens which is large and coloured green indicates »aye»; the upper right-hand one, large and coloured red, indicates »no»; the lower left-hand lamp which is small and white represents »abstain», and the lower right-hand one, small and red, indicates »absent». When the voting begins all the »absent» lamps light up. Immediately a desk-button is pressed the corresponding voting lamp lights up. While voting is not going on curtains are drawn across the board, this being done electrically from the Speaker's place.

The record board, Fig. 5, like the above-described board, holds four lamps for each Riksdag member, which represent »aye», »no», »abstain» and absent». The board is set in the lower part of a cupboard in the upper part of which a camera is fitted so that the film holder can easily be inserted. The illuminated board's lamps are set together in rows of 20, each row therefore containing lamps for 5 Riksdag members. All the lamps have white lenses as in this case only the position is required to show what they indicate. Alongside the illuminated board is a compartment which also comes in the range

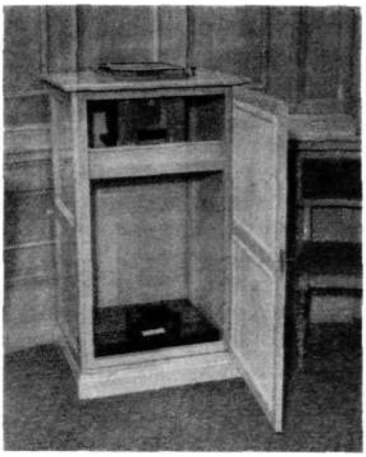


Fig. 5 X 3350
Record board

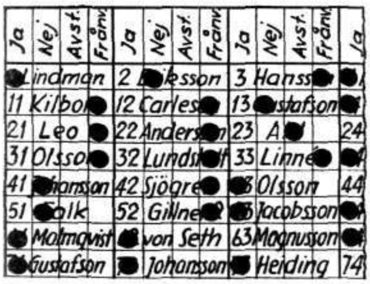


Fig. 6 X 3354
Detail of record film
The film showing black spots is superimposed on a printed form, thus indicating each member's vote

of the camera. In this can be inserted a paper giving the date and number or code word, this being illuminated by its own lamp which lights at the same time as the others on the board. The film is exposed in the usual way for a little over a second. The film shows black for those parts of the board where the lighted lamps are, while the text of the paper at the side of the illuminated board stands out in white letters on a black ground. The film is attached to a printed form bearing the names of the Riksdag members. Through the parts of the film which are unexposed and therefore transparent can be read the names of the members together with the position of the black point indicating the nature of the vote, Fig. 6, from which the official record of the Chamber can be copied.

The boards on the walls giving the result of the vote, see Fig. 1, show this in illuminated figures 60 × 100 mm in size. The light from a lamp is collected in a lens and falls on a round flat disc which can be turned step by step by means of a magnet. The figures are stamped out in the disc. By means of a lens the number is reproduced on a ground glass disc. On another glass disc placed alongside stand out, also in illuminated letters, the text »aye», »no», »abstain» and »absent».

The relays are common for both Chambers and are located in a room which is near the Second Chamber on the floor beneath. The diagram of the installation is shown in Fig. 7. It has two main functions, one to indicate the individual vote and ensure its going in the protocol, the other to count the result of the vote and indicate it.

The relay exchange contains arrangements for the carrying out of both these functions. For each Riksdag member's desk there are 3 relays, an »aye» relay, a »no» relay and a supervisory relay. If the »aye» button is pressed the »aye» relay is closed and remains closed. In this way the vote is registered. The relays also light one of the four lamps representing each place on the voting board and the record board. Which lamp lights up depends on the position of the relay, as can be seen from Fig. 8. If the »aye» relay is attracted, the »aye» lamp lights up; if the »no» relay is attracted, the »no» lamp lights; if both relays are attracted, the light indicating »abstain» lights, and if neither relays is attracted the lamp indicating »absent» remains lit.

The principle of the counting is illustrated by Fig. 9. The organ which carries out the actual counting is the vote collector. It consists in principle

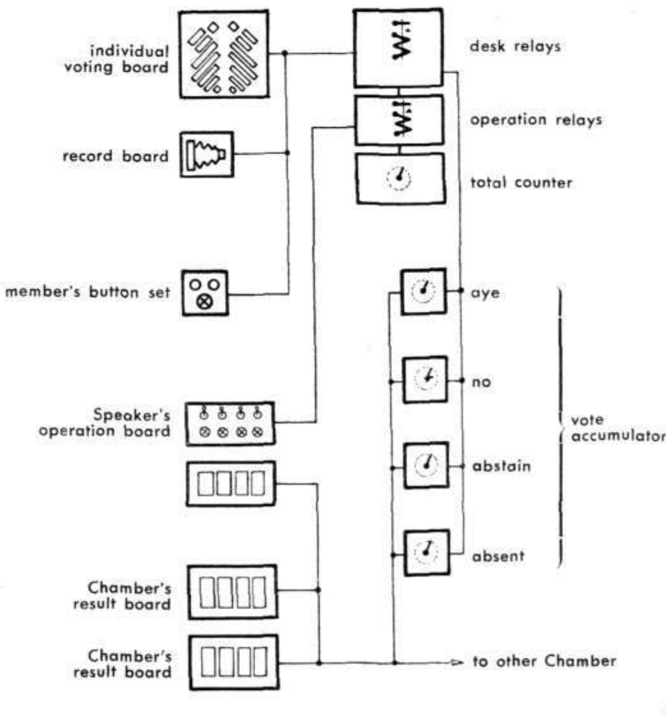


Fig. 7 X 3351
Principle diagram of electric voting installation

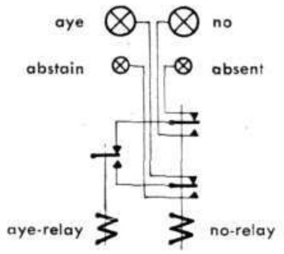


Fig. 8 X 3352
Diagram of connecting process
when voting lamps light up

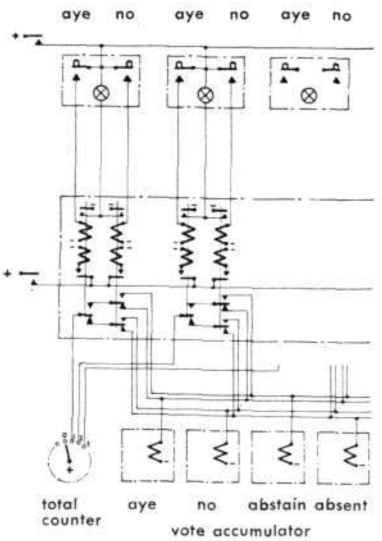


Fig. 9 X 3353
Diagram of counting process

of a rotating selector which passes over the wires leading to the place relays. When counting is to be performed the vote collector is set in operation, whereupon the selector in its movement connects for a moment the positive pole to the wire to each desk in turn. The position of the desk relays determines to which of the vote accumulators the positive impulse shall go, in the same way as described above for the lamps.

The vote accumulator registers the impulse received which corresponds to one vote. When the vote collector has passed over all the wires leading to desks the four vote accumulators have together registered as many impulses as there are desks, as the vote from each place must be registered in one of the four categories »yes», »no», »abstain» and »absent». Now when the counting is completed the result boards are set in agreement with the positions of the vote accumulators, the lamps are lit up and the result appears. At the same time the lamps on the Speaker's result board light up.

There is in addition an arrangement to announce the result of voting in the neighbouring Chamber. When the other Chamber has voted, a lamp lights up in the Speaker's apparatus and the Speaker can then by means of a switch display the result on the board in his Chamber. This is of the greatest utility, in view of the joint vote prescribed by the Swedish Constitution in certain cases when the votes of the two Chambers on a question do not agree. For such a joint vote the votes given in the two Chambers are added together. If the voting is done at about the same time the members of the Chambers can learn immediately how the joint vote has gone.

A voting machine must be entirely free from failures. The apparatus is made up of parts which have been tested over a long period in the automatic telephone; no appliance is, however, entirely free from defects, and there must therefore be a number of supervisory arrangements. Thus in each place the signal lamp lights up when any of the relays is attracted, which acts as a check that the vote has been registered.

As already stated, not only are the numbers of »yes», »no» and »abstain» votes counted, but also the number of absentees. The total of these four categories should be the same as the number of desks. It can therefore be seen immediately if any failure has occurred. The total in the First Chamber should be 149 and in the Second Chamber 229; the speaker in each Chamber is not included as he has not the right to vote.

The voting machine has been in operation since the beginning of the year and has given complete satisfaction to the members of the Riksdag, in spite of objections raised during the debate last year, when the question of ordering the machine was under discussion, that the Riksdag was becoming too much mechanised. This opinion formed the subject of a cartoon in a Stockholm daily paper, as shown in Fig. 10.

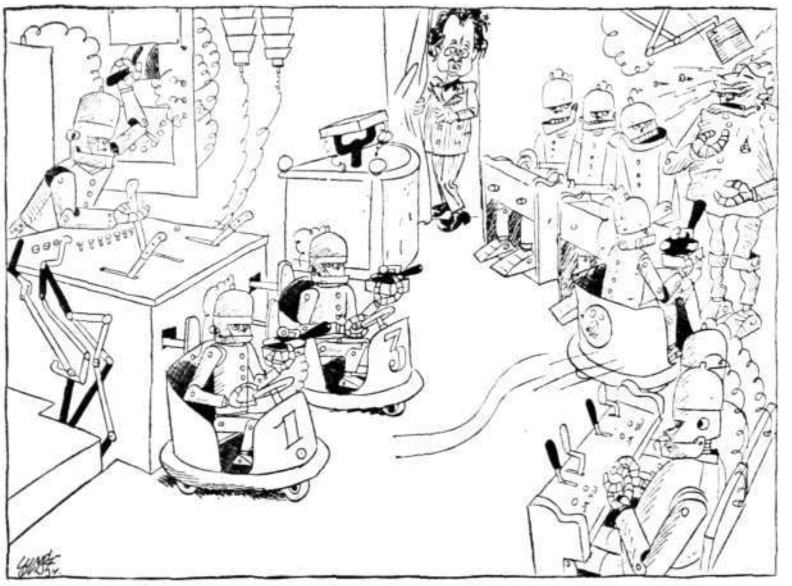


Fig. 10 X 5188
»The mechanised Riksdag»
(from the newspaper Dagens Nyheter)

New Types of Electricity Meters

A. DROUGGE & B. SILFVERHJELM, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

Among the many new electricity meters which Telefonaktiebolaget L. M. Ericsson will put on the market in the course of the year, three special meters deserve particular notice: load indicator, sum-total meter and time meter.

Load indicator.

The load indicator, Type VM 13, is an apparatus which will be found useful for, among others power users to whom it is important for one reason or another to avoid the load exceeding a certain limit, while at the same time it is required to keep it as near to that limit as possible.

Such is the case in an undertaking which subscribes for a certain fixed amount of energy from a power station, paying a basis price for this effect, but in the event of the consumption exceeding the subscription limit is obliged to pay a considerable supplement in price. The amount of excess consumption is in that case usually determined by means of a maximum meter with $^1/_4$ hour registration period. The sum to be debited is then calculated on the average imput per $^1/_4$ hour, fixed as the subscription limit, as well as on the highest average imput registrered in $^1/_4$ hour, peak loads of short duration not affecting the resultant figure.

In order to insure that the load of the plant does not exceed the subscription limit during any $^1/_4$ hour it is necessary that the foreman in charge should be able at any given moment to form an opinion regarding the state of the load then prevailing and of its subsequent tendency. A peak load can very well be tolerated, if only it is compensated earlier or later in the same registration period by a sufficiently large reduction in the load to bring the average input during that registration period down to or below the subscription limit. The foreman must therefore receive warning both audibly and visually whenever a peak load is about to occur, he must be able to see what was the state of the load during the earlier part of the registration period, and he must then make an estimate of how the load will be up to the end of the registration period.

If he finds that a peak load is tending to cause the subscription limit to be exceeded, the measures to be taken will depend naturally on local circumstances. One undertaking may have its own power plant to furnish peak and reserve power, while another may have a section of its load which may be cut off for a short time without inconvenience. In the first case the foreman would obviously require to take out to begin with the whole amount of the subscribed input, at the same time regulating the private power supply so that it takes over the peak load. In the second case he would at the proper moment make whatever reduction in the load was possible. As may be seen from what follows, such load regulation can be made completely automatic. Finally, there are cases in which the load indicator is employed, not to determine whether the existing load shall be decreased but to determine whether a load which has been temporarily cut off shall be connected again during the prevailing registration period.

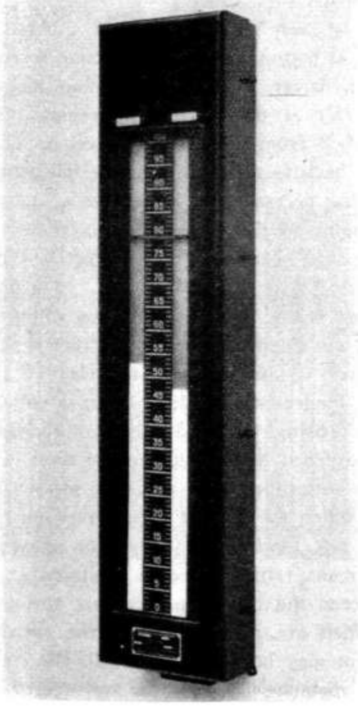


Fig. 1 X 3317
Load indicator, Type VM 13

The main parts of the load indicator are two illuminated columns built into the same frame and provided with a common scale graduated upwards from 0 to 100, placed between the two window panels. Each illuminated column consists of a luminous tube in front of which runs a screen. The position of the lower edge of the screen in relation to the scale can be read without difficulty from a distance of 50 m or more, as the dividing line between the lower lighted part of the panel and the upper part covered by the screen stands out very sharply and distinctly.

Both screens start from zero on the scale at the beginning of a registration period and move upwards until their mechanism at the close of the registration period is released by the master clock of the maximal meter, when they fall back to their starting point. The indicator when in operation thus appears to consist of two growing columns of light.

The screen of the light column on the left, seen from the front, receives its movement from a synchronous motor and in this way during the registration periods moves at a constant speed up to a certain point on the scale.
The screen on the right is driven step by step by a movement which in its turn is actuated by impulses from an impulse contact mounted on the main meter of the plant. Its speed, not counting the discontinuity of the movement, is thus proportional to the speed of the meter rotor disc, *i. e.*, to the momentary effect. The distance travelled, or the height on the scale, is proportional to the number of revolutions made by the rotor disc of the main meter, *i. e.*, to the energy consumed. By a suitable selection of the wheels in the gearing the mechanism is so arranged that the screen will be at about 74 on the scale when the amount of energy corresponding to the subscription limit has been consumed. The remaining divisions on the scale should be reserved for indicating excess consumption. The subscription limit is marked by a moveable rule running across the scale and visible from a considerable distance.

The mechanism of the left-hand light column is arranged so that its screen at the close of the registration period stands at the division on the scale representing the subscription limit.
In this way, from a glance at right-hand side of the indicator, the load column, it is possible to arrive quickly at an estimate of the amount of the subscribed energy for the prevailing $^1/_4$ hour that has been consumed and how much remains. At the same time, from the left-hand column, the time column, it is possible to see how much of the $^1/_4$ hour has passed and what time there is still to go.
From the working diagram Fig. 2, it can be seen that a complete installation can be made up of two parts only, *viz*, a main meter with impulse contact, Type VM 100, and a load indicator, Fig. 1. This is, however, on the assumption that DC for driving the relays is available, otherwise a rectifier will be necessary in addition. On the other hand a separate master clock is not a necessity as the synchronous motor with the help of the contact *K6* can be used for determining the time period.
The working of the load indicator may be seen from Fig. 2 and 3. At the beginning of the period both screens are at bottom position. The time screen immediately begins its upward movement, driven by the synchronous motor and continues upwards until its relay *OR1* at the end of the registration period automatically disconnects the clutch *8* from the driving wheel *9*. The time screen then drops by its own weight back to zero position, the fall being checked by the rotating wing *10*, this being necessary to keep it at a higher level than the load screen which is dropping at the same time, since otherwise the signal arrangement would come into operation. The correct bottom position is regulated by the spur wheel *12*.
The movement of the load screen is caused in the following way: on rotation of the main meter the middle spring of the impulse contact *K4* receives a to and fro movement causing the resistance *r2* and the driving relay *IR* to be short-circuited alternately. Each time the resistance *r2* is short-circuited the driving relay attracts its armature, causing the load screen *2* to rise one step, the extent of the rise being governed by the number of teeth on wheel *5*. During the whole registration time the relay *OR2* is attracted, thus preventing the screen from falling. When the contact *K6* of the master clock is closed both the releasing relays *OR1* and *OR2* of the two screens are shunted at the same time and the screens return to home positions.
During the upward movement of the screen the two signal contact springs *11* to the right are driven at speeds which are proportional to the speeds of the respective screens. The arrangement may be so adjusted that the signal current can be closed at a certain distance between the springs, the current being cut off again when the distance is reduced to below the limit fixed.

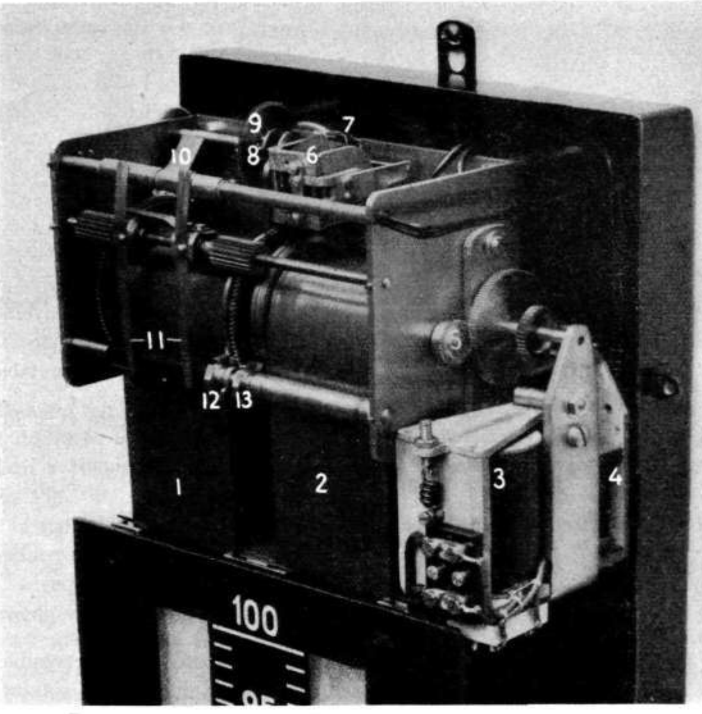
Fig. 2 X 331
Diagram of load-indicating plant

A	luminous tubes illuminating the columns
IR	operating relay for load screen
K2	signal contact
K4	impulse contact in meter
K6	releasing contact for time screen
M	synchronous motor
OR1	time-screen releasing relay
OR2	load-screen releasing relay
r2	resistance

Fig. 3 X 5175

Load-indicator mechanism

1 time screen
2 load screen
3 load-screen operating relay
4 load-screen releasing relay
5 load-screen driving wheel
6 time-screen releasing relay
7 synchronous motor
8 clutch
9 time-screen driving wheel
10 brake wing
11 signal-contact springs
12 time-screen spur wheel
13 load-screen spur wheel



The location of the load indicator is in no way dependent on the position of the main meter, so that the two apparatus may be placed far apart. The only necessity is that the resistance of the cables in the connecting wiring shall be kept within certain limits, usually fixed at 15 ohm per single cable. Only three cables are required (not counting the signal and the connecting cables) on the understanding that use is made of the master clock belonging to the indicator. Otherwise one or two cables is called for, dependent on whether the master clock is mounted at the same place as the main meter or not.

If the input consumed by the plant during a whole registration period is constant and in accordance with the subscribed input, it is obvious from the foregoing that both screens, starting at the same time and moving at a constant speed, arrive together at the mark indicating the subscription limit and that throughout the whole of the $^1/_4$ hour they move upwards side by side. To bring about such a constant parallel upward movement of the screens is therefore the ideal which the foreman in charge should aim at. Deviation from this ideal, however, is of no importance, if only the result at the end of each $^1/_4$ hour is that the right-hand column of light is alongside or below the left-hand one.

The following three cases may occur during working:

1. *both the light columns have the same height,* see Fig. 4 a; as stated above, this indicates that the average load during the portion of the registration period which has gone by has been in accordance with the subscribed average input;

2. *the right-hand light column is lower than the left-hand one,* see Fig. 4 b: this indicates that the speed of the main meter is slower than corresponds to the subscribed average input, and it is thus permissible to take out a correspondingly greater amount of energy;

3. *the right-hand light column is higher than the left-hand one,* see Fig. 4 c: this indicates that during the expired portion of the $^1/_4$ hour more energy has been taken out than corresponds to the permitted average consumption. The height of the right-hand light column above zero indicates in kWh the amount of energy used since the beginning of the prevailing $^1/_4$ hour. Its height in relation to the left-hand light column shows whether the average

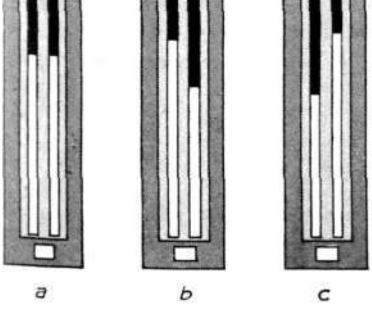


Fig. 4 X 3318

Load indicator in operation

a average load same as subscribed input
b average load less than subscribed input
c average load greater than subscribed input

input during the expired portion of the $^1/_4$ hour has been equal to, less than or greater than the subscribed energy.
At the close of each $^1/_4$ hour it is possible with the aid of the constants given in W/degree of the scale on the indicator cover to reckon the average input during the registration period in question. It should however be noted that the said constants are only good for a completed $^1/_4$ hour, as can be easily seen from the following example: if the subscription limit is 80 kW, it is suitable to regulate the screens to that they are indicated by the division 80. The constant then will be 1 division = 1 kW. Then if at the close of the ¼ hour the right-hand screen stands at 50, the average load will have been 50 kW. If the load screen after 10 minutes is already at this division, it is not possible to read the average input direct, but it must be calculated in the following way, taking into account that kWh and not kW are shown on the right-hand part of the table:

since 80 divisions indicate $\frac{1}{4} \times 80 = 20$ kWh, then 50 divisions represent

$\frac{50}{80} \times 20$ kWh, and

an energy consumption of $\frac{50}{80} \times 20$ kWh per 10 minutes thus represents

an average input of $\frac{60 \times 50}{10 \quad 80} \times 20 = 75$ kW.

Even though it may not be possible to read off the momentary load in kW, a good idea of its size is obtained by judging the relation of the movements of the two light columns to each other. If in any of the three cases cited they move upwards with unchanged difference between them they have obviously the same speed, from which it follows that the load at the moment is the same as the subscribed average input.
If the difference in height becomes less in case 2 or greater in case 3, that is a sign that the load exceeds the average effect.
It is case 3, of course, which above all should be the object of the attention of the foreman in charge. For this reason the signal arrangements of the load indicator are so arranged that a signal circuit is closed so soon as the right-hand screen passes the left-hand screen to an extent which may be fixed. In this signalling circuit may be connected a lamp, an alarm bell, a siren or other signal arrangement, visual or audible. It is also possible to put in circuit an intermediate relay which, with or without delayed action, automatically disconnects a certain load, regulates the demand on the private power plant or the like.
Only one of the uses to which the load indicator can be put has been described above. It can, however, as may easily be understood, be employed for many other purposes, for control of operation not only in electric power plants, but in all cases of control of consumption, *i. e.*, gas, water, steam etc., or for control of the speed in a machine, a shaft etc. Whether it is placed at the disposal of the foreman or worker to prevent exceeding a certain consumption or speed, or whether it is placed in an operation office to make it possible for the works management to control the operation, it fulfils an important function.

Sum-Total Meter

It is at times desired to collect together the results of a number of energy meters, or rather quantity meters, into a total to be read at a central point. This refers in the first place to electricity meters, such as kWh or Ah meters, but also applies to water meters, gas meters or meters in general for measuring machine production during a certain period of time. For this use the sum-total meter is employed.
In Ericsson Review No 3, 1934, a description was given of a sum-total meter plant which Telefonaktiebolaget L. M. Ericsson had delivered to the Royal Board of Waterfalls for the Älvkarleby Power Station. Ericsson has now

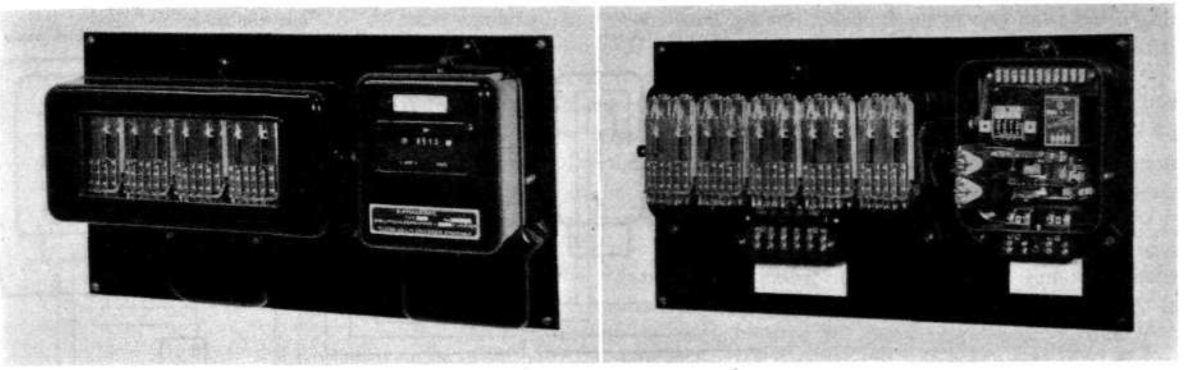


Fig. 5 X 7071
Sum-total meter, Type VM 10
left of illustrations, impulse collector
right, impulse distributor with counter

taken up the manufacture of a simplified form of the sum-total meter plants as delivered to Älvkarleby, that is the sum-total meter, Type VM 10, Fig. 5. Such a simplified sum-total meter plant will consist of the following parts, see Fig. 6:

1. a number of quantity meters — primary meters — with built-in impulse contacts, Type VM 100;
2. a sum-total meter, Type VM 10, consisting of:
an impulse-collecting arrangement, comprising for each meter an impulse relay and a cut-off relay, built together as one unit; five such units may be mounted in one cover;
an impulse-distributing arrangement common for up to 12 primary meters, consisting of a rotary selector, a test relay and a step-by-step relay, built together as one unit;
a calculating mechanism;
3. a rectifier, Type RH 30236 for 50 c/s or RH 30237 for 25 c/s, to feed the relays and selectors of the sum-total meter.

The primary meters for which the figures require to be totalled are provided with a contact arrangement, Type VM 100. This contact arrangement is described in detail in Ericsson Review No 3, 1934, so that it is not necessary to go further into it here.

When the number of units which it is desired to measure has been registered by the primary meters, a current impulse is sent out by the contact arrangement, and this actuates the calculating mechanism of the sum-total meter, moving it on one step.

As all the primary meters send their impulses to the same calculating mechanism, this will show the total of the readings on the individual meters. Each impulse from the primary meters should correspond exactly to the number of units, this in most cases being obtained by a suitable selection of the number of teeth in the contact arrangement, combined with locating them on the proper axle of the calculating mechanism. In certain cases an intermediate gearing is provided.

Since it may obviously happen that two primary meters send out impulses at the same moment to the sum total meter, a special arrangement to provide for this eventuality is introduced to ensure that the totalling shall be correct. This arrangement consists of a rotary selector with 12 positions, to which the primary meters are connected.

Immediately an impulse is sent out from a primary meter the selector seeks the contact corresponding to this meter, after which the impulse is counted. The selector then seeks the next contact receiving an impulse and which for that reason is under tension, after which this second impulse is counted, and so on.

If now two primary meters should send their impulses at the same moment to the sum-total meter, the selector first seeks the contact lying nearest and only after this contact has been counted does the selector seek the second contact and reckon its impulse.

Since the selector as stated has 12 contact positions, not more than 12 primary meters can be served by the impulse distributor. The present standard

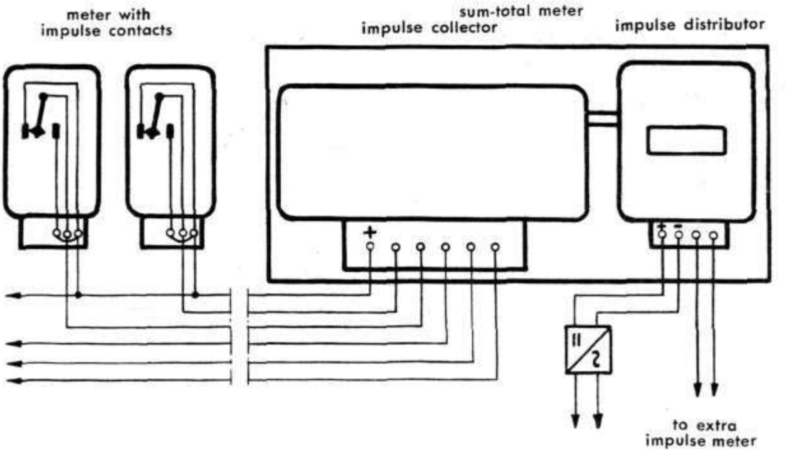


Fig. 6 X 5176

Diagram of sum-total meter installation

for manufacture is, however, to make sum-total meters for not more than 5 primary meters, because, as stated, the hood for the impulse collector is made only for this number of receiving relays.

Nevertheless, if required one additional impulse arrangement may be connected to the impulse distributor, thus enabling the sum-total meter to be connected to a total of 10 primary meters. Still further means of extension can be obtained by employing two selectors in the impulse distributor.

As has been said, it is mainly in connection with electricity meters that the sum-total meter will be of utility.

For instance, a power station delivers electric energy over several lines on each of which energy meters are installed. It is desired to know the total of the energy distributed during the 24 hours over these lines. By building into these meters contact arrangements, Type VM 100, and connecting same to a sum-total meter, Type VM 10, the total energy is arrived at by direct reading on a single calculating mechanism. The totalling can be done no matter whether the energy meters are for DC or AC. They can be distributed in different transformer stations, from which the transmitting of the impulses can be carried out over ordinary two-wire cables, such as telephone cable.

A great advantage is also offered by the fact that the total may be read while delivery is going on; if so desired it may even be carried out at several spots, for instance in the central control, seeing that for this purpose is is only necessary to connect further calculating mechanisms to the sum-total meter. When the calculating mechanism has been read it is returned to zero by means of a steel pin provided for the purpose.

At times this simple totalling is not sufficient, but the totals are required first in groups by connecting different groups of meters each to its own sum-total meter and later the totals from these group-total meters combined by a grand-total meter. Moreover, it can be arranged that the readings are taken every other hour from two calculating mechanisms, each of which is connected for its appropriate hour to the sum-total meter. The disconnecting is looked after automatically by a special disconnecting clock, as described in Ericsson Review No 3, 1934.

In case an undertaking wishes to take up a duration curve for its whole energy requirement, covered partly by purchase of current from some power station and partly from its own plant, the latter delivering the peak loads, the sum-total meter is the only sure manner of taking the duration curve.

The meter for the purchased current and the meter for the current deliveries from the concern's own generator are in these circumstances provided each with its contact arrangement, Type VM 100.

The impulses from these two meters go to a sum-total meter, are totalled by this and then re-forwarded to a duration meter, Type VM 1, see Ericsson Review No 1, 1933, this being connected to two terminals on the sum-total meter.

Such combinations of sum-total meters and duration meters have during the last year been delivered to Imatra Power Station in Finland, the Swedish Naval Dockyards at Karlskrona and others.
When the sum-total meter is to be used for water meters or gas meters, the contact arrangement is mounted on the existing calculating mechanism, the respective shaft for the contact arrangement being lengthened if the contact arrangement is to be placed outside the calculating mechanism; if space allows the contact arrangement is fixed between the two bearing points.
By a suitable selection of the number of teeth, possibly by addition of a suitable intermediate gear, the calculating mechanism of the sum-total meter may be employed for indicating gas or water consumption in m^3 or cu. ft.
The sum-total meter can also be used for measuring the production of a machine during a certain period of time, say at a sawmill where a number of sawframes deal with timber of a certain dimension.
At each sawframe an impulse arrangement is fixed, arranged in such a way that it sends out impulses during the time a piece of timber is going through the frame. A certain number of running metres sawn length thus represents an impulse. The impulses can then be reckoned for each frame and thereafter transmitted to the sum-total meter for totalling. In this way the production is arrived at for each frame and for the total.
A similar arrangement can be used for a spinning mill, in which for instance several frames are spinning yarn of the same kind. The sum-total meter in this case indicates the production of each machine and in addition the total production.
Many other similar examples could be cited, but the above will be sufficient to show the utility of the sum-total meter in various spheres.

Time Meter

The time meter is, as its name indicates, a meter which registers the duration of consumption.
Such a meter is employed for energy measuring in cases where the input is constant and its extent known.
In addition this meter is considerably used to determine for statistical purposes duration of connection or the lifetime of various appliances, such as motors, rectifiers etc.
The time meter, Type VM 11, Fig. 7, which is now put on the market can be used, because of its method of construction, only for AC, as the metering organ consists of a synchronous motor which is connected and disconnected at the same moment as the load whose duration is to be measured. A gearing transmits the movement of the motor to a six-figure calculating mechanism of the type usual for measuring kWh. The gearing is selected so that the indication is done in hours with four or five unit figures, according to the requirements of the purchaser.

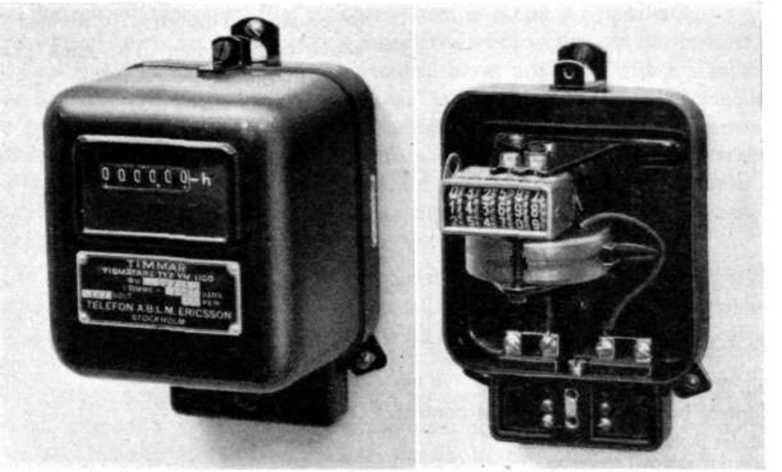


Fig. 7 X 5177
Time meter, Type VM 11
on right-hand illustration, below counter, synchronous motor

Watchman-Control Installations

N. SUNDEVALL, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

In order to make the keeping of watch in buildings really effective, the watchman on his rounds should be under supervision in such a way that the times at which he comes to the fixed control stations are registered. For this purpose Telefonaktiebolaget L. M. Ericsson has produced a watchman control system which can easily be adapted to different conditions.

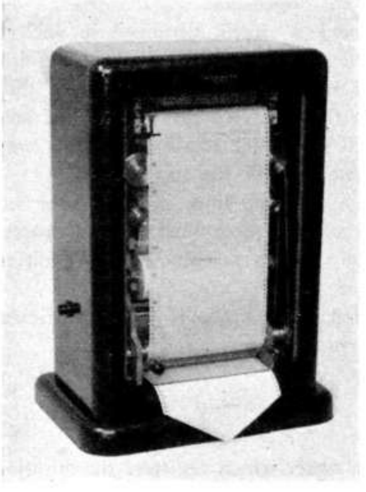


Fig. 1 X 3334
Central apparatus for watchman control

A very common form of watchman control is the watchman's tell-tale clock. This the watchman carries around with him and by means of the keys hanging up at the different control stations he marks on a diagram disc in the clock the times at which he arrives at these control stations. There are innumerable variations of this system, all of which have the disadvantage that the check cannot be made until the watchman has completed his rounds.

A really useful control system should be so constructed that it is possible at any moment to ascertain when the watchman has passed the various control stations and approximately where he is at that moment. When the control signals arrive regularly it is a sign that the watchman is making his round normally. Irregularity or the absence of signals may indicate negligence; as, however, the watchman knows that his movements are under supervision, the absence of a signal would in most cases indicate that something unusual had happened, for instance, that the watchman had come upon a burglar whom he was trying to capture or that he had himself been attacked or sustained an accident. Thus the watchman control would not only be a check on the watchman but would also be protection for his own security.

A watchman-control plant on the Ericsson system consists of control boxes which are set up in the places from which control signals are to be sent, together with a central apparatus in which these signals are registered. The central apparatus is set up in a convenient place in the watchmen's office, the caretaker's room etc. The control boxes are connected with the central apparatus.

A control signal is given by the watchman inserting in a key-hole in the *control box,* Fig. 2, a key he carries with him. When this key is turned current impulses are transmitted to the central apparatus where the number of the control box and the time of the signal are registered.

For installations at places where the watchmen go two by two, there are two control boxes at each control place, these being so constructed that both watchmen must give the signal at the same time, otherwise it is not registered.

The *central apparatus,* Fig. 1, contains a number of stamps which when registering stamp the number of the control box on a constantly moving paper strip. This strip is divided into 30 columns and a stamp is mounted above each column. The time graduation is made by horizontal lines for each 10 minutes.

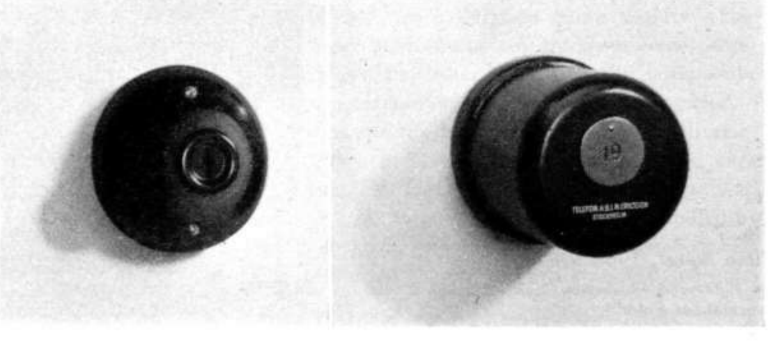


Fig. 2 X 5180
Control boxes for watchman control
left, for flush mounting
right, for external mounting

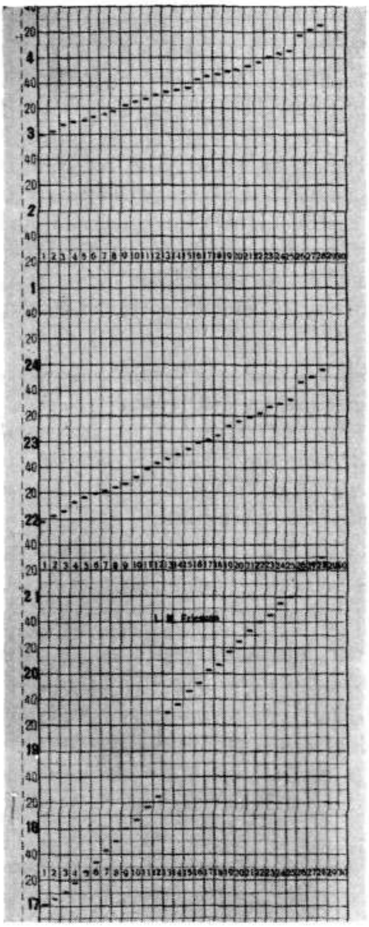


Fig. 3 X 3332
Watchman-control diagram

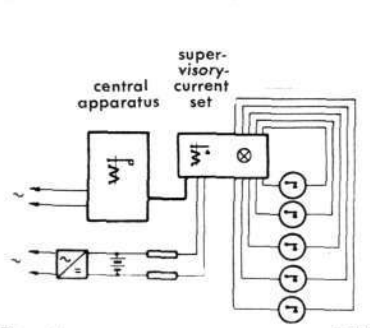


Fig. 4 X 3341
Diagram of watchman-control plant
on the star-connection system

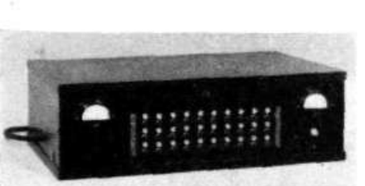


Fig. 5 X 3331
Supervisory-current set

The registering strip is driven at the rate of 30 mm/h by a synchronous motor, a clockwork or by 60-second impulses from a master clock. The stamping is done with typewriter ribbon thus eliminating the inconvenience of inking. Fig. 3 shows a diagram from a factory and is a good example of the great clearness and ease of reading of the registration system.

The diagram shows that the watchman began his round at 5 p. m. and that he took $4^1/_2$ h to complete the round. The 66 minutes stop at control point *13* arises from the fact that this point is in the enamelling shop where the watchman has to wait until the enamel ovens reach a certain temperature whereupon the watchman must turn their heat off. The interval between the registrations *25* and *26* is explained by the fact that the three last control places are situated outside the factory buildings and that the time taken to reach the first of these is longer than between the different departments in the workshops. The last signal of the first round is given at 9.30 p. m.

The second and third rounds were made between 10 and 11.55 p. m. and between 3 and 4.25 a. m. The reason for the different times taken is that on his first round the watchman inspects all the water and gas taps, the electric lights, the tempering furnaces, fans, windows etc. On the second round inspection is restricted to the water taps and the turning off of the electric lights after the cleaners. The third round is only to see that all is as it should be.

Those who have to supervise the watchmen can see on the control slip how the round has proceeded. The form of the diagram shows this without the necessity of adding or subtracting the times.

The system can be made in various combinations for different purposes. All the apparatus comprised in the system is standardized and a simple installation can be extended or completed by additional units.

The manner of registering the control signals is the same for different combinations, but the connections of the control boxes to the central apparatus can be done in various ways suitable to meet local conditions.

Fig. 4 shows an installation on the *star-connection principle.* In this case each control box is joined to the central apparatus by separate connection. This system is employed when the control boxes are situated comparatively near to the central apparatus so that the cost of wiring is not too high.

If there should be risk that the wiring of the system may be exposed to damage, either accidental or intentional, then the cable net is kept under tension of a supervisory current. The central apparatus is then provided with a supervisory-current set, Fig. 5, by means of which the whole network is traversed by a feeble electric current when the system is not in operation. Any interruption in the wiring causes an alarm signal to be given as a warning that a fault has arisen.

Fig. 6 shows an installation on the *loop-connection system.* The control boxes are connected in series in a loop which begins and ends at an impulse receiver on the central apparatus, Fig. 7. This system is useful for installations where the control boxes are spread over a large area when wiring on star-connection system would be too expensive. The control boxes are fitted with a signalling mechanism by which, when a signal is given, a number of impulses is transmitted corresponding to the number of the control box: thus box *1* emits one impulse, box *2* two impulses, and so on. The impulse receiver contains a selector which moves forward as many steps as the number of current impulses received and from its final position actuates in the central apparatus the stamp belonging to the control box in question.

The two wiring systems may be combined; such an arrangement might for example be used at a sawmill: in the mill itself the net is made on the star wiring principle but in the scattered area of the timber yards it is carried out in loops.

The watchman-control system can also be combined with an automatic telephone exchange, in which case the cable net of the exchange can be utilised for the transmission of the control signals to the central apparatus. The

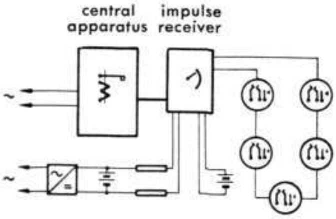


Fig. 6 X 3342
Diagram of watchman-control plant
on the loop-connection system

Fig. 7 X 3333
Impulse receiver

signals are sent by means of the telephone instrument dials. The principle of operation is shown by the diagram, Fig. 8.

A certain number of telephone instruments is selected at suitable places from which control signals are to be given. In parallel with the corresponding line relay in the exchange is connected a relay *Kr*, and this is connected with a certain stamp *S* in the central control apparatus. The relay *Ar* is connected to an ordinary subscriber's number in the exchange. These relays are fitted to a relay set. To give a control signal the watchman lifts the microtelephone at the control place. This actuates the relay *Kr*. When the dialling tone is heard, the watchman dials the *Ar* number of the relay and when the ring signal is emitted this relay comes into operation causing the stamp *S* to register.

At the same time as the relay *Ar* is actuated a time relay comes into operation, for a period of about 10 seconds short-circuiting and breaking the short-circuit alternately 3 times a second in relay *Ar*'s circuit. The ring signal is then disconnected and the relay *Ar* and stamp are cut off; in addition the watchman receives an intermittent reply signal as an indication that he has called the right number and that registration has taken place.

From the point of view of installation cost the system just described has the great advantage that there is no expense for wiring and for control boxes. The system is suitable for all automatic telephone exchanges, Type OL.

The system can be supplemented by certain attachments, such as an *alarm apparatus* giving the alarm in the absence of the normal signal.

This alarm apparatus can be provided for intervals between the registration times of 5—10—15 up to 60 minutes. If it is reckoned, for example, that the watchman during his round should send a control signal, say every 20 minutes, the alarm connection is installed to give alarm if the interval between two signals is more than 20 minutes.

For installations in which the distance between boxes varies, an *alarm transmitter* can be supplied to give alarm at certain fixed intervals every hour for the different control boxes. In most cases it is sufficient to employ the alarm transmitter for checking signals from one particular box on the round, the middle one being convenient. Times are selected for the sending of signals from this box, say 30 minutes after midnight, 1.30 a. m., 2.30 a. m. and so on; in the absence of the signal, alarm is given.

Another supplementary attachment is an *indicator board* which indicates the place from which the watchman last gave a signal. It can be used for speedily noting where the watchman happens to be. It consists of a lamp board with a lamp for each control box. When a signal comes in from box *1*, lamp *1* lights up; on signal from box *2*, lamp *1* goes out and lamp *2* lights, and so on. Another way is to have the board in the form of a plan of the area covered by the watchman's round. The control boxes are indicated by lamps numbered according to the numbers of the boxes. A watchman-in-charge or other official can with the aid of these boards easily follow the movements of the watchman.

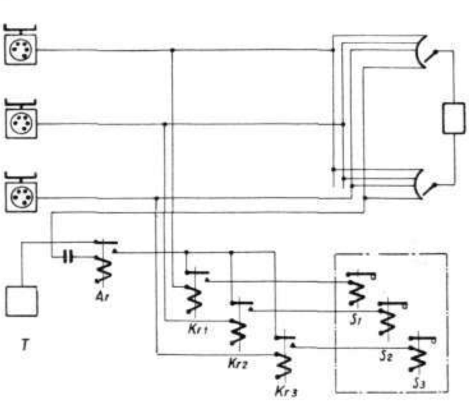


Fig. 8 X 1442
Diagram of watchman-control system
combined with automatic telephone exchange

Ar calling relay
Kr control relays
S stamp
T delayed-action relay

Super-Audio Telegraph System

A. WESTLING, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

Ericsson Technics No 6, 1933, contains a description of a new telegraph system, called the super-audio telegraph system, which has been developed by Telefonaktiebolaget L. M. Ericsson in conjunction with the Royal Swedish Board of Telegraphs. The use of such a system on international circuits has now received the approval of the CCIT and CCIF, which have also issued recommendations concerning the choice of frequencies, levels etc. The new design of the Ericsson super-audio telegraph system, here described, takes into account not only these recommendations but also the working experience gained by the Swedish Telegraph Administration. A fresh and more compact mechanical arrangement allows also of a wider application of the system than had at first been anticipated.

The system is based on utilisation of the frequency ranges not brought into service on lightly loaded four-wire cables. The object of light loading, as is well known, is to reduce the propagation time on long channels; however, the higher cut-off frequency thus obtained is not utilised to transmit a broader speech frequency band. Four-wire repeaters can as a rule without distortion transmit considerably higher frequencies than the highest frequency in the speech band, so that four-wire circuits with four-wire connections can transmit a broader frequency band than is required. In newer cables the frequency limit is often made so high that an extra telephony band for carrier-frequency telephony can be introduced. On the other hand older four-wire cables are not capable of transmitting such a broad band; yet the band is still quite broad enough for a telegraph channel.

The Royal Board of Telegraphs therefore decided some years ago that the existing four-wire circuits should be utilised for an extra duplex-telegraph channel and Ericsson produced the system described in the paper referred to above and which is also included in Catalogue 176 »Carrier Systems».

From the above it will be seen that the transmission circuit can be used without any change. Additional equipment is required only at the terminal stations and consists of *filters* designed to separate the telegraph frequencies from the telephony band, *transmitters* which transform the ordinary DC signals into AC impulses, together with *receivers* which carry out the corresponding rectification to DC.

Fig. 1 shows the diagram of the terminal equipment for a duplex-telegraph channel, with transmitters on one pair of the four-wire line and receivers on the other. The same frequency is of course used in both directions.

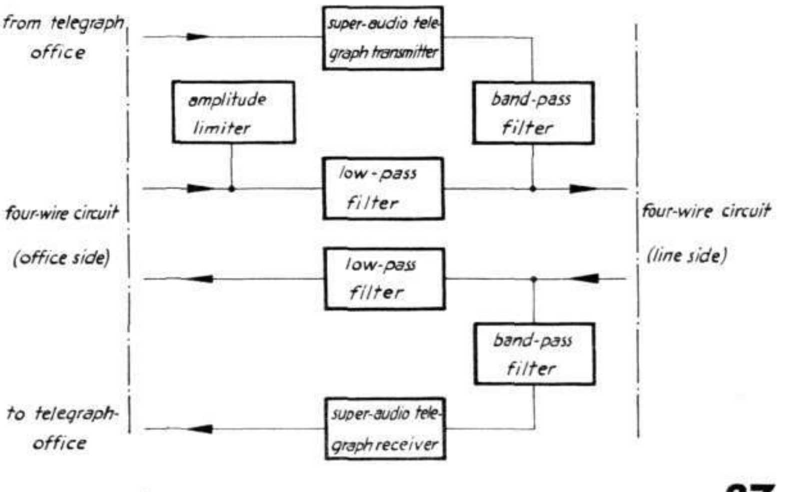


Fig. 1 X 5186 E
Diagram of terminal equipment for duplex telegraph channel

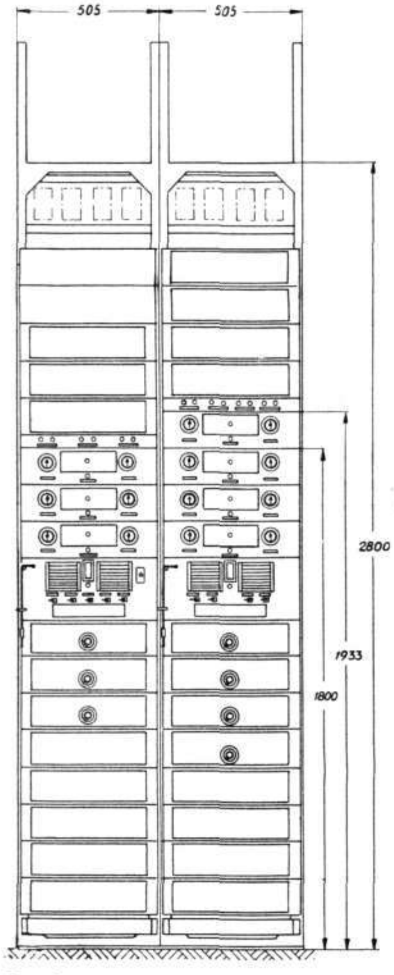


Fig. 2 X 3343

Super-audio telegraph bay

The left-hand section contains oscillator, reserve oscillator and equipment for three channels the right-hand section holds equipment for four channels

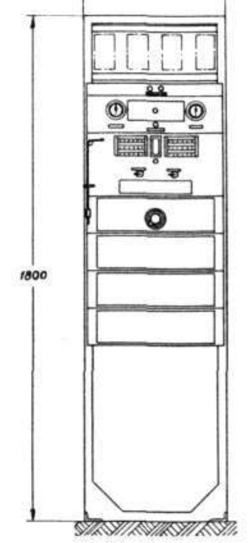


Fig. 3 X 3344

Super-audio telegraph bay for one channel

Frequencies

In the original design the frequency of 4 000 c/s was used, this being suitable for the capacity of transmission of the Swedish four-wire circuits. In its recommendations for international circuits the CCI, however, has standardised two alternative frequencies, 3 540 and 3 180 c/s. It has been necessary to adopt these lower frequencies because in a number of countries outside Sweden the four-wire circuits, and particularly their repeaters, are not able without distortion to carry the higher frequency of 4 000 c/s. Of course for national circuits each administration is quite free to employ whatever frequency is desired. As a higher frequency naturally carries with it certain advantages, Ericsson has designed the new super-audio system with two alternatives: one for a frequency of 4 000 c/s and the other for the CCI frequency of 3 540 c/s; the second is intended for international circuits and the first for national circuits having good transmission quality.

Levels

According to the prescriptions of CCI, the level for the telegraph channel must in no case exceed the level for the telephone channel. The Ericsson system is therefore designed for working with the levels normally employed for telephone channels. There is, however, facility of regulation permitting the use of lower levels if such are considered advisable.

The CCI make no stipulation relating to the connection of super-audio telegraph apparatus to the circuit. Consequently that may be done either before or after the four-wire repeaters in the terminal station, if such are used. The instruments are of course smaller if use be made of amplification in existing repeaters, but on the other hand it has been found by experience that disturbance, particularly from the ringing current, can be avoided by providing the super-audio telegraph system with its own amplifier. Even in the earlier designs, therefore, outgoing amplifiers were used, which made possible the connection on the line side of amplifiers, *i. e.*, at a point in the telephone channel where the level normally lies between 0.6 and 1.1 neper. Such an amplifier is of course necessary in cases where the ring repeater is connected on the line side of the four-wire repeater and on the whole it makes the super-audio telegraph system more independent of the telephone equipment. Besides it prevents reaction on the oscillator, which is common for several channels. In the new design the receiving side has also been provided with its own amplifier for the reason just cited that in any case disturbance may arise from ringing on account of the 25 c/s ringing current getting to the telegraph receiver.

With the levels stated there does not as a rule exist any risk of overloading repeaters, with resultant signal distortion, unless it be by disturbing current. It is usually the ringing arrangements that may give rise to such disturbing elements, for instance through the 25 c/s ring signals penetrating in the channel. Such disturbances are eliminated with the help of amplitude limitation in the telephone filter.

Construction

With the exception of the modifications referred to above, the new design agrees in principle with the description contained in Ericsson Technics No 6, 1933. Mechanically, however, modifications have been made with a view to compactness in mounting. Thus it has been found possible to mount in one bay the equipment for four duplex-telegraph channels, excluding oscillators. As the oscillators for carrier frequency can be combined into one for up to 20 channels it is sufficient to provide the first bay with an oscillator, Fig. 2. This first bay holds, in addition to the oscillator and a reserve oscillator, the equipment for three channels. Fig. 3 shows a special bay designed for one channel only.

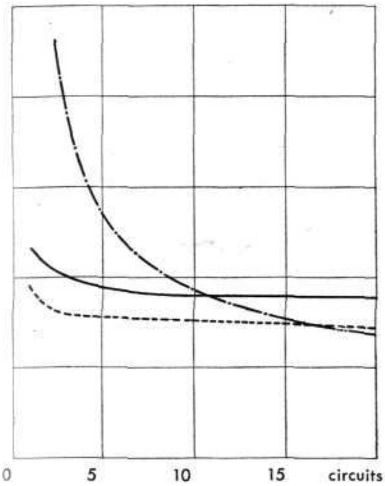


Fig. 4 X 3345

Terminal station costs of super-audio telegraph compared with voice-frequency telegraph

The curves show relative costs per circuit for different numbers of circuits between two terminal stations, leaving out line costs

——— super-audio telegraph

– – – – voice-frequency telegraph with separate oscillator

–·–·–· voice-frequency telegraph with rotary generator

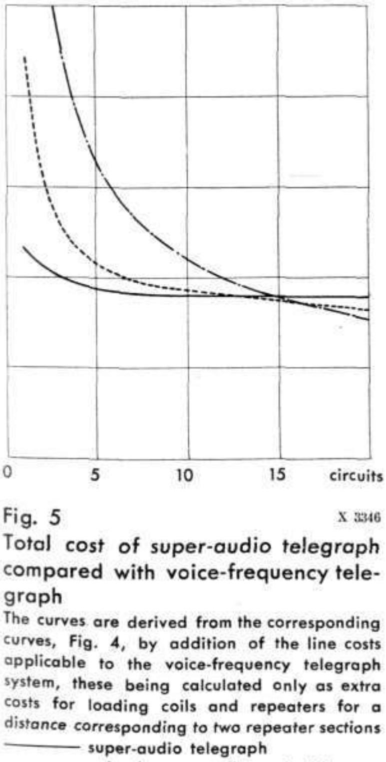


Fig. 5 X 3346

Total cost of super-audio telegraph compared with voice-frequency telegraph

The curves are derived from the corresponding curves, Fig. 4, by addition of the line costs applicable to the voice-frequency telegraph system, these being calculated only as extra costs for loading coils and repeaters for a distance corresponding to two repeater sections

——— super-audio telegraph

– – – – voice-frequency telegraph with separate oscillator

–·–·–· voice-frequency telegraph with rotary generator

Intermediate Stations

In the introduction it was stated that no special equipment is necessary for the circuit itself, as the existing repeaters also amplify the telegraph frequencies. That is true with one reservation, namely if there is an echo suppressor in the four-wire circuit. This must be of such construction that it does not suppress the telegraph channel. Such a selective echo suppressor is described in Ericsson Technics No 1, 1934.

It should also be mentioned that if in the ordinary way it is required to supervise the telephone channel at intermediate stations, the speaking equipment must be provided with a filter which prevents disturbance on the telegraph channel.

Current Supply

The super-audio telegraph system as now designed is equipped with 0.15 A valves for feeding from 24 V filament batteries and 130 V anode batteries. The current consumption from the 24 V battery is 0.15 A per duplex-telegraph channel and 0.15 A for the common oscillator.

Telegraph Speed

The system is normally supplied with relays of the Swedish Telegraph Administration's model, designed for a telegraph speed of up to about 100 Baud. The band width in the telegraph filter is, however, sufficient for higher telegraph speeds, especially in the system for 4 000 c/s carrier frequency. If required therefore the system can be supplied with relays designed for higher speeds.

Application

The super-audio telegraph system is of course particularly suited for giving occasional telegraph communications over long distances. Indeed, four-wire circuits are as a rule only used on comparatively long distances. It should, however, be pointed out that from the economic point of view the super-audio telegraph system is able to compete also over short distances and with a number of communications at the same time, provided that four-wire circuits are available.

It is most convenient to compare the super-audio telegraph system with the voice-frequency telegraph system. The curves, Fig. 4, show roughly the comparative terminal station costs per communication at various numbers of communications for the two types of telegraph systems. It should, however, be observed that as regards the super-audio telegraph system the curve represents the total cost of installation. On the other hand with the voice-frequency telegraph system a certain amount of cost for transmission circuits must be reckoned, as the voice-frequency telegraph system requires a whole telephone circuit and not only a hitherto unutilized frequency range. It is difficult to estimate in general these circuit costs; for both the actual costs of installation and their proper repartition among the different circuits vary greatly, for one thing in respect of reserve circuits. If, in order to arrive at an approximate opinion on the matter, the cost of the circuit is reckoned only as the extra cost for loading coils and repeater, the comparison, Fig. 5, is nevertheless in favour of the super-audio telegraph system even over short distances, provided the number of circuits is less than 10 or 15.

New Installation Material

E. JENSEN, SIEVERTS KABELVERK, SUNDBYBERG

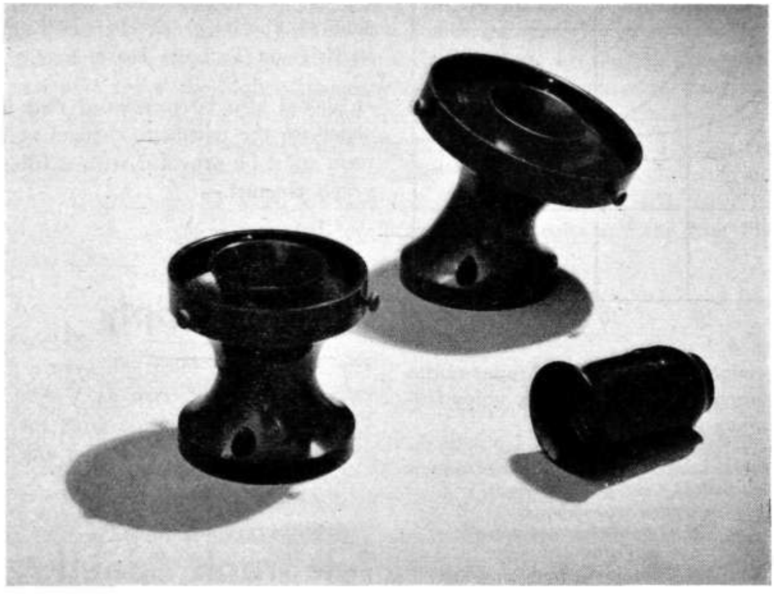


Fig. 1 X 5179
Alpha lamp-holders

A.-B. Alpha has recently produced a series of lamp-holders in bakelite as also a double wall socket, which are particularly noteworthy on account of several new details in construction.

Lamp-Holder

The lamp-holders are made in accordance with specifications required for official tests. They are of the usual type with Edison screw-thread (thread *E 27*) and the hoods are of bakelite.

As a rule ordinary bakelite with wood-meal as filling material is not the right quality for lamp-holders. A number of manufacturers have at different times used bakelite not quite suitable in quality and have even employed bakelite for the thread itself. This has often led to the result that the heat from the lamp socket has caused the bakelite to shrink, so that after a time it is impossible to unscrew the lamp. The trouble this has caused to makers of fittings in particular need not be stressed.

To ensure that the Alpha lamp-holder shall not have this defect, a kind of bakelite has been selected which is not affected by the highest temperature arising from the heat of the lamp and which is yet of sufficient strength. Special treatment after pressing prevents contracting of the bakelite.

The construction of the lamp-holder is such that all the types in common use can be made up from a small number of parts without detriment to the appearance. The lamp-holders are made either with the bottoms arranged for screwing firmly to a nipple or the like or with a straight or oblique foot. They may be used as they are or be fitted with a holder for a shade with 60 or 80 mm neck; the system may be seen from Fig. 2.

Fig. 2 X 3328
Alpha lamp-holder
Various kinds of holders may be made up from standard parts

As far as the construction of the lamp-holder parts themselves is concerned, Fig. 3, a number of interesting points should be mentioned. As is often the case with installation material the designers have been restricted to rather

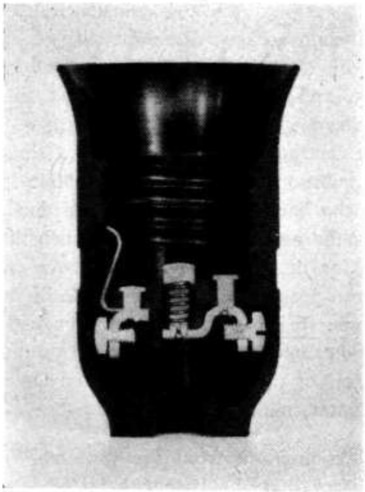


Fig. 3 X 3329
Cross-section of Alpha lamp-holder

narrow limits, owing to the fact that among other things the lamp-holders must fulfil certain conditions in respect of protection of connections; the contact parts must have a certain amount of spring so that they give proper contact with the various lamp sockets which are on the market; the contact parts must be of material which is not affected by the heat from the lamp; the lamp-holder must be neat and strong; and, finally, it must be cheap enough to sell. The protection of connections means that there must be no contact of the metal parts of the lamp when screwing in or when the lamp is screwed in. There is no doubt that stipulations on this point go a little too far. They automatically involve methods of construction requiring spring contacts, though for other reasons these may not be desirable. Moreover, stipulations vary for different countries, with the consequence that at the present day it is hardly possible to make a lamp-holder which would be approved in all the countries which have official inspection of material.

The protection of the connections has been affected in the Alpha lamp-holder by the form adopted and by providing both bottom and side contacts with springs.

The side contacts are made of phosphor bronze and are firmly rivetted to a connection piece of solid brass. The bottom contact is of turned brass with a broad head, this also being rivetted to a brass terminal. Beneath the head of the bottom contact there is a strong spiral spring which provides the necessary contact pressure while not conducting any current. Connection of the conductor is made by a set-screw located under the head of the terminal.

The skirt is fastened to the cap by only one screw. The cap of the lamp-holder has in the ordinary way a 10 mm stud screw. In order that the wires shall not be damaged by rubbing against possible edges on the stud opening thus causing leakage, the opening at the bakelite bottom has a rim on the inner edge of the screw thread against which the stud rests and which prevents contact between the conductor and the stud mouth. The bottom is firmly locked to the stud by a dented metal plate which is pressed against the thread of the stud by means of a screw. The screwhead is countersunk in the bakelite so that here also contact between the conductor and the metal has been avoided.

As with other apparatus having an insulated hood the Alpha lamp-holder has the advantage that there is no possibility of getting a shock through leakage, such as is only too frequent in the case of lamp-holders with brass hoods as hitherto used. The construction is such that there is no risk of the lamp-holder falling to pieces when a lamp is screwed in or unscrewed, a possibility that exists in all the old types of brass lamp-holders and in many bakelite holders as well.

Fig. 4 X 3330
»Multiple wall socket»
a dangerous makeshift when there are not enough wall sockets

Double Wall Socket

Wall sockets in our dwelling houses have acquired considerable importance with the constant increase in uses for electricity, but it is too often found that they are lacking in numbers. The insufficiency of sockets has led to the use, though undesirable in itself, of double plugs, double-double plugs etc. It has led to the manufacture of plugs which can be plugged one into the other without end, see Fig. 4. These provisional arrangements cannot be considered neat and they are often really dangerous on account of the risk of fire.

In an effort to improve matters electricity works and others have in recent years begun to carry on propaganda for several wall sockets. There should be a socket in every room and more than one if the room is of any size. It has also been emphasised that one socket in each place is not enough, but that two single or one double socket should be fitted.

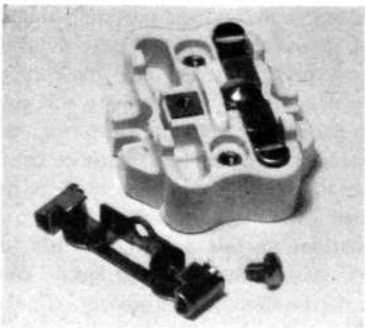


Fig. 5 x 3339
Base of double wall socket
The socket can be sunk into an ordinary 70 mm box

To satisfy the demand for double sockets, Alpha has now constructed one on the same lines as hitherto applied to single sockets. Metal parts used for single sockets have as far as possible been used for the double sockets. In the shape of the porcelain base, Fig. 5, and the hood the aim has been to allow of the socket being fitted as low down as possible and to give it an attractive appearance. When fixing the clearance from the wall for a single socket, account has to be taken of the regulation that it must be possible for the conductor in piping to terminate at the back of the socket. For double socket it has been found possible to press the contacts together so much that inside the hood there is sufficient room for one piping terminal above and one below the base. In this way it has been possible to make the base of the double socket lower down that of the single sockets. The width of the hood, about 60 mm, is determined by the regulation that the single-pole insertion of a plug shall not be possible. The rounding off of the hood upwards and downwards has been made concentric, with countersinking for the plugs.

The double sockets are made both for standing out from the wall and for flush mounting, Fig. 6. In view of the fact that the base can be made of the largest size 60 mm, it is possible to insert the base into an ordinary 70 mm box. The flush socket is provided with a rectangular cover 85 × 100 mm. Up to now it has been found necessary to set up two boxes for flush-mounted sockets. As it may happen that the one is not immediately above the other, it often occurred that the rectangular cover common to both was set askew, and there was no means of setting it right. The method of construction in the Alpha socket allows of it always being set right. A further advantage of the double socket is that the cost of fixing is no more than that for a single socket.

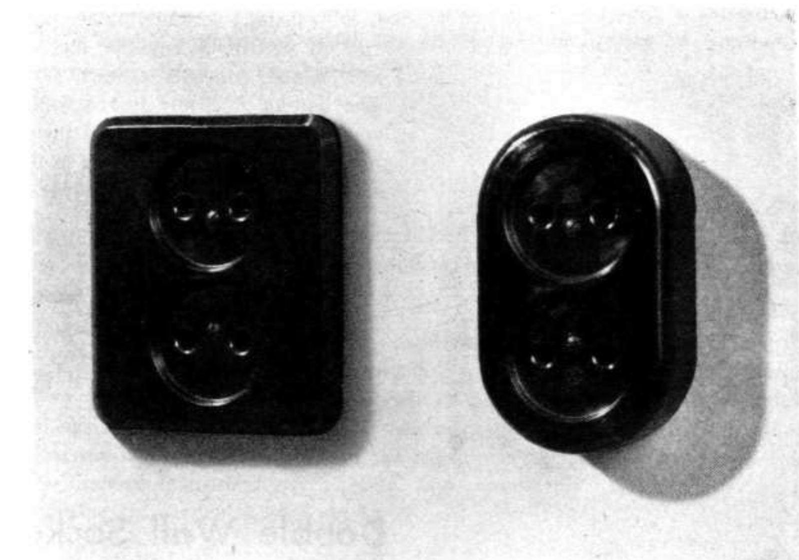


Fig. 6 X 5185
Double wall socket
left, for flush mounting
right, for external mounting

Electrolytic Condensers

AKTIEBOLAGET ALPHA, SUNDBYBERG

After long and thorough investigation A.-B. Alpha have started the manufacture of electrolytic condensers, and as these are coming more and more in use both for telephone and radio purposes a short description will be of interest.

As is well known, a paper condenser consists of two metal foils forming the electrodes, between which paper is placed as a dielectric, usually in several layers impregnated with oil or wax.

The electrolytic condenser also consists of two aluminium foils but the dielectric is made up of a very thin aluminium-oxide film on the positive póle, the anode. The space between that and the clean aluminium foil, the cathode, is filled up by an electrolyte, either a liquid when the condenser is of the wet type or a paste usually held by a gauze for the type called a dry electrolytic condenser.

Since it is now possible to produce condensers of the dry type nearly as satisfactory in respect of electric properties as the wet type, while at the same time the drawbacks of the latter have been eliminated, production is confined to the dry type.

The positive aluminium foil is covered with the aluminium-oxide film through formation, which is carried out in stone-baths containing a suitable electrolyte in which the electrodes are placed under tension. There is a special relation between the thickness of the oxide film and the formation voltage, so that the capacity per unit of area reached, expressed in $\mu F/dm^2$, will depend on the voltage; *e. g.*, with a working tension of 5 V there is obtained about 65 $\mu F/dm^2$ and at 450 V 1.8 $\mu F/dm^2$.

The advantage of the electrolytic condenser over the paper condenser is especially noticeable at lower tensions, in respect of volume and consequently

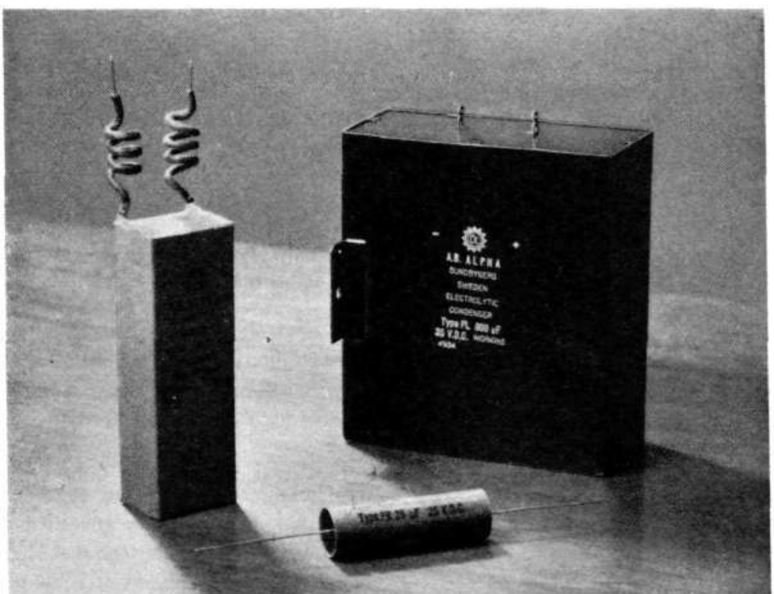


Fig. 1
Electrolytic condensers

X 5178

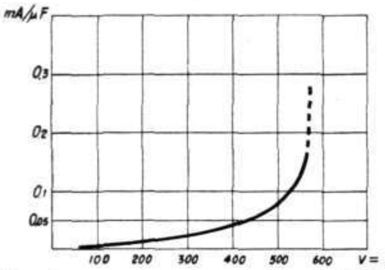


Fig. 2
Leakage-current curve
for electrolytic condenser, 8 μF, 450 V

of price. Condenser paper cannot be manufactured thinner than 0.006 mm and at least two layers must be used to ensure safety. By impregnation with wax a capacity of about 0.8 $\mu F/dm^2$ is obtained and a working tension of 70 V DC can be permitted. No means have been devised up to now for making paper condensers for lower tensions having a higher capacity per unit of area.

The volume of the electrolytic condenser is, moreover, less than that of the paper condenser even at the highest tensions for which it can be manufactured, 450—500 V. This arises from the fact that the electrolytic condenser, unlike the paper condenser, can be used for a working tension only slightly below the break-down tension. The above-mentioned tension of 450—500 V is the highest for which electrolytic condensers can be made owing to physical limitations.

Fig. 1 shows three different types of electrolytic condensers of the Alpha manufacture. The smaller types are made in tubular bakelized cardboard containers, sealed and provided with bare-wire leads for mounting in radio receivers, either on connecting strips or directly on the connecting wires. The larger types are carried out in plain waxed cardboard containers which are completely sealed and provided with insulated wire leads. Fig. 1 shows a sample of a large electrolytic condenser in a black-enamelled metal container with bakelized cardboard lid and terminal lugs.

Compared with the paper condenser, the electrolytic condenser shows a relatively high leakage current. If the leakage current is determined with regard to the applied tension, a leakage current curve, Fig. 2, will be obtained. This curve shows a characteristic knee, above which the oxide film is submitted to too great a strain and is finally broken down. If the dielectric of a paper condenser is perforated, the condenser cannot be used, whereas an electrolytic condenser has the advantage that it heals itself after a perforation, thanks to the action of the electrolyte.

The electrolytic condenser must be connected with the anode to the positive pole, otherwise the condenser will be injured. When the condenser is used for smoothing rectified currents it is of importance that the peak value of the AC does not exceed the DC voltage, *i. e.*, the anode must always be positive.

No agreement has been reached regarding the value of the AC voltage in comparison with the DC voltage for standard condensers. The electrolytic condensers are manufactured by Alpha on the condition that the superimposed r. m. s. ripple voltage is 5 % of the DC working voltage, and only the latter is marked on the container.

The peak voltage of the condenser is the absolute value of the highest tension to which it must be submitted, Fig. 3, and if the rated DC working voltage of the condenser is E_1 V, the peak voltage as above will be

$$E_t = E_1 + \sqrt{2}\, e_{eff} = E_1 + \sqrt{2}\,\frac{5}{100} E_1$$

e_{eff} being the r. m. s. ripple voltage.

For electrolytic condensers, and especially with high voltages, it is of the greatest importance that the peak value of the applied tension does not on any occasion exceed the rated voltage of the condenser. Otherwise such a serious break-down might occur that the condenser will not be able to heal itself.

The leakage current of an electrolytic condenser does not show an absolute value but, besides being governed by the temperature of the condenser, it is dependent on the period that has elapsed since the condenser was last submitted to tension, as well as on the time the condenser had been under tension before reading took place.

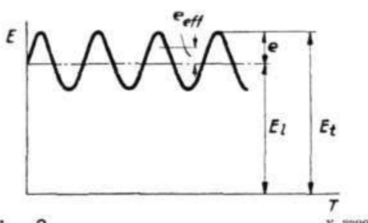


Fig. 3
El DC or working voltage
E_t peak voltage
e_{eff} r. m. s. ripple voltage
e amplitude of AC

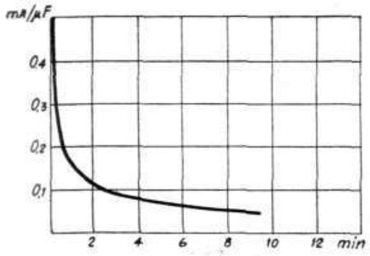


Fig. 4 X 3321

Leakage current as function of the time after connection to working voltage

for electrolytic condenser, 8 μF, 450 V

For laboratory tests it has been suggested that the condenser be connected to the tension for a certain number of hours, then allowed to rest for a determined time, and that the leakage current should then be measured.

Tests for deliveries must, however, be carried out immediately, but it is then found that the leakage current varies according to a curve, Fig. 4. The manufacturer and the customer must therefore agree upon the time during which the condenser should be under tension before reading. If, for instance, a 5 minutes' test is used, the leakage current will have reached a nearly constant value, but when applying such a relatively long time for reading, special arrangements must be made for continuous tests.

In case the 5 minutes' test is replaced by a shorter one, for instance of 30 seconds' duration, it must be recognized that manufactures of different designs and even samples from the same manufacture do not always show curves of the same shape for leakage current.

For a certain tension the leakage current is directly proportional to the capacity and, as the latter may vary between certain allowances, it is advisable to express the leakage current in mA/μF.

On the other hand, it should be noted that condensers made for different voltages show quite different values of leakage current. No general agreement has been arrived at regarding an accepted value for the leakage current. The following maximum values have been suggested, *viz.*

for peak voltage $<$ 100 V: leakage current $<$ 10 μA/μF
for peak voltage $>$ 100 V: leakage current $<$ 125 μA/μF

the condenser being tested at the working tension and reading made after 5 minutes.

Most users of electrolytic condensers have possibly had the experience that the leakage current is not only liable to the variations mentioned above and which can be referred to regeneration but that it may change entirely and increase with the passage of time. This change depends on chemical reactions in the condenser and may have the fatal result that the condenser becomes entirely unfit for use on account of the high leakage current.

In comparison with paper condensers the electrolytic condensers possess higher dielectric losses. Some time ago the losses reached a value even of $\text{tg}\ \delta = 0.25$ at 50 c/s, the applications of the condenser being thus considerably reduced. Since, however, it is now possible to produce raw material of sufficient purity, there is no longer any difficulty in manufacturing electrolytic condensers with much lower dielectric losses. The electrolytic condensers made by A.-B. Alpha for 450 V working tension show generally a value of $\text{tg}\ \delta = 0.5$—0.6 and the dielectric losses are guaranteed never to exceed $\text{tg}\ \delta = 0.10$.

The measurement is carried out by applying a DC voltage of 80 % of the rated DC working voltage with a superimposed r. m. s. ripple voltage equal to 5 % of the DC working voltage.

On account of difficulties in manufacture it is not possible to produce electrolytic condensers in large quantities exact to capacity. Some manufacturers consequently apply a tolerance on the capacity of ± 20 %. In cases where the customer appreciates that the capacity of the condenser is sufficient, a tolerance of, say, $^{+100}_{-5}$ % may be agreed upon.

New Catalogue

A new catalogue containing a selection of Telefonaktiebolaget L. M. Ericsson's productions has just been issued in English and Swedish and will in the near future be published also in Spanish and German. The intention is to issue at intervals new editions of this catalogue, so that up-to-date catalogues will always be obtainable.

The main group *telephones* covers the following subsections: galvanic telephone apparatus, together with apparatus for LB system and manual and automatic CB system, intercom. system, ships' telephones, manager's telephones, portable telephone apparatus with accessories, as also manual and automatic exchanges. The apparatus in the first-named subsection are designed for small plants with short lines and good insulation. The carrying out of such installations is facilitated by the connection diagrams inserted in the catalogue. In addition, the catalogue includes all the telephone apparatus which is at present included in the programme of production. A novelty is the manager's telephone system which should constitute a valuable accessory in offices etc. Among the telephone apparatus for LB systems there is a novelty which should be noted, namely telephone instruments with laryngotelephones. These are intended to be used in places where much noise occurs. By the use of laryngotelephones extraneous noise is eliminated and the speech can be heard clearly and distinctly. The laryngotelephone is also used with ships' telephones, which are described in detail in Ericsson Review No 3, 1933, and elsewhere in this number.

Further there are to be found new *exchanges and switchboard* for LB system replacing the older types. The new exchanges are characterised by simplicity and standardisation of construction, as a result of which the possibilities of future extension are well looked after. As regards automatic exchanges, only those taking up to 22 lines are dealt with, but estimates for larger automatic exchanges will be supplied on request.

In a special section is to be found a general description of new subscribers' exchanges, the big automatic system with 500-line selectors, an automatic LB system specially designed for the automatisation of rural networks, selective-calling telephones, synchronous clocks etc.

Only a brief account is included of the material for long-distance telephony as this material is of altogether too complicated a character to be described in a catalogue of this nature. A selection of the most current types of measuring apparatus is also to be found.

In the next group, covering *bells, signal horns* and *telephone accessories*, among the new products worth noting is a series of AC bells of entirely new type. For these bells only one kind of bell mechanism is used, this being equipped with various gongs. The bells can also be supplied with vibrating indicators, while a special hood has been designed for use when the bells are to be mounted out-of-doors. Of special note among the new telephone accessories are extra earphones for table and wall instruments, of modern type in bakelite, and a subscribers' list holder designed for fixing to table telephone instruments.

In the following group which deals with *rectifiers and charging arrangements* a number of the older types have been replaced by new. In addition there is a new type of charging-control arrangement, with and without fusibles.
A special section treats of *fire-alarm material*. This section opens with a

general description of a magneto system for manual fire signalling. Then comes material for automatic fire-alarm and automatic burglar alarm. This section has been completed with several new productions. All the installations of this kind are executed on the supervisory current system, *i. e.,* a feeble current is constantly passing through the cable system. In this way alarm is received immediately a fault or a breakage in the cable net occurs, which is of great importance as regards safety. The fault signals are, moreover, different from the fire-alarm signals, so that they can be easily distinguished. For fire-alarm installations there are listed thermo-contacts with bi-metallic springs and with soldered contacts, alarm press buttons and central apparatus.

For *burglar alarm installations,* there are various kinds of alarm contacts and central apparatus. A fresh feature in this domain consists of a new combined central apparatus for fire and burglary alarm, which is particularly suitable for smaller installations in villas, shops etc.

In the next group are to be found the *manager's room signals* consisting of a wall contact with a press button, designed to be put outside the door, and a table contact for the manager's desk. The visitor announces himself by means of the signal lamp mounted in the contact and the manager can in the same manner indicate whether he is engaged or disengaged. A telephone contact, which indicates whether the manager is engaged by a telephone call, has been added.

Further there are apparatus for *staff location* in offices, warehouses etc. In these installations the different persons are called by means of various combinations of light signals which appear on a lampboard set up in the different departments. The various combinations are set up on a central apparatus which may be manual or automatic, connected in the latter case with an automatic telephone exchange. Special attention has been devoted to staff-locating installations for hospitals, where it is a necessity to be able to find a wanted person rapidly. At the entrances and exits indicator boards are set up, provided with a switch for each person who may be sought, and a similar board is mounted in each room where anyone is likely to be sought. When a person is to be sought, the operator presses the corresponding switch in the central apparatus mounted in the telephone exchange and a lamp indicates where the person in question last pressed his switch; the person can then easily be reached by telephone. The boards are so constructed that when a person presses his indicator button in a room the last button pressed before is released. Among the new appliances in this section may be mentioned a terminal strip and type of cable specially designed for staff locating installations. There are also apparatus for multi-coloured luminous-signal systems for hotels etc.

The section for *electricity meters* has been revised and considerably concentrated. New products in this section worthy of mention are totalling meters for measuring, e. g., the total input registered by all the kWh meters in a plant, as well as time meters which show how long a certain plant was in operation, and a load indicator which should be of great value to plants where it is necessary to keep the input as near as possible to a certain fixed average load.

The catalogue is provided with thumb index, facilitating the finding of any desired material group, and finally there is a complete index of all the types dealt with in the catalogue.

The English catalogue, which is numbered 188, will be sent on request to all those interested.

Ericsson Technics

Ericsson Technics No 6, 1934.

E. Winkel: The Use of Interlinking and Time Diagrams for Simplifying the Study of Complicated Circuit Diagrams.

The graphical description of connecting processes described in this paper was used for the design of test and demonstration apparatus presented by Ericsson Österreichische Elektrizitäts A.-G. to the Laboratories of the Electrical Communication Institute of the Technical University in Vienna. The new method enables the student to see for each connecting process which devices have been actuated and consequently the order in which the various stages of the connecting process have occurred.

In the method here described stress is laid on the graphical curves, as greater attention has been paid to the time constants of the various devices, to the duration of certain connecting stages and to the moment of starting or ending of the connecting stage as governed by the contacts of the relays. In this manner it is possible to judge whether the projected diagrams provide sufficient margin of safety as regards the time.

The interlinking plan, which indicates in what manner the devices are dependent on each other, forms a convenient complement to the graphical curves, since the technical conjunction between the various devices is through it explained clearly.

In the introduction to this article the new method is compared with the common methods of drawing circuit diagrams and the interlinking and time diagrams are explained. The application of these diagrams to a couple of actual circuit diagrams is shown and finally the advantages of the new method are emphasized.

New Pamphlet

Sieverts Kabelverk, Pamphlet II/4.

H. Spanne: Condensers in Power Technics.

Sieverts Kabelverk has issued a pamphlet giving a detailed description of the construction of power condensers together with the requirements put on insulating material. The description is confined to condensers with oil-impregnated paper as insulating material, this being the type in most general use.

The dimensions of condensers are governed by the properties of the insulating material especially in respect of loss angle and dielectric strength. The variation of the loss angle with the temperature for different numbers of layers is dealt with. As a result of improved methods of refining it has been possible to obtain a decrease in the loss angle with increase in temperature, thus ensuring a stable temperature equilibrum and minimizing the possibility of ageing of the oil through excessive temperature. Dielectrical strength in insulation material is dependent on the properties of the paper, but is also affected to a large extent by the nature of the oil impregnation, the moisture content and the number of layers of paper, and this is fully dealt with in the booklet.

As regards the design of condensers, the booklet contains detailed descriptions of the current types of condenser windings and their different properties. The condenser winding is enclosed in an outer envelope, in the design of which account must be taken of the best possible heat transfer and this is illustrated by some of Sieverts Kabelverk's designs. It is of the utmost importance that the containers should be hermetically sealed, so that dust and damp cannot penetrate and spoil the insulation material. In this connection, some sealing arrangements for the terminal bushings are described.

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Cía de Teléfonos y Bienes Raices	*México, D. F.,* 2:a calle Victoria 53/61; apart. 1396
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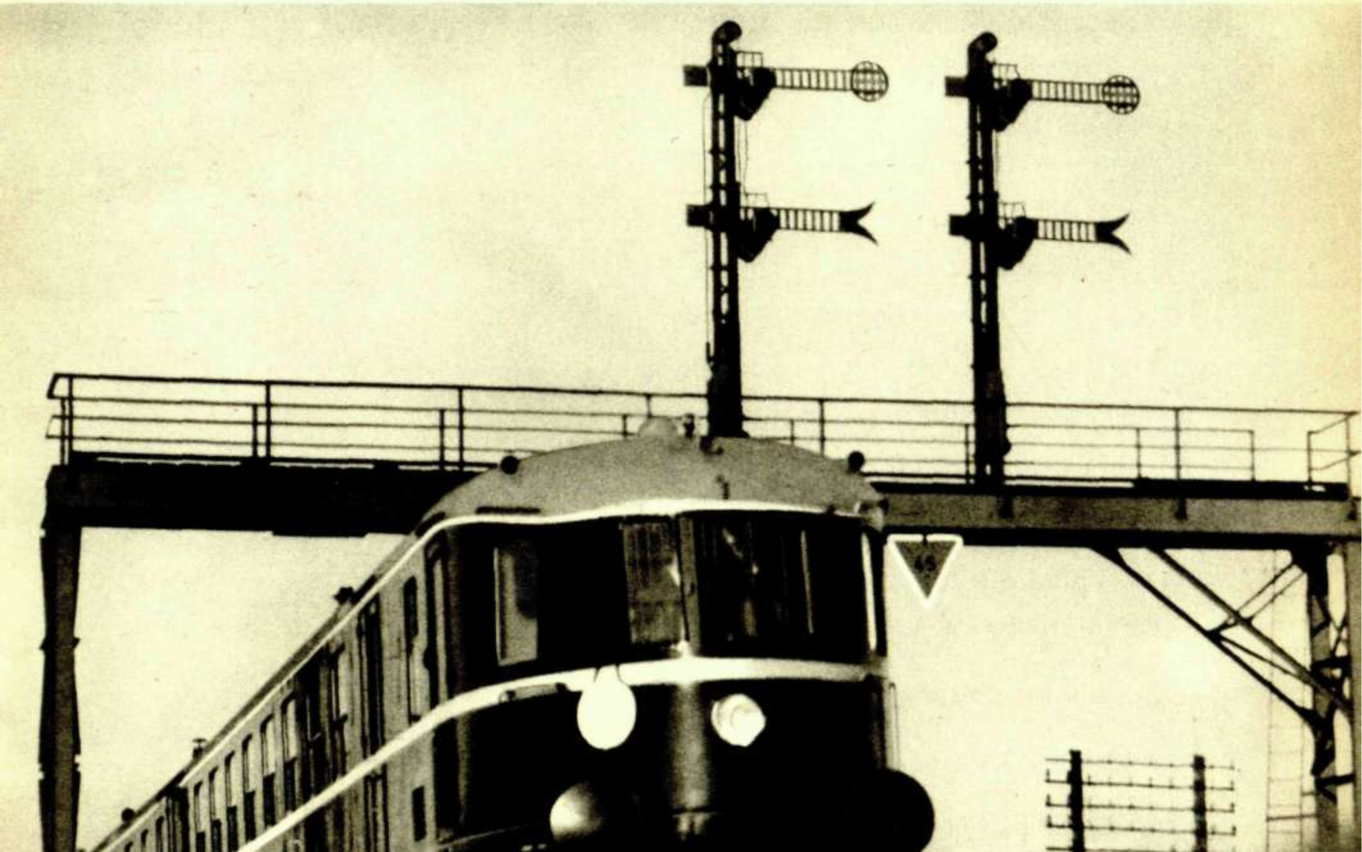

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Field Telephone Instruments

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 headquarters 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.

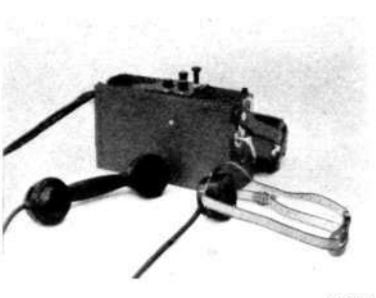
New Field Telephone Instruments

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

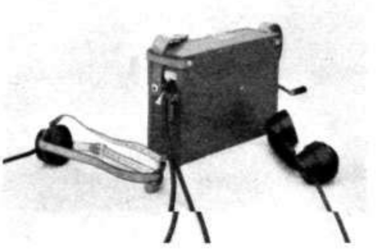
Field telephones do not constitute a standard article to the same extent as ordinary subscriber's instruments do, but are to be found in various designs according to the special purpose which the instrument is required to serve. Thus the requirements on a portable telephone instrument for military service 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.

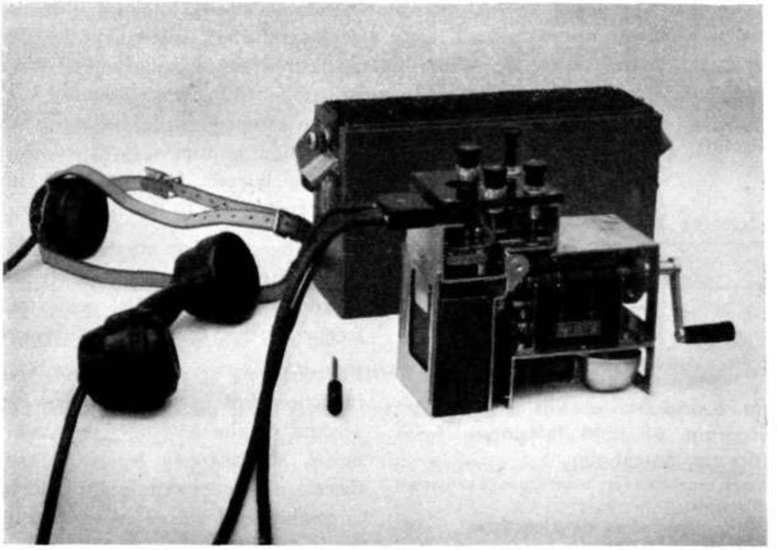


Fig. 4 X 5211
Field telephone from Ericsson, Stockholm
with inset taken out for inspection

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.

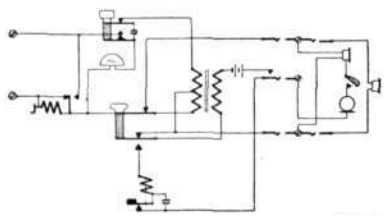
Operation

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.



X 3440

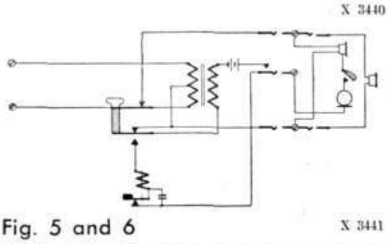


Fig. 5 and 6 X 3441

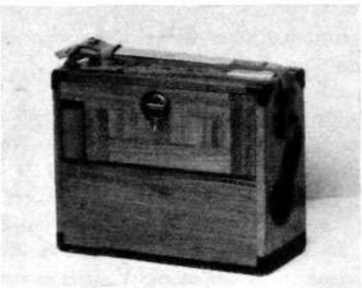
Diagram of field telephone from Ericsson, Stockholm

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

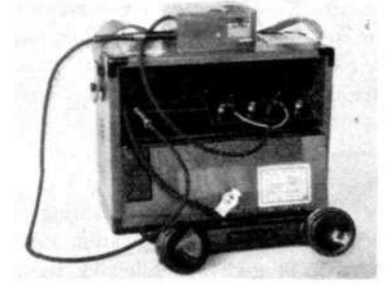
Fig. 7, 8 and 9
Field telephone from Elektrisk Bureau, Oslo
above, closed for transport
middle, open for use
below, lid shut for use in bad weather

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



X 3434

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

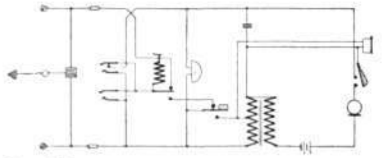


Fig. 12 X 3438
Diagram of field telephone from Elektrisk Bureau, Oslo

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 × 60 × 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.

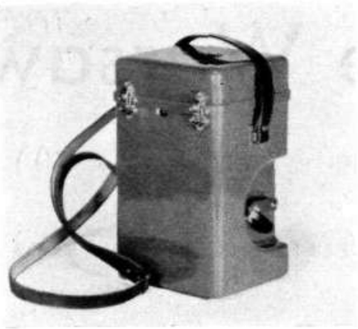
The *induction coil*, anti-sidetone connected, has closed metal core of alloy steel.

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

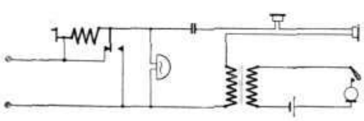
The connection of the instrument is shown by the diagram, Fig. 12. When ringing current flows from the instrument no current passes through the instrument's bell and when the test button is pressed the bell rings for its own ringing current if the circuit connected to the instrument is closed. When the 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.



X 3435

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

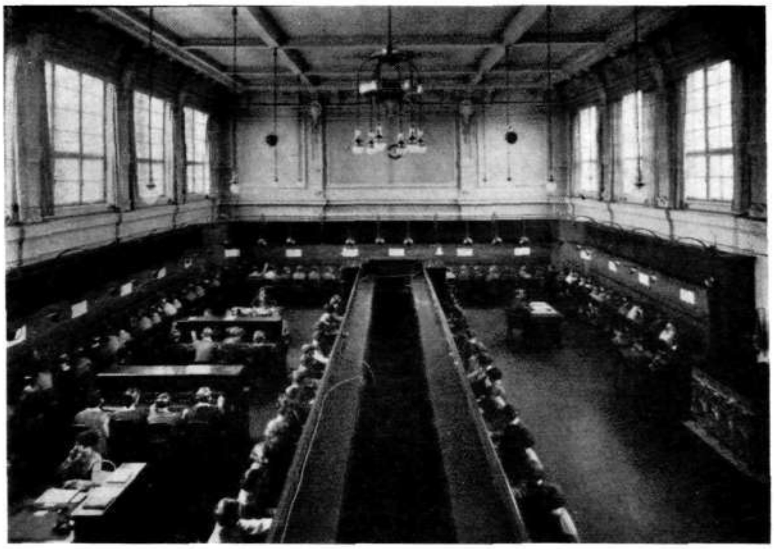


Fig. 3 X 5197
The old Zielna manual exchange, hall A

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.

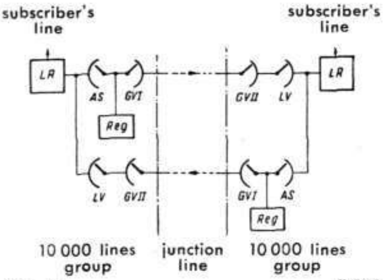


Fig. 5 X 3392

Routing diagram for automatic traffic

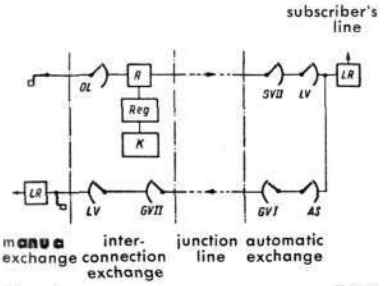


Fig. 6 X 3393

Diagram of interconnection between automatic and manual exchanges

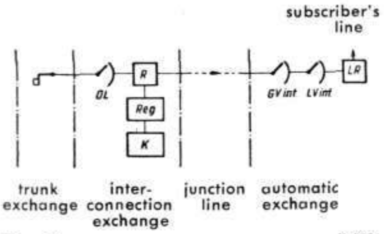


Fig. 7 X 3394

Diagram of interconnection between automatic exchanges and trunk and regional exchanges

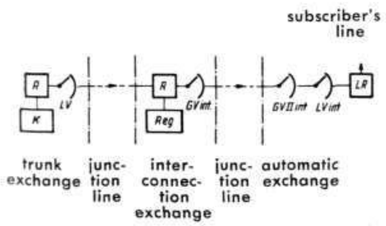


Fig. 8 X 3395

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.

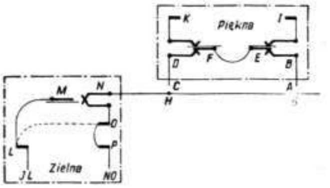


Fig. 9 X 3396
Diagram of transfer from Zielna to Piękna

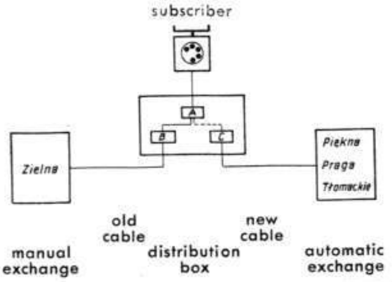


Fig. 10 X 3397
Diagram of transfer from old to new cables

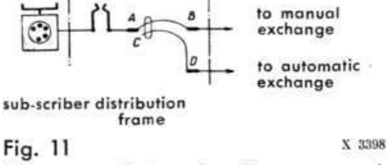


Fig. 11 X 3398
Diagram of transfer from manual exchange to automatic exchange at Zielna

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

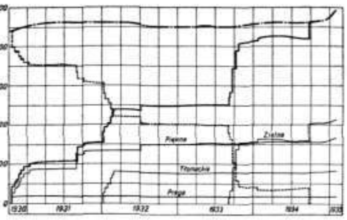


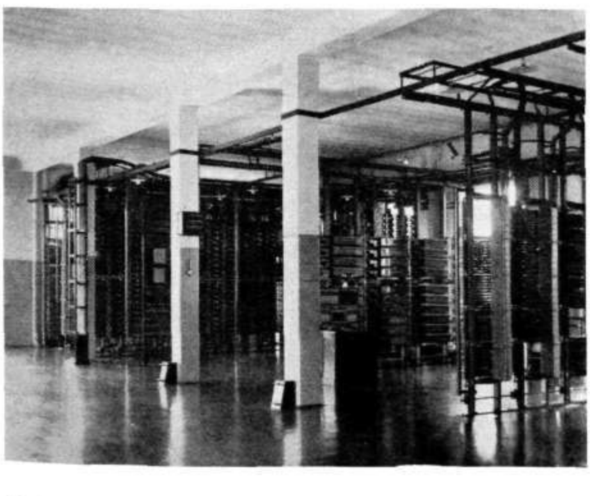
Fig. 12 X 3386
Progress of automatisation
— - — - — - — all subscribers
———————— automatic subscribers
··················· manual subscribers

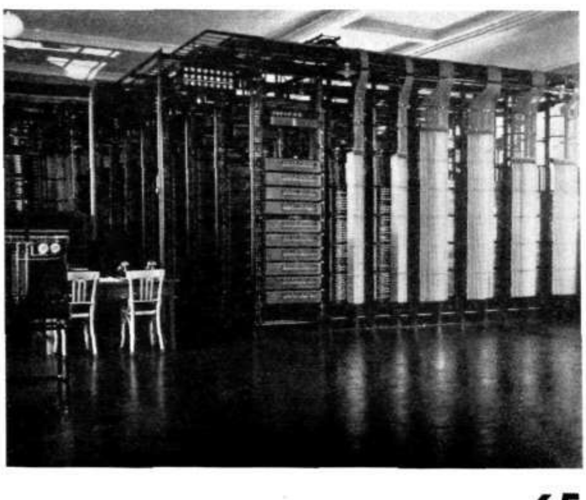
new distribution wire was firmly attached to the old distribution wire *AB* and at *D* it was soldered. The transfer, which took place at night, was done by detaching *A* and soldering *C* on the line side of the distribution frame.
In addition to the above three manners of transfer, yet another method 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

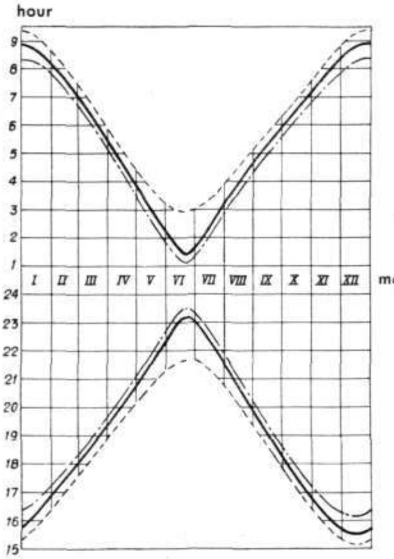


Fig. 1 X 3424
Curves for lighting and extinguishing of street lamps in Oslo
.... sunrise or sunset
———— lighting or extinguishing
— · — · — beginning of twilight

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:

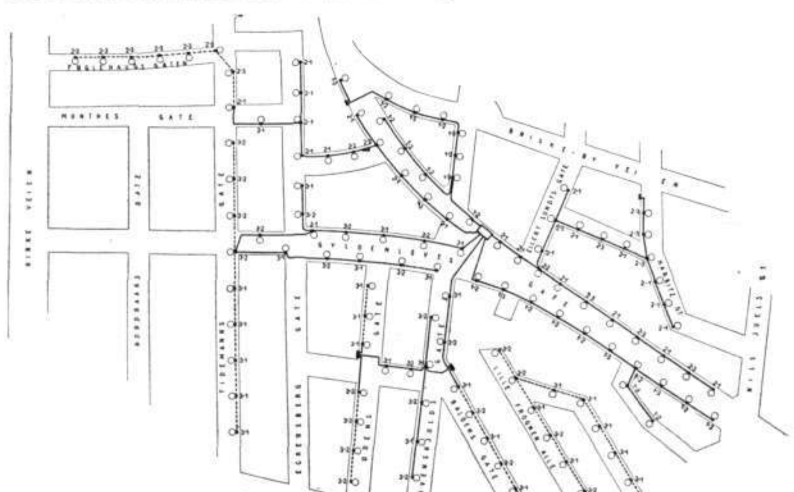


Fig. 2 X 5205
Sketch map showing lighting point with 6 cables

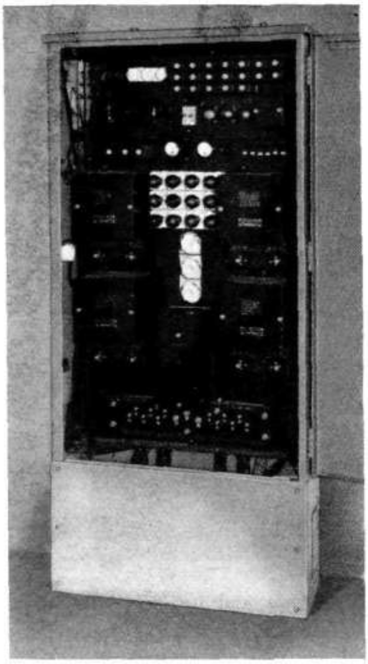


Fig. 3 X 3408
Lighting box

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.

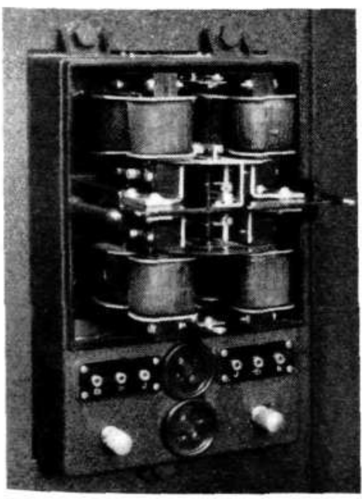


Fig. 4 X 3409
Differential relays

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

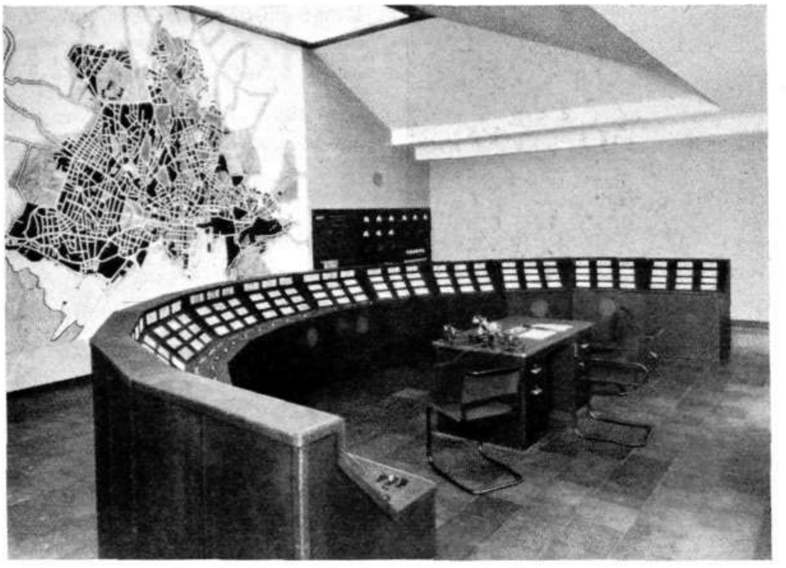


Fig. 5 X 5206
Lighting central at Oslo Electricity Works

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 photocell, thus making the street lighting dependent on daylight and darkness. In this connection it may be mentioned that the central worked with photocells 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.

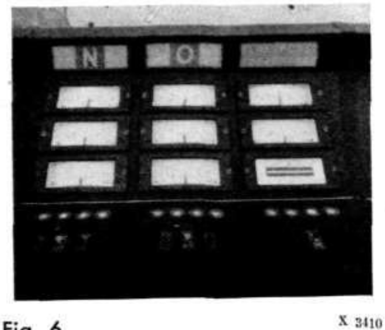


Fig. 6 X 3410
Part of central desk

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.

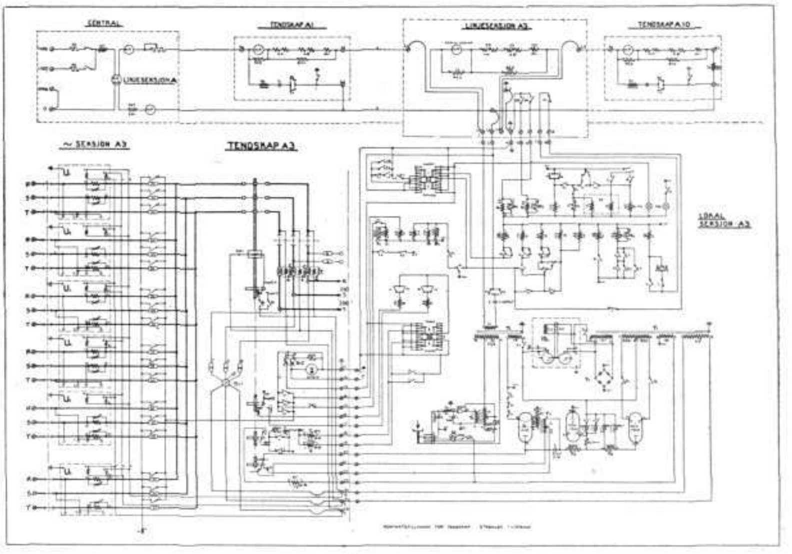


Fig. 7
Diagram of lighting box

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

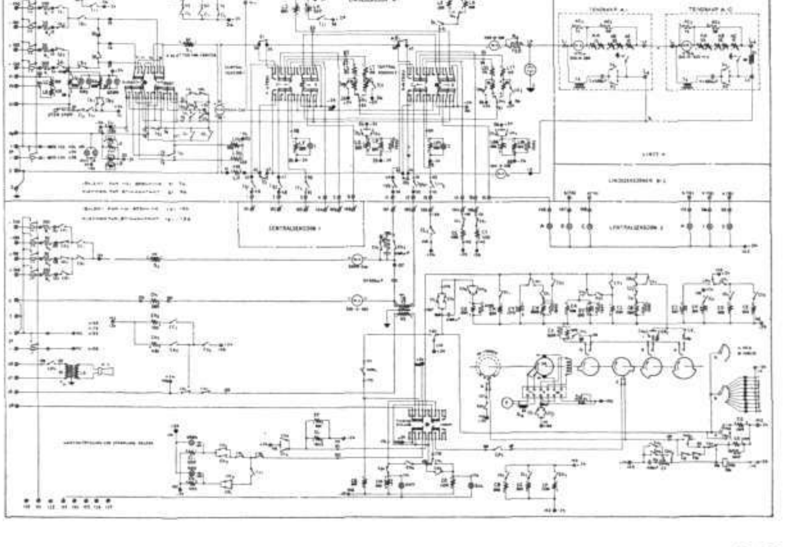


Fig. 8
Diagram of lighting central

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.

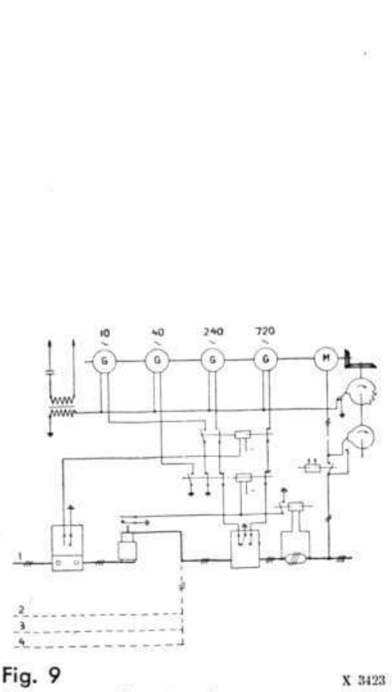


Fig. 9 X 3423
Diagram of voice-frequency generator

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

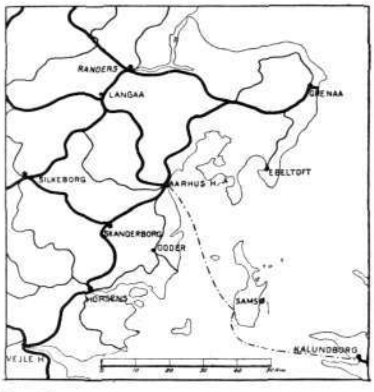


Fig. 1 X 3412
Map showing railway lines meeting at Aarhus

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.

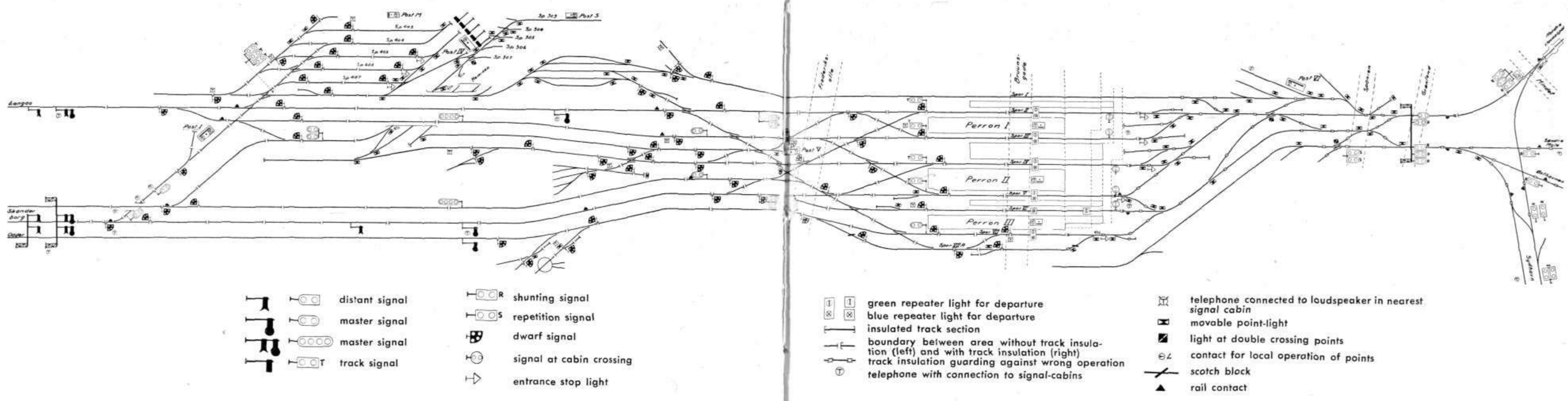


Fig. 2 X 9022
Track signalling plan of Aarhus station

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-arrival 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

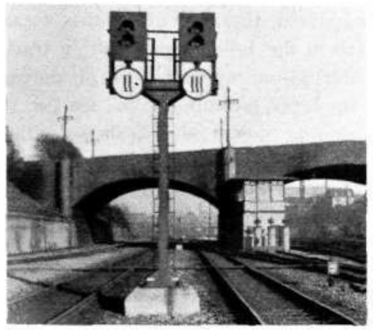


Fig. 4 X 3414
Daylight track signals for entrance on tracks II and III
In front of the bridge may be seen Cabin V (master cabin)

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.

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

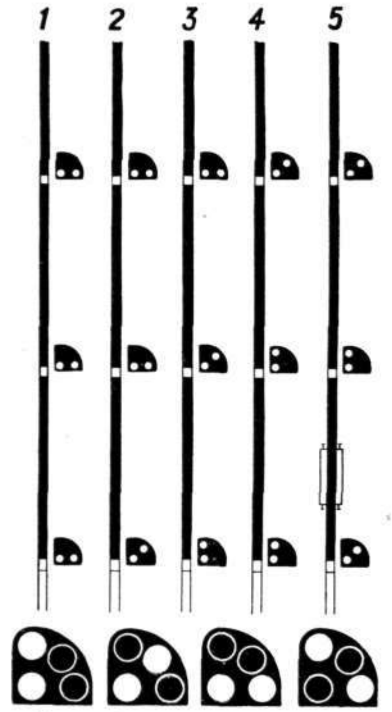


Fig. 6 X 3420
Cooperation of dwarf signals

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».

Fig. 7 X 3416
Dwarf signal

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

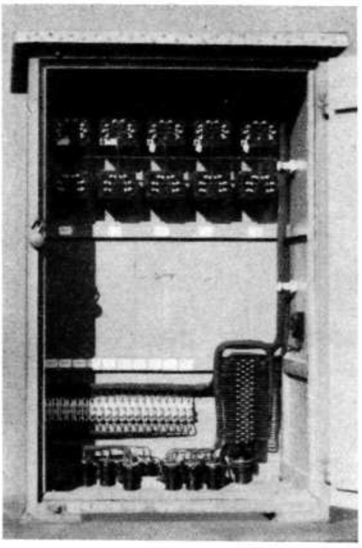


Fig. 8 X 3417
Transformer cubicle for five track sections
showing track transformers above and rectance coils below

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 $3\times220/3\times110$ 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.

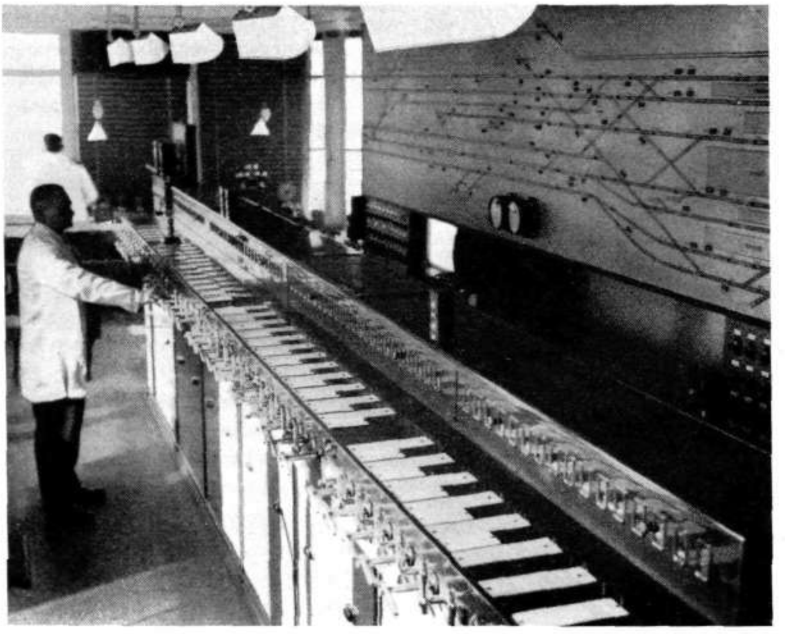


Fig. 9 X 5207
Interlocking apparatus and illuminated track diagram in Master Cabin

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.

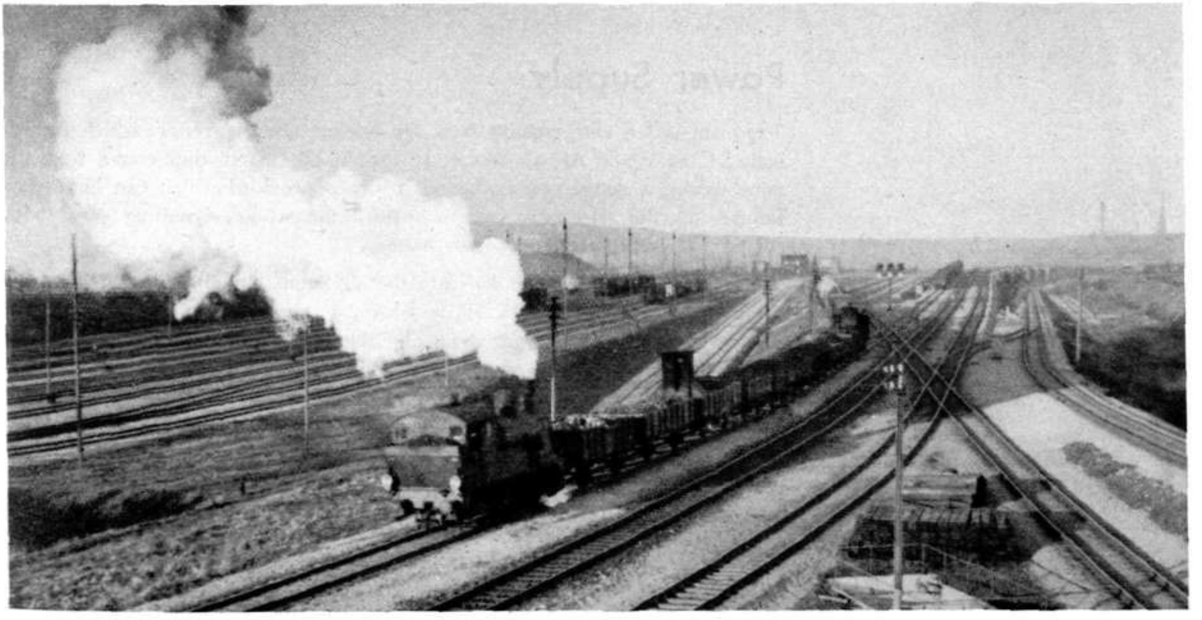
Fig. 9 shows the interlocking apparatus and the illuminated track diagram in Cabin V, the main cabin. Fig. 10 shows Cabin VI and Fig. 11 the view from Cabin I towards the main station. The illustration shows the double-track harbour line which runs under the main track at bridges.

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



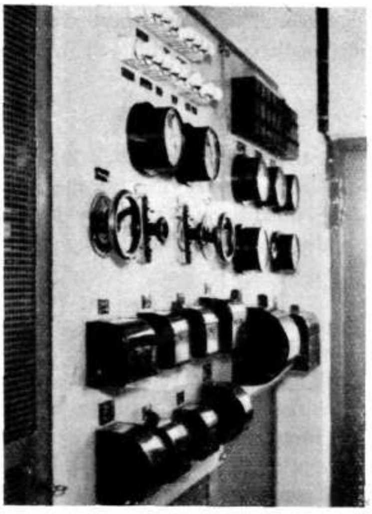


Fig. 12 X 3419
Instrument board in Cabin VI

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 3×220/3×110 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.

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.

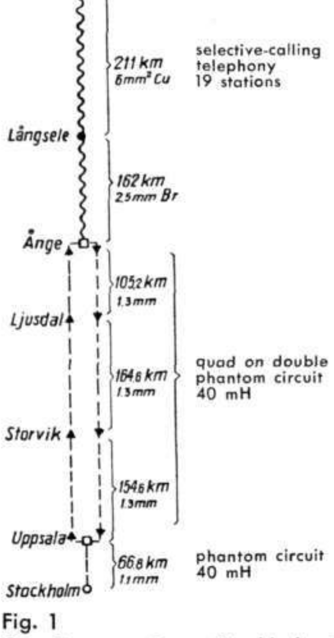


Fig. 1 X 3467

Circuit connections Stockholm—Luleå

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.

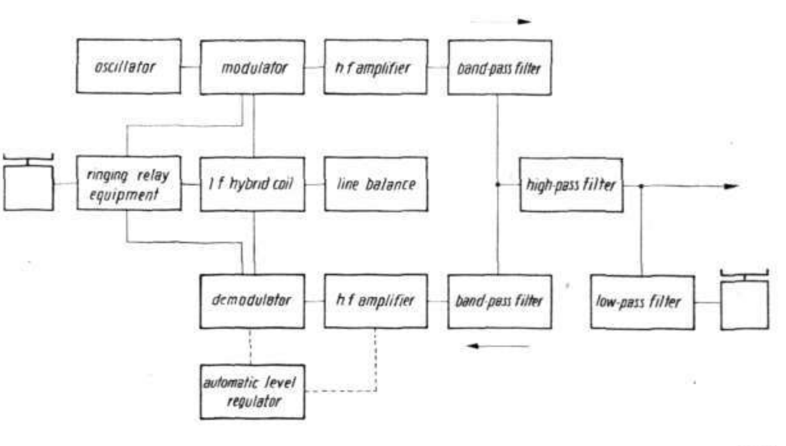


Fig. 2 X 5202
Diagram of terminal station equipment

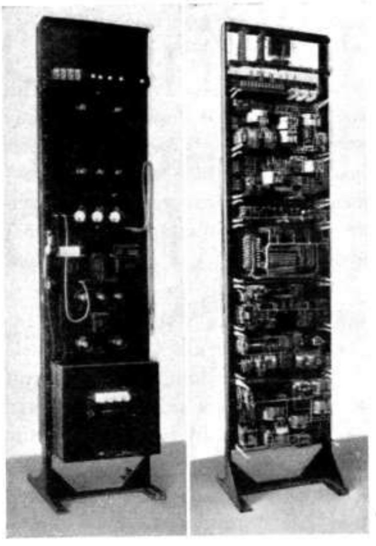


Fig. 3
Terminal station rack

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

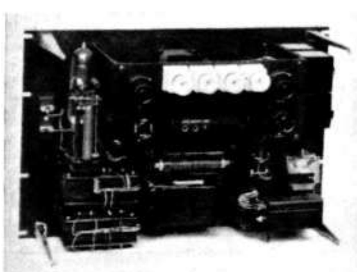


Fig. 4
Mains-supply panel

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

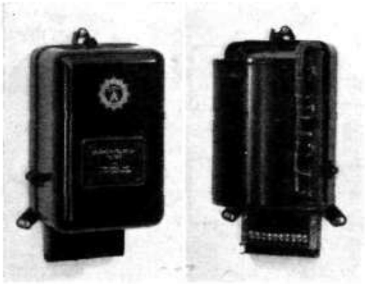


Fig. 5 X 3404
Selector filters

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.

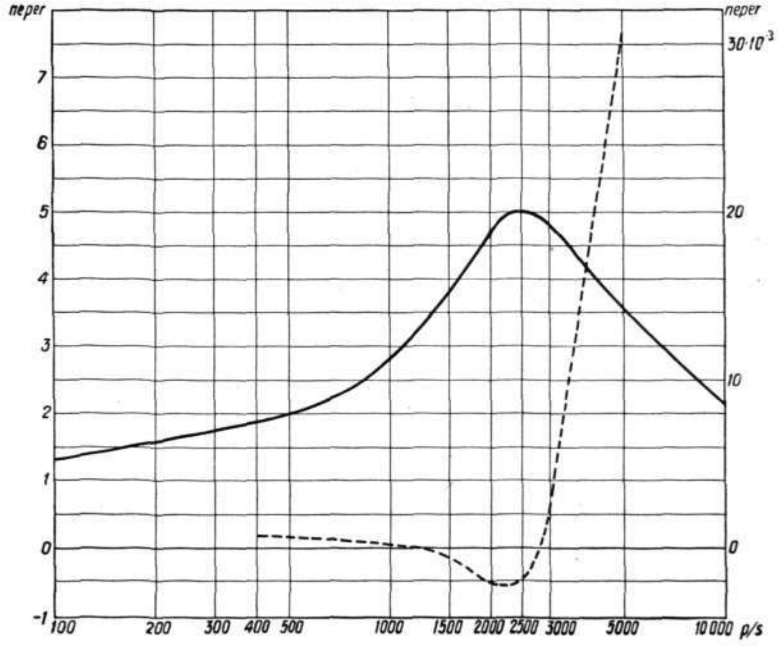
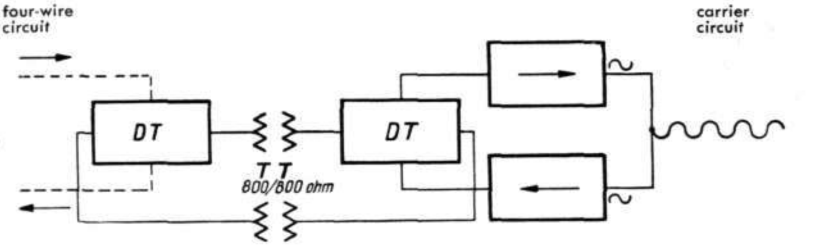


Fig. 6 X 5204
Attenuation curve for selector filters
———— overall attenuation
·········· branch attenuation



X 5203

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

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

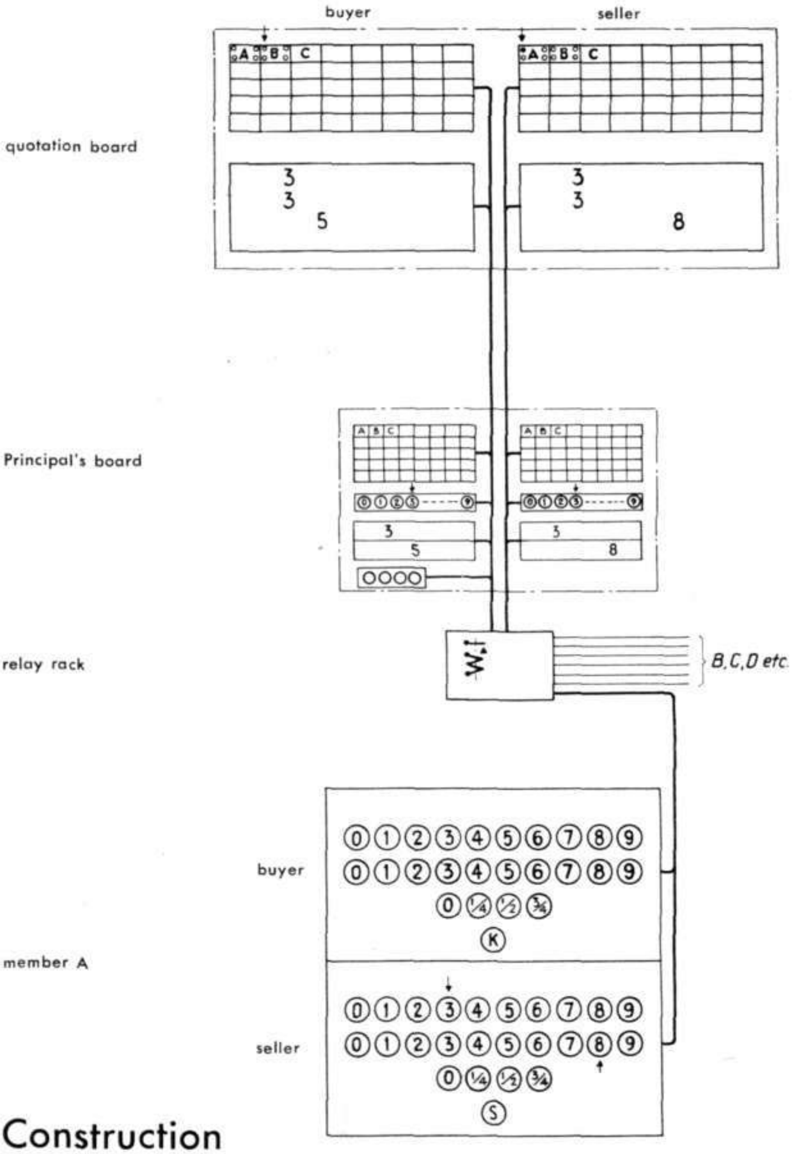


Fig 2 X 1464
Diagram of electric listing arrangement

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-

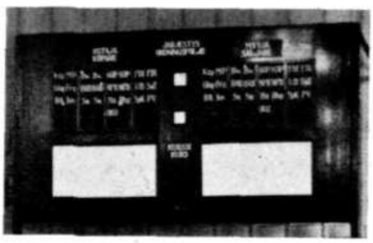


Fig. 3 X 3426
Main quotation board

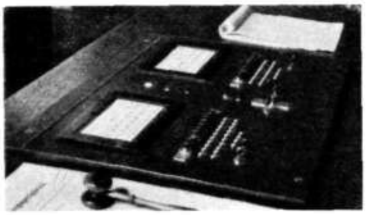


Fig. 4 X 3421
Principal's quotation board
with operating devices

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

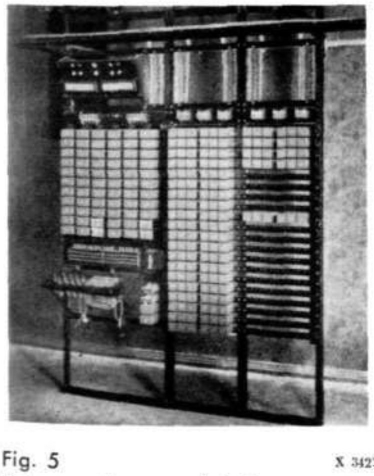


Fig. 5 X 3422
Relay exchange of listing arrangement

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.

X 3403

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

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.

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

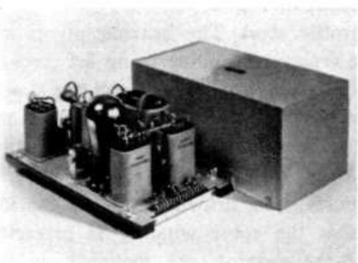


Fig. 3 X 3400
Amplifier with suppressor

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.

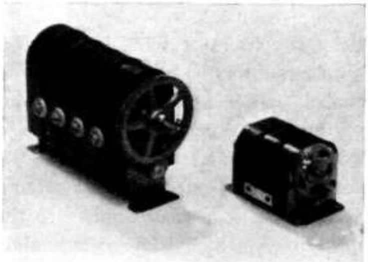


Fig. 1 X 3442
The new magneto
compared with magneto of older type

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 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.

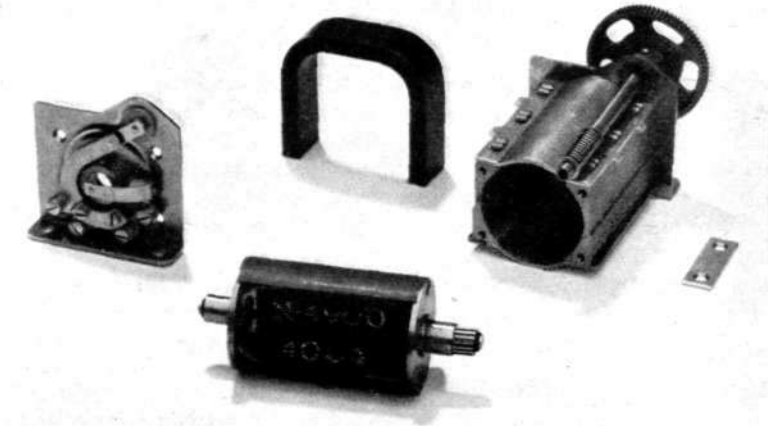


Fig. 2 X 5212
Magneto dismantled
left to right: spring set, rotor, a magnet and stator

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.

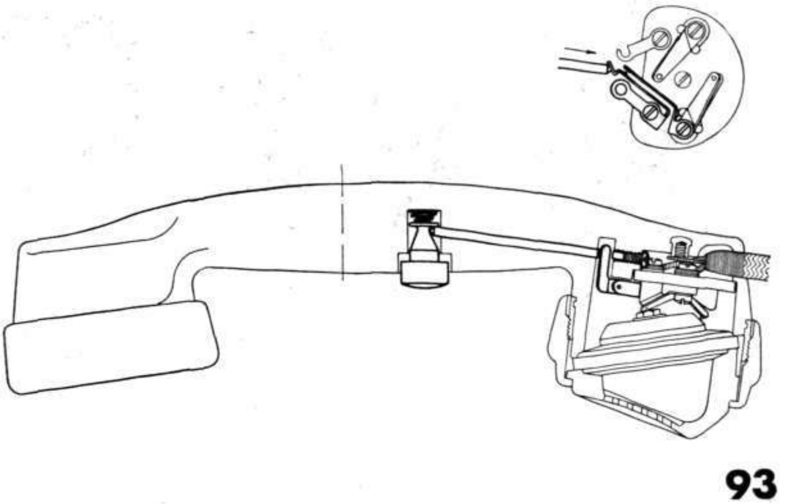


Fig. 1
Section of handset with key

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

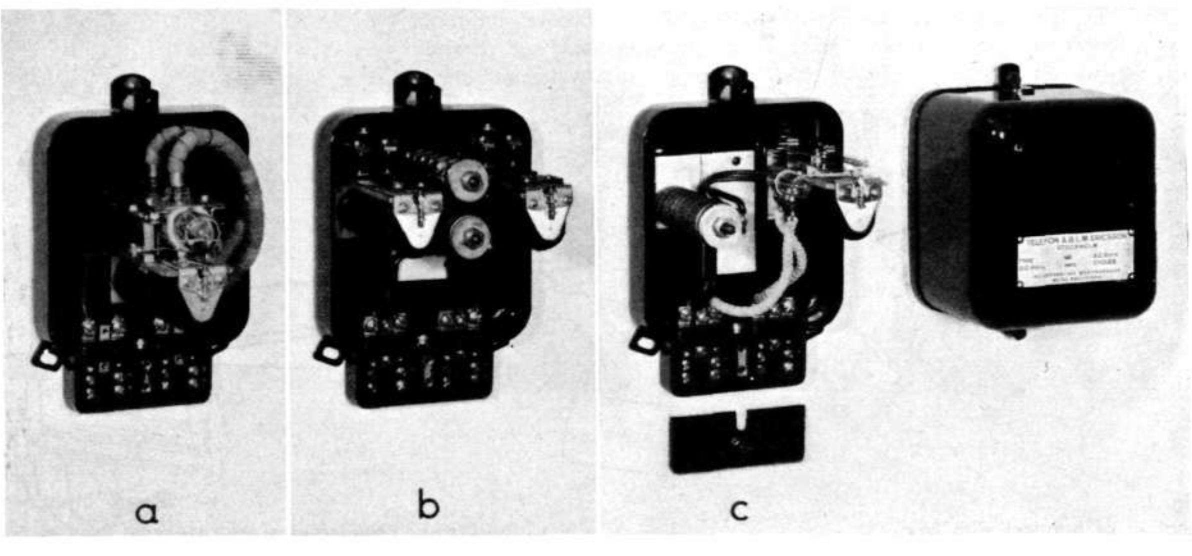


Fig. 1 X 7080

Operating relays of different types with

a mercury contact
b wolfram contact
c silver contact

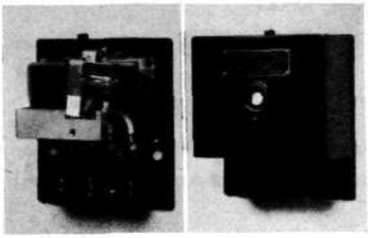


Fig. 2 X 3411
Operating relay with mercury contact and visual signalling

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.

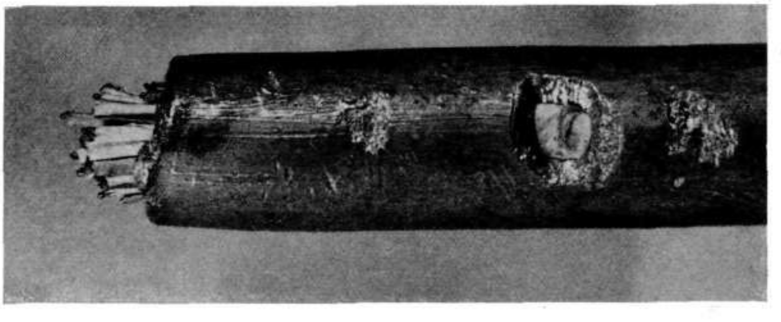


Fig. 1 X 5214
Cable attacked by insects

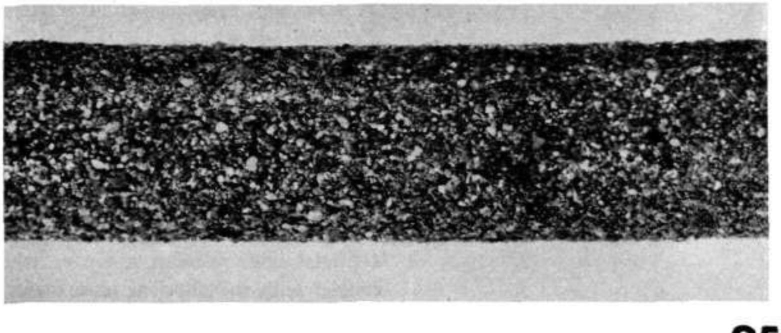


Fig. 2 X 5215
Sand-covered cable

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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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*
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Società Ericsson-Fatme	*Roma*, via Appia Nuova 572; C. P. 348
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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
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Sverige Telefonaktiebolaget L. M. Ericsson	*Stockholm*, Döbelnsgatan 18
Svenska Radioaktiebolaget	*Stockholm*, Alströmergatan 12
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Aktiebolaget Alpha	*Sundbyberg*
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Elektriska Aktiebolaget Skandia,	*Stockholm*, Tunnelgatan 14
L. M. Ericssons Försäljnings A. B.	*Stockholm*, Kungstensgatan 20
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Fastighetsaktiebolaget L. M. Ericsson	*Stockholm*, Kungsgatan 33

ASIA

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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

AMERICA

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Corp. Sudamericana de Teléfonos y Telégrafos 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

AUSTRALIA & OCEANIA

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Irish Free State E. C. Handcock	*Dublin*, Handcock House, Fleet Street
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Portugal Sociedade Herrmann Ltda	*Lisboa*, calçada do Lavra 6
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Ericsson House Telephone

G. GRÖNWALL, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

To meet the demand for telephone instruments suited for installations of a character requiring different and simpler designs than those employed in the larger and more comprehensive plants, Telefonaktiebolaget L. M. Ericsson has produced a new instrument which is described below under the name of »house telephone».

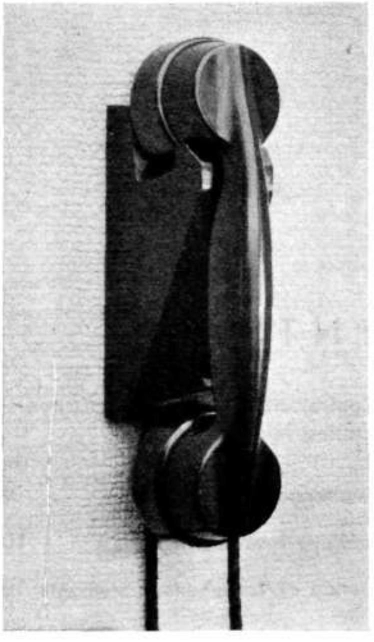


Fig. 1 X 3477
House telephone
in use as wall instrument

The instrument, which is made of bakelite throughout, is primarily intended as a wall-instrument, Fig. 1. At the same time it is so constructed that, by the addition of a metal base-plate fitted with rubber feet, together with a wall-fitting and cord, it can easily be converted into a table instrument, Fig. 2.

Construction

The main parts of the instrument consist of case, inset and handset. The case is cast in bakelite and shaped to form a stand for the handset. It should be particularly noted that the handset is very stable when at rest and that the back part of the case is of such a shape that it prevents the handset from touching the wall when lifted. The instrument is attached to the wall by two screws, easily accessible from the front. The inset fitted into the case consists of a plate of insulation material on which are fitted the switching device, the buzzer and terminals for connection of the circuit lines and the handset cord. The buzzer is of strong design giving good clear signals.

The press-button, located in a recess of the case at the back of the handset, has three positions, *viz:* normal position when the handset is at rest, speaking position when the handset is lifted and ringing position when the button is pressed right down to give a calling signal.

The handset is of Ericsson standard design, of bakelite with hygienic mouthpiece, and has interchangeable inset microphone and two-pole receiver with permanent magnet of high grade cobalt steel. The handset is connected to the instrument by a three-wire cord.

Fig. 2 X 5227
House telephone
in use as desk instrument

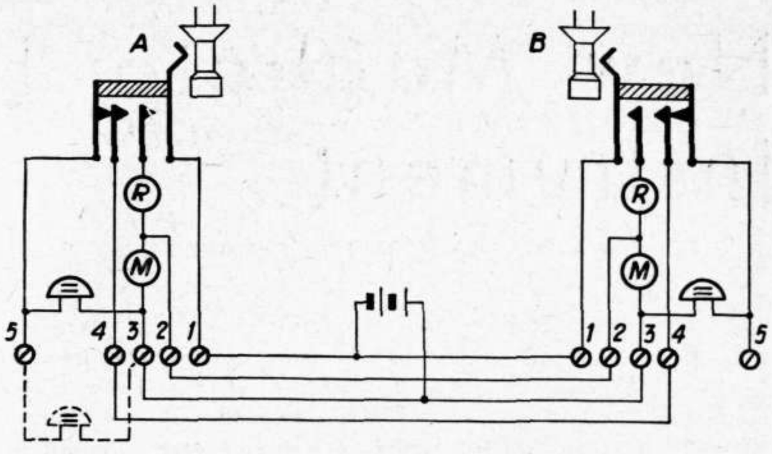


Fig. 3 X 5228
Diagram of house telephone installation
with two instruments

Connection

The most simple form of installation consists of two instruments joined up by a four-wire conductor, together with a battery, see diagram, Fig. 3. The press-buttons with their spring parts are shown in the position taken up when the handset is in place.

As will be seen the instruments are connected in parallel, while up to now it has been customary to connect this kind of installation in series. Connection in parallel presents several advantages, such as the fact that all the instruments are alike and connected to the line in a similar way, making the connection of three or more instruments a simple matter. The instruments, with their microphones and receivers in series, are connected in parallel to the battery. The connecting points between the receiver and the microphone are in addition joined by a third wire with the result that the receiver in the called instrument is connected in parallel with that of the calling instrument so that the two speech currents are about equally divided between the two. Unlike instruments connected in series, the Ericsson instrument contain high-resistance microphones and receivers, with resistances of 200 and 100 ohm respectively. An ordinary 4.5 V dry battery is used. In cases where it is necessary an extra bell may be connected as indicated in the diagram.

Should it be desired to add a third instrument, this is connected in parallel with the two others. Ringing up from one instrument to either of the other two may then be done by code signals. For installations comprising more than three instruments, special signal buttons should be employed, see Fig. 4, showing an installation of four instruments, each of which has a set of three press-buttons, which may be of the kind used for ordinary electric bell installations.

As will be seen from the foregoing it is possible by the use of simple units to build up a selective-calling installation. Ordinary bell-wire may be used for the circuits. The distance between two instruments may be as much as 400 m, if 0.6 mm wire is employed.

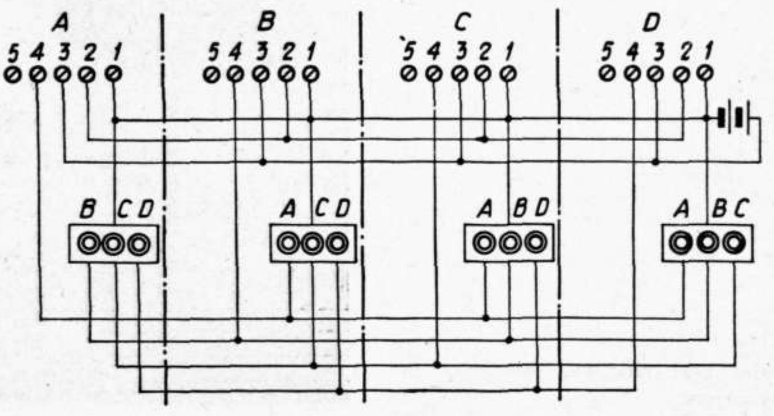


Fig. 4 X 5229
Diagram of house telephone installation
with four instruments

New Magneto Telephone Instrument

G. GRÖNWALL, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

The series of modern telephone instruments recently described in the Ericsson Review has received a further new addition in the form of a bakelite magneto table instrument. This instrument, probably the first of its kind, constitutes a marked advance in instruments of this description.

The introduction of synthetic resins has in recent years led to radical changes in the construction of telephone instruments; these have applied, however, almost exclusively to instruments for automatic and manual CB systems, while magneto instruments have continued to be made in their traditional form, with frame and outer casing composed of metal or wood.

The fact that the general development of magneto instruments has not progressed at the same pace as automatic instruments may be attributed to several cases, chief among these being the comparatively small market, the bulkiness of the magneto used, necessitating larger and more expensive cases than those required for automatic instruments, and, finally, the smaller attention generally given to the shape and outer appearance of magneto instruments. The material at present available has, however, now made it possible to produce a magneto instrument, Fig. 1, which is fully reliable in operation and perfectly adapted to its purpose, with the result that this category of instrument has sprung with a bound into the same class as the most up-to-date of automatic instruments.

The chief factor that has contributed to make possible the accommodation within the narrow limits allowed by a standard instrument, of all the parts necessary for a magneto instrument has been the new, small but exceedingly efficient hand magneto, described in Ericsson Review No 2, 1935. The inset of this new instrument, Fig. 2, consists of a base-plate fitted with magneto

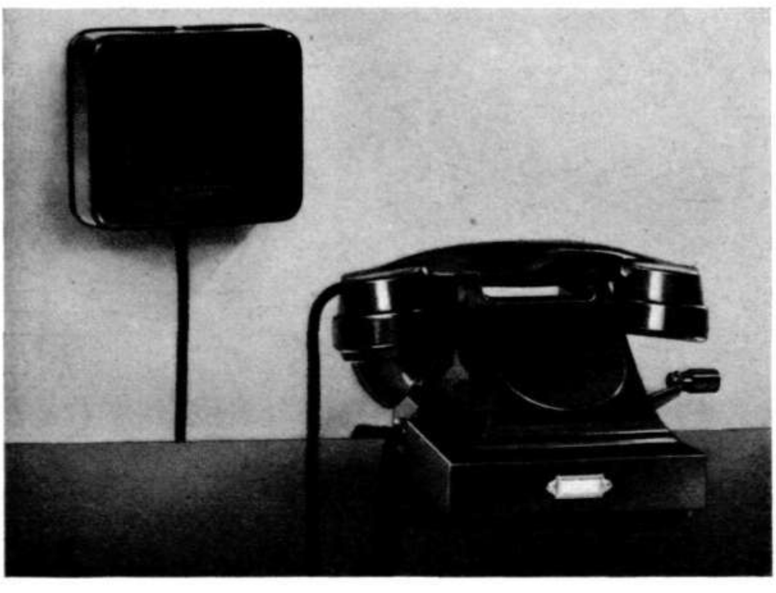


Fig. 1 X 5224
The new magneto telephone instrument

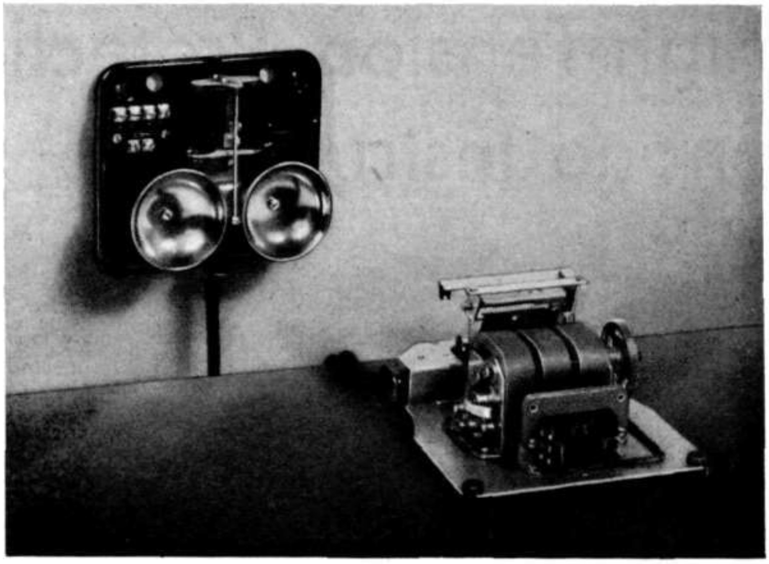


Fig. 2 X 5223
Inset and wall-fitting for magneto telephone

and induction coil switch and terminal. The induction coil and the terminal are of the same design as for automatic instruments. The inset is attached to the case by means of three screws.

A new and interesting feature is the location of the terminals on the underside of the base-plate. When the cover which shields the line-side of the terminal is removed, it is a simple matter to exchange the handset and the cord wall-fitting, without disturbing other parts of the instrument.

The polarised bell is standard type and is attached to a wall-fitting of black enamel, which latter also holds the terminal for connecting the line. Except for the magneto crank, the instrument differs in no way as regards appearance from an ordinary CB instrument. The instrument is anti-sidetone connected, see diagram, Fig. 3. On outgoing calls the bell is disconnected.

Fig. 3 X 3474
Diagram of magneto telephone instrument

The instrument is made in two forms, namely, Type AC 650, with two-magnet inductor, and Type AC 660, with three-magnet inductor. The microphone feed requires a 3 V battery, which can be conveniently made up of two dry cells in series fitted in a battery-case, *e. g.* Type RK 2 300.

High-Tension Protection of Telephone Instruments

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

Telephone instruments connected to circuits exposed to high tension from adjoining power lines require to be protected in a special way to prevent injury to users. This is particularly the case when the telephone lines are on the same poles as a high tension line.

Telefonaktiebolaget L. M. Ericsson has constructed a series of protective devices, designed to be combined together to suit local conditions in each case. By suitable selection of protective elements it is possible to obtain, practically speaking, any desired degree of safety.

There are three main ways in which tensions may be transferred to the telephone lines: by electromagnetic or electrostatic induction or by direct contact.

Tension due to electromagnetic induction arises from the telephone circuits being exposed to the magnetic field of the high tension lines and is proportional to the strength of current in the disturbing lines. These disturbances can be considerably reduced by *transposition* of the telephone conductors. The greatest possible symmetry between the various transposition spans should be aimed at. The shorter the intervals between transposition points, the greater the reduction obtained in the induced tension.

Disturbances due to electrostatic induction arise when the telephone circuits are actually located in the high tension field. If the distance between the wires is small in comparison with the distance between the disturbing conductor and that disturbed, then both wires become charged to the same tension. This tension is proportional to the tension of the power line. In order to neutralise this type of disturbance use is made of *drainage coils,* these being connected between the line branches. The centre of the coil is earthed, so that the discharge currents are conducted to earth and nullify each other's fields in the coil.

In the case of direct metallic contact arising between the power line and the telephone circuit there must be devices which immediately disconnect the instrument from the circuit. These devices should also come into operation when from other causes, lightning for example, there occurs overtension which might be dangerous for those using the telephone. These devices are mainly of two kinds: *arresters* and *fuses.* There are several kinds of both. In addition, for the purpose of insulating the instrument from the line, use is made of *insulating transformers,* with a high degree of insulation between the windings. To increase the factor of safety the transformers should be provided with an earthed shield between the windings.

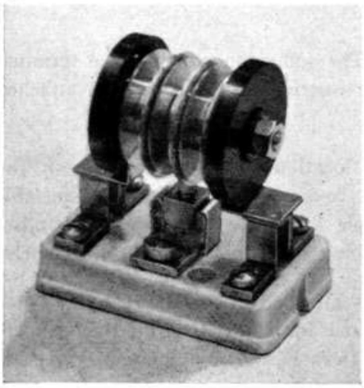


Fig. 1 X 3458
Lightning arrester, Type ND 10 070
for voltages above 700 V

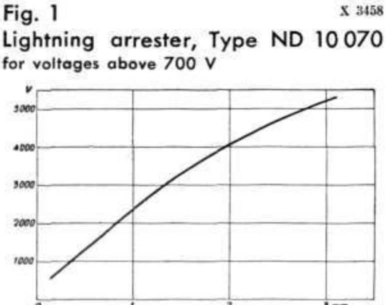


Fig. 2 X 3459
Lightning voltage as function of the mica-folium thickness in the lightning arrester

Lightning Arresters

Fig. 1 shows a lightning arrester, Type ND 10 070, for tensions above 700 V. It consists of three electrodes, one for each of the line branches and one for earth, insulated from each other by perforated mica folium. Connections are made by means of knife contacts. The electrodes are made with cheeks, thus ensuring good cooling. The knife contacts have large contact surfaces with a view to keeping down contact resistance between the knife and the spring; the connecting springs are mounted on a calite holder. The two spring halves for each knife are insulated one from the other; the circuit is connected on one side and the instrument on the other. Connection is obtained when the arrester is set in the holder. This device

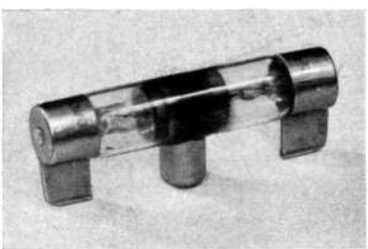


Fig. 3 X 3460
Rare-gas tube, Type NB 3 300
for voltages below 700 V

ensures that the arrester is really installed when the instrument is in operation. The curve of Fig. 2 shows the lightning voltage as a function of the thickness of the mica folium.

Fig. 3 shows another type of arrester, a rare-gas tube, Type NB 3 300. This tube is designed for tensions between 100 and 700 V. The electrodes are enclosed in a gas-filled tube. To prevent the tube being damaged by overloading, the electrodes are provided with bimetallic contacts which short-circuit the tube if the discharge current gets too high. The life of the tube is thus practically unlimited, while at the same time the short-circuiting is a guarantee that the fuses connected before the tube really function. The tubes are to be had both two-pole and three-pole and for various ranges of tension between 100 and 700 V. The tubes is connected to the same holder as the air-gap arrester described above.

Fuses

The types of fuses employed are two: Type NB 4 100, with an effective length of 180 mm, and type NB 4 020, with an effective length of 29 mm. The first type, the high tension fuse, has the fuse-wire embedded in asbestos powder and is made for currents of 5 and 2 A; it is used with a specially constructed switch. The second has free fuse-wire for currents of 0.5, 1, 2, 2.5, 3, 4 and 5 A.

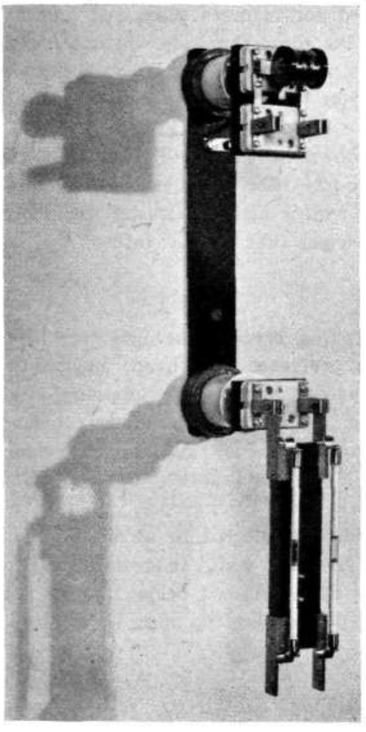


Fig. 4 X 3461
Disconnecting switch, Type ND 21 100
with fuses, Type NB 4100, mounted on the switch arm

Disconnecting Switch

In order to disconnect the line from the instrument when repairs, replacement of fuses, etc. are to be carried out a disconnecting switch should be included among the protective devices. If the maximum tension which can arise in the telephone line is low, for example ordinary lighting tension, an ordinary switch may be employed. For higher tensions, a switch with a considerable gap, Fig. 4, must be used. The disconnecting switch, Type ND 21 000, is mounted on two porcelain insulators fitted on an iron rail. The knives are fitted on an insulated plate on the back of which are the above-mentioned fuses. A lightning arrester of the type already described is placed between the line terminals. The total gap in open position is 260 mm. The disconnecting switch is actuated by means of a rod of insulating material, which engages a loop on the switch.

Fuse Strip

The holders used for air-gap and rare-gas arresters are so constructed that they can at the same time be employed as holders for fuses. This is carried out in the manner shown by Fig. 5. The springs intended for

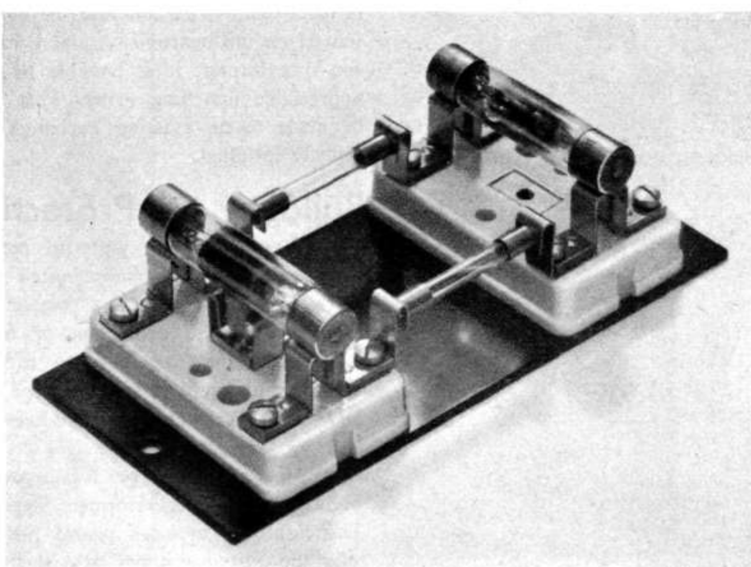


Fig. 5 X 5219
Fuse strip, Type ND 20 100
Left to right: three-pole rare-gas tube, fuses and two-pole rare-gas tube

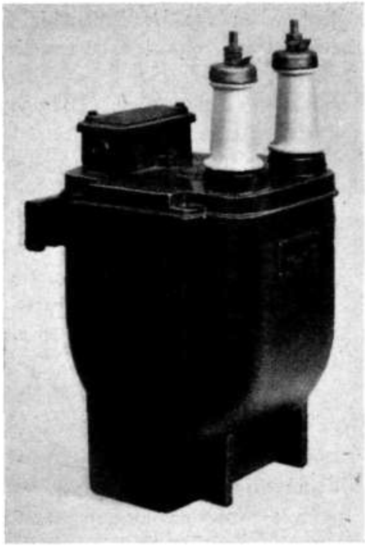


Fig. 6 X 3463
Drainage coil, large type

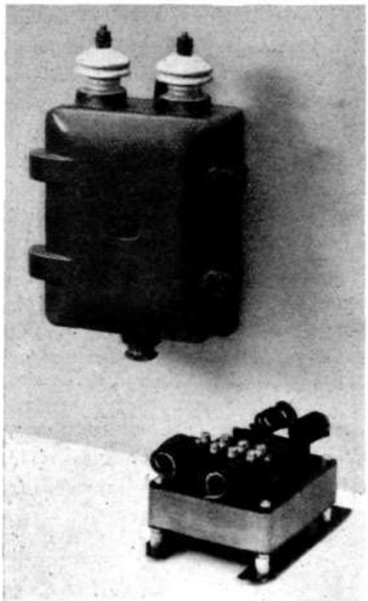


Fig. 7 X 3462
Insulating transformer, Type RM 800

fuses are of the same type as those used for rare-gas tubes and lightning arresters. These springs have a hole on the plane stop side which serves as a support for the fuse. By means of this arrangement the separate elements may be combined without jointing while at the same time mounting is the simplest possible.
In addition to the form of execution shown by Fig. 5, Type ND 20 100, with 1 three-pole and 1 two-pole rare-gas tube together with 2 fuses, there is also another, Type ND 20 300, with 1 air-gap arrester (with bed-plate), 1 three-pole and 1 two-pole rare-gas tube and 4 fuses.

Drainage Coil

As stated above, it is possible, by connecting between the line branches a coil with the middle point earthed, to overcome disturbance in the line due to static charges. As the charging currents then produce opposing fields in the two halves of the coil, this latter acts only as an ohmic resistance to the currents. On the other hand, for voice-frequency and ringing currents, the polarities of which are opposed on the two line branches, this coil offers a high impedance so that the attenuation is of no consequence.
The dimensions of the drainage coil must be selected in accordance with the discharge currents which have to be dealt with. In certain cases a transformer of the same construction as that described below may be adequate. In more serious cases a larger type, see Fig. 6, must be employed.

Insulating Transformer

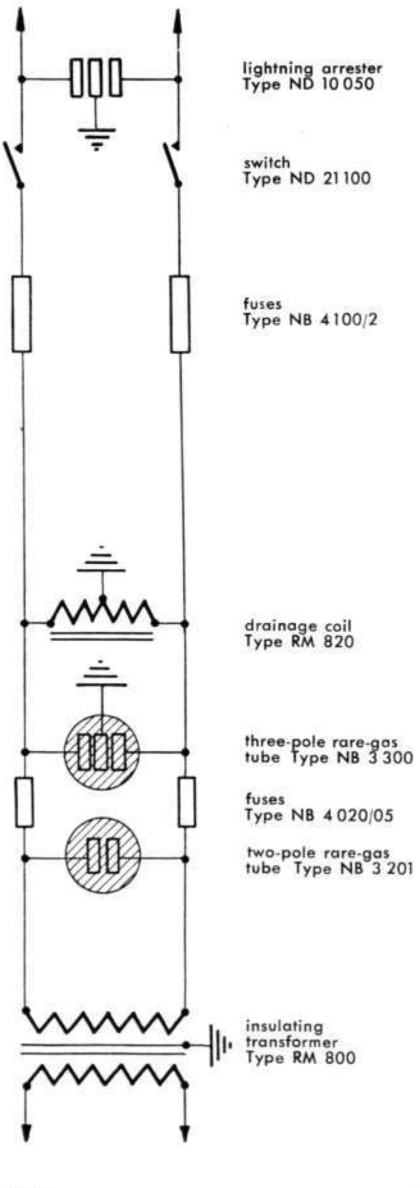
In order efficiently to prevent the static charge on the line from reaching the telephone instrument, an insulating transformer is connected between the line and the instrument. This should be furnished with the highest possible degree of insulation between the windings. Fig. 7 shows a transformer designed for this purpose. The transformer, Type RM 800, which is built in to a metal case, is of mantle type having a core of silicum-alloy dynamo sheet. The windings are placed in two recesses separated from each other on sheet bakelite supports. A shield is inserted between the two recesses and on connection this is earthed. Any leakage arising between the windings must of necessity pass over this shield. The leakage tension between the windings is about 20 000 V. Between the individual windings and the core the leakage tension is lower than this figure. The core is also earthed. In view of the fact that all leakage must first pass a part that is earthed (shield or core) the transformer constitutes a sure protection, even should there be a flash-over in the insulation. The protective devices connected before the transformer do not allow the passage of higher tensions than 110—150 V. The margin of safety is thus ample. Finally, the transformer is made with a tension ratio of 2 : 1. The above-mentioned tensions are thus halved on the instrument side. By the selection of a relatively low ratio for the transformer, it is possible to connect normal LB instruments without appreciable matching error. This is of importance when connection is to be made to an existing exchange or where the telephone instruments are already installed.

Building up Protective Equipments

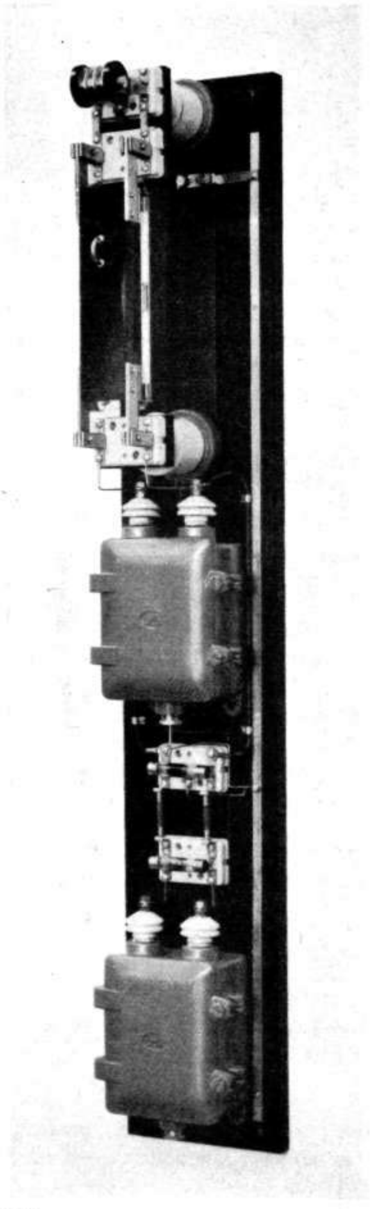
It is a simple matter with the protective elements described to build up a protective system specially suited to each individual case. As an example there is shown in Fig. 8 a complete protective equipment, Type ND 20 800, designed for the protection of telephone instruments connected to lines mounted on the same poles as a 25 000 V power line. Beginning from the line, it consists of a switch, Type ND 21 100, with air-gap arrester, Type ND 10 050, and high tension fuses, Type NB 4 100/2, drainage coil, Type RM 820, fuse strip, Type ND 20 100, with three-pole rare-gas tube, Type NB 3 300, fuses, Type NB 4 020/05, two-pole rare-gas tube, Type NB 3 201, insulating transformer, Type RM 800.
The lightning arrester placed nearest the line is intended to protect not only the instrument but also the neighbouring stretch of line from over-

tension. It remains connected to the line even when the switch is in »off» position. The fuses protect the drainage coil from overloading, should the discharge current for some reason become excessive. They should in addition disconnect the succeeding devices in the event of a tension in the range of 400—1 000 V getting past the lightning arresters; in that case the three-pole rare-gas tube would light up. Should the over-voltage continue, for example because of contact with the power line, then the rare-gas tube is connected to earth, by which the releasing of the fuses is ensured. The two-pole rare-gas tube, with a lighting tension of 110—170 V, is intended to equalise the tension differences between the line branches and, should this persist, to release the fuses in front of it. By locating these fuses in front of the transformer, the latter is protected from overloading, while at the same time overvoltages that might endanger the insulation are prevented from getting into the transformer. In spite of this, the transformer has been furnished with a high degree of insulation with a view to providing extra safety against injury to those telephoning.

The equipment here shown constitutes only one example of the building up of a protective equipment. The unit types described offer great possibilities of variation to suit different conditions of working. For very high tensions



X 3468



X 3464

Fig. 8
High-tension protection equipment, Type ND 20 800
for protection of telephone instruments connected to a line mounted on the same poles as a 25 000 V high tension line

still more protective elements may be added. When the tension on the power line is low, for example ordinary lighting tension, an ordinary two-pole commutator may be used as a switch, while the protective equipment may consist of a fuse strip, Type ND 20 100, along with a transformer, Type RM 800. The last-named might possibly be of simpler type with a lower degree of insulation. Should the line be of considerable length and there is risk of lightning discharge a lightning arrester should be included in the equipment. In this case the above-mentioned fuse strip, Type ND 20 300, is used with lightning arrester, a three-pole and a two-pole rare-gas tube, together with four fuses.

As the telephone lines leading to a protective equipment may come in contact with high tension, it is particularly important that these lines be erected in such a way that they are not liable to be touched. If it is not possible to place the protective equipments in the immediate vicinity of the wall bushing then the lines should be laid in cable with earthed sheath. These cables should be high-tension insulated. The connections between the protective equipment and the telephone instrument may be made with ordinary lead-sheathed indoor cable; as an extra precaution the sheath should be earthed.

The earthing of protective equipment should be carried out with the greatest possible care, as the functioning of the protection is based on the drainage to earth of the over-tensions. It is therefore very important that the earth connection and the earth plate are of ample dimensions, so that the earth resistance is as low as possible, while the earth connection follows the shortest line from the equipment to the earth plate. This last point is especially important in case of lightning. In other respects the work should be carried out in conformity with prescriptions applicable to protective earthing.

Construction of Telephone Lines

It goes without saying that telephone lines in the immediate vicinity of a power line require to be of special construction in certain respects, to meet the requirements imposed on them particularly as regards freedom from noise. It is therefore of the utmost importance that, even at the time the power line is being planned, account should be taken of the fact that one more telephone lines may eventually be placed on the same poles as the power lines. The great advantages a telephone line of this kind provides would as a rule counterbalance several times any extra cost such an arrangement involves.

The telephone lines should always be placed beneath the power line and so far below that, even at the greatest sag, a safe distance exists between the tension carrying conductors and the telephone wires.

As previously pointed out the wires should be transposed at regular intervals. The object of the transposition is to eliminate noise due to electromagnetic induction from the power lines. In each transposition span, tensions are induced which, on account of the transposition, become opposed and cancel each other out. Moreover, differences in static charges are levelled by means of the transposition, for the reason that the two circuits lie in tension fields of differing intensities. Complete balancing of the line in this respect is not as a rule feasible, on account of unavoidable differences in the width of the spans as well as the positions of the conductors in relation to each other. As a general rule it may be said that the closer the transposition points are one to another the greater is the freedom from noise obtained under difficult conditions of operation. In many instances it is necessary to have transposition at each pole. While this certainly involves increased expense for insulators, etc., it is counterbalanced by the greater freedom from noise, which will be of importance, if not at the beginning, at least when the network is extended at some future time.

A factor often contributing to noises, specially on old lines, is defective joints. These cause unbalance in the two wires whereupon the discharge currents become unequal, giving rise to equalising current through the transformer. This may in certain cases be so strong that conversation over the line is rendered impossible. All joints should consequently be carefully soldered.

Handling of Subscribers' Tickets and Accounts at the Stockholm Trunk Exchange

A. LIGNELL, FORMER DIRECTOR OF TELEPHONES, STOCKHOLM

In the Stockholm Trunk Exchange, the handling of subscribers' tickets and accounts has been rationalized to a very great extent. The methods used for the sorting of the tickets as well as the mechanisation of the booking operations has given, as is shown in the following article, very good results in accuracy as well as in efficiency.

Booking of Calls

In Stockholm the booking of calls is not centralised, subscribers' bookings being received either direct by the trunk operator (three operators sitting together, each ready to help another when necessary) or, in case of heavy traffic, by special record operators stationed close to the trunk operators. In the latter case the arrangements permit also of calls being booked by the trunk operators, which helps to equalise peaks in the bookings. Even for circuits where traffic is light a supplementary recordoperator may be employed to book calls from several or all the record circuits for 9 positions. Special stress is laid on the necessity for good teamwork by operators in handling the bookings.

Centralised booking, involving sorting and distribution of call-tickets by pneumatic tube to the operators, is not used for the following reasons:

1. the constantly increasing demand for reduction of delays on calls renders it necessary to avoid intermediaries as much as possible. Sorting and distribution of tickets takes time, especially in large exchanges;

2. with decentralised booking the subscribers come into direct contact with the operator on the route where the call is to be handled and are thus able to obtain information regarding delays and other traffic questions immediately and with more accuracy than is possible in the case of centralised booking, which latter requires very accurate service if it is to give reliable information;

3. questions concerning calls already booked, changing or cancelling of calls, etc. can be handled much more quickly and easily by the routing operator than by the intervention of a central booking staff;

4. the familiarity of operators with the regular traffic and callers on their circuits greatly facilitates the booking and setting up of the calls;

5. all doubtful or badly written information on call tickets can readily be cleared up, as the trunk operator can easily get in touch with the operator who received the call;

6. for international traffic it is of the greatest importance that the public should be in direct contact with the staff on the international positions who speak foreign languages;

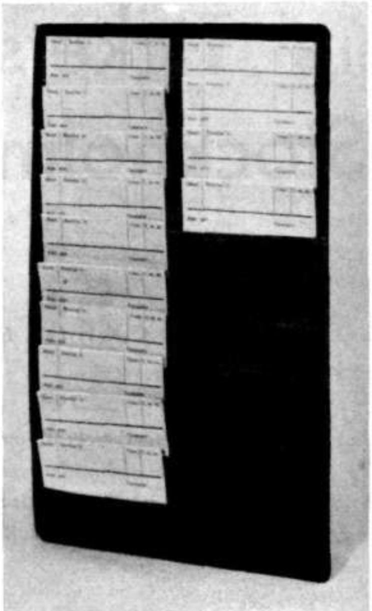


Fig. 1 X 3384
Ticket file

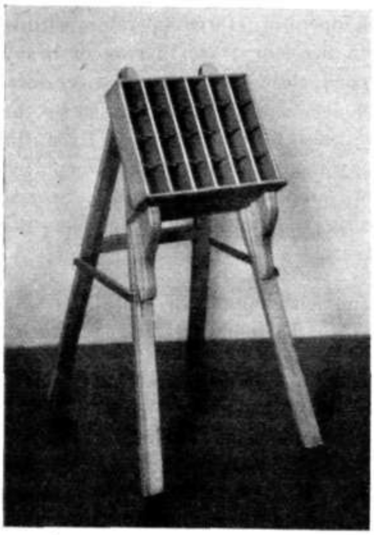


Fig. 2 X 3385
Sorting box
for sorting in ten thousands

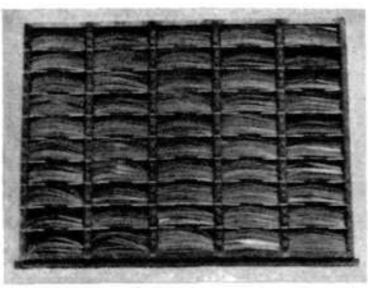


Fig. 3 X 3386
Sorting box
for sorting in hundreds

7. it is not necessary to burden the long-distance operators with the cumbersome apparatus required for the pneumatic tube service.

Subscribers in Stockholm requiring trunk calls are connected to the operators of the different routes through a position distributor. This distributor employs a staff of 9 operators during the busy hour (10—11 a. m.). The present volume of traffic in Stockholm is 6½ million outgoing trunk calls per annum. An experienced operator is capable of handling up to 450 connections in an hour.

On a manual exchange the call is put through by the A-operator who asks, on the order wire of an operator in the distributor, for the exchange desired. The distributor operator connects the subscriber with a record circuit of the corresponding route.

Subscribers with automatic instruments dial the number 9 thus calling a group selector which selects the first free operator in the distributor. When this operator answers »nine» the subscriber asks for the exchange desired, the operator repeats and says »please wait» and then connects the subscriber to a record circuit.

The position distributor serves also as a means of communication between the operators on the trunk exchange, *i. e.*, when calls have to be put through over two trunk lines.

Call-Tickets

The tickets are delivered in packets specified to contain of 100, the colours being different for day calls, morning and evening calls, night calls and other kinds of call. Use of the different colours has the advantage, among others, of facilitating the compiling of statistics. The tickets are distributed to the trunk operators by a special office, called the Ticket Office. On receipt of a call the particulars are written direct on the ticket which thus serves both for booking and for accounting. The call having been booked on the ticket, this is placed in a leather file having 20 pockets, Fig. 1, in the same order as the call is to be handled according to its class and the time of booking. By this arrangement an excellent survey of calls not dealt with can be obtained, not only by the operator but also by the supervisors. At the end of the call the charge is noted by the trunk operator

Once every hour the tickets of calls put through are collected by the staff of the Ticket Office which also sees to it that the stubs of the packets are received back. The tickets are immediately handed over to the statistical checking department which checks the charges and enters up the necessary statistical particulars. Afterwards the tickets go to the sorting department, to which deliveries are made three times daily.

Sorting of Tickets

The sorting department, which handles the tickets as they come from the statistical department, divides them first into the ten thousands for the numbers, into the name-calls and the provincial exchanges. The sorting boxes used for this purpose are shown in Fig. 2. Following this the numbers are sorted into hundreds, the divisions used for this being shown partly in Fig. 3. The name-calls are sorted direct into boxes provided for the purpose.

The preliminary sorting described above is shown in Fig. 4. About 1 200 tickets are dealt with per operator and hour during this operation. Finally the tickets are sorted into the individual numbers at the rate of 700 to 800 tickets per operator and hour. The boxes used are as shown in Fig. 5. These boxes each contain cards for from 800 to 2 000 subscribers according to the number of tickets per subscriber and per month. Subscribers' numbers are separated by index cards of fibre, with the two last figures of the number printed on the tab. The hundreds are separated by index cards of a different colour bearing the hundred number. The tickets are held in place by sliding blocks.

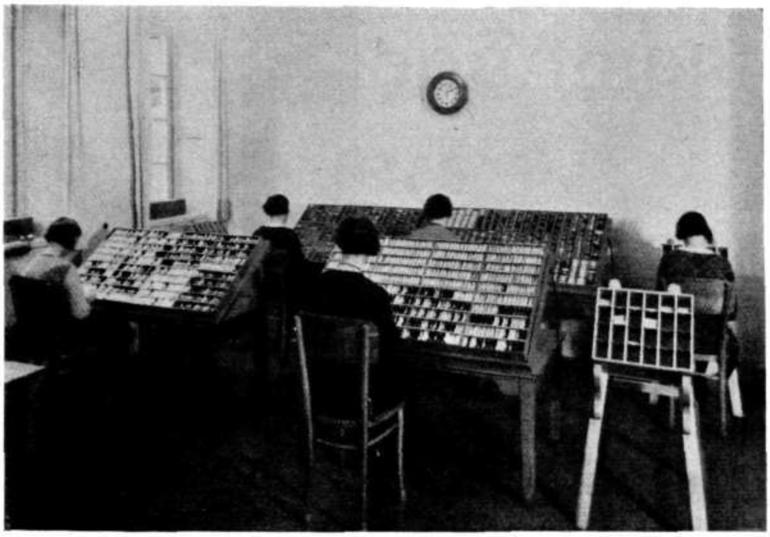


Fig. 4 X 5199
Preliminary sorting of tickets

Totalling the Call Charges and Accounting

The sorting of the tickets for one month is completed by the second day of the following month and then the totalling of the amounts on the tickets for entry in the books, as well as the totalling of the charges for each subscriber and the transfer of them to the charge notes, is immediately put in hand. The totalling and transfer is done by special motordriven calculating machines, which also are used for the accounting of subscription and telegram charges. The machines are shown in Fig. 6. They are fitted with three calculating mechanisms, *viz.:*

one for totalling the call charges of each subscriber,

one for totalling all call charges,

one for totalling the number of tickets.

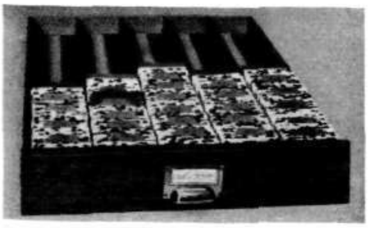


Fig. 5. X 3388
Sorting box
for final sorting into numbers

The debit journal and the bills to the right are set in the machine, Fig. 6. When the calls of a subscriber are entered in the journal the total of the charges to be debited to that subscriber is obtained, on the one hand in the journal and on the other transferred to the bill, which eliminates possibility of errors in making out the bills. Afterwards the subscriber's number is inscribed on the bill and repeated automatically in the journal.

To ensure the necessary check the call-tickets are counted, simultaneously with the above described operations, by other machines which enter them in a checking journal without bill printing. At each hundredth telephone number the total amounts in both journals are carried forward, which makes it easy to localise and put right discrepancies between the two journals.

Fig. 6 X 3387
Calculating machine
in foreground ticket tray

The total of taxed call tickets indicated by the machines is added to the number of service calls and the spoiled tickets, and the result should correspond with the number of tickets issued by the Ticket Office. During 1934 the number of tickets so accounted for exceeded by 110 the number entered as distributed. The difference was due to the fact that the packets do not always contain exactly a hundred tickets. The discrepancy is, however, practically of no importance and to number the cards distributed in order to fix the precise quantity would cost more than it is worth from the point of view of checking. At the daily operating control of the trunk circuits a check is always made that the call charges on the trunk-line observation schedule are noted on tickets and it is further ascertained that these charges are duly printed in the debit journal.

Fig. 7 X 5196

Sorting room

On the desk, to the left, is ticket box from which tickets are transferred to the metal tray beside the calculating machine; to the right, fire-proof metal cabinets in which the tickets are kept

The calculating machines are mounted on tables fitted with a metal trough as shown in the figure below. During counting the tickets are transferred to this trough from the box seen on the table in Fig. 5. The bundles of tickets are held together by a clamp which is released by a foot pedal. The turning over of the tickets is carried out by the left thumb, while the right hand is used to operate the machine. The bills, prepared in advance by the stencil department with the numbers, names and addresses of the subscribers, are placed subscriber after subscriber in the bill pocket of the machine.

Bills are not sent to the subscribers unless the total amount is at least Sw. Kr. 10: —, and for that reason the sorting staff keeps special cash journals for each month. The call-tickets are mailed to subscribers along with the bills. The totalling of the tickets and the making out of the bills for one month are usually completed about the 16th of the month following.

In view of the fact that during part of the month tickets representing charges appreciably superior to one million Swedish crowns require to be stored, it has been considered necessary that the place where they are kept shall be fully protected against fire. For this reason, the sorting boxes are stored in wooden cases, containing each 20 boxes, which are in turn locked into metal cabinets.

Efficiency and Costs

In 1934 the number of tickets dealt with was 7 139 349, of which 6 468 930 were call-tickets and 670 419 telegram tickets. In that year the average number of tickets totalled per hour and machine operator was 1 106, with 144 bills made out at the same time.

As will be seen from the above, the sorting department not only sorts the tickets according to the subscribers' numbers and makes out the bills, but also performs a considerable amount of bookkeeping and checking. During 1934 the staff of this department, including two supervisors, consisted on the average each month of 33, of whom 24 were constantly in service. The cost of the work, including the salaries of the supervisors, amounted to Sw. Kr. 0:013 per call-ticket.

Ericsson's Testing Department for Electricity Meters

A. GARTNÄS, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

After careful consideration and the evolving of new methods in certain instances, Telefonaktiebolaget L. M. Ericsson has opened a testing department for electricity meters, which is equipped with the most up-to-date appliances, ensuring that every meter dealt with may be relied upon for high and uniform accuracy and safety in operation.

A testing plant for meters must be free from dust, vibration and disturbing noise. In addition it must be equipped with measuring instruments of the highest class, continually kept properly adjusted and carefully tended. The measuring instruments employed for the work must be capable of speedy checking immediately there is the least suspicion of any change in the errors noted in them. The testing boards must be provided with regulating devices of the highest class, and easy to operate when readings are taken at the same time on the instruments.

In order to reduce to a minimum the effect of dust, the new testing department, Fig. 1, of Telefonaktiebolaget L. M. Ericsson has been located as high as possible in the building, on the fifth floor, thus avoiding to a great extent all dust from the street. The floor is covered with linoleum which is thoroughly washed every day. All wiring is as far as possible internal to that the testing boards, the walls and the ceiling present no collecting places for dust; the boards are as a rule dusted down several times every day. The walls and ceiling are of concrete, finished with a special easily washable paint.

In addition the testing room must be free from external noises so that any unusual hum or the like in the meters can be detected and eliminated; the machine room has therefore been separated from the testing room by double walls with a 600 mm space between. To prevent vibration from the machines being transmitted to the testing room and other rooms in the vicinity, cork lining has been put between the concrete floor and the machine bed-plates which latter are also of concrete. This also makes for quieter running of the machines. In addition the larger machine units are mounted on vibration absorbers to prevent vibration affecting the building.

Fig. 1 X 3486
Ericsson's testing department for electricity meters
Right, testing board for single-phase meters; in background, testing board for DC meters and instrument board

Checking Instruments

An electricity meter, even though regulated with the greatest care and in accordance with all prescriptions, will display certain errors if the adjustment is made with instruments which themselves give incorrect figures. To eliminate this source of error the testing department has been provided with a set of checking instruments, placed in an oak case with locked glass-lid; these instruments may only be used by authorised persons. The instruments rest on a rubber sponge bed in the case. To prevent the instruments being affected by vibration from the street and the like, the oak case is set on a concrete base, separated from the frame of the building by cork sheets; to begin with a cork sheet is placed on the concrete floor, then a concrete slab is cast over the cork, after which another cork sheet is laid, an so on. After the instruments have once been put in their

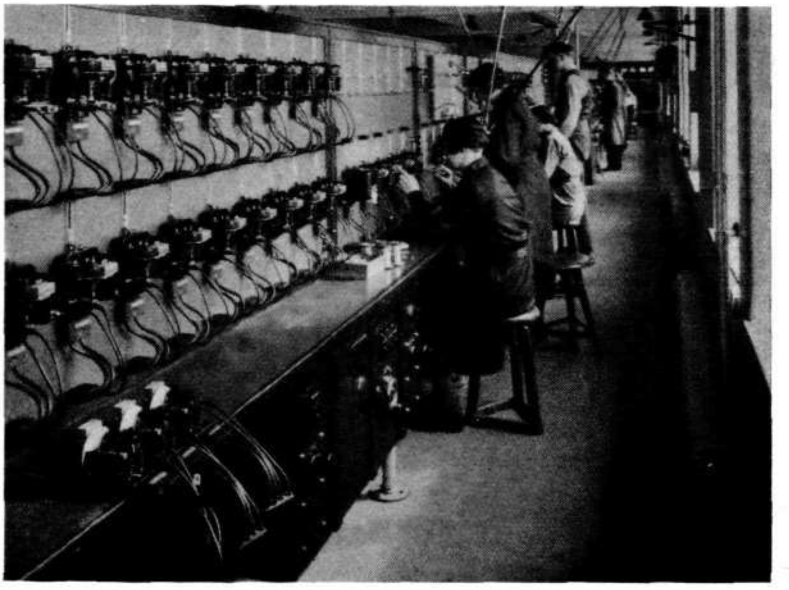


Fig. 2 X 5234
Testing board for single-phase meters
The meters are fixed to the board and connected up by a simple operation

place in the case and checked by compensator, so that the errors are known, they may not be moved any more; once or twice a year they are checked without being moved.

Like the checking instruments the working instruments are well protected from outside influences and set in cases with glass-lids so that it is easy to lock them up. Immediately an instrument is suspected of alteration it is compared with the standard instruments and adjusted if necessary.

Testing Boards

The meters are adjusted at testing boards of entirely new type, Fig. 2. Previously testing boards were so arranged that each meter was adjusted by the same adjuster from beginning to end. With the adjustment method now employed by Ericsson the adjustment work is divided into a number of subsidiary operations which are afterwards combined in one main operation; one operator is responsible for each main operation. The adjustment of single-phase meters, for example, is divided up into five main operations. For each main operation there is a testing position, specially equipped for the nature of the operation. These are so arranged that there is place for a team of operators at each side of the boards. Each board is fitted at one end with a distribution panel to which is connected the current supply. Two three-phase cables branch off from the distribution panel, one to either side of the board. By means of plugs these cables may be connected with any desired generator. From these feeding cables the current is led to the various testing positions, where it is transformed by two regulating transformers one for the voltage circuit and one for the current circuit. By means of the regulating transformer in the voltage circuit the voltage may be constantly varied between 1 and 600 V. In the same way the intensity of current may by means of its regulating transformer be constantly varied between 0 and 150 A at 0—3 V. There are no instruments on the boards. The meters are adjusted by being compared with other standard meters, which are carefully adjusted at boards specially equipped for this purpose.

The current and the tension are regulated by means of the regulating transformers and checked by a set of instruments, volt-, ampère- and wattmeters, set in a portable instrument car. The current coils of the different meters

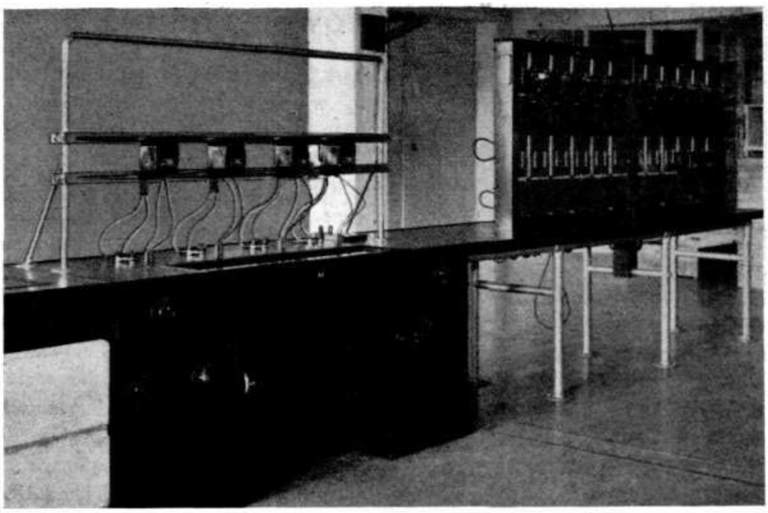


Fig. 3 X 5233
Control board
Left, checking instruments; right, control board for meter testing

are series connected and the tension coils lie parallel to the same tension during testing. This ensures that the standard meter and the meter to be tested receive the same load.

To enable the meters to be connected and disconnected rapidly and easily the testing positions are provided with a number of contact sockets. The current and tension to be fed to the meters via the regulating transformers are taken out by means of plugs. As these plugs are combined as units the meters may be connected and disconnected in one operation, see Fig. 2.

The meters are fixed in place at three points, by a suspension device above and by two moveable clamps below. The moveable clamps run horizonatally in a brass rail; the suspension device is also moveable in a brass rail, but vertically. This enables meters of various sizes to be fixed on the boards. The boards consist of an underframe of steel tubing with wood fittings holding wooden panels covered with green linoleum. On two of these wooden panels which are hinged the wiring for current and tension are mounted. This arrangements produces a very compact construction with all the current-carrying parts built in, though easily accessible, resulting in a clean surface easy to keep free from dust.

When the adjustment of the meters is completed, they are subjected to insulation test with three-phase AC 2 000 V, 50 c/s, in a specially designed test appliance, provided with control lamps which indicate whether primary tension is being delivered to the 190/2 000 V transformer and whether there is tension on the secondary side of the transformer. Flash-overs are localised by the lamps. On testing the meters are put in a glass cage, the door of which on opening breaks the primary tension of the transformer. The staff are in this way effectively protected against coming in contact with high tension.

When the meters have been adjusted and tested, the case is replaced. From each lot of meters finished, a certain number is picked out and taken to a special control board, Fig. 3, for final tests.

For other type of meters, three-phase meters, DC meters, special meters, etc. there are special boards constructed on the same principle but with regulating organs and other equipment suited for the purposes required, see Fig. 4.

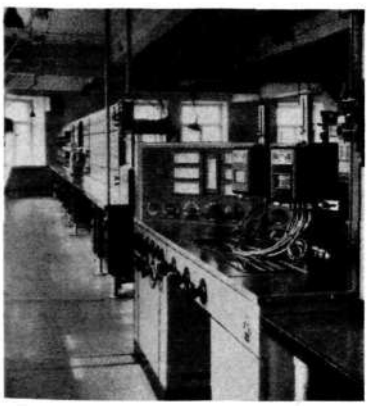


Fig. 4 X 3483
Testing board for three-phase meters

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Fig. 5 X 3484
Machine room

Power Plant

The testing boards must be fed with both AC and DC, the tensions of which should be as constant as possible while allowing of variation over a wide range if required. Further the frequency and phase-shift of the AC should be capable of regulation according to needs; current and voltage should moreover be sinusoïdal. Finally it should be possible to obtain very high currents at low tension.

To comply with the above requirements the machine room, Fig. 5, is equipped with converters, a main converter together with a number of subsidiary converters. The main converter is fed with 3×190 V AC, 50 c/s, which is converted into 440 V DC. With the aid of a valve regulator the tension is kept constant so that the variation does not exceed $\pm 50\,^0/_{00}$. Thus the variations of tension are so small that they can hardly be detected by a 440 V voltmeter. The high figure of 440 V has been selected in order to eliminate undesirable tension variations in the contacts between the brushes and the collectors, etc. The subsidiary converters are fed from the DC mains. These converters consist partly of a series of small converters all alike which convert 440 V DC into AC of the desired frequency, 15—65 c/s, and required voltage, 0—220 V, and partly of larger DC converters which convert 440 V to DC 0—20 V. These converters consist of a motor and two generators, identically the same and mounted on the same shaft. Each generator can deliver voltages ranging from 0 to 10 V. By coupling these two generators in series or in parallel the voltage can thus be varied from 0 to 20 V and 0 to 10 V respectively, and current between 0 and 750 or 0 and 1 500 A taken out.

By thus making use of a number of small DC-AC converters for feeding the testing boards instead of a single large converter, it is possible for meters of different frequencies to undergo adjustment at one and the same time. Moreover the plant is more independent of stoppages in operation, for instance, on repair and inspection. Certainly a large converter works more smoothly than a small one, but this is of less account when the converter is fed with a constant voltage and the load to a great extent is also constant.

As already mentioned, a double wall has been built between the machine room and the insulation room. The wall in the testing room is used as an instrument board with several sections, Fig. 6, one section for each set of machines with, in addition, a section for incoming and outgoing mains. The instrument boards are of sheet metal set in an iron frame. The wall to the machine room is divided up into doors, one for each section of the board. The space between the two walls is partly filled up with the central rheostats mounted at the back of the instrument board. This arrangement ensures that the fittings are easy of inspection and yet free from dust and interference, and at the same time good noise insulation is obtained.

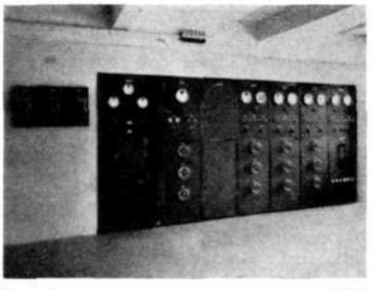


Fig. 6 X 3485
Instrument board

The cables from the machine room to the testing room are laid loose on he floor by the wall and protected by a wooden casing. From here the branch cables are taken to the various testing boards. These branch cables are sunk in the floor and protected by covers so that they do not interfere with movement. The cables then go direct from the floor through the legs of the tables, which are made of 2″ tubing. This arrangement is particularly simple and cheap, while at the same time the cables are well protected.

The Problem of Noise Elimination and Condenser Eliminators

G. A. KOHRTZ, AKTIEBOLAGET ALPHA, SUNDBYBERG

Noises in the form of crackling, buzzing, howling, clicking, etc. in a wireless receiving set may wholly take away all the pleasure of listening in. The causes of these noises are of many kinds, i. e. atmospherics, defects in the receiver, badly fitted aerial or earth, interference from unwanted wireless broadcasting stations, inconsiderate operation of neighbouring receivers, or noise from machinery or apparatus in the vicinity.

Of the sources of noice detailed above the last named without a doubt constitutes the greatest and is at the same time the one which produces the most persistent and annoying noises in wireless receivers. The present article is therefore confined to methods for reducing noises of this nature.

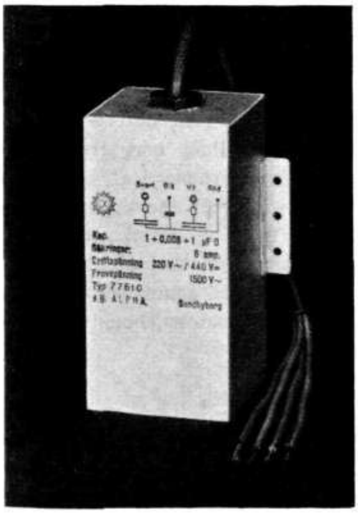


Fig. 1 X 3450
Condenser noise eliminator
fitted in metal case

Fig. 2 X 3467
Condenser noise eliminators
fitted in pertinax tubes

To understand the methods of eliminating noise and of dealing with the problem of reducing noise from electrical machinery and apparatus, it is necessary to have a clear idea of the manner in which the noises arise. In the majority of cases it may be said that noise waves are produced in every instance where an electric spark is formed. Every electrical machine or apparatus which in operation produces sparking sends out noise waves. The noise waves are of the same nature as the wireless waves, by which are meant the modulated carrier waves sent out by a wireless transmitting station. The waves sent out by a source of disturbance differ however from the wireless waves in that, in the majority of cases, they cover the complete wave spectrum, *i. e.*, consist of a whole series of waves of widely differing lengths. For this reason the intensity of the noise is in many cases the same on all wave-lengths. To this, as to most other things, there are naturally exceptions. Certain apparatus, for example, cause more noise on long waves, while others on the other hand are more noticeable on short waves. It is only in rare instances that a certain noise is apparent only within a small well-defined range of wave-lengths.

It is obvious that the intensity of a noise is governed by the sending capacity of the station tuned in to and the distance from same, *i. e.*, the strength of the station's field at the place in question. A level of noise, which takes away all the pleasure of listening in to a distant station, has in many cases no effect on the reception from the local station. The most common sources of disturbing noise are: electric motors and generators (of these, motors cause more noise than generators and universal motors are without doubt the worst propagators of noise in this group), electric switches of various kinds, high-frequency apparatus, electric signs, electric trams and railways, mercury rectifiers and lifts.

The waves from a source of noise flow out in all directions from it and are propagated especially along the circuit network to which the source of noise is connected. Moreover this network acts as aerial for the noise waves and broadcasts the noises over a wide area. This area has been given the name of noise zone, and it goes without saying that receivers situated in the zone are more or less exposed to the noises in question.

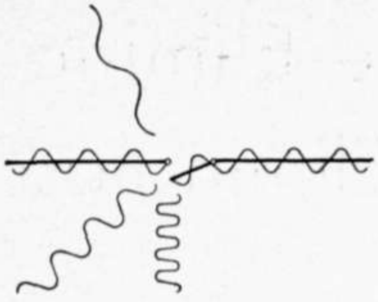


Fig. 3 X 3446
Breaking contact without noise elimination

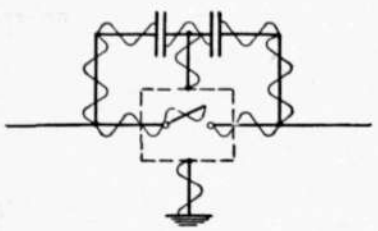


Fig. 4 X 3447
Breaking contact with condenser noise eliminator

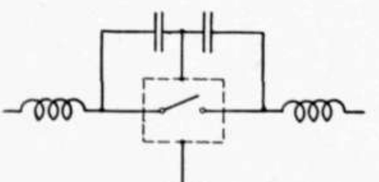


Fig. 5 X 3484
Breaking contact with condenser noise eliminator and chokes

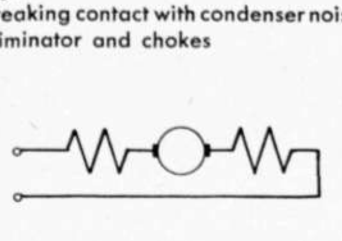


Fig. 6 X 3449
Above, electrical machine symmetrically connected and, below, unsymmetrically connected

The means employed to eliminate such noises are *condensers, chokes* and *filters* which last constitute a combination of condensers and coils. Of the three means, the first in most cases produces such good results that the others need not come into question. For this reason, A.B. Alpha has confined its manufacture to condenser noise eliminators.

To make it clear how a condenser eliminator functions, a simple case will be described below, *viz,* noise from a breaking contact. The breaking contact shown in Fig. 3 is not provided with noise elimination and the noise waves are thus able to spread along the circuit, as shown in the diagram on the figure. If, however, a double condenser is connected across the breaking contact according to Fig. 4, then the noise waves are short-circuited over the condenser. The double condenser, the mid-point of which is earthed, offers a much lower resistance to the high-frequency noise waves than does the circuit network. In aggravated cases it may be that, in spite of the condenser eliminator, the noises spread along the network. To eliminate these, chokes must be employed. The connection of the chokes is made in general according to Fig. 5.

How Are Noise Waves Eliminated?

This question will be treated only briefly, seeing that the great majority are still lacking in experience in connecting noise eliminators. Where there is noise from an electrical machine or apparatus, before noise elimination is decided on the equipment should be overhauled to make sure that it is satisfactory from the electrical point of wiev. Thus all loose contacts must be tightened, burnt contacts, polished or replaced, collectors and slip-rings cleaned and, if untrue or grooved, re-turned, the brush bearings adjusted for sparkless running, and the brushes so adjusted that they have the proper pressure and run easily in the holders, etc. The defects cited are the most usual met with, but there are others also which may give rise to noise, incorrectly wound armateurs, for instance. Symmetrical adjustment of windings and coils, the repartition of the wiring of the apparatus and the machine symmetrically in relation to the sparking point, see Fig. 6, is of great utility. It should perhaps be pointed out that short-circuited motors do not cause noise. Only after the electrical equipment has been put in the very best working order that noise eliminators should be fitted to do away with any noise still existing.

In practice it has been observed that a thorough overhauling of an electrical installation often results in almost complete disappearance of noises. For instance, it can be stated that large-sized generators usually cause little noise, and this is doubtless because of the care exercised in maintaining them in good order.

If, however, it becomes necessary to provide noise eliminators, then condensers as eliminators are to be recommended, as these give the best results at moderate cost.

Condenser Noise Eliminators

The condenser noise eliminators placed on the market by A.B. Alpha are of two types: large, enclosed in metal cases, Fig. 1; and small, in pertinax tubes, Fig. 2. The eliminator in metal case consists of two condensers, 0.1, 1 or 4 μF, in series, with earth terminal, Series 77 700. Series 77 600 differs from the foregoing in that an extra terminal is provided for elimination capacity over 0.005 μF. Moreover in each branch there is fitted a fuse, which is not replaceable, for 2 or 6 A according to the size of the eliminator. All these noise eliminators are embedded in compound in the

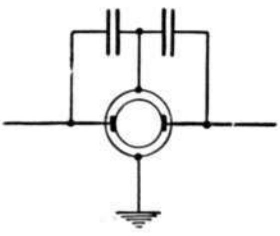


Fig. 7 X 3451
Connection of eliminator for earthed electrical machine

metal case and provided with tight-fitting lids, so that they are suitable for damp places as well as dry. The connecting flex consists of a rubber cable 350 mm long with 3 or 4 wires.

The noise eliminators in pertinax tubes consist of one or more minor capacities connected together and embedded in compound in a pertinax tube, which is closed by bakelite covers at both ends. In two cases there is an ohmic resistance inserted in addition to the condenser. There is no safety fuse, as these noise eliminators are designed to be connected for group-fuse protection. The connecting cables ar 100 mm long and covered with systoflex tubing. All these eliminators will normally stand a temperature of $+60°$ C, but can also be supplied on request for higher temperatures.

Selection of Condenser Eliminators

It is not possible to postulate general rules for the selection of noise eliminators on account of the many factors that intervene. All the same, certain conditions may be indicated for determining a suitable eliminator. The Alpha noise eliminators, Series 77 700, are used for DC machines and DC apparatus, no matter whether earthing exists or not, and for AC machines and AC apparatus which are earthed. AC motors and AC apparatus which are not connected to earth should only have eliminators with the elimination capacities of Series 77 600. The purpose of the capacities is to prevent the stator or frame from getting a tension dangerous to those coming in contact with it. When choosing noise eliminators for portable machines and for apparatus using both DC and AC, only types with protection capacities should be employed (Series 77 600, 75 511 and 75 701) and neglect of this point may result in accident.

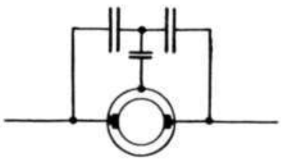


Fig. 8 X 3452
Connection of eliminator for electrical machine not earthed

It should be noted that eliminators connected to apparatus or machines which are not earthed lose a considerable amount of their effect. A good earth connection should therefore always be provided where possible. Cases where the earthing causes trouble are so rare that they may be entirely left out of account.

The sizes for noise eliminators may be selected from the following:

Type 77 601 and 77 701 for DC machines up to about 10 kW and for AC machines in general of any size,

Type 77 710 for DC machines above 10 kW,

Type 77 740 for the larger DC machines, where Type 77 710 fails to give the desired result.

When dealing with noise in apparatus, the various eliminators must be tried out in order to arrive at the best result. The trials should be made while broadcasting is going on, otherwise the results may be misleading.

The Alpha noise eliminator, Series 75 000, is designed for small motors, vacuum cleaners, small electric fans, calculating machines, electric bells, switches, etc. Particulars of connections and spheres of utility are given below for the various types.

Type 75 511 (main capacity 0.07 μF and protection capacity 0.0025 μF) for small-sized motors with connection direct over the brushes, and for contacts of apparatus,

Type 75 701 (two series capacities of 0.1 μF and protection capacity 0.005 μF) for noisy motors of greater power with stators not earthed,

Type 75 601 (two series capacities 0.1 μF) for small motors with earthed stators,

Type 75 512 (one 0.1 μF condenser) for shunting breaking contacts, electric bells, current regulators, etc.,

Type 75 513 (one 0.1 μF condenser in series with a 100 ohm resistance) and

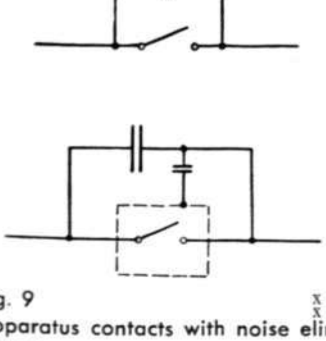


Fig. 9 X 3453 X 3454
Apparatus contacts with noise elimination

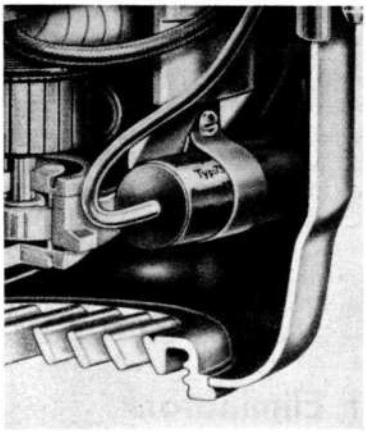


Fig. 10 X 3455
Condenser eliminator
fitted in vacuum cleaner

Fig. 11. X 3456
Condenser eliminator
fitted on lift motor

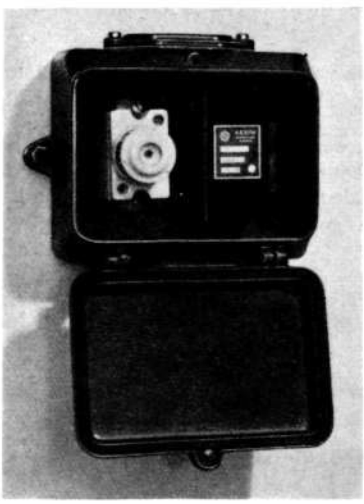


Fig. 12 X 3457
Tramway condenser-eliminator
The water-tight box contains a fuse for 6 A, 750 V, connected in series with a condenser for 2 or 4 μF

Type 75 705 (one 0.5 μF condenser in series with a 50 ohm resistance) for shunting breaking contacts causing great noise, such as electric bells, electric heaters, switches, etc.

In the case of a number of apparatus contacts, it may be that a noise eliminator, Type 75 512, proves to be too small. In such instances a single condenser, Type 76 510, 1 μF, or Type 76 520, 2 μF, may be connected. In this respect it may be pointed out that Type 75 512 gives good results in overcoming noise from electro-magnetic relays. It should be observed, however, that an eliminator should not be connected without proper consideration. The connection, as may easily be realised, may considerably affect the functioning of the relay and thus give rise to trouble.

Fitting Condenser Eliminators

The connecting cables have distinctive colours to facilitate the work of connecting. The following system of colours has been adopted: *black or white cables* are terminals for main capacities and are connected on both sides of the point of noise; *blue cable* is the terminal for the protection capacity; and *red cable* for earth. The red cable is earthed for earthed equipments and the blue cable is connected to the stator or frame when no earthing exists. In eliminators which have terminals both for protection capacity and for earthing, the terminal (red or blue) not in use should be insulated.

A general rule for the connection of noise eliminators is that the connecting cable should be as short as possible. Long connecting cables act as aerials and thus reduce the efficiency of the elimination. For the same reason the eliminator should be connected immediately over the point of noise. For example, a condenser eliminator which is placed directly between the brush bridges gives better results than one located between the terminals. Fig. 7 and 8 show how condenser eliminators are connected on earthed and non-earthed machines, while Fig. 9 and 10 show apparatus contacts with noise eliminated by means of condenser eliminators. As a guide to the fitting of noise eliminators, Fig. 11 and 12 give a few examples of installations.

A new feature of Alpha's production is tramway noise eliminators. As is well known, tramways often cause considerable noise. It has been ascertained that for the most part the noise is due to sparking between contact wires and trolley. The noises due to the motors and the controls are on the other hand of minor importance. Further, noise from trams is greater when they are running with the motor turned off and only the lighting switched on, than when a steep ascent is being negotiated at full power. The reason is that the current taken by the motor on full load is so great that the light arc formed at the input is not extinguished but persists, which is not the case when only lighting current is taken from the supply network; the noise due to a light arc is insignificant.

The methods available for overcoming tramway noise are carbon contacts and condenser eliminators, inserted between the trolley wire and the rails. The Alpha noise eliminator for tramways, see Fig. 13 and 14, consists of a condenser for 2 or 4 μF, with a series connected fuse for 6 A, 750 V, enclosed in a watertight cast-iron case. The condenser is designed for an operating tension of 600—800 V DC and tested for 4 000 V DC. On specially noisy stretches eliminators are set up on the wall of a house nearby, at intervals of about 60 m and connected with the trolley wire and the rails.

Finally, it should be remarked that all persons dealing with the elimination of noise sooner or later come across installations in which every kind of protection gives negative results. In such cases, almost without exception, there will be found defects in the construction of the installation in question.

Interlocking Plant at Fredericia Railway Station

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

In order to do away with the train-ferry between Strib and Fredericia established in 1872, a bridge for traffic has been erected over the Little Belt between Jutland and Fyen. One result of this has been that a fairly long stretch of railway line has had to be constructed necessitating a complete new railway station at Fredericia. The new Fredericia station has been provided with an interlocking plant furnished by L. M. Ericssons Signalaktiebolag. The new plant is of much the same type as the interlocking plant recently delivered by Signalbolaget for Aarhus, which is described in Ericsson Review No 2, 1935, but it is, as will be seen, rather more comprehensive. The plant has been very quickly delivered, seeing that woork only began on the site about 1st October, 1935, and it was ready for service in all respects on 15th May, 1935.

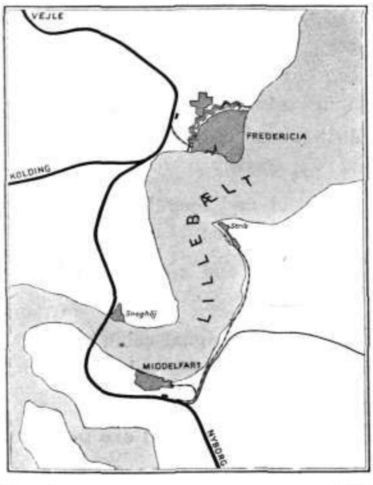


Fig. 1 X 3469
Map showing railway lines meeting at Fredericia

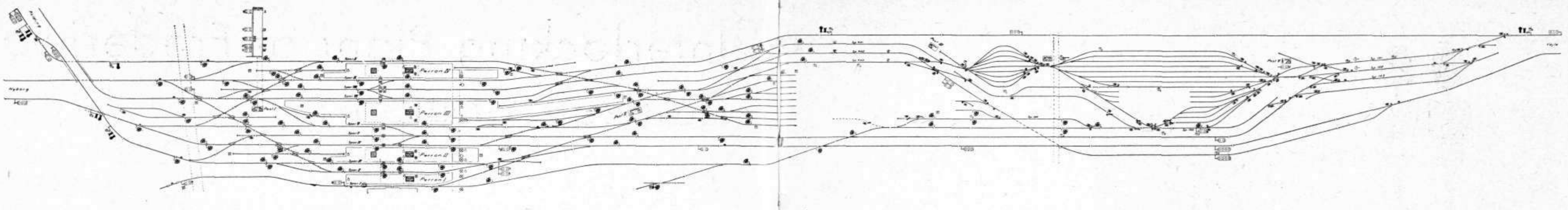
Fredericia is the largest railway junction in Jutland, as the main line through Fyen here joins up with the Jutland lines. Three double tracks meet at the station, namely: that from Nyborg (Copenhagen and Zealand), Vejle (Aarhus) and Kolding (Esbjerg, and Padborg, Germany), see Fig. 1.

Planning

The station covers an area of 70 ha, and the distance between the most northerly and most southerly points, both of which are locked, is about 5.6 km. In consequence of this and other things the interlocking plant is of considerable extent. As will be seen from the signal diagram, Fig. 2, the goods and shunting station is in the northern part and the passenger station at the south. Between them lie the two turn-tables for locomotives. Before the reconstruction there were at the passenger station 10 tracks, 8 of which served platforms while the remaining two, *viz:* track V and track VIII in addition to shunting were used for goods trains running to and from the East, South and West.

Fredericia being a junction for converging lines, incoming trains are for the most part made upp of groups and before the individual groups proceed considerable shunting of the groups from the incoming train must be shunted in the shortest possible time before it goes on. The trains from the East include through coaches for the North, the South and the West, while trains from the North have such coaches for East, South and West, and trains from South and West include through coaches for East and North, seeing that the double track line to Kolding for a large number of incoming trains works as two lines, namely one to the South (Germany) and one to the West (Esbjerg). In addition there is a considerable sorting of post, and quick and express goods traffic.

As this exceedingly intensive shunting is thus fairly well determined beforehand and for a great part also includes passenger coaches, it was decided when planning the interlocking plant that one with dwarf-signals—as that recently installed at Aarhus—would in the circumstances be required to provide safe and rapid handling of the traffic. The plant is therefore supplied with dwarf



- distant signal
- master signal
- master signal
- track signal
- shunting signal
- information signal
- dwarf signal
- signals at level crossings
- entrance stop light
- green repeater light for departure
- blue repeater light for entrance
- key for requesting shunting off
- insulated track section
- boundary between insulated (right) and uninsulated (left) track sections
- track insulation guarding against wrong operation
- telephone connected to Master Cabin
- telephone connected to Cabin V
- telephone connected to station's automatic exchange
- telephone connected to loud-speaker in nearest cabin
- light at double crossing points
- moveable point-light
- centrally locked point
- centrally operated point
- departure light signal
- departure light signal
- contact for local operation of points
- scotch block
- rail contact

Fig. 2 X 9023
Track signalling plan of Fredericia tation

signals for the passenger station. This also allows the running on blocked lines of locomotives and motor coaches to and from the sheds and sidings, and coaches to an from the coach depot, while in addition goods trains from East, South and West can be directed to the incoming grid by dwarf signal. In the same way the harbour shunting traffic can be directed to the goods station by means of dwarf signals. On the other hand the goods station is provided with general interlocking plant without dwarf signals. There are at the passenger station 2 signal-cabins (I and II) and at the goods station 3 signal-cabins (III, IV and V), namely:

Cabin I, at the south of the platforms, a signal and operating cabin; the main tracks are subject to release by the master cabin;

Cabin II, at the north of the platforms, a signal and operating cabin as well as control cabin;

Cabin III, at the southern end of the station tracks, a signal cabin and block cabin; the main tracks are subject to release from the master cabin;

Cabin IV, between the station tracks and the shunting tracks, a shunting cabin only from which a number of points in the station yard are operated;

Cabin V, right to the north, between the shunting tracks and the goods entrance tracks, a signal and operating cabin; the main tracks are subject to release from the control cabin.

There are following main tracks:
from Kolding to tracks II, III, V and X and »run through» on track III,
from Nyborg to tracks III, IV, V and VI and »run through» on track IV,
to Kolding from tracks VI, VII and VIII,
to Nyborg from tracks VIII, IX and X,
to Vejle from tracks II, III and IV,
from Vejle to tracks VII, VIII, IX and X and »run through» on track VII to Kolding and on track IX to Nyborg,

while for goods trains there are:
to Kolding from tracks 401 and 402 through track VIII,
to Nyborg from tracks 401 and 402 through track VIII,
to Vejle from tracks 402 and 403,
from Vejle to tracks 101 and 102,
from the passenger station to tracks 102 and 103 (goods trains from East, South and West on track V).

Fig. 3 X 3416
Dwarf signal

Moreover shunting sections have been provided to and from the harbour. Line blocking in the direction of Nyborg has been introduced and same is also to be arranged for the Kolding and Vejle directions.

Signals and points etc. are indicated by three and in some cases four digit numbers, the first digit of which indicates the cabin from which the operation is carried out, while the others indicate the field in which the operating lever is located in the corresponding interlocking apparatus. If a lever can be pulled either to right or left, the number is followed by an *v* or an *l*. For example *271v* indicates that the signal or point in question is operated from Cabin II by pulling to the left the lever in field 71.

Arrangement of Signals

As in the case of Aarhus, the main entrance signals are semaphores, while the remaining signals consist of two types of daylight signals, namely *distant daylight signals* and *position daylight signals* (mostly *dwarf signals*). The distant signals show red, green, yellow or blue light, while the position signals show indications corresponding to the positions of several white lights, Fig. 3.

All the distant signals consists of daylight signals of a type new to Denmark and are set up 800 m in front of the main signal. »Caution» (main signal indicating »stop») is indicated by a yellow flashing light, »clear» is shown by a green flashing light and »run through» by two green flashing lights.

In respect signalling the goods station is chiefly treated as a separate station, as here both incoming and outgoing passenger trains are given »run through». The goods station is provided with the following pole signals, operated from Cabin V:

for *goods and passenger trains from Vejle:* an entrance semaphore with run-through arm and distant daylight signal for through running to the passenger station and entrance to tracks 101 och 102; the signal is provided with direction indicator, see further;

for *goods trains to Vejle:* a daylight signal with run-through indication and further in outside Cabin III two daylight signals for outgoing from tracks 402 and 403; the last-named signals being operated from Cabin III;

Fig. 4
Departure signals
with letter frames

X 3470

for *passenger trains to Vejle:* a daylight signal with run-through indication and distant daylight signal;

for *goods train to goods entrance tracks 102 and 103* (from East, South and West through track V): a daylight signal; for *harbour tracks, etc. to goods entrance tracks:* one shunting signal.

In addition the goods station has two daylight signals, operated from Cabin II, for outgoing goods trains from departure tracks 401 and 402 to both Nyborg (East) and Kolding (South and West). These signals are provided which letter frames which show an *N* for trains to Nyborg and a *K* for trains to Kolding, see Fig. 4.

The passenger station has the following pole signals:
operated from Cabin II:

for *trains from Vejle:* an entrance semaphore with run-through arm. A direction indicator and a distant daylight signal (the direction indicator is a light frame which when the track is set for the direct line shows a vertical illuminated bar and when the track is set for a diverging line shows an oblique illuminated bar, see Fig. 5);

for *trains to Vejle:* three daylight track signals for outgoing from tracks II, III and IV and further out a daylight departure signal;

for *lines leading to and from the harbour to track I:* two pole shunting signals;

operated from Cabin I:

for *incoming from Kolding:* two entrance semaphores before the furthest points, each provided with run-through arm and advanced daylight signal;

for *trains from Kolding* to tracks II, III and V: an entrance semaphore with run-through arm and a distant daylight signal;

for *trains from Kolding* to track X: an entrance semaphore with distant daylight signal;

for *trains from Nyborg* to tracks III, IV, V and VI: an entrance semaphore with run-through arm and distant daylight signal.

On a signal bridge at Cabin I, see Fig. 6, there are set up five daylight track signals, namely:

for *trains to Kolding* from tracks VI, VIII and VIII;

for *trains to Nyborg* from tracks VIII, IX and X;

for *trains to Nyborg and Kolding* two further daylight signals for outgoing to Nyborg or Kolding as the case may be.

Traffic on the level crossing at the north end of the platforms is safeguarded by 8 light signals in all, located at each side of the various points. These signals are normally unlit and allow free passage to the crossing of the track covered by the signal in question. A signal when lit shows a vertical short white streak and is warning that there is danger in passing over the track in question. The lamps are suitably connected to the main signals, dwarf signals and insulated sections and they are for the most part lit and extinguished automatically when the track insulation is passed, by time relays of the requisite size. For through trains there are in addition at the level crossing two loud bells which are set ringing by the trains, Fig. 7. The settings of the incoming and starting signals for trains are repeated by blue and green lights respectively in the platform hall above the corresponding tracks. There are besides on the platforms press-buttons for the nearest dwarf-signals for the platform tracks by which Cabin II or Cabin I as the case may be can be advised that shunting off is wanted. When a button is pressed a light shines on the track diagram of the cabin operating the dwarf signal. The button operates a lamp which shows a white arrow at the dwarf signal to be moved.

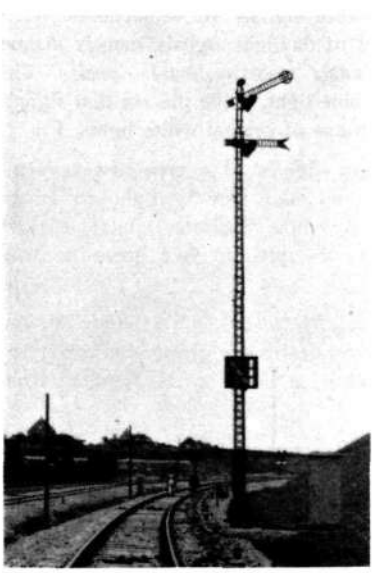


Fig. 5
Entrance signal
with direction indicator

X 3471

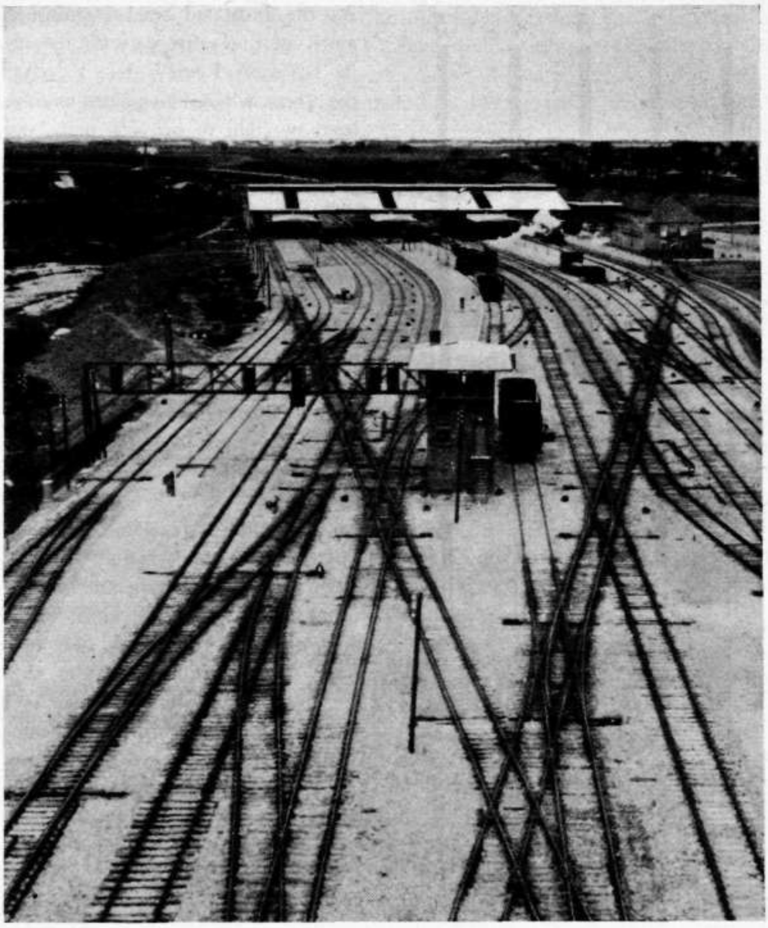


Fig. 6 X 5220
Southern station area
with Cabin I and signal bridge

Insulated Tracks, Dwarf Signals, Shunting Tracks

In regard to Cabin I (but not around point 102) and Cabin II and also, as far as track 100 and 200 is concerned, for Cabin V the installation is — as previously stated — in addition to the main tracks provided with shunting tracks, and the signal system includes dwarf signals which are arranged in connection with the points and insulated track sections. Likewise the tracks for trains to and from Vejle are insulated over the stretch between Cabins II and V.

The track system is divided up into a fixed number of insulated sections and each section is fed with AC which operates a relay. When a coach, a locomotive or the like enters a section the current is bridged by the wheel axles and the relay armature falls. The signals, etc. are connected by contacts with these track relays, and thus a »clear» signal cannot be shown when there is a coach, locomotive or the like in the section. This gives automatic indication whether a section is clear before signal can be given. For all the main sections the blocking is in principle arranged so that train movements take place on definite tracks, while shunting ways comprise all those in the track system, seeing that all movements in this area are directed and controlled from the corresponding interlocking machine. The dwarf signals and daylight signals are in the form of small low signals, though conditions on the spot may require some to be set high. A dwarf signal is placed immediately to the right of the track, it refers to and is not repeated behind. The signal indications are made by two white lights taking up different positions in relation to each other, see Fig. 8, which show four signal indications, *viz:* »stop», »caution», »clear» and »cancelled», the last-named being used to a very limited extent.

Fig. 7 X 3472
Light signals and bells
for protection of level crossing

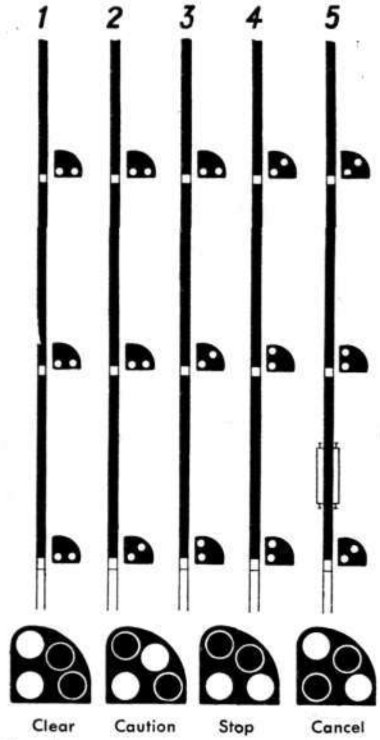


Fig. 8 X 3420
Cooperation of dwarf signals

Fig. 9 X 3475
Point drive with enclosed motor and point lock
for distant control and protection of points

As the insulated tracks, shunting tracks, dwarf signals, etc. are arranged much in the same way as the new interlocking plant at Aarhus, described in Ericsson Review No 2, 1935, attention is directed to that article. In the areas where the points are protected by dwarf signals, it has in general been possible to provide point signals and block signals at catch-points and scotch-blocks.

There are however variations from this rule, especially places where dwarf signals may be useless. At all those points not protected by dwarf signals and which are included in the interlocking plant, point signals and block signals are provided.

Insulation of the fish-plates and intermediate plates is by means of American fibre layers. The insulated rails are as a rule provided with insulation in both rail ties with the exception of rails, in the fields of Cabins IV an V, insulated against untimely reversal and locking of the tracks, where insulated may be on one side only. Connection within the individual insulated rails is provided by double 5 mm copper wire attached to the insulation by conical spikes. The rails insulated for protection against untimely reversal and locking of the tracks under Cabins IV and V are fed with 34 V DC, while the other insulated rails under Cabin V, together with the insulated rails under Cabins I and II are fed with 110 V AC in conjunction with the track transformers and the reactance coils. Two-phase induction relays (vane relays) are used here. The current feed to the track relay local phase is taken from the 110 V side of a $3 \times 380/3 \times 110$ V transformer placed in each signal cabin, while the current supply over the insulated relays to the track phase of the relays is taken from the same transformer over a special track transformer for each single section. The track transformers and the reactance coils are located in cubicles at the station. The track relays are placed in the basement of the signal cabins. The connecting wires are laid in armoured underground cables.

Operation of Points and Signals

The points are operated and locked by drives of Signalbolaget's make. A number of the points are fitted with hook-locks or Voegel-locks and for these are used drives with only one driving rod for the point-lock. For those protected points which are not provided with a special lock drives with built-in locks and two rods one for each point tongue, see Fig. 9, are used.

Double crossing points are operated by two drives, each of which operates and controls two pairs of tongues. All opposite points in the train tracks are control-locked, each corresponding drive being provided with two further control rods, one for each tongue or pair of tongues, in such a way that an independent control of the position of the tongues is obtained from the drive rods. The motors of the drives are fed with 136 V for moving the points. Supervision of the position of the points is carried out in cabins I and II areas by means of three-position vane relays installed in the relay rooms, with local and indicating phase for 110 V AC, 50 c/s. In the area of Cabins IV and V supervision is by 34 DC in the usual way with control magnet but without special relays. In Cabin III area the points are locked by electro-magnetic locks. The most distant points towards Kolding and Vejle are also control-locked by special electric locks.

The semaphores are operated by drives from Signalbolaget for 110 V motor current (DC) and 34 V control current (DC). The daylight signals and the dwarf signals below them are operated by special DC relays located in the signal cabins.

Interlocking Apparatus, Relays, Signal Cabins etc.

The interlocking apparatus in Cabins I and II are Signalbolaget's newest type. The point levers each operate 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 more than two train tracks. Where, for example, the throwing of a lever to the left corresponds to more than one train track, there are placed above the lever track buttons with which the desired train track is selected. The dwarf signal levers also which are operated in much the same way as the general signal levers, can serve for each position (to right or left) several train tracks, but in their case without track buttons. All the tracks on one lever must naturally be mutually opposed. Both for main tracks and for shunting tracks the connection is solely electric (there is no mechanical locking register provided), which is effected partly with the lever magnets armature on contact of the lever with the armature, and partly by means of a large number of relays housed in the basement of the signal cabin. The relays, some for AC and some for DC, are for the most part made with contacts enclosed in glass cases.

Fig 10 shows the interlocking apparatus and the illuminated track diagram in Cabin II (control cabin). Fig. 11 shows Cabin II (master cabin) and Fig. 12 shows the relay room in Cabin II. The design of the interlocking apparatus in Cabins I and II is in essentials the same as described in Ericsson Review No 1—3, 1931. The interlocking apparatus in Cabins III, IV and V are of Signalbolaget's general type. An occupied train section is automatically blocked and is cleared likewise automatically on the passage of the train.

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

	Cabins					
	I	II	III	IV	V	total
sections in the interlocking apparatus	88	128	12	24	56	308
point levers	37	42	—	11	31	121
signal or clearing levers	9	20	1	1	5	36
dwarf signal levers	28	37	—	—	4	69
locking levers	1	—	6	—	1	8
spare sections	13	29	5	12	15	74
train tracks	19	13	2	—	7	41
shunting tracks	154	237	—	—	9	400
centrally operated points	53	66	—	11	44	174
centrally operated scotchblocks	1	3	—	—	4	8
semaphores	5	1	—	—	1	7
distant daylight signals	12	9	2	1	8	32
dwarf signals	44	65	—	—	6	115
insulated tracks with lamp on track diagram	57	78	—	—	19	154
tracks insulated only against untimely operation	—	—	—	3	13	16
relays	340	450	10	1	69	870
locked points	1	—	11	—	1	13

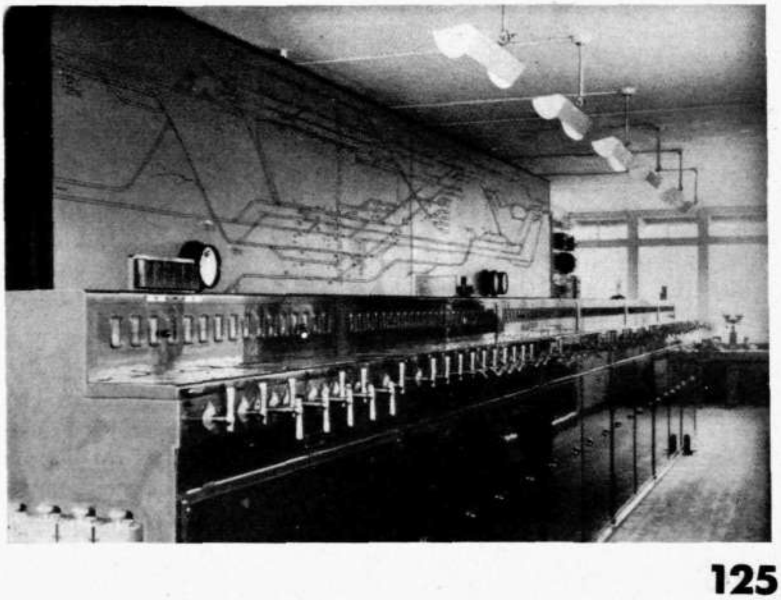


Fig. 10 X 5221
Interlocking apparatus and illuminated track diagram in Master Cabin

Illuminated Track Diagram

As the shunting in the areas of Cabins I and II and part of the area of Cabin V is to be controlled by and directed from the cabins, it is necessary that the operating staff should be able easily to supervise and follow the individual movements. 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 (mast 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 on the lighting of lamps set behind small coloured windows and which mark the signals. There is a lamp on the diagram for each track insulation in a line of track. The entrance of a train in a section is indicated by the lighting of the lamp corresponding to the section; when the train has left the section the lamp goes out. The lamps are thus not alight when the track is unoccupied. In this way 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 yellow light and »clear» by white light. »Cancelled» is indicated by yellow light lying in a black cross. The positions of the various pole signals are shown by red light for »stop» (train track signal for starting shows yellow light for the position »track not clear for train») and green light for »clear», while the shunting signals are indicated by yellow light for »shunting permitted» and blue for »shunting forbidden».

The traction line signals are repeated in yellow light on the track diagram in Cabin II, when they are lit, see above. The arrangement of the track diagram in the main cabin may be seen from Fig. 11.

In the direction of Nyborg, AC blocking is installed an such is also to be arranged in the directions of Kolding and Vejle.

Power Supply

The plant is fed with current from Fredericia Electric Works which normally furnish AC 3×380 V, 50 c/s, to each of the five cabins. In case the current supply to one of Cabins I, III, IV or V fails, the supply can be obtained from Cabin II over a special cable. In Cabin II there are two cables coming each from its own transformer station, one of which acts as reserve. Finally there is at Cabin II a petrol motor-generator to maintain the supply in case current fails entirely at the Electric Works. In each of the cabins there is a transformer 3×380/3×110 V. Current is taken from the 110 V side for the local phase of the point-control relays and for the local phase of the track relays, for dwarf signals, lighting of semaphore signals, etc.

Through other transformers, 110/110 V, is taken current for the indication phase of the point-control relays. The tension is transformed from 110 V to about 30 V for the daylight signals (mast signals) by transformers or series resistances. The 110 V is transformed for the track-insulation to 12—24 V by special track transformers, and for the lamps of the track diagrams the tension is transformed from 110 to about 12 V.

Fig. 11 X 3473
Cabin II (Master Cabin)

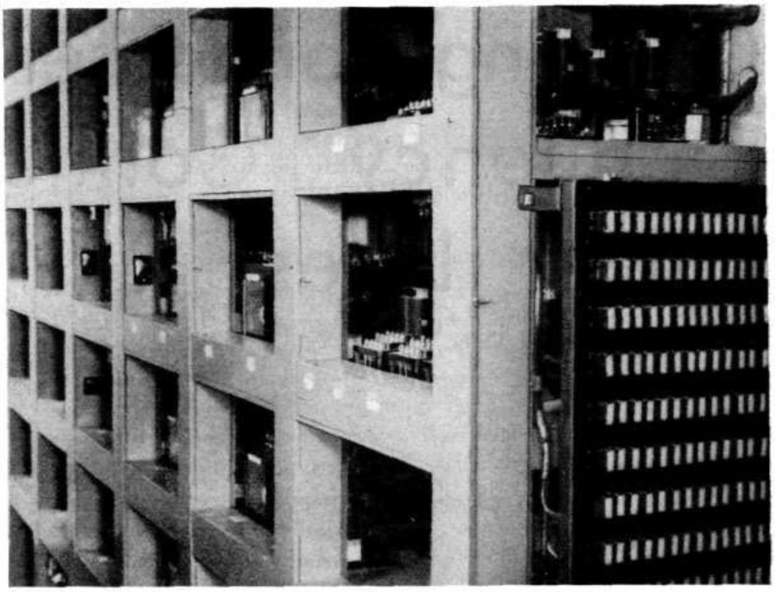


Fig. 12
Relay room in Cabin II

X 5222

The current feed for the point motors (136 V DC) and for the supervising current (34 V DC) is taken from metal rectifiers connected in parallel with fleating batteries and connected to the 380 V mains. As reserve for the metal rectifiers there is in each of Cabíns I, II, IV and V a motor generating set consisting of a 380 V motor, a 136 V generator and a 34 V generator. Cabin III receives its motor and supervisory current from Cabin IV by a special cable.

Telephone Installation

The plant is provided with a comprehensive telephone installation, since besides the customary connections between telegraph office, signal cabins, platform boxes, etc. which are made over an automatic private branch exchange with about 80 instruments connected, there is a considerable number of instruments at various spots, providing convenient communication with the signal cabin concerned, which is necessary in the cases where shunting is controlled and directed from the signal cabin.

Thus there are telephones at 10 places in the field of the Cabin I connected to a loud-speaking instruments in the cabin. In the same way are 15 place telephones connected to a loud-speaking telephone in Cabin II. Further there is in this cabin a CB exchange for 7 instruments at the main entrance signals. In the field of Cabin V there are 8 place telephones of the CB type served by an exchange in the cabin. Finally there are at the section tracks, the station tracks and the goods departure tracks 7 place telephones in all connected to the local automatic exchange and 3 further place telephones at the goods incoming tracks.

Coupling Condenser for Carrier-Frequency Connections on Power Lines

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For the transmission of communications and signals between various posts of a power-distribution system use is made to a great extent of the high-tension lines themselves.

High-frequency current is used for the transmission and the equipment for carrier frequency employed must be protected against high tension, while at the same time it must remain in electrical connection with the high-tension lines; for this purpose coupling condensers are utilised and these are described in the present article.

The progress of modern technique in the transmission of energy with the increase in cooperation between different power stations and the establishment of wide-spreading power systems impose much greater demands on the facilities of communication between the various parts of the system. Side by side with the extension of the power network it is necessary to establish comprehensive communication ways within the system, over which necessary reports and orders can be rapidly transmitted. The transmission may be either verbal by means of telephone or automatic by distance signalling.

The transmission is arranged in the most simple way on an ordinary telephone circuit, *e. g.*, by sending out a varying number of DC impulses per unit of time, or varying the current amplitude in relation to the measuring values to be transmitted. The transmission of modulated carrier current is of especial interest, as one and the same line may carry several channels. The carrier-frequency transmission may be made arranged on a special network, but as a rule it is much more economical to make use of the power line itself.

The principle of a carrier-frequency communication over a power line is shown in Fig. 1. The carrier-frequency is produced in a high-frequency generator and modulated in the modulator. For telephony the modulating is

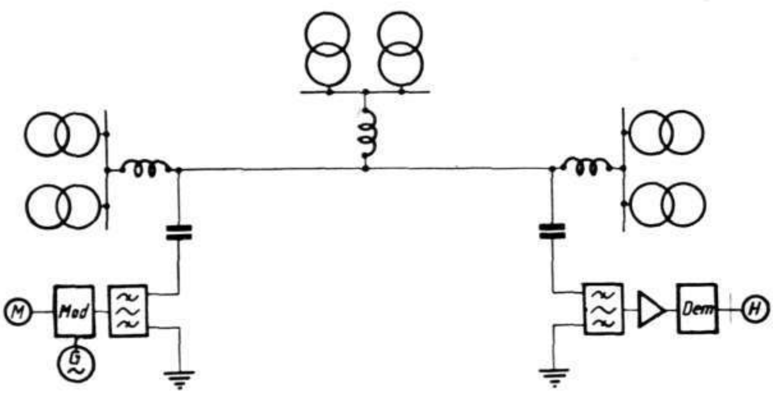


Fig. 1 X 5231
Principle of carrier-frequency communication on power line

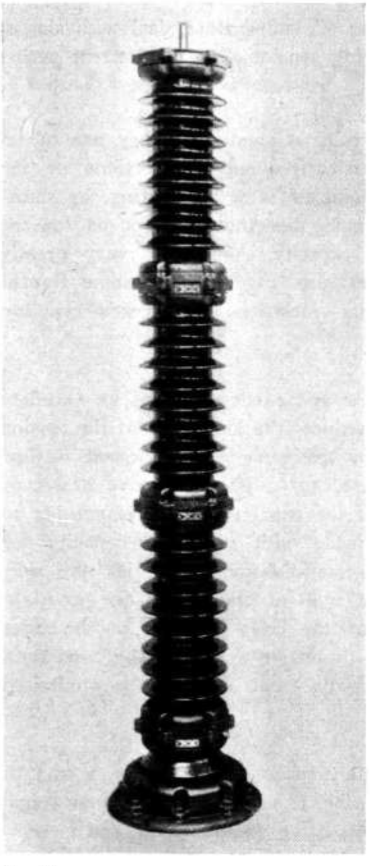


Fig. 2. X 3478
Coupling condenser, 900 cm, $220/\sqrt{3}$ kV, 50 c/s

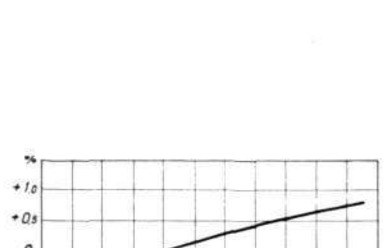


Fig. 3 X 3479
Capacity variation as function of surrounding temperature
for oil-impregnated coupling condensers

done with speech current from a microphone. For distance signalling the modulating takes place with voice frequency impulses, the number or length of which determine the meaning of the signal, the size of the test current, etc. The modulated carrier frequency is transmitted by way of sender's filter circuit, the coupling condensers and the line to the receiver's filter circuit with earth as return. With a view to reducing line attenuation and radio disturbance use is most often made not of earth but of another line phase for the return. In this latter case, however, twice as many coupling condensers are required.

On the receiving side the carrier-frequency is filtered, amplified and demodulated to the original speech currents or voice-frequency impulses, which are then passed on to the telephone receiver or the impulse receiver as the case may be. By sending out a number of carrier-frequencies, each one modulated for a speech band or a number of voice frequencies, it is possible to transmit a number of communications which, by means of repeated filtering, may be directed to one or more receivers. The number of communications is limited by the frequency bands required from the point of view of disturbance.

In principle the transmission of carrier-frequency on a power line does not differ from ordinary radio-telephony or radio-telegraphy communications. While for radio communications the sending is made through the ether and in all directions, the high-frequency currents for carrier-frequency transmission on a power line are obliged to follow a certain circuit. The high-frequency current's path is determined by the coupling condensers and the high-frequency chokes, which constitute the necessary line equipment for the transmission.

The high-frequency chokes are connected as shown in Fig. 1 and are intended to prevent the high-frequency from passing into the power station equipment. As a rule they are made in the form of parallel-resonance circuits, fixed according to the carrier-frequencies, which block the high-frequency but permit the passage of the operating frequency.

The purpose of the coupling condensers is to lead the high-frequency on to the power lines while at the same time insulating the carrier-frequency installation from the tension of the network. They represent av very considerable impedance to the operating frequency but high-frequency can easily pass them. Their effect is thus the exact opposite of the high-frequency chokes. The coupling condensers may be made in various ways. Porcelain, bakelite or paper are used as dielectrics, the two last-named invariably oil-impregnated. Porcelain condensers are usually made as condenserchains while the oil-impregnated coupling condensers are generally of upright mounting. Fig. 2 shows an oil-impregnated coupling condenser of Sieverts Kabelverk design. It is made up of a number of completely independent condenser units, which are fixed one above the other and connected both electrically and mechanically by screwing together. Each unit contains a number of series-connected condenser cells, which in turn are divided up into a number of series-connected capacities. The design of the cells and the connecting method used enable the line resistance and induction to be made insignificant.

The condenser shown in the figure is made up of three units which are insulated from earth by a porcelain socket. The power line is connected to the terminal at the top of the condenser and the carrier-frequency installation to the terminal immediately above the socket.

The connection of the coupling condensers to the power line should not in any way affect reliability of operation. The condenser should therefore be of a size to enable it to deal with all stresses whether of electrical, thermic or a mechanical nature. During a short time the condenser can deal with exceedingly high tension stresses. There is no risk at all of the condenser being damaged by over-tensions coming from the line, particularly as the capacity of the condenser ensures a considerable levelling of the front of the tension wave and reduction of its amplitude. With tension stresses of long duration the peak of the tension is limited by the heating produced by the condenser losses. The coupling condensers must have such dimensions

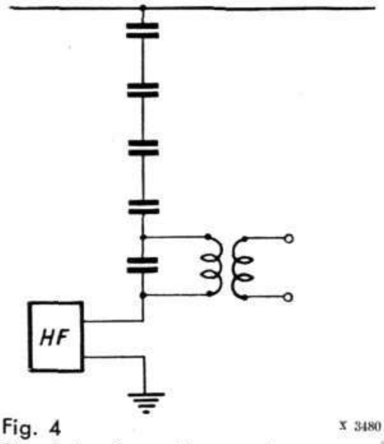


Fig. 4 x 3480
Principle of coupling condenser, connected for tension transforming

that they can, without harmful rise in the oil temperature, deal with single-phase earth connection, *i. e.,* full operating tension, for the longest period considered likely to arise.

The losses of the condensers are as a rule so small that they are of no importance whatever, either for the carrier-frequency connections or for the power transmission. Yet from the point of view of heating, as stated above, the have a great effect and should therefore be kept as low as possible. It is also important that the capacity should not vary greatly with variations in the surrounding temperature. Fig. 3 shows some figures obtained on measurement of the capacity variation in Sievert's coupling condensers.

A condenser connected between each phase and earth serves as an excellent over-tension protector in that it not only reduces the amplitude of the tension but also considerably levels the front of the wave; see Ericsson Review No 1, 1933, and Ericsson Technics No 1, 1935. The protective effect of the condenser is governed by the size of the capacity. There is nothing to prevent the coupling condensers being made with sufficient capacity for over-tension protection. As regards the transmission properties the only advantage of a larger capacity is that with it the impedance to high-frequency is reduced. The inductance of the coils included in the filter circuit causes a certain reduction of the protective effect of the condenser. This reduction, however, is as a rule fairly small and may be minimised by shunting the coils with a spark gap.

By providing the coupling condenser with tension tappings over a part of the capacities connected in series it is possible to use them for voltage transforming. The condenser then acts as a capacitive potentiometer and is combined with a tension transformer, the leakage reactance of which is compensated by the condenser reactance. The most suitable method of connecting the high-frequency installation is as shown Fig. 4. The transformer is provided with particularly large leakage reactance which prevents the high frequency from penetrating into it.

Sieverts Kabelverk supply coupling condensers for up to 220/$\sqrt{3}$ kV and 40 kVAr. Below are given some figures obtained from recent deliveries to the French power-supply undertakings, Compagnie Bourguignonne de Transport d'Energie and Société de Transport d'Energie de l'Ile de France, consisting of four coupling condensers for 220/220 kV line tension. The capacity per condenser is 900 cm, corresponding to 5.1 kVAr at operating tension and 50 c/s.

Test Voltage

Test Voltage kV	Frequency c/s	Duration min
Dry Test		
690	50	momentary
625	50	1
500	50	5
425	50	30
Wet Test		
550	50	1
Impulse Test		
1 200	5 impulses	1

Loss Factor at 50 c/s

Temperature °C	Loss Factor tan δ		
	Oil-Impregnated Paper		Whole Condenser
	0.045 mm	0.060 mm	
12	—	—	0.0053
20	0.0028	0.0040	0.0052
45	0.0025	0.0032	0.0042
80	0.0025	0.0030	—

Capacity Variation

Variation in		
Voltage %	Temperature °C	Capacity %
± 50		0
	+12—+45	1.03

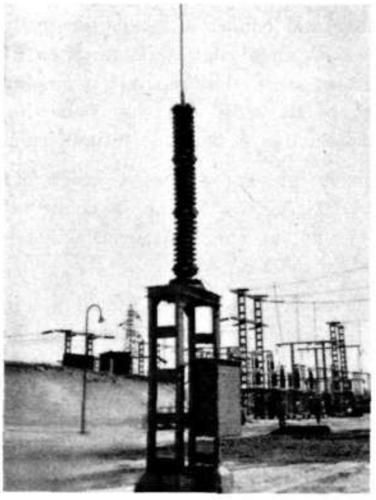


Fig. 5 x 3481
Coupling condenser erected at the switching plant of Creney, France

Tests of Automatic Fire Alarm

G. BERGH, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

At the instance of the Swedish Public Records Office a series of tests have been carried out to establish the efficacity of the Ericsson automatic fire alarm system. The tests made were partly as laboratory tests at Telefonaktiebolaget L. M. Ericsson's factory in Stockholm and partly as practical tests in the building of the Public Records Office, where an automatic fire alarm installation on the Ericsson System is installed.

The tests are described in the article below, which is reproduced with the kind permission of »Brandskydd», April 1935.

The object of the tests at the factory was to ascertain the fusing point of Ericsson thermo-contacts, Type TH 850. These contacts consist of metal springs soldered together in pairs with a fusible metal alloy, which springs when the temperature rises above a certain height break the circuit in which they are connected. For the first test, 6 thermo-contacts were taken from a box containing a large quantity which had only a short time before been taken from the factory store. The contacts were fitted in an aluminium vessel which was mounted on an electric heater. The temperature at the beginning of the test was about 50° C, and the heating was so arranged that a rise of temperature per minute of about 2° C was obtained. The spring groups of each thermo-contact were connected in series with lamps mounted on a signal board. As the contacts fused the corresponding signal lamps in the board went out, so that it was an easy matter to observe when the fusing of the respective contacts took place. When the test was completed, it was seen that the springs of all the contacts had fused at temperatures lying between 72 and 73° C. A further test was carried out on similar lines with a number of thermo-contacts taken from a lot ready for delivery. This second test gave the same results as the first. In addition a number of individual tests were made, single contacts being put into the holder which for the purpose had a temperature of about 75° C. The result was that the contacts put in fused after about 8 sec.

The first part of the test at the Records Office archives was intended to demonstrate how the contacts acted on the outbreak of fire in some room of the archive building and also how contacts which had been in position since the installation was completed would function.

For carrying out the test a room was selected from which damage due to smoke and the like could not be caused to the contents of the archive building. A lavatory on the ground floor was decided upon as a suitable room. This room, Fig. 1, had one door and one window, which during the test were kept shut. At the time the test began the temperature of the room was about 15° C. The termo-contact, which had been in place since the installation was made in 1930, was connected to the central apparatus for the automatic fire-alarm installation which in turn is connected over a main fire-alarm box to the communal fire-alarm network of Stockholm. Both alarm and fault signals are registered automatically at the fire station.

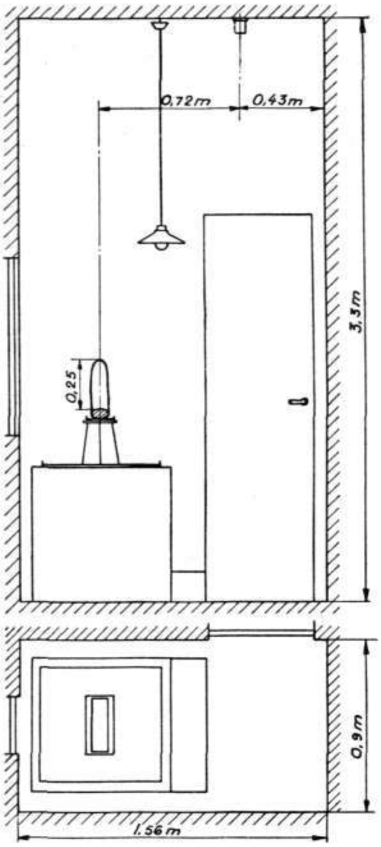


Fig. 1 X 3465
Plan of locality where test was carried out

The fire was laid in the lavatory and consisted of a packet of cotton-wool, 150 mm long and 70 mm diameter, resting on a grill over a bowl 300×140 mm. The whole was placed on a tripod stand which in its turn stood on a protecting tray 600×600 mm. The packet of cotton-wool was soaked in half a litre of methylated spirit. This was lit, after which the door of the room was shut. While the test was going on the door was, however, opened from time to time for observation purposes. The height of the flame did not exceed 25 cm and during the whole test the fire burned with exceptional evenness.

The following intervals of time, reckoned from the moment when the fire was lit, were noted:

1'30" fault signals was received (one contact spring had come into operation);
1'45" alarm signal (the second contact spring had come into operation);
3'30" the sirens of the fire-engine were heard in the distance;
4' the first fireman discovered, by consulting the indicatorplan, the position of the fire.

The total time from the moment the fire was lit until the fireman discovered the position of the fire was thus not more than 4 minutes, which must be considered exceedingly satisfactory. It should be stated that the outer door of the archive building was kept locked and had to be opened by the fireman with keys brought with him. Similarly the doors leading to the room where the fire had been laid were shut, but not locked. The fire, by the time the fireman arrived, had not become so great that the latter could not take up the bowl in which the spirit-soaked cotton-wool was and carry out the whole arrangement for extinguishing.

As soon as the fire brigade had dealt with the fire, the room was inspected with the result that no noticeable dramage could be detected. As an example, it may be mentioned that the electric light connection which hung from the ceiling close to the fire was in no way affected by the heat. As soon as the lamp was put back the lighting acted at once. The thermo-contact which gave the alarm signal was found after the test to be quite undamaged except that both the contact springs had broken their respective current circuits.

The above-described test was followed by a test for circuit fault. A thermo-contact was selected and a short-circuit of its contact springs was caused. Fault signal was immediately received at the central apparatus and the fault signal was transmitted in due course to the fire station.

That completed the tests, which had shown conclusively with what precision the installed fire-alarm system functioned. At the same time the tests demonstrated how sensitive to heat these fuse contacts were. Certainly the room in which the test was carried out was not of large size, but on the other hand the walls were well cooled and moreover the spread of the fire in comparison with the cubic measurement of the room was not unusually great. For the premises of the Public Records Office and the irreplaceable documents there preserved it is of great importance that the work of combating a fire should begin in the shortest possible time after the outbreak, so that damage by fire and also by water might be avoided. The test made demonstrated how specially after the fire was laid the fire brigade was on the spot and the seat of the outbreak discovered. Even should fire break out in some other part of the building, there is little probability that in such a short time it would be able to obtain such a hold that the fire brigade could not rapidly obtain the mastery over it. It is so much the more important that the extinguishing should be done quickly, as certain parts of the premises are liable to risk devastating conflagration if a fire be allowed opportunity to spread. As the premises for a large part of the 24 hours are unoccupied and the situation of the building is such that an outbreak of fire would most probably not be detected from outside, the installation is of the outmost value for the safety of the valuable contents.

Laryngophones

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

Telefonaktiebolaget L. M. Ericsson has recently produced a new type of laryngophone, specially designed for use in aircraft.

In very noisy places it is not possible to use for telephony ordinary carbon-granule microphones with diaphragms. These microphones capture far too much of the surrounding noise, causing considerable reduction in intelligibility. To eliminate disturbances of this kind a type of microphone is substituted, the diaphragm of which is acted upon direct by the vibrations in the speaker's larynx. To this type of microphone has been given the name of laryngophone. Its main difference in principle from the ordinary microphone lies in the fact that the diaphragm is much stiffer so that it is to a great extent intensitive to the noise waves in the air. When in use the laryngophone is held lightly pressed against the throat in the neighbourhood of the larynx. Like ordinary microphones the laryngophone is made in the form of an inset, so that it is easily interchangeable.

For certain purposes it has been found useful to combine the laryngophone with a telephone to form a laryngotelephone, corresponding to the ordinary hand-microtelephone, see fig. 1. A telephone instrument fitted with laryngotelephones may be seen on Fig. 2. Such instruments are used as order telephones on ships, in engine-rooms etc.

In other cases, for instance in aircraft, it is necessary for the speaker to have both hands free. In such case use is made of a loose laryngophone together with a headphone of normal design. This latter may be conveniently fitted in the pilot's helmet.

Telefonaktiebolaget L. M. Ericsson has produced a laryngophone specially designed for this purpose, see Fig. 3. It consists of microphone, connecting box, and tightening ring together with ring and strap for fixing. By means of the strap the laryngophone is held pressed against the throat. The dimensions are so small, the diameter being 39 mm and the thickest part 24 mm, that it can be worn without discomfort inside the collar. In such case the fixing strap can be dispensed with. The laryngophone gives a good sound quality and is intensitive to extraneous noise. Obviously the usefulness of a laryngophone of this type is not confined to aircraft. It may also be used for order telephone installations for fire-control on warships, in engine-rooms, on motor vehicles, tanks etc.

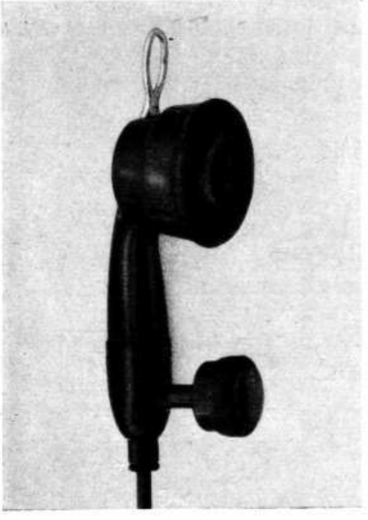


Fig. 1 X 5345
Laryngotelephone

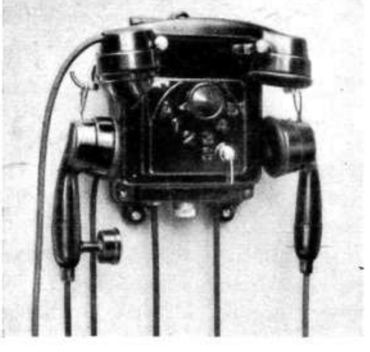


Fig. 2 X 3466
Ship's telephone instrument, with laryngophone

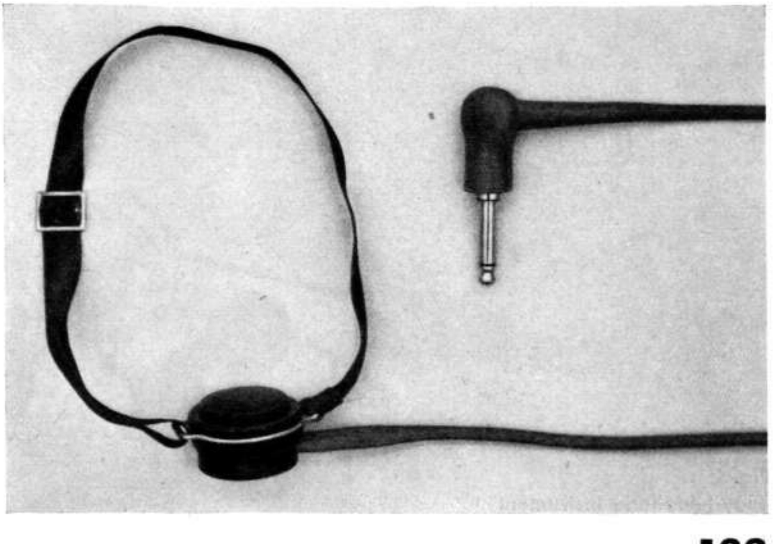


Fig. 3 X 5218
Aeroplane laryngophone

Buoy-Telephone Installation for Submarines

V. SÖDERSTRÖM, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

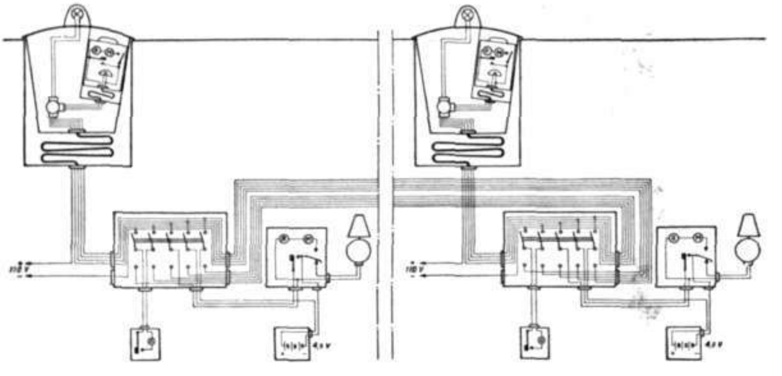


Fig. 1 X 5216
Diagram of buoy-telephone installation

For many years now the submarines of the Swedish Navy have been equipped with buoy telephones, a safety device for use when a submarine is sunk by accident. The buoy can then be released from the submarine and floats to the surface. A flexible cable then unrolls and constitutes a connection between a watertight wall telephone instrument in the submarine and a telephone instrument enclosed in the liberated buoy.

On the newest submarines the buoy-telephone installation has been extended to comprise two buoys with buoy telephones, connected in the submarine each to its own instrument placed in the fore and aft torpedo chambers, see diagram, Fig. 1. The buoy contains a telephone instrument, Fig. 2, consisting of a handset with key, a bell and a knob switch for signalling, the whole protected by a cover, together with a distribution box. To this is connected a 4 m long three-wire cable for the buoy-telephone and a two-wire cable for the pressure-resisting lamp fitted in the top of the buoy, by means of which flash signals can be sent out from the submarine to draw attention to the buoy. From the distribution box leads out

Fig. 2 X 5217
Buoy-telephone instrument

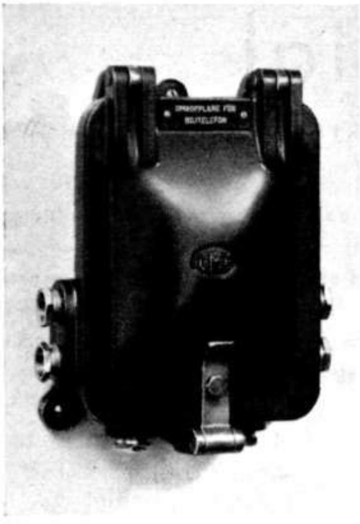


Fig. 3 X 3443
Pressure-resisting switch box

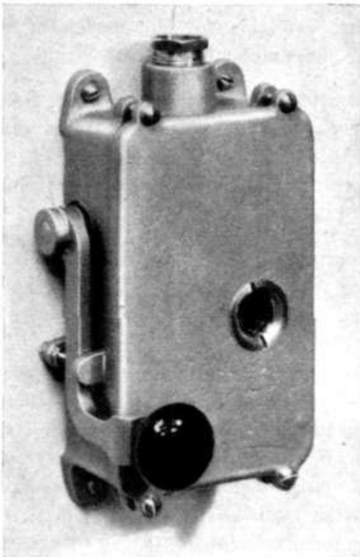


Fig. 4 X 3444
Watertight telegraph key
for signalling to lamp on top of buoy

the five-wire 120 m flexible cable to the submarine. The cable intakes are all made with strong rubber packing, particularly where the flexible cable enters the buoy and the submarine. The cable must naturally be of such strength that it can hold the buoy anchored to the submarine.

On the buoy is an instruction plate telling how to open the lid of the compartment in which the buoy telephone is to be found. On opening the lid the telephone is lifted out and the submarine is rung up according to directions to be found on a plate fitted on the telephone cover: *Turn handle clockwise. Lift cover. Ring submarine by turning key counter clockwise. Lift handset after which the instrument is ready for conversation as long as the key is held pressed. Wait for reply.*

The telephone instrument in the submarine is of the same type as the ship's telephones described in Ericsson Review No 2, 1933, and No 1, 1935, but without selector arrangement. The buoy telephone can be called by means of a signal button. The bell on the instrument is a diaphragm bell, Type RA 1 200, which is described in Ericsson Review No 4, 1933. The installation is fed by a 4.5 V battery.

To enable either telephone instrument in the submarine to communicate with both fore or aft buoys, there is a pressure proof switch box, Fig. 3, which contains a five-pole two-way knife switch. In the upper position of the switch the instrument is connected to the buoy nearest to it, while in the lower position it is connected to the other buoy. The two switch boxes are connected together by means of a five-wire armoured cable; they are moreover provided with a rapid closing lid and so strongly made that they can stand a pressure of 10 kg/cm² without permitting water to enter. This last safeguard has been provided in case the hull of the submarine is damaged; *e. g.*, if the fore torpedo chamber is full of water the aft telephone installation will still function. If one of the switch boxes be filled with water then both installations are put out of action, as may be seen from the diagram, and the cable intakes are therefore made with strong rubber packing.

As stated above, there is at the top of the buoy a signal lamp. This is fed from the 110 V accumulator of the submarine and lights up when the circuit is closed by a telegraph key, see Fig. 4. This also is made watertight. On the front of the key there is a panel, behind which is a small lamp connected in series with the lamp in the buoy; it can be seen by the lamp in the telegraph key whether the buoy lamp is receiving current and thus whether the lamp is functioning. When the instrument in the fore torpedo chamber is connected to the fore buoy the telegraph key is connected to the lamp in this buoy, and when it is connected to the other buoy then the connection of the telegraph key is to this other buoy.

New Telephone Dial

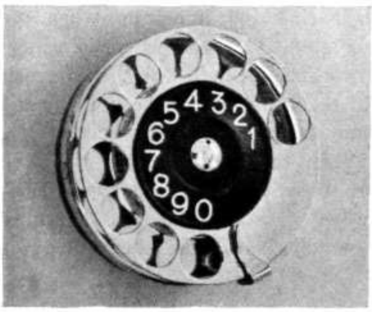
H. BLOMBERG, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

The new Ericsson dial, concerning the design of which some details were given in Ericsson Review No 2, 1933, has after thorough test been adopted as standard by the Swedish Royal Board of Telegraphs, which has recently placed an order for 25 000. Moreover, telephone administrations in other countries have adopted the new dial and it is now being manufactured at Ericsson factories in Czechoslovakia, Hungary, Italy, Poland and Sweden.

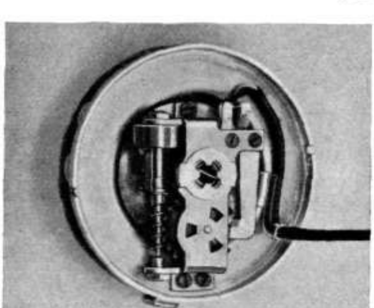
The new dial, Type RG 600, has exactly the same external dimensions, 76 mm diameter and 28 mm thick, as the earlier Ericsson standard dial. In appearance the new differs only from the old in that each finger-hole of the new take up only $^1/_{13}$ of the circumference, as against $^1/_{12}$ in the older type. In this way the distance from the first hole to the stop is one division greater than formerly. The interval between the impulses is increased in proportion and a longer time is therefore available for the movement of the selectors, which is a necessity for some automatic systems.

The mechanism is of quite a different construction from that of the older type, though like the latter it is entirely fitted to the back of he dial plae, thus making all parts easily accessible. It is covered at the back by a low hood which serves as dust protector and in which the fixing screws are set.

On the front of the plate there is only the finger-hole dial which is attached to the main shaft running in the plate, see Fig. 2a. This is perforated and contains the drawspring of the dial and also holds a toothed wheel which transmits the power of the spring to the impulse wheel and regulator. The impulse springs and other contact springs together with the regulator are fitted in a bridge, Fig. 2b, which is attached to the plate by three screws. Two of these screws also serve to hold the finger-stop. In this bridge and the plate there is fitted an intermediate shaft, Fig. 2c, for transmission power from the main shaft to the regulator. The intermediate shaft holds a cog-wheel gearing with the main-shaft wheel, as well as the spur-wheel of the regulator and the impulse wheel, Fig. 2d. By thus fitting the mechanism parts to such a bridge there is no need for a large number of small parts to be screwed to the plate and this holds only the bridge and the cord clamp. This makes the construction particulary strong and easy of inspection and permits of very simple assembling.



X 3487



X 3488

Fig. 1
The new dial
back and front views

The free end of the main shaft runs on a bearing in the bridge. The spiral spring lies loose inside the axle, but its lower end is held in a groove and is thus attached to the shaft while the upper end is held on the bridge by a washer with four teeth pointing downwards, see Fig. 2b. The spring is tightened by pressing it down and turning it with a simple key, after which on release the spring is held by the washer. This arrangement allows of adjustment of the tension of the spring by a simple operation and with an accuracy of a quarter turn of the spring. A feature of the design of the new mechanism is that the clutch which prevents the impulse contact and the regulator from following the dial on its return is not located on the main shaft but on the intermediate shaft, and that this clutch is divided into two independent parts in such a way that the coupling of the regulator and the impulse-wheel are carried out independently. The rapidly revolving regulator therefore does not stop at the same instant as the dial reaches the end of its movement but stops with a gentle slowing down from full speed to stop.

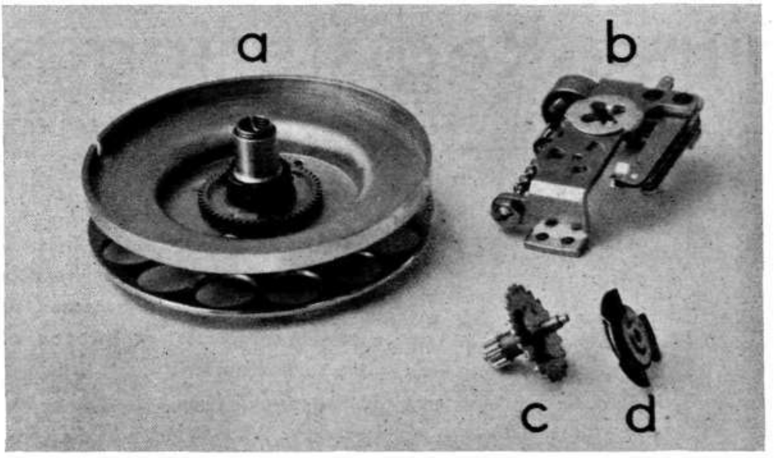


Fig. 2 X 5235
Parts of dial
a plate with finger-holes and main shaft
b bridge with contact springs and regulator
c *intermediate shaft*
d impulse wheel

The spur-wheel of the regulator is carried on the intermediate shaft. A spiral spring on the intermediate shaft stops the spur-wheel's progress, thus forming a clutch in such a way that the spur-wheel is free when the intermediate shaft turns one way but is driven round when it runs the other.

The impulse wheel must have a fixed final position in relation to the dial and is not therefore fixed to the regulator spur-wheel. Instead it turns around the intermediate shaft above a fixed clutch disc, with three grooves, see Fig. 2c. The impulse wheel has three impulse cams made of insulating material, which on the rotation of the wheel pass between the impulse springs and produce breaks in the impulse contacts. On each side of the impulse wheel is attached a thin flat steel spring one of which engages with the grooves of the clutch disc on the intermediate shaft and the other with one of the three holes in the bridge, Fig. 2b. By means of the last-named spring the impulse wheel is blocked when the dial is returning and by means of the first it is brought along with the movement of the dial so that the impulse contacts are operated.

In view of the fact that the distance between the first finger-hole and the finger-stop corresponds to two hole spaces the impulse wheel operates the impulse contact once too often with each return movement of the dial. In order to prevent this extra impulse being transmitted the spring group has been provided with an extra spring which short-circuits the impulse contact during the last period of the movement of the dial. This spring works in conjunction with a spring in the spring group, which short-circuits the speaking set when the dial begins its movement. A stop pressed on the mainshaft cog-wheel acts on this spring just before the dial returns to its original position and closes the short-circuiting contact on the impulse springs and breaks the short-circuit of the speaking set.

The impulse ratio of the standard design is 40—42 % making and 60—58 % breaking, but the dial can be made also for other ratios, for example the 37/67 required for certain automatic systems. The impulse speed is 10 impulses per second, with a permissible variation of ± 1 impulse per second. The spring group in standard design comprises the five springs whose function has been described, but the spring group may be constructed in other ways, according to requirements. In other words, the dial can be made suitable for connection to most automatic systems.

As will be seen from the description and the illustrations, the dial comprises only a few parts, all of which are simple in construction and small in dimensions. The weight of the dial is thus only 185 g without protecting hood. All parts are easily accessible for inspection and lubrication, and wear is reduced to the minimum. The design moreover ensures very quiet operation.

Tests made have shown that the new dial fulfils all reasonable requirements in respect of durability and that it can be relied upon to show no appreciable alteration in its properties, even after several decades in use.

Time-Registering Apparatus

A. PARSCHIN & S. Å. NILSSON, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

Telefonaktiebolaget L. M. Ericsson has constructed an apparatus for the registration of several simultaneous processes. The apparatus is useful for a number of different purposes, such as timing horse-races, time studies of working processes, registration of telegraphic communications arriving at the same time etc.

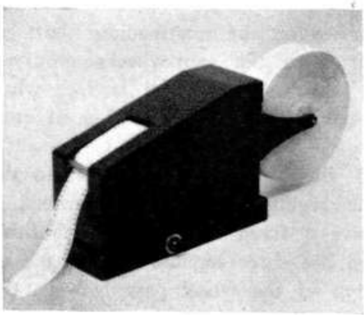


Fig. 1 X 3399
Time-registering apparatus

The time-registering apparatus, Fig. 1, is designed to register the current impulses in six signal circuits. Registration is done on a paper strip by means of six electro-magnets, connected in the different signal circuits. The marking is done by six stamps, see Fig. 2. When the electro-magnets receive current the stamps on the fixed arms of the magnet armature strike an inked ribbon which lies between the front end of the stamps and the paper. This marks the paper with a cross line 2 mm long. The ribbon is made to progress by a synchronous motor and changing of the direction of movement of the ribbon is automatic.

The 32 mm wide paper strip is divided along its length into six sections, each section corresponding to one of the six electromagnets of the apparatus. The paper is perforated at the edges and moves by a synchronous motor which is connected to 50 p/s AC mains. This ensures an even forward movement of the paper so that the intervals of time between the impulses received by the electro-magnets are proportional to the distances between the markings of the electro-magnets on the paper.

The apparatus is mounted on a stand of black-enamelled sheet metal and protected by a sheet-iron cover which is fitted at the back with a bearing for the paper roll. The roll holds about 500 m of paper, sufficient for six hours' continuous running. The windings of the synchronous motor and the electro-magnets are connected to terminal strips, fitted to the underside of the stand. There is a starting switch at the side of the stand.

On account of the accurate feeding of the paper and its rapid rate of movement, 25 mm/s, the apparatus can be employed for accurate time readings. The intervals of time between the different stampings can either be read off on a scale, or a special paper, Fig. 3, may be used. The space

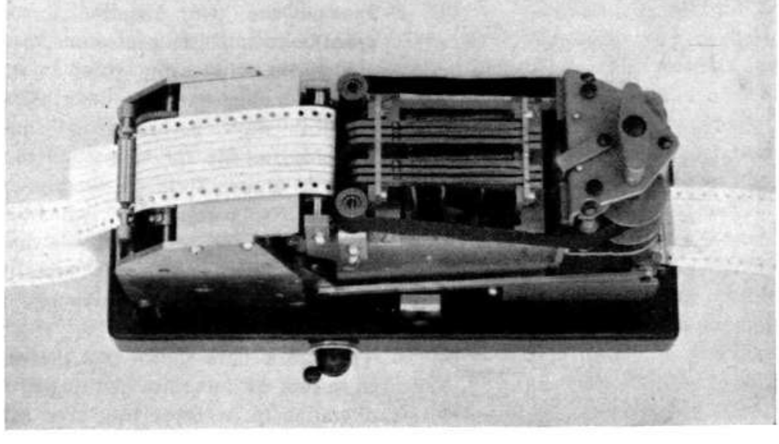
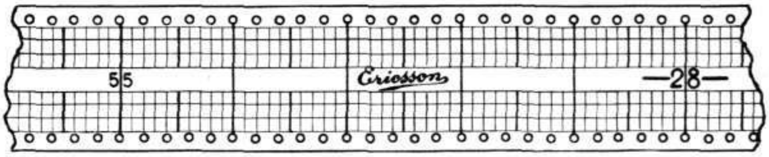


Fig. 2 X 5200
Time-registering apparatus, seen from above. In centre may be seen the stamps which are impressed on the paper by electro-magnets to register the passage of time

Fig. 3
Paper strip marked for accurate time-keeping
The interval between cross-lines represents 0.1 s

X 5201



between the cross lines on this paper is 2.5 mm which corresponds to 0.1 s, so that it is possible to read even considerable intervals of time with an accuracy of 0.01—0.02 s.

The apparatus is particularly suitable for timing horse races. Ususally the timing of these is done by the time for the winning horse being taken by one or more stop watches, the following horses' time being read on a mechanically operated double telegraph apparatus, one pair of magnets of which receives impulses from a seconds clock while the other pair of magnets receives current over a press-button which is pressed as each horse passes the winning post. For this purpose the time-registering apparatus with graduated paper is more suitable, since the time for the first horse as well as for succeeding horses is obtained by subtracting the time stamped at the start from the times stamped as each horse comes in.

The apparatus can also be used for accurate study of working-processes, it being possible to check six processes at one time. In comparison with ordinary stop watches more accurate times are obtained with the synchronously driven time-registering appartus while it may also be an advantage to have the time registered direct, which is not possible when stop watches are used.

In addition the apparatus is useful in large fire stations containing several telegraph apparatus for registering alarm signals and where it is a convenience to have a common control apparatus which registers all the alarm signals together. In this way the reading can be done more rapidly than if it is necessary to go from one apparatus to another to read off the signals. Besides, it is only the paper strip of the collecting apparatus which needs to be kept for record.

In the larger fire-station telegraph installations each supervisory circuit has two clockwork-driven telegraph apparatus or one double telegraph apparatus. As a control apparatus a double telegraph apparatus is generally used, one pair of relays registering all signals coming in on the left-hand telegraph apparatus of the supervisory circuit and the other pair registering all signals coming in on the right-hand apparatus. Thus it is not possible to see from the paper strip of the control apparatus from which supervisory circuit the signal has come and only two signals from one circuit can be registered simultaneously. On the other hand the time-registering apparatus is sufficient for up to six simultaneous signals, and it is possible to see direct on the paper strip from which telegraph apparatus a signal has come; no confusion can therefore occur with the simultaneous reception of several signals.

Bells for Alternating Current

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

Telefonaktiebolaget L. M. Ericsson has produced a new polarised AC bell of up-to-date and attractive design mainly intended as a supplementary bell for telephone instruments.

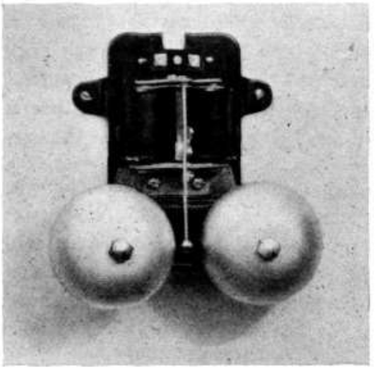


Fig. 1 X 3482
AC bell mechanism

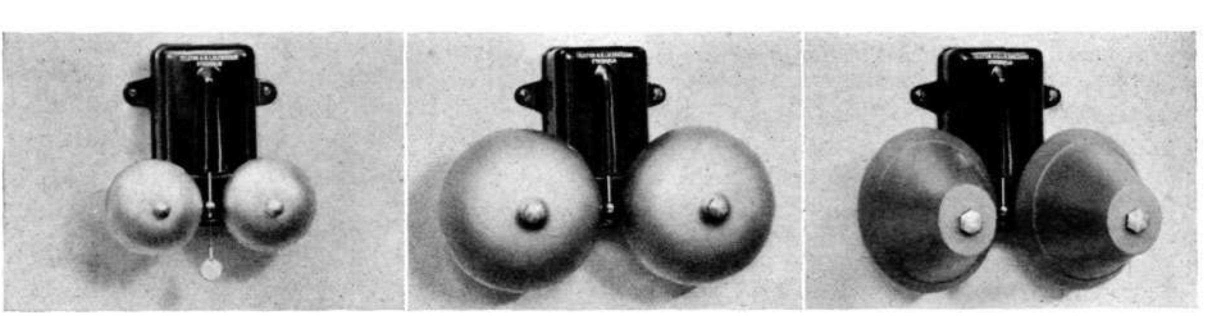
The mechanism of the new bell, Fig. 1, is of the same type as employed in the Ericsson standard bakelite instruments, see Ericsson Review No 1, 1933. The mechanism is mounted on a sheet metal plate which also serves to hold the gongs. The mechanism is provided with a cover which is attached to the metal plate by means of a simple snap fastener. By removing the cover the whole mechanism of the bell is easily accessible for inspection and adjustment. Connecting wires for the bell are led in through a hole on the top of the plate and connected to a bakelite terminal by means of two screws. The bakelite terminal is particularly simple and strong in design. The bell is completely enclosed so that no dust or dirt can enter. The gongs are of cadmiumised brass.

The bell is designed for 16—20 c/s AC, but may also be used for 50 c/s. It is supplied with windings for 300, 1 000 or 2 000 ohm, according to the instrument to which it is to be connected. For the connection in series of several bells, as for example in a fire-alarm circuit, it is delivered with 2 or 20 ohm resistance.

The bell can be supplied in three forms, Fig. 2, according to the size of the gongs. The smallest has two gongs of different strength of tone, each 64 mm diameter. It is principally used as extra bell for telephone instruments in private houses, offices and on premises which are not very large. The two larger types are intended for mounting in places where fairly loud ringing is required, such as in large premises or out-of-doors. They may be had with 108 mm gongs or with sheep gongs; the latter have a distinct tone, easy to recognise where several bells are set up close together.

In premises of considerable size, where several bells are mounted alongside each other, these may be provided with tremblers. The trembler consists of a steel spring attached to the clapper; at the lower end of the spring is a disc which continues swinging for a little while after the bell has stopped ringing, so that it is easy to see which bell has rung. The bells with 64 and 108 mm circular gongs may be provided with a hood to protect them against snow and rain when mounted out-of-doors.

Fig. 2 X 7083
AC bell
left, with 64 mm gongs and trembler; centre, with 108 mm gongs; right, with sheep gongs



New Ceiling Socket for Electric Light Fittings

E. JENSEN, SIEVERTS KABELVERK, SUNDBYBERG

Sieverts Kabelverk has recently designed a new ceiling socket for the connection of electric fittings, which constitutes a technically correct solution of this problem.

All the troubles associated with hitherto existing ceiling roses are avoided in the new socket, which has in additon a very efficient suspension device.

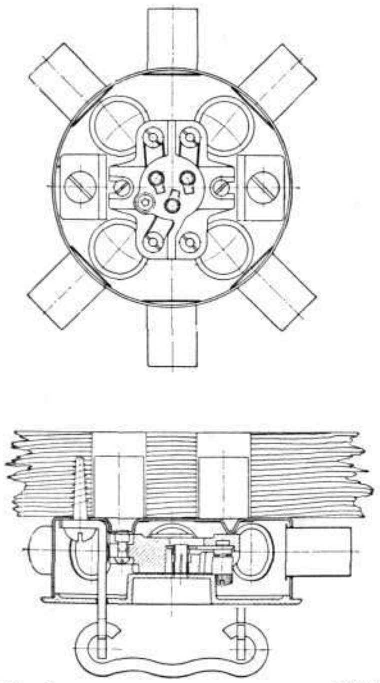


Fig. 1 X 3476
Plan and cross-section of ceiling socket

In the effort to arrive at a reasonable solution of the question of contacts, Sieverts Kabelverk has produced an entirely new ceiling rose designed to be inset in the ceiling where the fitting is attached. In view of the fact that it must be possible to connect old-type fittings to this new ceiling rose, the contact parts have been given the same dimensions in the main as former designs. The ceiling socket, Fig. 1, is provided with four terminals. Two of these are intended for the two leads from the switch, for connection to the contact sockets. The third is connected to the third contact socket and intended for the lead which does not pass through the switch, *i. e.*, the earth-lead in earthed systems. The fourth terminal is for the connection of the incoming tension supply lead, which branches off to the switch. The connecting terminals are of the same type as for ordinary wall boxes. Thus it is always possible to employ the ceiling rose even for distributing one or more leads.

The socket is fitted to the ceiling, Fig. 2, by means of a cadmiumised box made of 1 mm sheet metal. The rose is fixed to the bottom of this by two screws. There are guideholes in the box for connecting the insulating tubes, six in the cylindrical sides and four in the bottom. The holes may be opened as required and the tubes joined up by comparatively long connecting sections, pushed into the holes from inside the box. Connecting sections may be had for 11 and 13.5 mm Bergmann conduit and for the corresponding steel-armoured conduit. The box has a bakelite cover, with the recess in the centre for the plug so deep that effective protection against contact with tension-carrying parts is ensured.

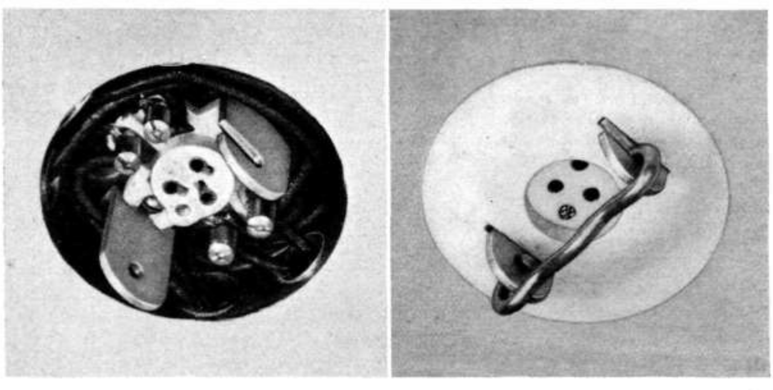


Fig. 2 X 5232
Socket fitted in ceiling
left, connecting box opened, note ample space for wires
right, socket closed with hook suspended in normal position

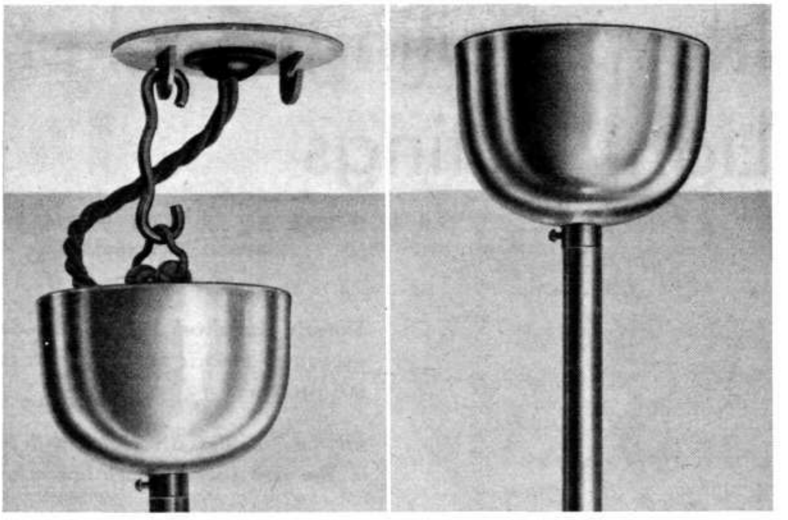


Fig. 3. X 5230
Connecting light fitting to ceiling socket
Left, fitting suspended from lower end of hook; right, the fitting, after connection, pushed up to ceiling, concealing all connecting devices

A point of the greatest importance is the suspension of the electric fitting. This may be arranged in various ways. The most simple is to employ an ordinary hook, fixed at the side of the rose. Sieverts has also considered this way but finally decided to have the socket in the centre of the box and use a hook, Fig. 2, so shaped that the light fitting also in the centre of the box. This enables the box to be made smaller in diameter, which improves the appearance; it is only 90 mm. The hook hangs from two iron rods fixed in the box. It is firmly fixed in a hole in one rod and fits in a groove in the other. When putting up the light fitting, the hook hangs loose from the rod, Fig. 3, while the other end is used to hold up the fitting. As the hook is about 80 mm long, the fitting then hangs an appreciable distance from the ceiling, and it is easy to push the plug into the ceiling socket. When the connection is completed, the fitting and the hook are lifted up, the hook being inserted in the other rod, see Fig. 3.

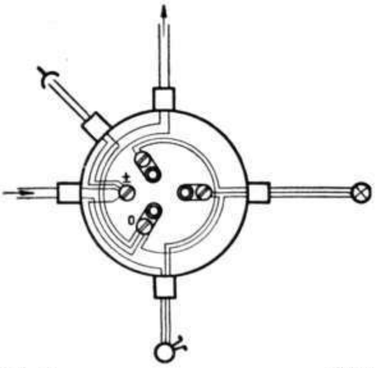


Fig. 4 X 3436
Diagram of connections to ceiling socket
To box, Fig. 2, have been connected a two-wire conductor from the mains, a three-wire conductor to a two-way switch, a three-wire to a fitting connected in parallel, a two-wire to a wall-socket and a two-wire to an additional light point

The new ceiling socket not only constitutes a good solution from the technical point of view of the problem. Seeing that the socket is in the shape of a terminal strip with good terminal screws, the distribution, hitherto done in wall boxes, may with advantage be transferred to the ceiling box, see diagram Fig. 4. Thus the lead from the mains can be taken direct to the first ceiling socket, from there to the next, and so on. The branches can be led from the ceiling socket to the switches and the wall sockets. By this means wall boxes, usually somewhat unsightly, can be done without. If the change-over from the earlier and more primitive arrangement is accompanied by the use of the much better insulated single-conductor cable instead of multi-conductor cable the whole work of connecting up the installation can be simplified. With a multi-conductor all the strands must be cut and joined up in each box; while with through-drawn single-conductor to be connected in a box, it is sufficient to insulate it at the required place and connect without cutting in the terminals. Those conductors which are not to be connected in the box, as for example the two conductors connecting two staircase switches working together, are simply drawn through the box without any attachment.

Ericsson at the Exhibitions

Telefonaktiebolaget L. M. Ericsson has during the summer participated in the Jubilee Exhibition of Härnösand, with a display of telephone and signalling material which has aroused real interest on account of the variety and the technical perfection of the productions on view.

Société des Téléphones Ericsson has taken the initiative in arranging a display of electric timepieces, which will in future be an annual event, with the French organisation, Office Central Électrique, as organiser. The exhibition this year, the first of its kind in France, constituted a general survey of the various makes of electric clocks, including the clocks for night connection manufactured by Société des Téléphones Ericsson in conjunction with the world-famed clock-making firm, Société Lip.

Ericsson Technics

Ericsson Technics No 3, 1935.

T. Laurent: Measurement of Attenuation and Phase Angle by a Balancing Method.

This paper demonstrates how several of the measurements essential to telephone practice may be carried out with a measuring bridge, the ratio of which consists of a symmetrical variable potentiometer with its output terminals connected to a high-resistance impedance composed of a variable condenser in series with a variable resistance.
The pontentiometer consists of a variable artificial line with low characteristic impedance, loaded without reflexion, the output terminals of which are connected to the high-resistance impedance without appreciably loading the artificial line. The three bridge points of the ratio are formed by the two input terminals of the artificial line as well as the junction point between the condenser and the resistance of the high-resistance impedance. At the end of the article a description is given of a measuring bridge, consisting of such a ratio, constructed by Telefonaktiebolaget L. M. Ericsson. This apparatus will certainly be a helpful accessory in the hands of the operating engineer for supervision and fault localizing in telephone networks.

Ericsson Technics No 4, 1935.

T. Laurent: Méthode de pupinisation de câbles permettant de reproduire l'impédance caractéristique des circuits aériens.

This paper describes a new method, worked out theoretically for the loading of cables. The method allows cables to be given a characteristic impedance reproducing with a high degree of accuracy that of aerial circuits; the method should therefore prove itself of great practical importance, particularly for adjustment without reflection between cables and aerial lines or between cables and the exchange instruments.
With this arrangement the properties of a large number of telephone circuits could be improved without great expense for additional plant.
The method is based on three-branch half-sections of filters as dealt with by the author in the Ericsson Technics No 5, 1934, which were used for the first time in the Ericsson two-wire repeater.

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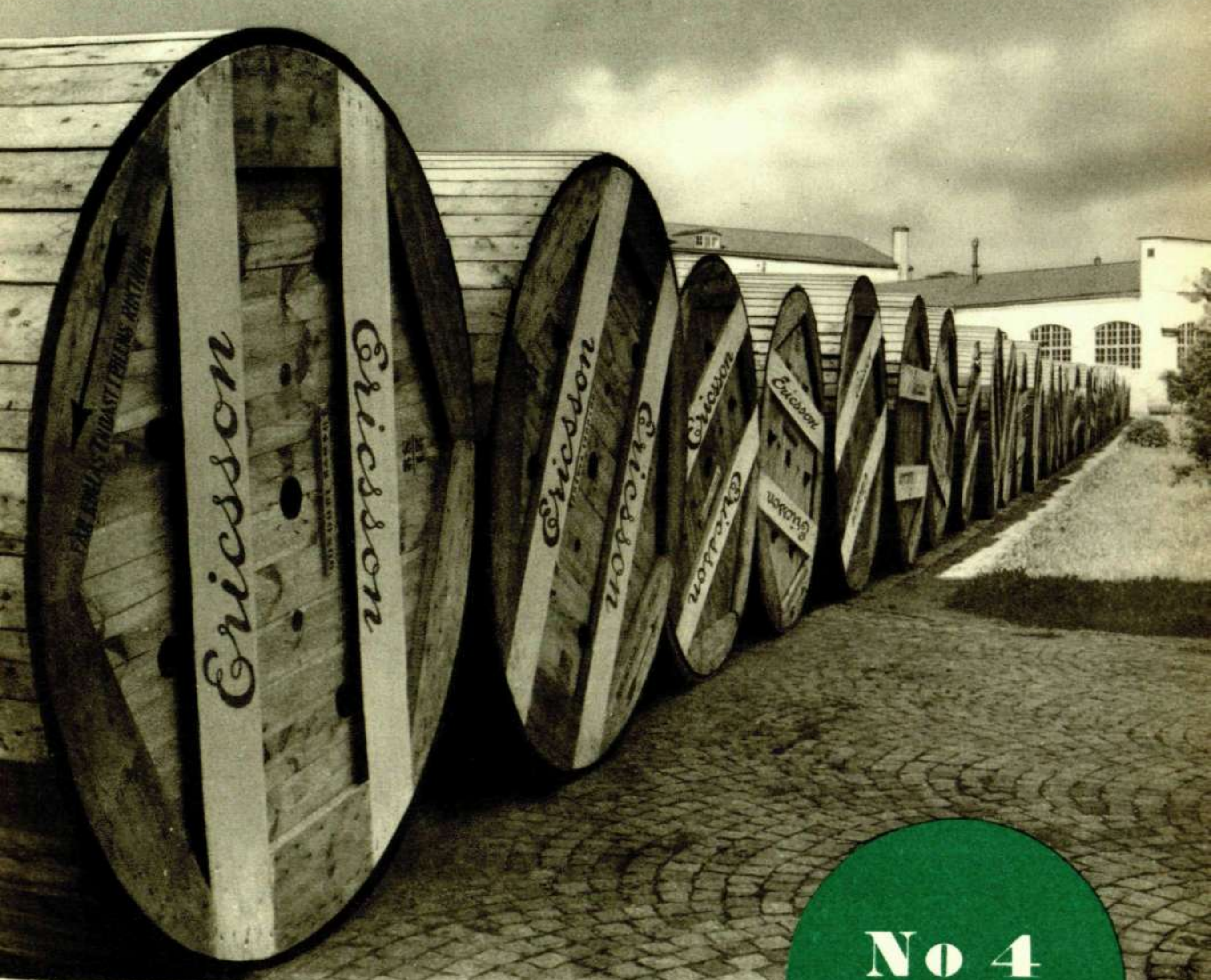
Ericsson Review



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Effect of the World Economic Crisis on the Number of Telephones

A. LIGNELL, FORMER DIRECTOR OF TELEPHONES, STOCKHOLM

It is quite natural that the economic crisis which spread over the world should affect the operation of telephones, which naturally is to a very high degree sensitive to good and bad times economically speaking. Telephone activity has been severely hit in a number of countries, where the number of telephones has considerably decreased, while in other cases the crisis has checked expansion, making it less than would have been the case in normal conditions.

It may be of interest to study more in detail the effect of the economic depression and the present review has therefore been made on the basis of the American Telephone and Telegraph Company's »Telegraph and Telephone Statistics of the World» for the years 1931, 1932 and 1933, the last-named representing the latest world figures available. The three year period in question is particularly suitable, seeing that the depression appears to have touched bottom during 1933. In the latter half of 1933 and during the whole of 1934 a marked improvement was noticeable in the countries most hardly hit, with a return to expansion in the numbers of telephones.

The number of telephones in the world showed continuous increase up to 1931. During the ten years 1921—1930 the number of telephones rose from 20 850 000 to 35 336 000, an increase of 14 486 000, approximating to 70 %. Of this increase 6 872 000 telephones, or about half, occurred in the pioneer land of telephones, USA, which on 1st January 1931 had 20 201 576 constituting 57.2 % of the world's total number of telephones.

During the same period the increase in Europe was 5 300 000, in South America 333 000, in Asia 756 000, in Africa 145 000 and in Oceania 418 000 telephones.

Beginning with 1931, however, there was a set-back. While, as stated, the number of telephones in the world increased during the decade 1921—1930 by 14 486 000 or an average of 1 448 000 per year, the number decreased during the years 1931—1933 by 2 840 000, an average of 946 000 per year. The reduction exclusively affected North America and Oceania representing 17.1 and 7.2 % of the telephones in those parts of the world. Telephone density throughout the world sank from 1.8 to 1.54 telephones per 100 inhabitants.

The increase or decrease per year in the various parts of the world for the periods 1921—1930 and 1931—1933 were

	Average 1921—1930	1931	1932	1933	Average 1931—1933
Europe	+ 530 000	+ 282 359	+ 185 634	+ 249 740	+ 239 200
North America	+ 753 400	— 560 856	— 2 375 727	— 792 368	— 1 242 900
South America	+ 33 300	+ 17 671	+ 7 721	+ 6 708	+ 10 700
Asia	+ 75 600	+ 5 913	+ 87 335	+ 77 751	+ 57 000
Africa	+ 14 500	+ 4 982	+ 6 621	+ 12 932	+ 8 200
Oceania	+ 41 800	— 28 861	— 27 683	— 478	— 19 000

As will be seen from the above, in cases where there is no decrease in the number of telephones, the increase during the years 1931—1933 was considerably reduced. The revival during 1933 is also plainly apparent.

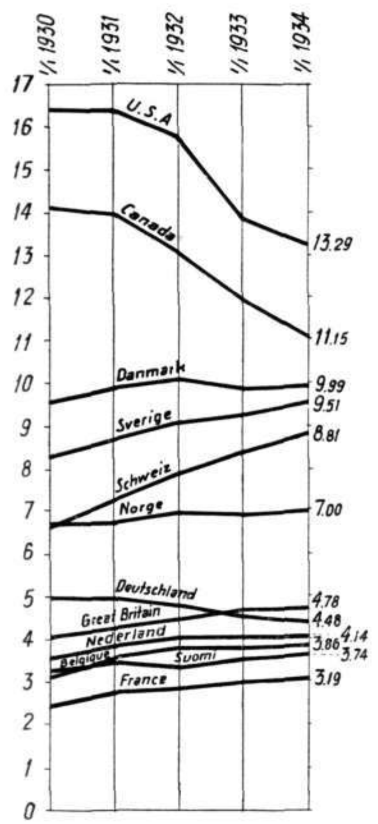


Fig. 1 X 3500
Number of telephones per 100 inhabitants 1/1 1930—1/1 1934

Europe

The period 1931—1933 brought about a small increase in the number of telephones in Europe, from 10 589 222 to 11 306 955 or a rise of 717 733 telephones corresponding to 6.8 %. The number of telephones per 100 of population shows a slight rise from 2.0 to 2.02. Reduction in the numbers of telephones took place in Germany by 295 240 telephones or 9.1 %, in Jugoslavia by 22 785 telephones or 32.6 %, in Poland by 10 174 telephones or 5.1 % and in Hungary by 4 116 telephones or 3.6 %.

In Germany bottom was reached in July 1933, after which a rise in the use of the telephone took place for the remaining part of the year. The fall in Poland affected the state-operated lines the most, *viz.*, with 7 844, while private operation lost 2 330 telephones. The other countries of Europe show increase in numbers of telephones. In respect of the absolute number of telephones at the beginning and the end of the period, Germany, Great Britain, France and Sweden have maintained their places in order of density. Great Britain shows the highest increase with 229 432 telephones, next to her being Russia and France with 198 746 and 195 960 increase in telephones respectively. Italy, which at the opening of the period held the fifth place in respect of number of telephones, has in spite of an increase of 100 515 telephones, corresponding to 26.3 %, been compelled to cede that place to Russia. Further, Switzerland has increased by 65 725 and passed the Netherlands; Spain with an increase of 68 447 has passed Austria; Norway has passed Poland, Latvia and Rumania have passed Jugoslavia and Greece has passed Bulgaria. The average increase per year is, as noted earlier, considerably lower than for the period 1921—1930.

Changes in the numbers of telephones per 100 inhabitants in a number of European countries compared with the changes in the USA and Canada, which two countries possess the greatest telephone density, are shown by the diagram in Fig. 1. As will be seen the telephone density in USA has sunk from 16.4 telephones per 100 inhabitants to 13.3 and in Canada from 14.2 to 11.24. At the same time Sweden, and more particularly Switzerland, registered a strong rise which appears to be continuing: during 1934 telephone density in Sweden rose to 9.9 and in Switzerland to 9.2. Great Britain went in front of Germany during 1932.

North America

The number of telephones in this part of the world has gone down by 3 726 951 instruments, or 17.1 %. Telephone density has sunk from 13.0 to 10.4. USA, which has the world's greatest telephone density in respect of size of population, lost 3 490 718 telephones during the three year period under review.

It was, however, to be expected that a severe economic depression would hit the telephone service most hardly where the telephone is spread also among those classes of the population which are less well endowed economically, as is the case in USA. Still during the latter part of 1933 the number of telephones in USA began once more to increase and for 1934 there was a net increase of 298 000 telephones.

Canada has during the period under review a loss of 210 531 telephones, corresponding to 15 %. In Cuba the decrease was catastrophic: a loss of 35 600 telephones, representing about 52 % of the number as at 1st January 1931.

Mexico is the only country in North America which shows an increase. The number of telephones there rose from 92 059 to 101 208, or by 9.9 %. This increase was solely in privately operated telephones.

South America

The number of telephones here rose by 32 094, or 5.2 %, and the telephone density rose slightly to 0.71. The largest increases were noted in Argentina, Brazil and Uruguay.

Asia

The increase in the number of telephone amounted to 170 099 or 13.7 %. There was a slight rise to 0.14 in telephone density. The chief increase took place in Japan with 102 215 more telephones, corrresponding to 11.2 %. There were insignificant increases in China and the British India, while the rest of Asia had an increase of 66 543, or 52.7 %.

Africa

An increase of 24 535 telephones has taken place, most of which are represented by the Union of South Africa. The telephone density is 0.18.

Oceania

There was a decrease of 57 022 telephones, or 7.2 %. Telephone density has gone down from 1.0 to 0.8. The greatest decrease took place in Australia consisting of 32 507 telephones, or 6.2 %, and in the Netherlands Indies and New Zealand showing decreases of 12 115 and 9 680 respectively, corresponding to 24.4 and 5.9 %.

Large Towns

It may be of interest to see how the crisis has affected the telephone movement in the large towns, especially those of Europe and USA. The following table gives a comparison of telephone densities in some of the larger North American and European towns, in the latter case where there were more than 5 telephones per 100 inhabitants on 1st January 1931 and 1st January 1934.

	1/1 1934		1/1 1931		Increase or Decrease 1931—1933
	Position Number	Telephones per 100 Inhabitants	Position Number	Telephones per 100 Inhabitants	
Washington	1	35.3	2	34.0	+ 1.3
San Francisco	2	35.0	1	40.2	— 5.2
Stockholm	3	32.0	5	31.2	+ 0.8
Denver	4	28.6	4	31.7	— 3.1
Los Angeles	5	25.8	6	30.4	— 4.7
Omaha	6	24.9	7	29.3	— 4.4
Seattle	7	24.5	3	31.8	— 7.3
Minneapolis	8	23.1	9	26.8	— 3.7
Chicago	9	22.4	8	28.7	— 6.3
New York	10	20.8	10	25.5	— 4.7
Zürich	11	20.5	14	17.1	+ 3.4
Copenhagen	12	20.4	13	18.5	+ 1
Oslo	13	20.3***	12	18.7†††	+ 1.6
Pittsburg	14	18.1	11	23.4	— 5.3
Gothenburg	15	16.6	15	15.4	+ 1.2
Paris	16	14.2	16	13.4	+ 0.8
Helsinki	17	14.0	17	13.1	+ 0.9
Honolulu	18	11.2	18	12.4	— 1.2
Berlin	19	10.9*	19	12.2	— 1.3
Brussels	20	10.7**	21	10.1	+ 0.6
Hamburg-Altona	21	9.2*	20	11.2	— 2.0
London	22	9.1*	23	8.7†	+ 0.4
Vienna	23	8.4	24	7.7	+ 0.1
Cologne	24	8.2*	22	9.5	— 1.3
Roma	25	7.6	30	4.3††	+ 3.3
Antwerp	26	7.4**	26	7.3	+ 0.1
Amsterdam	27	7.1	29	6.6	+ 0.5
Rotterdam	28	6.5	28	6.9	— 0.4
Danzig	29	6.4	25	7.5	— 1.1
Madrid	30	5.8	31	5.2	+ 0.6
Riga	31	5.6*	30	5.6†	0.0
Budapest	32	5.5	27	7.3	— 1.8

* 31st March 1934
** 28th February 1934
*** 30th June 1933

† 31st March 1931
†† 1st January 1930
††† 30th June 1930

Telephone density has, as was natural, decreased very considerably in the big American towns. Washington constitutes an exception; there it has increased from 34.0 to 35.3 telephones per 100 inhabitants. Stockholm has gone up from fifth to third place. For the rest the American towns maintain their advance, with the exception of Pittsburgh which has been passed by Zürich which latter has registered a considerable rise, as well as by Copenhagen and Oslo. The great gap formerly existing between the density in Europe and that of the American towns has been considerably reduced. Rome shows a remarkable increase, in that telephone density since 1st January 1930 has gone up from 4.3 to 7.6 telephones per 100 inhabitants.

Number of Telephones and Telephone Density in Various Countries 1/1 1931 and 1/1 1934

	1st January 1931				1st January 1934				Increase or Decrease 1/1 1931—1/1 1934	
	Number of Telephones									
	State Operated	Privately Operated	Total	per 100 Inhabitants	State Operated	Privately Operated	Total	per 100 Inhabitants	Number	%
Europe										
Germany	3 248 854	—	3 248 854	5.0	2 953 614	—	2 953 614	4.48	— 295 240	— 9.1
Great Britain	1 996 897	—	1 996 897	4.3	2 226 329	—	2 226 329	4.78	+ 229 432	+ 11.5
France	1 153 560	—	1 153 560	2.8	1 349 520	—	1 349 520	3.19	+ 195 960	+ 17.0
Sweden	534 722	1 670	536 392	8.7	589 394	1 520	590 914	9.51	+ 54 522	+ 10.2
Italy	—	381 992	381 992	0.9	—	482 507	482 507	1.13	+ 100 515	+ 26.3
Russia	377 586	—	377 586	0.2	576 332	—	576 332	0.35	+ 198 746	+ 52.6
Denmark	13 593	340 722	354 315	9.9	16 289	348 438	364 727	9.99	+ 10 412	+ 2.9
Netherlands	306 554	—	306 554	3.9	343 177	—	343 177	4.14	+ 36 623	+ 11.9
Switzerland	297 930	—	297 930	7.3	363 655	—	363 655	8.81	+ 65 725	+ 22.1
Belgium	292 633	—	292 633	3.6	317 217	—	317 217	3.86	+ 24 584	+ 8.4
Austria	233 912	—	233 912	3.4	239 870	—	239 870	3.55	+ 5 958	+ 2.5
Spain	—	222 382	222 382	1.0	—	290 829	290 829	1.24	+ 68 447	+ 30.8
Poland	108 683	90 696	199 379	0.6	100 839	88 366	189 205	0.57	— 10 174	— 5.1
Norway	115 164	77 400	192 564	6.7	121 376	78 400	199 776	7.0	+ 7 212	+ 3.7
Czechoslovakia	147 028	17 451	164 479	1.1	149 296	19 878	169 174	1.12	+ 4 695	+ 2.9
Finland	1 642	126 500	128 142	3.5	1 658	138 000	139 658	3.74	+ 11 516	+ 9.0
Hungary	115 273	—	115 273	1.3	110 430	727	111 157	1.25	— 4 116	— 3.6
Iugoslavia	70 000	—	70 000	0.5	46 006	1 209	47 215	0.33	— 22 785	— 32.6
Latvia	51 530	—	51 530	2.7	62 174	—	62 174	3.19	+ 10 644	+ 20.7
Rumania	—	49 809	49 809	0.3	—	51 613	51 613	0.28	+ 1 804	+ 3.6
Portugal	7 803	28 963	36 766	0.6	11 500	35 706	47 206	0.68	+ 10 440	+ 28.4
Iceland	30 601	—	30 601	1.0	33 450	—	33 450	1.11	+ 2 849	+ 9.3
Bulgaria	19 000	—	19 000	0.3	20 276	—	20 276	0.33	+ 1 276	+ 6.7
Greece	12 800	—	12 800	0.2	—	20 356	20 336	0.31	+ 7 556	+ 59.0
Rest of Europe	99 507	16 365	115 872	1.4	104 308	12 696	117 004	1.41	+ 1 132	+ 1.0
	9 235 272	1 353 950	10 589 222	2.0	9 736 710	1 570 245	11 306 955	2.02	+ 717 733	+ 6.8
North America										
United States	—	20 201 576	20 201 576	16.4	—	16 710 858	16 710 858	13.29	— 3 490 718	— 17.3
Canada	241 309	1 161 552	1 402 861	14.0	193 641	998 689	1 192 330	11.15	— 210 531	— 15.0
Mexico	1 427	90 632	92 059	0.6	1 337	99 871	101 208	0.59	+ 9 149	+ 9.9
Central America	11 893	13 376	25 269	0.4	12 137	14 020	26 157	0.39	+ 888	+ 3.5
Cuba	485	67 991	68 476	1.8	485	32 355	32 840	0.81	— 35 636	— 52.0
Porto Rico	602	11 776	12 378	0.8	537	11 209	11 746	0.71	— 632	— 5.1
Other parts of West Indies	8 222	13 531	21 753	0.3	7 044	14 135	21 179	0.32	— 574	— 2.6
Rest of North America	100	11 829	11 929	3.3	—	11 032	11 032	3.02	— 897	— 7.5
	264 038	21 572 263	21 836 301	13.0	215 181	17 892 169	18 107 350	10.38	— 3 728 951	— 17.1
South America										
Argentina	—	303 000	303 000	2.6	—	312 086	312 086	2.64	+ 9 086	+ 3.0
Brazil	674	162 000	162 674	0.4	1 041	169 764	170 805	0.38	+ 8 131	+ 5.0
Chile	—	48 687	48 687	1.1	—	46 159	46 159	1.04	— 2 528	— 5.2
Columbia	2 500	26 888	29 388	0.3	2 500	27 425	29 925	0.32	+ 537	+ 1.8
Uruguay	—	29 356	29 356	1.6	—	42 707	42 707	2.14	+ 13 351	+ 45.5
Venezuela	591	20 931	21 522	0.7	600	19 390	19 990	0.61	— 1 532	— 7.1
Peru	—	13 745	13 745	0.2	—	17 200	17 200	0.27	+ 3 455	+ 25.1
Ecuador	1 500	2 700	4 200	0.2	3 010	2 730	5 740	0.23	+ 1 540	+ 36.7
Bolivia	—	2 333	2 333	0.1	—	2 000	2 000	0.06	— 333	— 14.3
Paraguay	185	1 905	2 090	0.2	—	2 499	2 499	0.28	+ 409	+ 2.0
Rest of South America	2 830	—	2 830	0.5	2 808	—	2 808	0.52	— 22	— 0.8
	8 280	611 545	619 825	0.7	9 959	641 960	651 919	0.71	+ 32 094	+ 5.2

	1st January 1931				1st January 1934				Increase or Decrease 1/1 1931—1/1 1934	
	number of telephones									
	State Operated	Privately Operated	Total	per 100 Inhabitants	State Operated	Privately Operated	Total	per 100 Inhabitants	Number	%
Asia										
Japan	913 157	—	913 157	1.4	1 015 372	—	1 015 372	1.50	+ 102 215	+ 11.2
China	84 000	69 000	153 000	0.03	72 000	82 000	154 000	0.03	+ 1 000	+ 0.7
British India	22 000	35 000	57 000	0.02	22 804	35 437	58 241	0.02	+ 1 241	+ 2.7
Rest of Asia	108 881	17 502	126 383	0.1	132 669	60 257	192 926	0.12	+ 66 543	+ 52.7
	1 128 038	121 502	1 249 540	0.1	1 242 845	177 694	1 420 539	0.14	+ 170 999	+ 13.7
Africa										
Union of South Africa	112 900	—	112 900	1.4	126 608	—	126 608	1.50	+ 13 708	+ 12.1
Egypt	46 000	—	46 000	0.2	46 888	—	46 888	0.22	+ 888	+ 1.9
Rest of Africa	86 871	1 320	88 191	0.1	96 317	1 813	98 130	0.09	+ 9 939	+ 11.3
	245 771	1 320	247 091	0.2	269 813	1 813	271 626	0.18	+ 24 535	+ 9.0
Oceania										
Australia	520 169	—	520 169	8.1	487 662	—	487 662	7.35	— 32 507	— 6.2
New Zealand	164 739	—	164 739	10.2	155 059	—	155 059	10.01	— 9 680	— 5.9
Netherlands Indies	49 447	4 598	54 045	0.1	38 267	3 663	41 930	0.06	— 12 115	— 22.4
Philippines	6 000	20 017	26 017	0.2	6 000	20 182	26 182	0.19	+ 165	+ 0.6
Hawai	—	25 104	25 104	6.6	—	23 111	23 111	5.78	— 1 993	— 7.9
Rest of Oceania	3 638	776	4 414	0.2	3 294	228	3 522	0.15	— 892	— 20.2
	743 993	50 495	794 488	1.0	690 282	47 184	737 466	0.81	— 57 022	— 7.2
Summary										
Europe	9 235 272	1 353 950	10 589 222	2.9	9 736 710	1 570 245	11 306 955	2.02	+ 717 733	+ 6.8
North America	264 038	21 572 263	21 836 301	13.0	215 181	17 892 169	18 107 350	10.38	— 3 728 951	— 17.1
South America	8 280	611 545	619 825	0.7	9 959	641 960	651 919	0.71	+ 32 094	+ 5.2
Asia	1 128 038	121 502	1 249 540	0.1	1 242 845	177 694	1 420 539	0.14	+ 170 999	+ 13.7
Africa	245 771	1 320	247 091	0.2	269 813	1 813	271 626	0.18	+ 24 535	+ 9.9
Oceania	743 993	50 495	794 488	1.0	690 282	47 184	737 466	0.81	— 57 022	— 7.2
Whole World	11 625 392	23 711 075	35 336 467	1.8	12 164 790	20 331 065	32 495 855	1.54	— 2 840 612	— 8.04

Parallel Operation of Carrier Systems on Overhead Lines

A. WESTLING, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

It is often asked how many carrier systems may be run on one and the same pole line. Naturally, it is not possible to give a general reply, though certain rules may be indicated for judging the question. The present paper considers some problems connected with this, from which a number of conclusions may be drawn relating to the selection of the most suitable type of line and carrier system.

The problem of operating a large number of carrier circuits on the same aerial line is chiefly a question of cross-talk and as such is governed both by the carrier system and by the lines. Neither the supplier of the carrier system nor the builder of the lines has the problem entirely to himself, but the solution must be arrived at by the combined work of the two.

The only way in which it is possible to obtain complete independence of the cross-talk properties of the lines is to employ entirely different ranges of frequency for all channels. In order to have a sufficient number of circuits the range of frequency employed would have to be extended far beyond that used at present. The limit in that case would be determined by the attenuation and the noise level on the lines. Even though this method may be to a certain extent possible, it must be left out of account for the present, as it presupposes a departure from present practice.

Thus if it be taken for granted that several carrier systems with frequency bands that coïncide wholly or in part are to be used, then in general both the number of systems and the number of channels per system would be determined by the cross-talk properties of the lines. As is shown in a paper »Cross-Talk between Telephone Circuits» in Ericsson Review, No 10—12, 1930, the cross-talk between two carrier circuits on different lines is not due to a direct far-end cross-talk but to reflected near-end cross-talk. Therefore what is to be investigated more particularly is the near-end cross-talk attenuation on different kinds of lines. In this connection there are two main types to be taken into account: lines continuously twisted and lines transposed at intervals.

Cross-Talk on Twisted Lines

With continuously twisted lines the cross-talk attenuation between the two pairs in the same quad is, theoretically speaking, infinite. The same applies to two pairs in different quads in different phase, *i. e.*, pairs which lie in perpendicular planes the whole time. For two pairs in same phase, *i. e.*, in parallel planes, the cross-talk attenuation has on the other hand a finite value also under ideal conditions. With the type common in Sweden, having 40 cm distance between wires, this theoretical cross-talk attenuation is about 6 neper for two pairs in the same phase in adjacent quads. The corresponding figures for quads lying farther apart are naturally higher. It should be noted that these figures do not depend on the frequency, at least in the range of frequency of which it is question here.

In practice these figures are of course modified and the cross-talk between the two pairs of a quad is chiefly determined by the deviation from ideal conditions, which naturally must arise in practice, partly because of sagging and partly because of variations in distance between insulators and between poles. This cross-talk attenuation attainable in practice naturally shows dif-

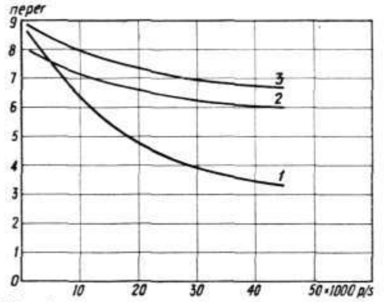


Fig. 1 X 3533

Far-end cross-talk attenuation as function of frequency

measured on twisted lines

1 between pairs in same quad
2 between pairs in neighbouring quads, the pairs in same phase
3 between pairs in neighbouring quads, the pairs in different phase

ferent results with different local conditions, but it always diminishes with increasing frequency. Cross-talk attenuation between pairs in different quads is also dependent on the accuracy of the wiring, but as the distances between the wires are greater the deviations play a smaller role as a percentage. Experience also shows that deviation from the theoretical figures for pairs in the same phase are relatively unimportant. A consequence of this is that the drop in cross-talk attenuation with increasing frequency is only insignificant.

Fig. 1 illustrates this. The curves represent the mean figures for far-end cross-talk attenuation measured on Mexican circuits and are not therefore directly comparable with the figures given above for the theoretical near-end cross-talk. They do, however, indicate the tendency stated, namely that cross-talk attenuation between pairs in different quads does not fall very rapidly with the frequency.

From the above it is clear that comparatively high cross-talk attenuation is attained without special precautions between pairs in different quads even at high frequencies. The cross-talk drops with certainty with the distance between the quads on the pole. The conditions exist therefore for the placing of a carrier system using high frequencies on each quad, even with pole sections having a large number of quads.

Cross-Talk on Transposed Lines

If comparison is made with lines which are not twisted certain deviations in principle will be found. To begin with, such conductors if they are not transposed, have, even with theoretically exact wiring, a finite and fairly low cross-talk attenuation between different pairs. This theoretical attenuation independent of the frequency is thus, for the pole section shown in Fig. 2, only 3.47 neper between one pair and the pair next above or below it. The table, Fig. 2, shows that the cross-talk attenuation is quite low even with pairs at considerable distances from each other. It is therefore, even for voicefrequency, necessary to go in for transposing. Transposing differs in principle from twisting, in that it is not continuous. With all such discontinuous types it is no longer possible to confine the calculations to a cross section of the line but a certain stretch must be dealt with, namely the transposition section in which the cross-talk induced in one part is intended to be compensated by cross-talk of opposite sense in another part. On account of the phase shift along the line, therefore, even the theoretically attainable cross-talk attenuation is dependent upon the redation between the transposition section's length and the wave-length, *i. e.*, on the frequency.

If a curve is drawn representing the additional attenuation $\triangle$ b obtained with a certain transposition as function of the frequency f with a given distance of transposition d, *e. g.*, 0.25 km, or more generally as function of the product of the frequency and the transposition distance, $f.\ d$, there is obtained a falling curve which cuts through the zero line. At higher frequencies therefore transposition gives a reduction in cross-talk attenuation, a reduction which at a certain frequency, the first resonance frequency, becomes very great. Naturally the curve will be different for different types of transposition. On Fig. 3 is shown such curves for the 32 possible types with 32 transposition points per section. It can be seen that the curves may be divided into groups having the same first resonance frequency. The curves really apply to the additional attenuation between a pair, transposed according to a certain type, and an untransposed pair. Between two transposed pairs there is however obtained a relative transposition which corresponds to some of the absolute types. Investigation further shows that two transposition types belonging to one and the same of the above-named groups with the same resonance frequency give a relative transposition which belongs to the same group. The theoretical cross-talk attenuation between two transposed circuits consists therefore of the sum of the fixed cross-talk attenuation for untransposed circuits, *e.g.*, according to the table, Fig 2, and the additional attenuation varying with the frequency, which the relative transposition between them gives, *e. g.*., as Fig. 3. Variations in pole intervals, etc arising in

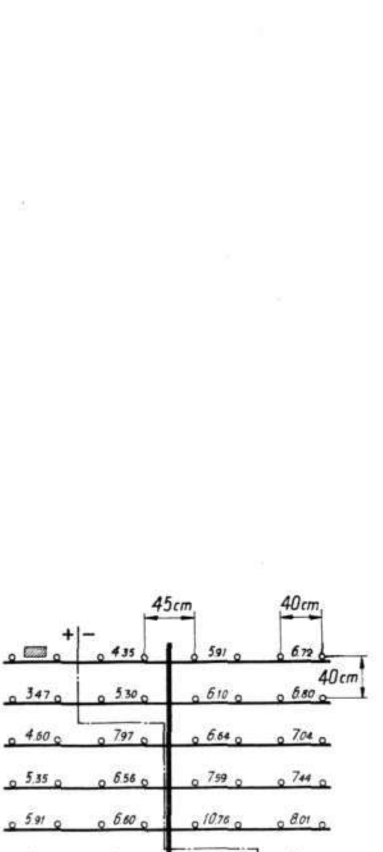


Fig. 2 X 3534

Theoretical near-end cross-talk attenuation between lines neither twisted nor transposed

practice, cause deviations from the theoretical figures, in the first place a reduction of the very high figures which the curves occasionally give.
Exact calculation of the cross-talk attenuations obtainable on a pole line with many pairs is very extensive and constitutes a time-wasting intricate work. It can, however, be seen from the curves, Fig. 3, that the number of transposition types which could be used, *i. e.*, which have a resonance frequency above the frequency range employed, is already quite small if a frequency range up to 20 000 c/s is used and the transposition distance is 250 m. If, therefore, the transposition distance cannot be made very short there are not the same possibilities of a large number of channels per system and a large number of parallel system as with twisted circuits. Phantomising of the circuits still further increases the difficulties, as the phantom transposition must also be of such a type that selective absorption due to resonance frequencies is avoided.

Effect of the Carrier System on Cross-Talk

The cross-talk attenuation resulting between two carrier channels on different pairs working with the same frequency is also determined, both by the cross-talk attenuation between lines proper dealt with above, and by reflections, differences in level and overall line attenuation.
As stated above, cross-talk between carrier circuits is due to reflected near-end cross-talk, and this may be reduced by good matching. A requiremen for the carrier equipment is therefore that it shall be well matched to the line over the whole frequency range. However, the cross-talk calculations cannot be based too much on the increase of cross-talk attenuation which may be attained with good matching. In practice, as a matter of fact, even correctly matched circuits show reflections due to unhomogeneities of various kinds, especially when a cable or apparatus is connected in the circuits.
Cross-talk attenuation naturally is reduced by the level difference which exists between the disturbing and the disturbed circuits. The carrier systems must therefore be so made that the differences in level are as small as possible. This entails, among other things, that the same frequency band cannot be utilised for transmission in both directions and is one of the reasons why carrier circuits are always made as four-wire circuits. A requirement for parallel operation of several carrier systems is thus that a frequency band used for one direction of transmission in one system may not be used for the other direction in any other system.

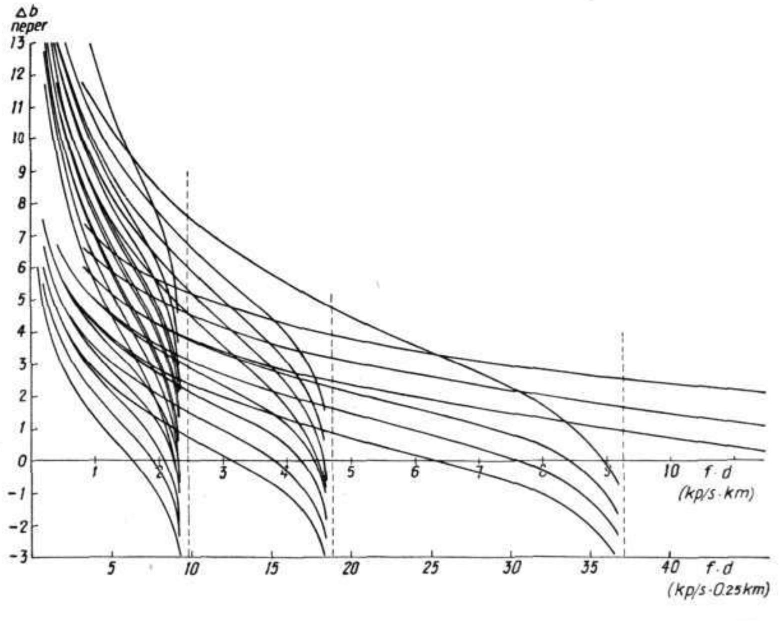


Fig. 3 X 5254
Additional attenuation as function of the product of frequency and transposition distance for different types of transposition

Compared with the near-end cross-talk attenuation for the line itself, the cross-talk attenuation between two carrier channels increases also with the equivalent with which they work. For exemple, if two circuits have a near-end cross-talk of 4.5 neper at the frequency in question and are working with an equivalent of 0.8 neper, one gets, if the reflected cross-talk at both ends is taken together, a resultant cross-talk attenuation between the carrier channels of $4.5 + 0.8 + 2 - {}^{e}\log 2 = 6.6$ neper.

This applies to two channels whose bands entirely coïncide so that the resultant cross-talk is comprehensible. Also if the above-stated assumption is accepted, that it is not possible to avoid using the same frequency band for different carrier systems if it is desired to have a large number of circuits, certain advantages may, however, be attained by using two types of systems with somewhat different frequencies. For practical and economical reasons there must be a certain gap between the channels on one and the same circuit. If in the one system the band transmitted is laid so that it mainly falls in with the gaps in the other, the cross-talk is considerably minimised. Naturally, the larger the distance between the channels is in proportion to the width of the band transmitted, the greater the improvement. In this case it is not possible to speak of any particular cross-talk attenuation as this is different for different frequencies within the voice-frequency band. The cross-talk is moreover incomprehensible and more nearly resembles noises of other kinds. With more than two systems some of the frequency distributions employed earlier must be repeated, and the greater demands on the cross-talk apply.

Optimal Number of Circuits on Twisted Lines

If on the above assumptions an attempt is made to indicate the properties of the carrier system which gives the optimal utilisation of a pole line, naturally different results are obtained for twisted and transposed lines. It is clear that twisted lines, the cross-talk of which does not grow very much with the frequency, allow of a greater number of channels than do transposed lines. Even if on the practical shaping of the system it is necessary to take other factors into account, this is also shown to be the case in the systems used in practice.

An example of a system suited for twisted lines is to be found in the Ericsson system, Type ZM100, which was made for the Ericsson telephone network in Mexico, and which has been described in Ericsson Review No 3, 1933. It is characterised by the following data: within the frequency range 9 750—4 775 c/s four telephone channels operate and this ample frequency space allows of the transmission of the carrier frequencies which in a simple and adequate manner provide all the accessory functions, such as ringing, automatic level adjustment and synchronising. The frequency range below 9 750 c/s may be used either for four carrier-telegraph channels or for a single-channel telephone system of Ericsson new system, Type ZL 400, such as will be described in a later number of Ericsson Review. Such an equipment can work on one of the side circuits of each quad. On the other side circuit and on the phantom circuit there can at the same time be run a single-channel system.

In Mexico there exists no need for a further multiple-channel system on the same quad and the original design of the system, Type ZM 100, does not allow of the use of such. A modernised design of the system, characterised by weaker carrier wave and group division of the frequencies, makes possible however the employment of a three-channel system with displaced frequencies on the other side circuit, in spite of the lower cross-talk attenuation between the pairs in the quad. It is thus possible, if so required, to operate a four-channel system, a three-channel system and three single-channel systems, or altogether 10 carrier circuits, on each quad. Such intensive utilisation of all the circuits should for practical purposes never come into question, but it shows what possibilities may be offered by the twisted circuits.

Optimal Number of Circuits on Transposed Lines

On transposed circuits it is not possible to calculate so generally the number of possible communications, as these depend in the first place on the transposition distance. In theory, the distance may naturally be reduced to such an extent that a sufficient number of utilisable transposition types is obtained, but in practice this is not as a rule possible. Basing on the types of circuit and the transposition distances met with in practice, each special case must therefore be considered separately. Such investigation of transposed circuits in use indicates that the frequency range used should be restricted to about 30 000 c/s if it is desired to calculate with a considerable number of parallel systems without comprehensive alteration of the circuits. Re-transposing must in general be done even for this frequency range, as the transpositions used for voice frequency in practice have often a rather low resonance frequency. In addition to closer transposing other measures are occasionally taken to increase the number of parallel systems, such as dropping the phantom circuit, and increasing the distance between pairs at the expense of the distance between the branches.

With the upper limit of 30 000 c/s mentioned above it is not possible to get in more than three telephone channels as against the five possible on twisted circuits. The best-known system developed for use on transposed lines, *viz.*, that of the American Telephone & Telegraph Company, is designed for three channels and a further reduction of the necessary frequency range is obtained by suppression of the carrier wave. The Ericsson system described above, Type ZM 100, can naturally be used also on transposed circuits. If it is intended to transmit several parallel systems it is, however, more convenient to reduce the number of channels to three and drop the highest frequencies. The division into directional groups of the frequency range in that case, however, is a different one than that in the American system, and as a rule it is not possible to operate these two systems on the same pole line. To make possible such parallel operation Ericsson has therefore recently designed a three-channel system with suppressed carrier wave, which agrees with the American frequency distribution. A description of this system, Type ZM 300—ZM 400, will appear later.

Recent Developments in Filter Technics

T. LAURENT, TELEFONAKTIEBOLAGET L.M. ERICSSON, STOCKHOLM

Frequency transformations such as are dealt with in Ericsson Technics No 5, 1934, and No 2, 1935, have been further developed in a successful manner. Below will be found a short summary of these new findings.

Frequency transformations signify that, in an arbitrary network of resistances and reactances, the reactances are altered according to certain simple rules, so constituted that the electrical properties of the new network may be determined by substituting the frequency for frequency functions in the characteristic functions of the original network. It has been demonstrated that frequency transformations offer simple, practical and universally applicable methods for the calculation of phase and attenuation equalizers. The frequency transformations make it also possible to transform easily a low-pass filter to a high-pass filter or to certain important types of band-pass and band-suppress filters. On the other hand, with the frequency transformations hitherto known, band-pass and band-suppress filters with one or two attenuation peaks arbitrarily located in the frequency band have not been attainable, and their practical utility for the calculation of the impedance network must therefore be considered to be limited.

Now, however, four new frequency transformations have been discovered, which appear to present unlimited possibilities for converting one type of filter to another. Thus, with these frequency transformations it is possible to convert a low-pass filterlink of entirely arbitrary design to, *e. g.*, a band-pass filter with one or two arbitrarily located attenuation peaks. To distinguish these four transformations the designations »*bm-*, *dm-*, *bn-* and *dn*-transformations» have been introduced, and the frequency functions corresponding to these which should replace the angular frequency ω in the characteristic functions have the following mathematical expressions

$$\omega_1 bm = \omega \sqrt{1 - \left(\frac{\omega_1}{\omega}\right)^2}$$

$$\omega_1 dm = -\frac{\omega_1^2}{\omega} \sqrt{1 - \left(\frac{\omega}{\omega_1}\right)^2}$$

$$\omega_1 bn = \frac{\omega}{\sqrt{1 - \left(\frac{\omega}{\omega_1}\right)^2}}$$

$$\omega_1 dn = -\frac{\omega_1^2}{\omega} \cdot \frac{1}{\sqrt{1 - \left(\frac{\omega_1}{\omega}\right)^2}}$$

where ω_1 is the transformation angular frequency.

These frequency functions may be imaginary, and it is necessary therefore to be acquainted with the properties of the original network, not only for positive and negative, but also for imaginary frequencies. If the characteristic functions are known then the calculation is simple. If there is a four-terminal network consisting, *e. g.*, of reactances alone, and if ω in the expression of the reactances is substituted for, *e. g.*, $\omega_1 bm$ there is obtained a new four-terminal network, the properties of which may be determined by substituting ω in the characteristic functions for $\omega_1 bm$, but the reactances cannot be physically realised.

All reactances, therefore, must be multiplied by $\sqrt{1 - \left(\frac{\omega_1}{\omega}\right)^2}$ or all reactances must be divided by this root expression to get a physically realisable four-terminal network. Such a multiplication or division does not however, alter the image attenuation or the image phase shift of the network. Their characteristic impedances, on the contrary, are multiplied or divided by the root. It is thus demonstrated that the frequency transformation of characteristic impedances may be transferred by multiplication or division by the root to one of the frequency transformations already known.

Thus each frequency transformation presents two possibilities, one being obtained with multiplication and the other with division by the root, and from this arise the following eight possible reactance changes, if L and C indicate an arbitrary self-inductance and capacity respectively in the original network, and all other self-inductions and capacities are treated on the same pattern as these:

bm-transformation, multiplication by $\sqrt{1 - \left(\frac{\omega_1}{\omega}\right)^2}$

L connected in series with a capacity $1/\omega_1^2 L$
C remains C

bm-transformation, division by $\sqrt{1 - \left(\frac{\omega_1}{\omega}\right)^2}$

L remains L
C is connected in parallel with a capacity $1/\omega_1^2 C$

dm-transformation, multiplication by $\sqrt{1 - \left(\frac{\omega}{\omega_1}\right)^2}$

L is connected in series with a capacity $1/\omega_1^2 L$
C is substituted for a self-inductance $1/\omega_1^2 C$

dm-transformation, division by $\sqrt{1 - \left(\frac{\omega}{\omega_1}\right)^2}$

L is substituted for a capacity $1/\omega_1^2 L$
C is connected in parallel with a self-inductance $1/\omega_1^2 C$

bn-transformation, multiplication by $\sqrt{1 - \left(\frac{\omega}{\omega_1}\right)^2}$

L remains L
C is connected in series with a self-inductance $1/\omega_1^2 C$

bn-transformation, division by $\sqrt{1 - \left(\frac{\omega}{\omega_1}\right)^2}$

L is connected in parallel with a capacity $1/\omega_1^2 L$
C remains C

dn-transformation, multiplication by $\sqrt{1 - \left(\frac{\omega_1}{\omega}\right)^2}$

L is substituted for a capacity $1/\omega_1^2 L$
C connected in series with a self-inductance $1/\omega_1^2 C$

dn-transformation, division by $\sqrt{1 - \left(\frac{\omega_1}{\omega}\right)^2}$

L is connected in parallel with a capacity $1/\omega_1^2 L$
C is substituted for a self-inductance $1/\omega_1^2 C$

An impedance network can naturally be submitted to a series of frequency transformations both of the new type and of the types already known, and in quite an arbitrary order of succession. There results therefrom such a large number of combinations that the usefulness of the frequency transformations for the calculation of impedance networks appears to be very great. In a coming number of Ericsson Technics the new frequency transformations will be dealt with in detail, and with the aid of these a number of new types of filter-links will be deduced.

Automatic Block Installation in Copenhagen, Denmark

O. GØTZSCHE, SIGNAL INSPECTOR, DANISH STATE RAILWAYS, COPENHAGEN

The completion in the summer of 1934 of the electrification of the Copenhagen-Klampenborg line of the Danish State Railways involved, as was to be expected, considerable changes in the safety plant on this section. The number of block sections had to be increased, semaphore signals, owing to their visibility being impaired by the erection of the trolley suspension devices, required to be changed to daylight signals, and the point circuits must be made free from earthing and independent of the tensions in the rails and cable sheaths arising from the use of the track as return circuit for the 1 500 V DC traction current.

On electrification there had also to be considered an appreciable increase in the number of trains, making increased demands on rapid clearing of the block sections, and it was therefore decided to provide the line with automatic line-block, which at the same time would allow of a saving in wages for line-blocking staff, whereas extension of the existing manual line-block by increasing the number of block sections would have involved an appreciable increase of these expenses. After tenders had been considered L. M. Ericsson Signalaktiebolag were awarded the contract for the delivery of the projected automatic block installation.

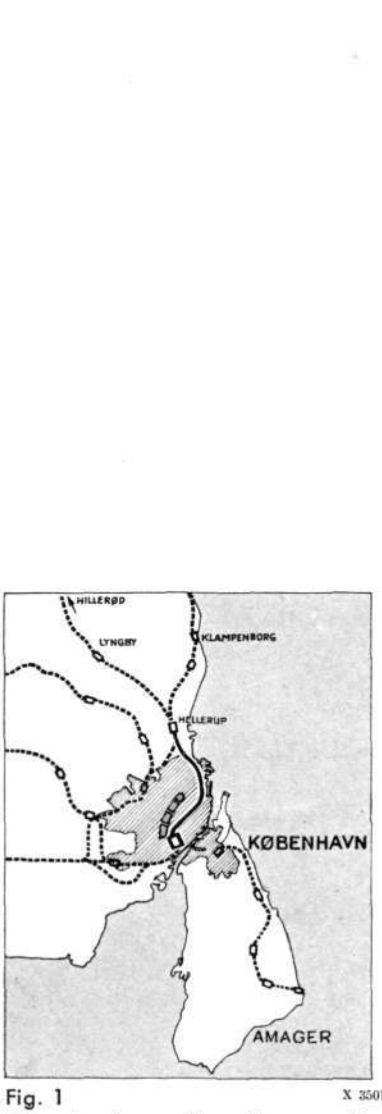


Fig. 1 X 3501
Map showing railway lines meeting at Copenhagen

As may be seen from Fig. 1, the Copenhagen—Hellerup line consists of two double tracks, the eastern of which carries traffic to Klampenborg and stations north of Klampenborg, while the western takes traffic to stations between Copenhagen and Klampenborg as well as to the northern line (Hellerup—Hillerød—Helsingør). On the western electrified double track some 120 trains run daily in each direction and on Sundays and holidays the number rises to about 150, at certain periods amounting to 11 trains per hour, so that perfect functioning of the block system is very necessary.

Signals

Between Copenhagen and Hellerup there are the following stations: Vesterport, Nørreport, Østerport, Nordhavn and Svanemøllen, all of which are provided whith central platforms, see Fig. 2. At these stations, block signals are located at the ends of the platforms and likewise the entrance signals for the stretch are provided with distant signals at 400 m distance. The greater part of the stretch between Vesterport and Østerport lies in a tunnel, Fig. 3. Further, it may be seen from Fig. 4 what signals are comprised in the plant.

At Østerport both entrance and departure signals for the western double track may be operated either manually or automatically, according to the position of the switching lever concerned at Østerport station. This is done to allow of shifting of the points at the station when the signals are set at »stop».

Fig. 2 and 3 X 7085
Copenhagen—Hellerup line
seen left, from north at Nordhavn Station
right, from east at Vesterport Station

All the signals are made as daylight signals with red and green lights for the main signals and yellow and green flashing lights at the distant signals. The lamps on the signals are provided with two filaments and in the lamp circuits there are inserted supervisory relays with built-in rectifier valve which connect up the spare filament if the main filament burns out. The connection of a spare filament is indicated by a control lamp lighting up in the relay cubicle concerned. When the main filament of a lamp burns out the lamp must be replaced as soon as possible, as the spare filament is only reckoned to burn for 300 h, while the main filaments are estimated to last for about 3 000 h with the tension used.

Track Relays

To supervise the track clearance of the block sections and for the control of the signals there is fitted at one end of the block section a two-phase vane relay, one coil of which, the track phase, is connected direct to the two rails, while the other coil, the auxiliary phase, is connected to 220 V AC. The track-relay armature can take up three positions: plus position, zero position and minus position. On inversion of the track phase the armature moves from plus position to zero position and on short-circuit of the track phase it goes to minor position. At the other end of the block section a track transformer is connected which puts the rails under suitable tension, about 1.5 V. The relays and track transformers are generally fitted in relay boxes, see Fig. 5, which, in addition, house cable terminal boxes, fuses, resistances, etc.

Impedance Connections

To allow of the return of the traction current through the rails in spite of the rail insulation, at each end of the block sections there are inserted impedance connections, Fig. 6, *i. e.*, inductive resistance coils with very low DC resistance, 0.0007 ohm, and high AC resistance, about 3 ohm. The impedance connections consist of an iron core on which are placed two coils: a heavy wire copper coil the ends of which are connected to the two rails and the middle of which is joined to the middle of the adjoining impedance coil and to earth, for which last the parallel running double track is used, and a thin-wire coil the ends of which are connected to a condenser which is so arranged that the AC resistance in the heavy coils is the greatest possible, *i. e.*, that there is resonance between the two coils.

Fig. 4 X 7086
Signalling plan of Copenhagen—Hellerup block installation

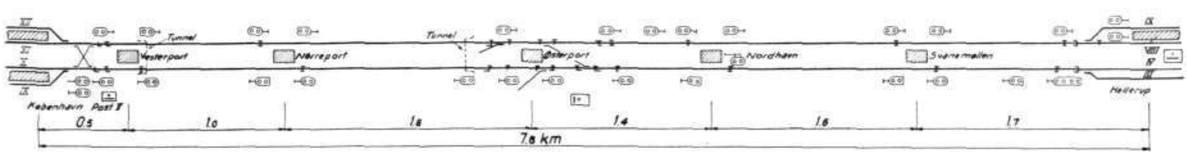


Fig. 5 X 3502
Relay cubicle

Fig. 6 X 3503
Impedance connections

Functioning

In the stipulations for the plant it is laid down that the signals, with the exception of the manually operated signals at Copenhagen and Hellerup stations, shall normally indicate »clear», but go automatically to »stop» when the block section behind the signal is occupied. Further the condition for return to »clear» is that the block section after the signal is free, and that the signal immediately following shows »stop» and that the relays of the latter block section have functioned properly during the passage of the last train.

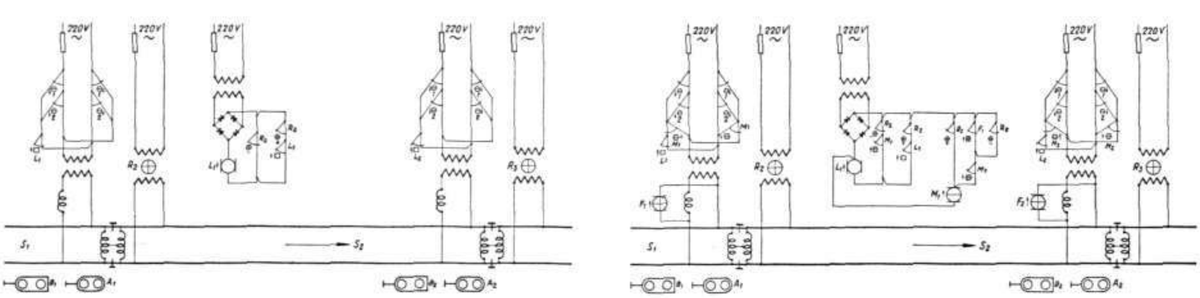
Fig. 7 shows the diagram according to which the block system was originally installed. The passage of a train has the following effect: before the train enters block section S_2, track relay R_2 is in plus position, control relay L_1 is attracted, and signal A_1 indicates »clear». When the train enters section S_2, relay R_2 is short-circuited and its armature goes into zero position, whereupon both positive and negative contacts on the relay are broken. The control relay L_1 is without current and the signal A_1 changes to »stop». When the first pair of wheels of the train enters section S_3, track relay R_3 is short-circuited, whereupon control relay L_2 is without current and signal A_2 is set to »stop». On this the track current to section S_2 is reversed which has the effect of making the armature of relay R_2 go to minus position when the last pair of wheels of the train have left section S_2, and relay L_1 receives current again and sets signal A_1 at »clear». When the section is again free and the signal A_2 has gone to »clear», the current to section S_2 is again reversed, whereupon track relay R_2 changes from minus to plus position. As relay L_1 is provided with delayed action its armature remains attracted while relay R_2 changes from minus to plus and the signals and relays of block section S_1 are restored to normal position.

As stated, the mid point of the impedance is connected to the mid point of the adjoining impedance and to the parallel running eastern double track to ensure the largest possible cross section for the return circuit of the traction current. This circumstance, however, provides the possibility that in certain conditions a »clear» may arise in an occupied block section, *viz.*, when two rail joints are defective at one time and a train happens to be between these defective joints at the same time as there is a train in the section immediately following. A train between such joints will, on account of the connection of the double-track to the mid point of the impedances, not short-circuit the track relay, and when a train in the following block section causes an inversion of the current the track relay will go into minus position and the signal will indicate »clear».

As a defective rail joint, in view of the above-mentioned connection with the parallel running double track, does not show itself by setting the track relay at zero position and the signal at »stop», the occurence of two defective rail joints at the same time may very well happen. This situation, moreover, arose during testing of the plant when it was to be taken into service. To eliminate the risk there was inserted at the feeding side of every block section an extra track relay F and, parallel with each control relay, an auxiliary

Fig. 7 and 8 X 1491 X 1492
Diagram of block installation
left, original diagram, right, final diagram

a	distant signal		
A	main signal	M	auxiliary relay
F	extra track relay	R	track relay
L	control relay	S	block section



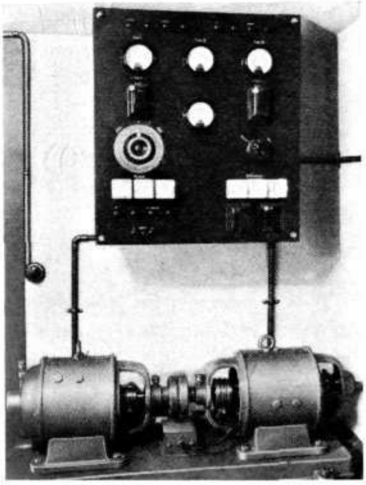


Fig. 9 X 3504
Rotary converter
for reserve current supply

relay *M*. The function of the track relay was to hold the auxiliary relay attracted during the whole time the train was passing the signal. The relays thus added are moreover connected to the necessary contacts, as may be seen on the current diagram in Fig. 8, which is that now applying to the plant. As may be seen, the auxiliary relay normally receives current, but is cut off when the last wheels of the train quit the following block section. As the relay has delayed action it causes a delay in the inversion of the current which the red-light supervisory relay establishes during the passage of a train, so that the track relay for the preceding block section goes into plus position for an instant, about 1.5 s, before it goes to minus position. When the last-named track relay thus goes into plus position, it connects the corresponding auxiliary relay and when the track relay, on account of reversal of current immediately afterwards, goes into minus position, the control relay belonging to it receives current again and the signal returns to »clear».

As a study of the diagram will indicate, the armature of the track relay changes position during the passage of a train in a clearly defined order, *viz.*, plus, zero, plus, minus, plus; for any other order the signal will remain at »stop» and thus also if the order is that occuring when a train is between two defective rail joints at the same time as the next block section is occupied. With the diagram employed a defective insulation will have the effect of showing »stop» to a train in the nearest block section.

As may be seen, in the plant here described there has been taken into account to a great extent the possibility of false »clear» signal on weakness in various parts of the plant and safety provisions have been made for supervision of the proper functioning of the relays and signals in all circumstances. This has naturally caused the installation to be somewhat more complicated than the system most often employed in America, where it is considered that the risk of faults in the track relays may be ignored. Still no inconvenience has arisen with the method selected here, which provides safeguards which it was desired not to dispense with.

Current Supply

The installation uses AC 3×380 V, 50 c/s throughout. The section between Copenhagen and Østerport is fed from Copenhagen and the section Østerport—Hellerup from the last-named station. For this purpose a special supply cable has been laid along the whole stretch. The cable comprises 7 conductors, *viz:* 3 of 4 mm^2 area and 4 of 1.5 mm^2. The three 4 mm^2 and one 1.5 mm^2 conductor are employed for the track apparatus, operating circuits and the like, while the remaining three 1.5 mm^2 conductors are used for lighting circuits. In order to avoid the quite strong reactive current in the track circuits, transformers have been inserted at some points of the network.

As a reserve there has been installed at Copenhagen (Signal Cabin V) a converter, Fig. 9, for converting the town mains 220 V DC current to 3×380 V AC, 50 c/s, but normally current is delivered from AC mains. At Østerport the two feed cables, normally separated, can be connected together, so that the whole current supply can be furnished either from Copenhagen or from Hellerup. In addition there is a reserve petrol generator at Hellerup station for the block installation, which is automatically connected in when drop in tension occurs.

At Hellerup and Østerport there are converters, by which the lamp tension for the block signals can be changed from day to night tension. This is done by connecting the signal transformers during the day to 380 V between two phases, while at night they are connected to 220 V between phase and neutral.

Telephone Exchange of the Victorian Railways, Melbourne

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

Early in 1934 an automatic telephone exchange of PABX type was ordered from Telefonaktiebolaget L. M. Ericsson for the Victorian Government Railways in Melbourne. This new exchange, which is one of the biggest PABX exchanges made by Ericsson, had to replace a 20 years old one of Strowger type. The order also included new exchange equipment in Melbourne for the magneto lines of the railways. The exchange was mounted by the Victorian Railways' own staff and put into service on February 24th 1935.

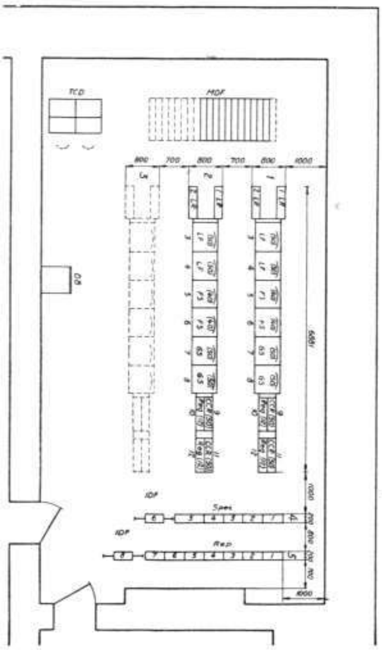


Fig. 1 X 3532
Lay-out of the automatic-exchange room

CCR	cord circuits
DB	distribution board
FS	final selectors
GS	group selectors
IDF	intermediate distributing frame
LF	line finders
LR	line relays
MDF	main distributing frame
Reg	registers
Rep	repeaters
Spec	special lines
TCD	traffic-control desk

The new automatic exchange is made for an initial capacity of 700 lines. The main part of these serve the Victorian Railways head office, where also the exchange is mounted, and the two big railway stations in Melbourne. A smaller part of the lines serve the railway power house and workshops and some of the railway stations in the suburbs. The exchange is connected to the Post Office system by 30 incoming and 26 outgoing main exchange lines. The ultimate capacity is 1 500 lines with 60 incoming and 48 outgoing main exchange lines. At present equipment is also mounted for 180 magneto lines, which number can be extended to 300.

Automatic Exchange

The automatic switching equipment used for this exchange is of the Ericsson machine-driven system with 500-line selectors. Owing to the density of traffic through the exchange it has been necessary to provide two panels for each type of switch in each 500-line group, and therefore the unit racks have had to be made twice as long as the standard unit rack. As can be seen from the lay-out, Fig. 1, there is space for three unit racks each for 500 lines. Rack 1 is fully equipped for 500 lines, but rack 2, Fig. 2, is equipped only for 200 lines and because of that has at present only one panel for each type of switch. In a fully equipped 500 lines unit there is space for 100 cord circuits with line finders and group selectors distributed to 24 registers and 80 final selectors. The reason why the number of cord circuits is greater

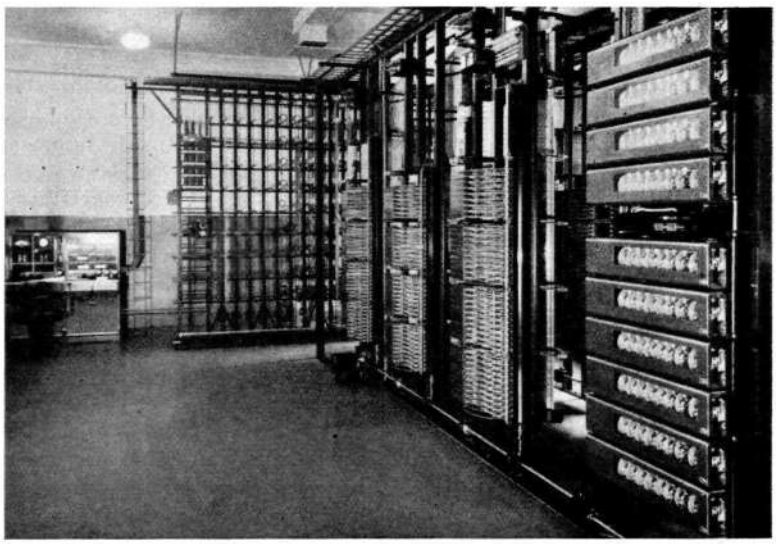


Fig. 2 X 5249
Automatic exchange room
left background, supervisor's table and main distributing frame
left, rack 2 with line finders, selectors and registers for a 500-line group

Fig. 3
Unit racks 1 and 2

X 3523

than the number of final selectors is that an equivalent part of the traffic goes to the special lines leading direct from the group-selector multiple.
Racks 4 and 5 contain relay sets for the main-exchange lines and other special lines and also relay equipment for the manual switchboards and some intermediate distributing frames. Thus panel 1 of rack 4 is mounted for the cord-circuit relay sets of the auto-manual switchboard, and the panels 2 and 3 contain the same equipment for the magneto-manual switchboard. In panel 5 the magneto-line relays are mounted, and panel 6 is an intermediate distributing frame for the magneto lines and all the special lines leading from the group-selector multiples. Panel 1 of rack 5 contains the equipment for call back and transfer. The panels 2, 3 and 4 accomodate the relay sets for the outgoing main-exchange lines and the panels 5, 6 and 7 the same for the incoming main-exchange lines. Part of panel 4 is also mounted for tie lines to other PBX exchanges. Panel 8 is intermediate distributing frame for the automatic-line multiple, which in this frame is divided into auto-manual and magneto-manual switchboards.
As may be seen from the lay-out the main distributing frame is also placed in the automatic exchange room. The test desk and the traffic-supervision desk are also placed there, as shown in Fig. 2. These are both made for one position each and installed beside each other.

Manual Equipment

The auto-manual and magneto-manual switchboards are mounted in two rows opposite one another in a room adjacent to the automatic exchange room. Fig. 4 shows the auto-manual switchboard. The reason why the manual switchboards are divided into auto-manual and magneto-manual, and that they are mounted in two different rows, is that the traffic from the railways magneto lines coming from the different parts of the state of Victoria is not allowed to be brought over the main-exchange lines to the Post Office exchanges in Melbourne and vice versa.
Each row of switchboards has been mounted with three operator's positions, which number can be increased to five. In each position there is space for maximum sixteen pair of cords, and fourteen of those are now mounted. Between the two rows of switchboards there is a place for a supervisor for whom an observation cabinet is provided. For supervision there are tappings from every operator's telephone circuit to this cabinet. This is also equipped with two waiting call indicators, one for each row of switchboards, and the necessary traffic-control meters. The supervisor is thus given full possibility of control over the traffic. In addition the observation cabinet is

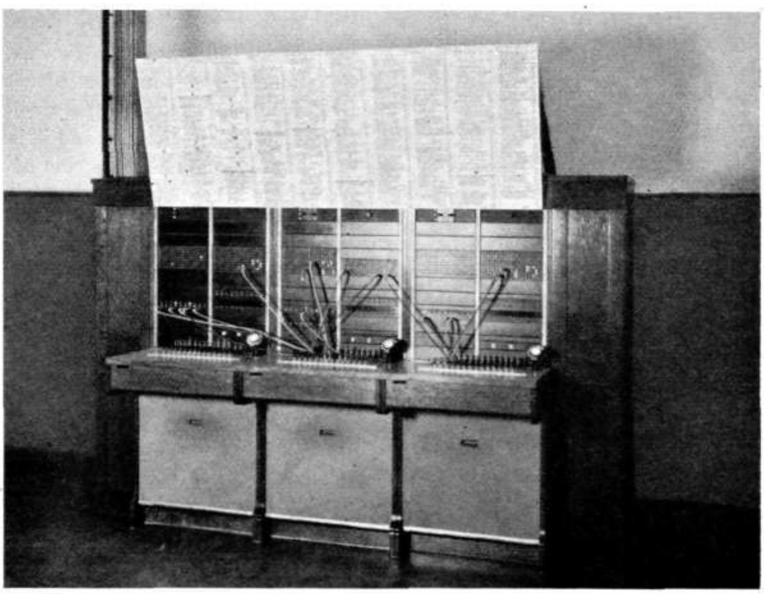


Fig. 4
Auto-manual switchboard

X 5250

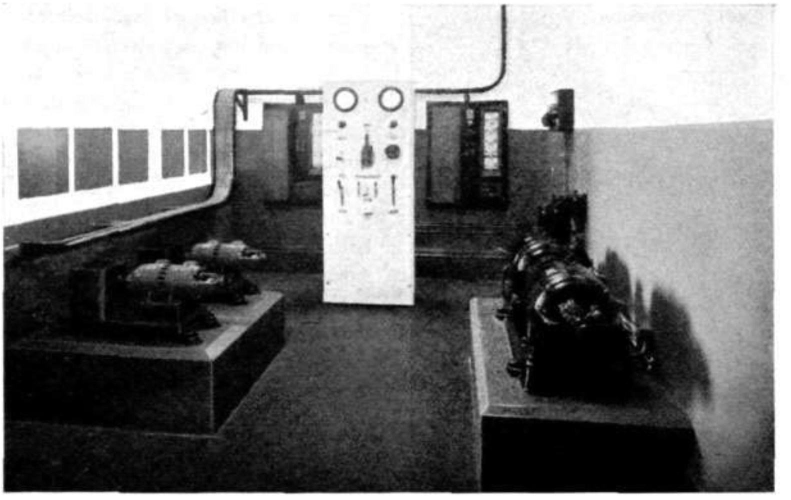


Fig. 5 X 5251
Power plant
left to right, two signal generators, instrument board and charging converter

fitted with control jacks for all outgoing main-exchange lines and all cords in the auto-manual switchboard giving the supervisor the facility to control that no unpermitted private calls are made over the outgoing and incoming main-exchange lines of the railways.

Power Plant

Fig. 5 shows the power plant, which consists of two 24 V storage batteries, each of 288 Ah capacity but with possibility for extension up to 508 Ah. For charging the batteries and for floating in the daytime there is a motor-generator operating off 230 V, 50 c/s single phase AC. Two tone and signal generators are installed, of which one operates off the single phase AC. The other is switched in automatically if the AC fails, and runs off the 24 V battery.

Trunking Scheme, Operation and Special Arrangements

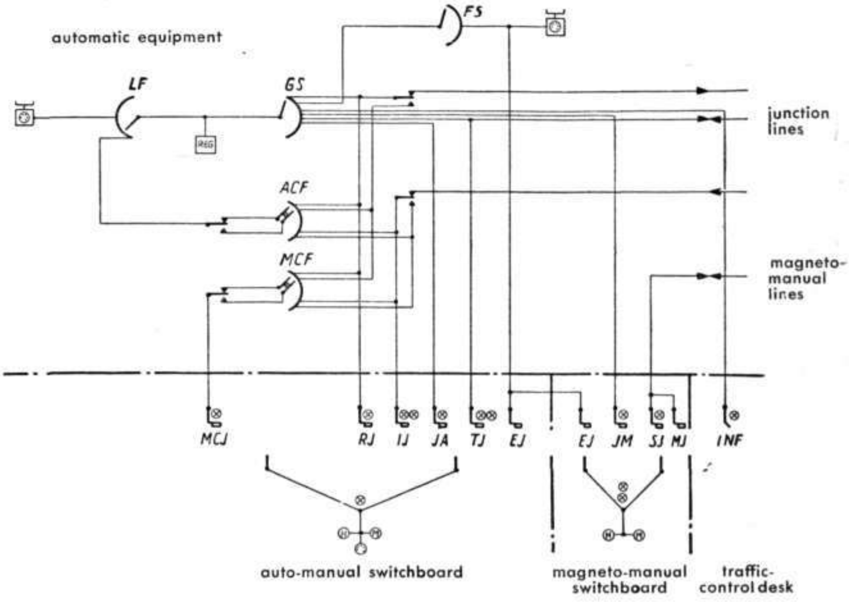
For the design of the diagram for this exchange the most modern principles have been used. The routing diagram, Fig. 6, gives an idea of the ways the different kinds of traffic are led. The registers of the automatic exchange are made for 2 000 four-digit subscribers' numbers. At present five single-digit numbers for special lines are in use. These are: outgoing main-exchange lines, lines to auto-manual positions, lines to magneto-manual positions, tie lines to a PABX exchange at the State Public Offices in Melbourne, and information lines going to the test desk. In addition to this the registers are so arranged, that a number of two-digit special lines can be connected. The first 500 lines group in the automatic exchange has facility for connecting PBX line groups therein, and it is of course a simple matter to arrange likewise in any 500-line group. 500 of the existing 700 subscribers have exchange access, *i. e.*, they have the facility for making a call over the outgoing main-exchange lines by dialling the special number therefor. The other 200 subscribers are barred from this traffic facility. A small number of the 500 subscribers with exchange access are in addition exempted from the observation facility of the supervisor mentioned earlier. The control jacks fitted in the observation cabinet for the outgoing main-exchange lines and the cords in the auto-manual positions are connected through at the moment a main-exchange line is taken inte use. The subscribers with exchange access, which are observation exempted, are therefore connected in such a way that this connecting through is prevented. It is a simple matter to change over a number of lines from any of these three groups to one of the other two groups.

A subscriber of the automatic exchange connected to a main-exchange line has the facility to make call-back to any other subscriber of the automatic

Fig. 6
Routing diagram

ACF automatic call-back finder
EJ automatic extension lines
FS final selector
GS group selector
IJ incoming main-exchange line
INF information line
JA auto-manual junction line
JM magneto-manual junction line
LF line finder
MCF manual call-back finder
MCJ manual call-back line
MJ magneto line, multiple jack
Reg register
RJ outgoing main-exchange line
SJ magneto line, answering jack
TJ tie line

X 5253



exchange. After this call-back it is also possible to transfer the call on the main-exchange line to the subscriber called thereby. These facilities are provided for outgoing as well as incoming main-exchange lines. Outgoing main-exchange lines are led to the South Melbourne automatic exchange, which is of Strowger type. A subscriber with exchange access in the Victorian Railways automatic exchange has thus the facility of dialling the wanted number in the network of Melbourne. At present the incoming main-exchange lines come from the Melbourne Central manual exchange. This exchange will soon be converted to the automatic system, but this will not cause any alterations of the relay sets for these lines. Incoming calls from main-exchange are via the auto-manual switchboard connected to the wanted subscriber's line. The auto-manual operators, who are provided with dials, have also access to the outgoing main-exchange lines. They can thus make a call via those lines if necessary. For ordering such calls the lines from the automatic exchange to the auto-manual switchboard are used. These operators also handle the manual call-back and transfer traffic and the incoming traffic on the tie lines.

The cords of the auto-manual positions are provided with automatic ringing, which begins as soon as the operator inserts the ringing plug, and is disconnected when the subscriber answers. An operator cannot listen in on a conversation, because the subscribers are disconnected, if the cord key is thrown. A faint intermittent busy tone is connected to the line, if an operator cuts in on an existing connection with another cord to offer an urgent call. This signal informs the subscribers of the operator cutting in on the conversation. The incoming main-exchange lines are cleared as soon as both subscribers have replaced their handsets. The lines are first cleared at Melbourne Central, and then the clearing signal appears at the Victorian Railways switchboard. Therefore it may happen that a new call is connected to the main-exchange line from Melbourne Central before the operator at the Victorian Railways gets time to take down the cords. In such cases the calling lamp will light up in the usual way, and the ringing signal or other disturbances are not repeated by the cord to the still connected subscriber. An interurban call on an engaged main-exchange line releases the existing connection and lights the calling lamp at the auto-manual switchboard.

A subscriber of the automatic exchange connected to a main-exchange line has, as already mentioned, the facility for making call-back to any other subscriber of the automatic exchange. Automatic call-back is effected by dialling the digit 1. In doing so the line towards the subscriber is changed over from the main-exchange line to a call-back line via an automatic call-back line finder, while the connection to the main-exchange is held by a loop circuit

in the relay set of the main-exchange line. In this way a new call is made into the automatic exchange, and connection can be established in the usual way. Having obtained the wanted information the subscriber who originated the call can go back to the waiting connection on the main-exchange line by again dialling 1. In this case alternative connection with the main-exchange line and the local subscriber can be effected by dialling the digit 1, if the called local subscriber does not clear during an interval. Manual call-back is effected when the subscriber connected to a main-exchange line dials the digit 2. The line is changed over from the main-exchange line in the same way, and a call is made to an auto-manual position via a manual call-back line finder. The call is then connected to the wanted subscriber by the operator. Connection can thus be obtained by means of manual call-back, if the line to which automatic call-back is made is engaged, as the operator has the facility of entering the connection and offer the call. There are the same facilities for repeated call-back as mentioned for automatic call-back. If a subscriber connected to an outgoing or incoming main-exchange line has made call-back to another subscriber and then replaces the handset when the called subscriber has answered, the connection on the main-exchange line is transferred to the latter subscriber. This is the same both for automatic and manual call-back. A subscriber who in this way is connected through to the main-exchange line has the same facilities of call-back and transfer as the subscriber who originally was connected to the main-exchange line.
The magneto-manual operators also handle, in addition to the traffic between the different magneto lines, the traffic from the automatic lines to the magneto lines and vice versa.

Traffic Results

The exchange was put into service on February 24th this year. The lines to offices not used during the weekend were first cut-over during the Saturday evening February 23d. The final cut-over and putting into service of the new exchange then took place in the night between the last train on February 23d and the first train on February 24th. This time had to be chosen, on account of some lines from the automatic exchange and also most of the magneto lines running to different railway stations.
The density of traffic at this telephone exchange must, of course, be largely dependent upon the railway traffic. Consequently the number of calls is greatest during the days prior to holidays etc. After the cut-over the first occasion of this kind was during the four days before the Easter holidays. The number of calls made by subsribers of the automatic exchange was 20 972 on Thursday April 18th between 9 a. m. and 5 p. m. During the same time 2 995 calls were received on the incoming main exchange lines. An additional 1 042 calls on these lines were handled after 5 p. m. It should be borne in mind that the three auto-manual operators usually first had to be informed of the nature of business in order to determine the proper office. At that time about 670 of the 700 lines of the automatic exchange were in use. Previously there had been about 30 direct lines to the Post Office exchanges from different offices of the Victorian Railways. These lines were eliminated when the new exchange was put into service. All such traffic is now concentrated to the main-exchange lines.
The fault-record figures available after four months service give evidence of a very high reliability of operation. A close control of the operation of the exchange shows that there were only 13 faults on a total of 308 238 calls between May 4th and June 1st. During June and July the respective figures were 10 faults on 305 491 calls and 13 faults on 311 512. There are thus about 0.04 faults per 10 000 calls, an exceptionally low figure. At present the automatic exchange is being extended to a total of 1 000 lines, *i. e.*, the second 500-line group is mounted for full capacity. This is to enable the connection of some additional lines, which were not included in the initial project. At the same time the number of auto-manual positions is extended to 5 and the number of incoming main-exchange lines to 50, whereas the outgoing main-exchange lines only need to be extended to 30.

New Ericsson Exchanges during 1935

Fig. 1 X 3536
Äppelviken Telephone Exchange, Sweden

Fig. 2 X 3537
Lwów telephone exchange, Poland

In 1935 the following automatic telephone exchanges on the Ericsson system with 500-line selectors were put into service:

date	town	exchange	number of lines
1/1	Melbourne, Australia	Victorian Railways (PABX)	700
30/3	Nitra, Czeckoslovakia		420
12/5	Malmö, Sweden	State Railways (PABX)	150
15/5	Borysław, Poland		1 000
15/5	Drohobycz, Poland		600
13/6	Naples, Italy	Vomero (extension)	1 500
13/6	Naples, Italy	Bagnoli (extension)	300
27/7	Bydgoszcz, Poland		3 000
15/8	Trani, Italy	(extension)	200
18/9	Stockholm, Sweden	Gas Works (PABX)	160
21/9	Lwów, Poland		12 000
25/9	Stockholm, Sweden	Electricity Works (PABX)	200
1/10	Gothenburg, Sweden	Vasa	2 500
31/11	Stockholm, Sweden	Orthopedic Hospital (PABX)	125
1/12	Tangiers, Morocco		1 500
31/12	Stockholm, Sweden	Technical University (PABX)	120
31/12	Stockholm, Sweden	Äppelviken	7 000
31/12	Warsaw, Poland	Piękna III (extension)	3 000

In the same period the following exchanges built by Société des Téléphones Ericsson, Colombes, using the Rotary system, were opened:

27/4	Paris	Laborde	10 000
21/9	Paris	Montmartre	10 000

Ericsson Telephones Ltd, London-Beeston, have supplied during the year the following exchanges, constructed on the Strowger system:

4/1	Bath	Batheaston	300
/11	King's Lynn		900
/12	Taunton		1 400
/12	Manchester	Trafford Park	2 000

Time-Recording Installation at a Great Stockholm Printing Plant

O. PERSSON, OPERATING ENGINEER, ESSELTE AKTIEBOLAG, STOCKHOLM

In the new building of the Swedish Lithographic Printers in Stockholm, the largest printing works of Scandinavia, there is also to be seen Scandinavia's most comprehensive electric time-recording plant, delivered by the Ericsson Sales Company. The installation is of great interest because recording is done throughout both as regards times of arrival and departure and as regards the execution of individual jobs, which considerably facilitates the calculation of costs, thus forming an excellent means of checking actual cost.

Fig. 1 X 3505
Esselte printing works, Stockholm

With the amalgamation into one industrial undertaking of the Stockholm firms affiliated to Sveriges Litografiska Tryckerier (SLT) a number of organisation problems naturally arose. One of these was the question of conveniently arranging the checking of the work and of the workers numbering some 1 800. It is true that SLT had introduced a long time previously uniform principles for the various printing shops as regards supervision of operation. For each job handled by a firm the times in the various departments were noted and thus the cost of completing the work arrived at. These figures formed the basis of the debiting and were used at the same time for the statistics employed to facilitate the estimating of costs and operating expenses. Such figures are required not only for costing but also to provide figures for the estimates necessary in most cases when tendering for jobs.

The principles applied in the various printing shops were, however, somewhat different. A feature common to all was that records of times, whether entered by the individual workmen or by foremen, were written out by hand. The time notes were handed in just before the close of the working day, even when the work had been completed in the forenoon. The consequence was that in too many cases they gave an indication of working time that was far from exact. It may even be supposed that the staff found it to their interest, when work was interrupted for one reason or another, to conceal the resulting loss of time by spreading it over a number of jobs or by transferring it from a small order to a large one. In those firms where times were entered on time slips by the worker himself, along with particulars of the work carried out during the day, it was observed that the making out of the time slips encroached to an appreciable extent on the actual working time.

This problem has now been solved by the introduction of an Ericsson time-recording installation which is employed in the following way: on arrival at his department the worker passes a card cabinet where his weekly time card is inserted under his number in a rack marked »out». He takes his card from this rack and places it in the card receiver of the time recorder which stamps it. The time of arrival then appears automatically in the proper day-column and shows that the worker has passed in. Then the card is put in another rack, marked »in». The colour of the figures recorded is changed automatically at the beginning and end of the working times, normal times of arrival and departure appearing in blue, while, in the case of late arrival, for instance, the colour will be red. A glance at the two

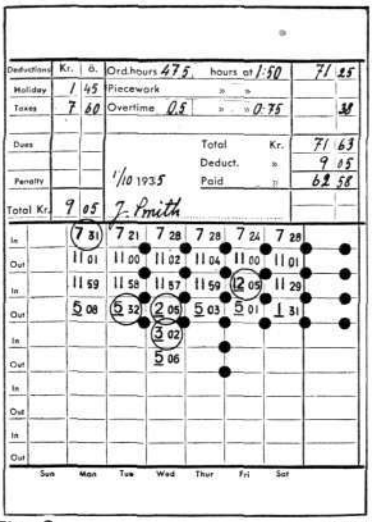


Fig. 2 X 3506

Wage card

ringed figures indicate records stamped in red, representing late arrival, overtime and leave

card racks tells the foreman at any moment what workers are on the premises. At the close of the working week the card, the upper part of which is shaped to make a receipt form in duplicate bearing the worker's name, is delivered to the wages office which at the same time issues the card for the coming week.

Each department has one or more timekeepers. At the beginning of each job each worker receives a job card, Fig. 3, ready filled in with the nature of the job, the order number, the quantity, etc. Immediately work on this order is interrupted or completed the card is stamped again. Even if no new job can be started at once, a fresh card is stamped containing a note concerning the lack of work, cleaning or repairs of machines, etc. The cards carry a number of headings enabling the workers without difficulty to supply all information required, each department having its own formula for its job cards. Instructions are indicated on the cards by underlining the job to be done.

Times are recorded on the cards by means of a special job recorder in charge of the timekeeper. To facilitate sorting of the cards, all cards dealing with direct work, *i. e.*, work which can be assigned to a definite order number, are white, those for indirect work being yellow; otherwise the job cards are identical. To simplify final costings there is also a series of red cards for overtime work. A white or yellow job card giving the ordinary hour rate is stamped for overtime in the usual way and in addition a red card marked with the overtime rate is stamped.

As it often occurs that a job is interrupted several times, the cards are divided into columns in which times for starting and stopping the work may be recorded in succession, one card being thus as a rule used for a job until it is completed. The card is kept during the intervals by the timekeeper or the foreman. Not only the time, hour and tenths of an hour, but also the day and a number representing the week are recorded. With these details the total time expended on each job can be worked out by the timekeeper and entered in the appropriate space. The number of hours is then multiplied by the wage rate noted on the card. The completed cards, always with duplicate attached, are forwarded to the wage office. There they are separated, one copy going to the invoice department and the other to the pay office. The total job times are checked with the wage card mentioned earlier and the upper portion of this, the duplicate receipt form, is filled up with details of the wages and deductions, if any, after which it goes to the cashier's office. There, one part is detached to accompany the wages paid, as specification, and the remainder of the card bearing the times recorded and the signature of the worker is retained as receipt.

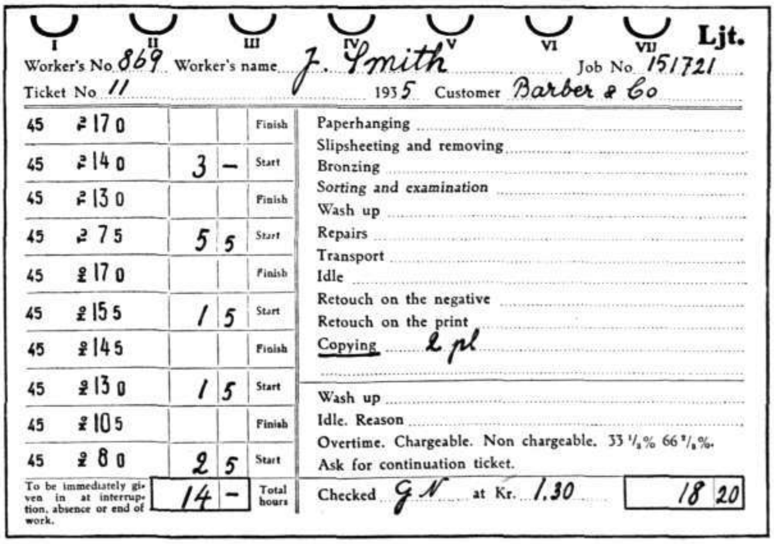


Fig. 3 X 5242

Job card

Fig. 4 X 3515
Time recorder, Type KC 100
for stamping wage cards with times of arrival and departure

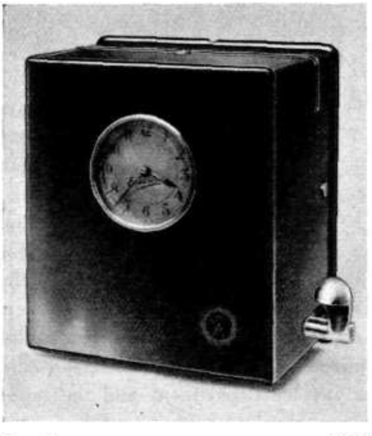


Fig. 5 X 3514
Time recorder, Type KC 150
for stamping times on job cards

While the job cards are stamped in tenths of an hour, the weekly time cards are stamped in minutes. If a worker is late by less than six minutes this only appears on the wage card and in such case a deduction is made from the workers wage, this deduction, however, being paid in to a common fund for the staff.

The time recording installation consists of a *master clock* operating by means of minute impulses *secondary clocks* and *time recorders* spread over the entire ten-story building. Two *signal secondary clocks* are also run from the master clock and transmit automatically all time signals.

For the recording of arrival and departure times there are 32 automatic time recorders, Typ KC 100, Fig. 4. In these recorders there is mechanism for automatically shifting the two colour ribbon, so that the figures recorded change colour at the beginning and end of the ordinary working day. Also the special working times which apply on Saturdays are recorded automatically in this way. The colour for which a recorder ribbon is set is always shown in an aperture in the dial.

The recorders, Type KC 150, Fig. 5, for stamping the jobs cards are 19 in number, and, as stated above, are in charge of the timekeepers or, in the smaller departments, of the foremen. No colour shifting device is fitted in these job recorders as overtime is recorded on special cards. As the day and the number representing the week are also indicated, there is no possibility of confusion of the times and the same card can serve for a considerable period.

The signal secondary clocks are connected to a number of bells which ring at the beginning and ending of work. One of these clocks controls the signals to one part of the works while the other takes care of signals for another part where different working hours apply.

The current for the installation is obtained from a 24 V accumulator of about 48 Ah capacity. The battery is charged automatically by a rotary converter connected to the AC mains. Supervision of the whole installation is most simple, all that is needed being to see that the battery has the proper voltage and that the recorders are in good order, as they may at times be exposed to rather careless handling. Naturally the ribbons require changing as they wear out. This, however, is a simple matter and, with the supervision, may be attended to by the ordinary mechanics of the works.

Staff Locaters for Hospitals

S. Å. NILSSON, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

A point of great importance, though often overlooked, in the organisation of an hospital is the possibility of rapidly being able to get in touch inside the hospital with doctors, nurses and other persons on the staff. A staff locater on the Ericsson system makes up for this deficiency, at the same time being reliable in operation and inexpensive in upkeep. The system may also be employed for other purposes.

Staff locaters are usually designed for visual or audible signals to be sent from a central point to luminous boards or signal sounders in various rooms within the establishment. Each person likely to be sought has a determined signal, consisting of a combination of lights or a code-signal emitted by bells or buzzers.

In an hospital an acoustic locater system is out of the question, as it would be far too disturbing for the patients, while an optical system would not be efficient enough. Moreover it is often not possible for the person sought to answer a call, *e. g.*, if it is a surgeon who is engaged on an operation or the like.

For hospital staff locaters the principle has been adopted that the persons it may be required to locate should themselves indicate where they are to be found, *e. g.*, by inserting a plug or pressing a button on an indicator board. These boards are set up in all places where any person should be able to indicate that he is there, and on each is a jack or a button for every person who is liable to be sought in that place. The indicator boards are connected by cables to a central point consisting of a location board with press buttons and a department board with lamps. The locating board contains a press button for each person who is likely to be sought and on the department board is a lamp for every place where an indicator board is set up. When locating, the button corresponding to the person sought is pressed in the locating board, whereupon the lamp for the place in which the person last indicated his presence lights up on the department board. When indication has to be done by a loose plug which is taken with him

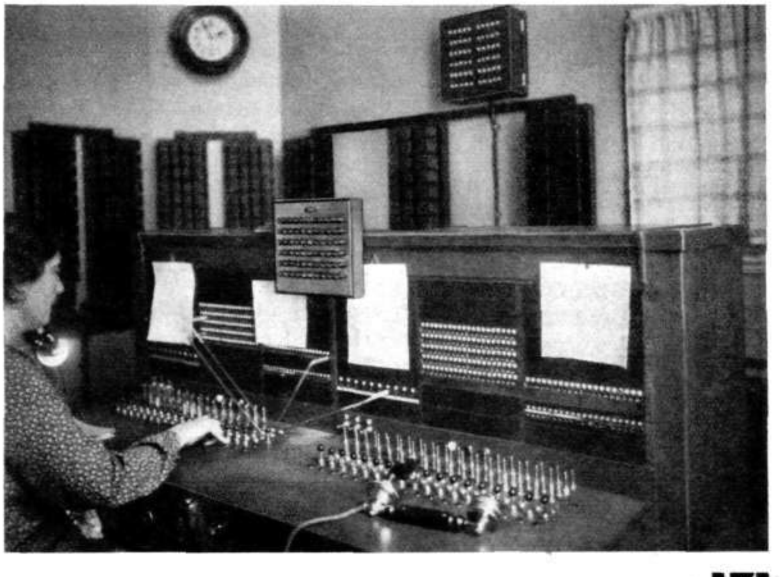


Fig. 1 X 5244
Staff locater installed at Sabbatsberg Hospital, Stockholm
in front of operator, locating board; on wall, department board

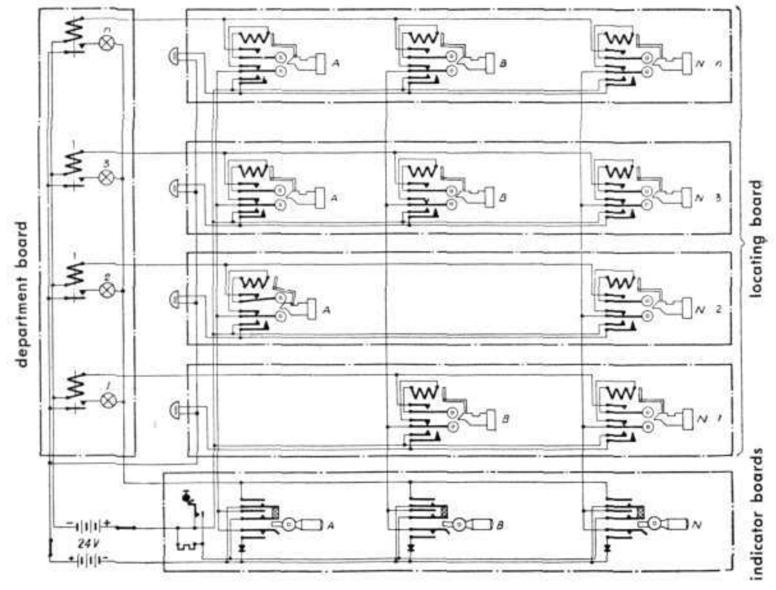


Fig. 2 X 5245
Diagram of staff locating plant

by the person on leaving the place in question, misleading indication often occurs because the plug has been forgotten. Even press buttons which should be released when leaving a place often cause wrong indication through forgetfulness, or cause indication for several departments simultaneously. Ericsson has therefore adopted a system, see Fig. 2, with indicator boards on which are special press-buttons so constructed that a button pressed down earlier in one indicator board is automatically released when the button of another board is pressed. These press buttons have a normal position, a bottom position without locking and a mechanically locking middle position, the indicating position. The locking device consists of a pawl fixed on the armature of an electro-magnet mounted on the press-button. The pawl rests against a stud in the press-button contact, which when the button is pressed pushes the pawl down into a slot in the button socket. Behind the pawl is another stud to the contact. When the button is released, this latter stud presses against the pawl which in its turn is held by the front edge of the slot, so that the press-button is kept in indicating position. When another button on the line of the same person is pressed down to bottom position, a release current goes through the electro-magnet of any button pressed earlier. This attracts its armature whereupon the locking pawl is lifted and releases the button contact and then the button is restored to normal position by a spring which presses against the first of the studs mentioned.

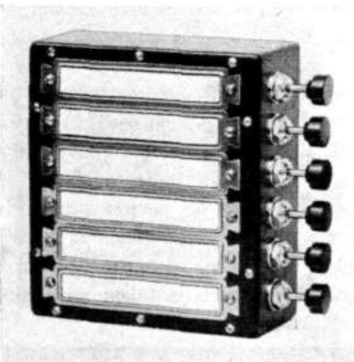


Fig. 3 X 3508
Indicator board

The indicator boards, Fig. 3, are made in three sizes, the smallest with 1—3 press-buttons, the next with 4—6 and the largest with 7—10 buttons. When more than ten persons are likely to be sought in the same place then two or more indicator boards are set up there. An indicator board is set up at the main exit, having ordinary press-buttons which close a release circuit for release of the electro-magnet of the button last pressed. Release of a button which has been pressed may also be done at the central point by pressing simultaneously the locating button of the person and a restoring button in the locating board. The indicator boards are connected to the central point by a lead sheathed cable, Type EEB, 0.5 mm. The cable should comprise plus and minus wires, one circuit for each person likely to be sought and in addition one circuit for each place where there is a marking board.

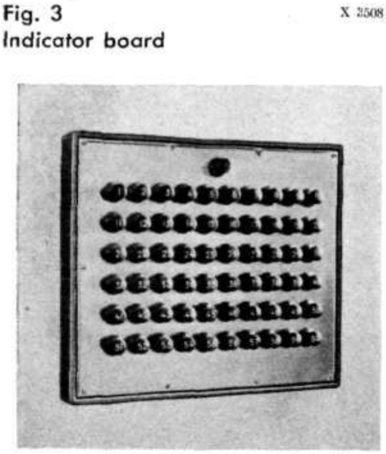


Fig. 4 X 3509
Locating board with press-buttons

As stated above, the equipment at the central point consists of a locating board, with press-buttons, Fig. 4, and a department board with lamps, Fig. 5. The lamps are lit over relays mounted in the department board. To keep down the number of circuits in the cable and the number of springs in the press-buttons the system is so designed that both locating current and release

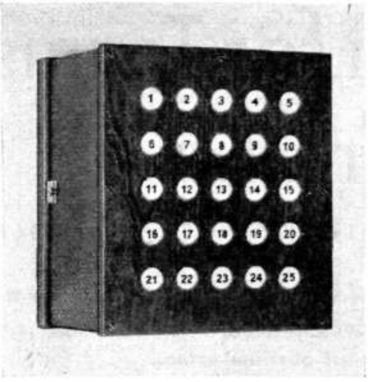


Fig. 5 X 3510
Department board

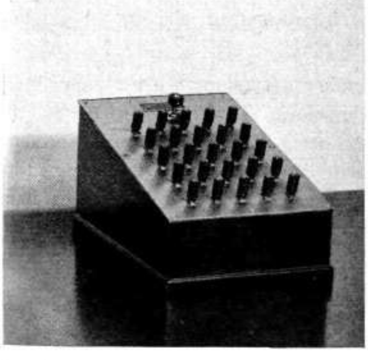


Fig. 6 X 3511
Locating board with switches

current go through the electro-magnet of the button pressed. For locating, therefore, the current must be limited so that the button is not released. This is done by a resistance in the locating board being connected in series in the circuit when locating. The weaker locating current is not sufficient to make a lamp light up and therefore a relay is connected instead and over this the lamp is lighted.

An installation on this system, for locating sixty persons in sixty places, has been made for the Sabbatsberg Hospital in Stockholm, Fig. 1. For the Maria Hospital in the same city an installation for locating twenty-five persons in twenty-five places has been installed.

This latter installation differs to a certain extent from the installation above described. At each indicator board there has been mounted a little bell with a wooden gong, and the press-buttons in the locating board have been replaced by switches, see Fig. 6. The switch has three positions, the middle position, or normal position, a top locking position and a bottom position not locking. Should a person who is being sought have already left the department where he last pressed his indicating button, the switch rises to the locking position. When the person in question next presses his button in an indicator board, there is obtained over a contact in the switch's bottom position a short signal on the signal bell mounted on the indicator board, which notifies the person that he is wanted. When he reports himself to the central point his switch on the locating board is restored to normal. The system carries current only during the instant that an indicating switch is pressed down and when a switch on the locating board is pressed, so that the consumption of current is very small and dry batteries may conveniently be employed. Two 24 V batteries are required. For the bells an extra wire is required in the cable connecting the indicator boards to the central point.

The system is also suitable for other establishments besides hospitals. While the coast of installation is rather higher than for the ordinary locating systems, the system here described has the advantage that any number of persons may be located at one time. If there is a PBX exchange the central point can be conveniently situated beside the telephone operator. When a person is wanted on the telephone the operator, if he does not receive a reply from his instrument, can immediately see where he is and connect the call direct without the necessity of waiting until the person sought replies to a signal. If a person sought has gone out, considerable time is wasted with the ordinary systems by waiting until the person answers the signal and during that time the locating installation is blocked. The system now described also permits of a discreet check being made as to whether the person is on the premises during his time of duty.

Time-Table Supervision for Trams and Trains in Local Traffic

N. SUNDEVALL, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

For local traffic with short running intervals it is a necessity both for the passengers and from the point of view of operating economy that the time-table should be maintained to the greatest possible extent.

Supervision of the running times, arrival and departure times, as well as the periods of waiting at terminal stations, is generally carried out by inspectors stationed at various points, a method which is both expensive and unsatisfactory.

Telefonaktiebolaget L. M. Ericsson has therefore worked out a system with the aid of which it is possible to record automatically at a central point, e. g., at the operation office of the traffic administration, the arrival and departure times of cars at convenient places in the network.

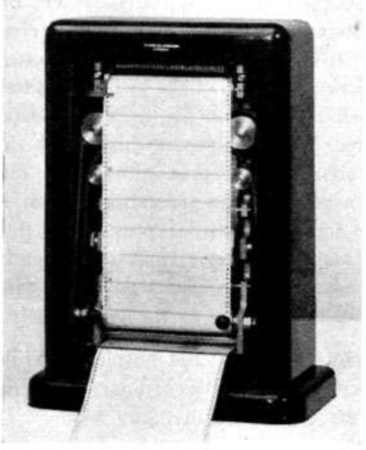


Fig. 1 X 3513
Recording apparatus

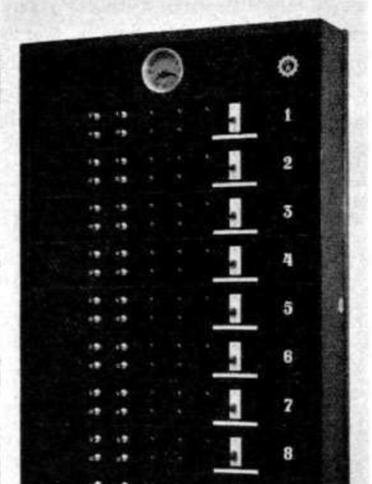


Fig. 2 X 3512
Control apparatus
Each panel contains apparatus for control of one checking point; the upper panel contains a secondary clock for setting and starting

A time-table supervision installation consists of a recording apparatus, Fig. 1, and a control apparatus, Fig. 2, both located in the operations office, together with contact devices in the overhead wires and operating relays located at the checking points in the tramway network. The relays may be connected to the apparatus in the office by means of circuits in existing telephone cables.

The recording apparatus consists of a number of stamps with a paper strip moved along by impulses from a master clock. The time spaces on the strip consist of horizontal rulings and the strip moves along at a speed of 120 m/h, or 2 mm/min. The diagram strip is divided into 30 columns, for each of which there is a stamp. The stamps are actuated by impulses from the driving relays placed in the network and they mark a horizontal stroke to indicate the passage of a car. There is one column for each checking point. The apparatus can thus be used for recording from 30 checking points.

To facilitate the reading of the diagram the control apparatus is used. This consists of a set of selectors and relays for each checking point, these being set in accordance with the time-table in force for each service. Setting is by means of switches marked 5—6—7—8—9—10—12—15— or 20 min and the functioning is such that when a car passes a checking point in accordance with the time-table the recording is normal in the respective column. Should, however, the car pass too early or too late, an extra registration is recorded in the thirtieth column. With this arrangement the reading of the diagram is limited to taking note of the records in the last column and then referring in the other columns to that which bears a mark in line with it, see Fig. 3.

Another form of recording is shown in Fig. 4. This system requires two columns for each checking point. In the first column the apparatus stamps the time-table time and in the other the actual time of arrival or departure. The control apparatus may be set in such a way that it records discrepancies from the time-table only if the actual time of arrival or departure deviates from the time-table by, *e. g.*, one minute either way, so that unavoidable variations in running are not recorded. Should a line during certain periods of the day have different running times, for example, 6 min during some periods, and 10 min during others, changes to suit may be carried out by means of the switches mentioned above. Switching to cover varying services for a whole day may also be arranged by means of a special switching clock.

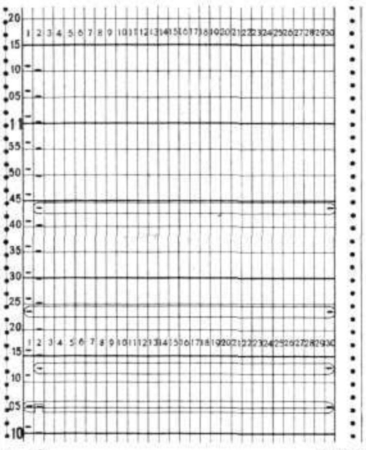


Fig. 3 X 3519
Record strip

On this strip all times differing from time-table (ringed round in the figure) are signalled by repetition in the last column

Fig. 4 X 3518
Recording strip

On this strip all times differing from time-table (ringed round in the figure) are signalled by comparison with time-table times

The requisite devices for each checking point are mounted together on panels which are placed in a cabinet. The top panel, see Fig. 2, contains a clock for the setting and starting of the other panels. This clock, like the recording apparatus and the control apparatus, receives its impulses from a common master clock. It is advisable to use the same time impulses for the operation of clocks located at terminal stations and possibly at places along the tracks. In this way uniform time is ensured for the whole transport system and the drivers may set their watches to agree with the time shown by the recording apparatus, so that all disputes concerning correct time may be avoided.

A complete diagram of a time-table supervision installation is shown in Fig. 5. It is assumed that there is a certain section with checking point *I* to be checked. It is further assumed that the time-table provides that a car shall leave the checking point every fifth minute with a tolerance to the driver of one minute, *i. e.*, that he may leave the checking point at any moment during, say, the fifth minute. Finally, it is assumed that the day's service begins operation at 7.05 a. m.

The first duty of the supervisor is to connect up the time-table supervision installation at 7 o'clock prompt, by means of switch *O*, at the same time pressing switch T_5 which corresponds to one car every fifth minute. There is then obtained a current circuit for one minute impulses from the master clock contact *C* through the driving armature *M* of the installation. As a result the contact organ now begins to move forward one step for each impulse, so that at 7.05 a. m. it is in fifth position. If the car departs during the fifth minute after 7 o'clock, the relay *r* is first actuated. This closes a circuit for relay *R*. Relay *R* is attracted and, over its contact, connects plus potential to the contact bar in the contact group *a* and, as the contact device is in fifth position, the plus potential is connected to the wire connected to this contact. As, however, this contact has no issue, no fault is recorded via relay *K*. But the contact bar in the contact group *a* is connected also direct to the stamp C_1 in the recording apparatus and a record of the exact time of starting is made there.

If the driver starts too early, *e. g.*, during the fourth minute or 7.04 a. m., a circuit is closed over contact *g* of switch T_5 through relay *K*. This relay attracts and actuates the fault stamp C_{30} of the recording apparatus.

If the start is late, say during the sixth minute, the process is as follows: as the contact device gets to the sixth position, from the positive pole on contact bar *b* over contact *h* of switch T_5 there is closed a circuit through

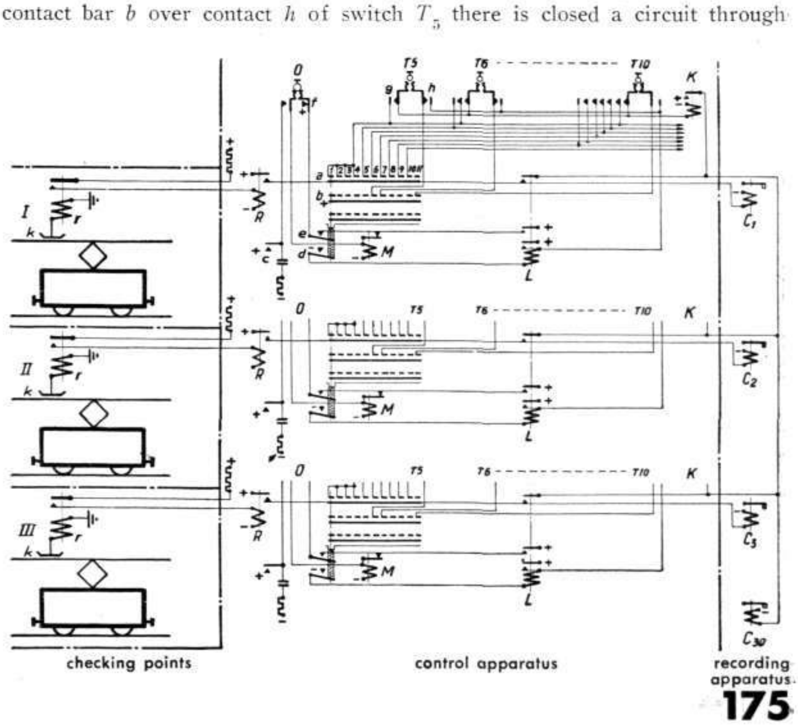


Fig. 5 X 5246
Diagram of time-table supervision installation

C_1—C_{30} stamps
K fault-recording relay
k trolley contact
L restoring relay
M driving magnet
O switch
R switching relay
r operating relay
T_5—T_{10} time-setting buttons

restoring relay L and over contact d which last closes immediately the contact device starts from position *1*. The relay L is attracted and in its turn closes a circuit through armature M and a self-breaking contact on same. The recording device therefore moves forward rapidly until position *1* is once more reached, when contact d is broken. If during this restoring moment the impulse caused by the departure of the car arrives, a circuit is closed over a contact on relay L through the fault recording armature C_{30}. Should, however, the start take place after the contact organ has returned to position *1*, a connecting process corresponding to that described for departure during the fourth minute is obtained. The same connecting process occurs, even should the driver start the car during the second or third minute.

The time-table supervision apparatus continues working in unbroken cycles as described above during the whole time of traffic, or until the supervisor at the central post disconnects it by throwing over svitch O. When the switch-over is made, the contact organ is restored to position *1* over contacts e and f and self-breaking contact of magnet M.

Traffic density can of course be altered at any desired moment by restoring switch T_5 and pressing any other switch T_6—T_{10}. From the preceding it is clear that supervision of traffic at one checking-point is quite independent of the checking at other points. Traffic at these points may therefore be arranged according to a time-table quite different from that applying to the first supervision point.

A time-table supervision installation has now been in operation for nearly a year on the tramway lines in Malmö, Sweden, see Fig. 6. The recording apparatus with the control equipment is installed in the traffic department of the head offices and is connected to the relays at the different checking points by telephone circuits. In addition to the recording and control apparatus, all the clocks in the tramway offices, sheds and workshops, as well as the time-recorders for the staff, are driven from the master clock.

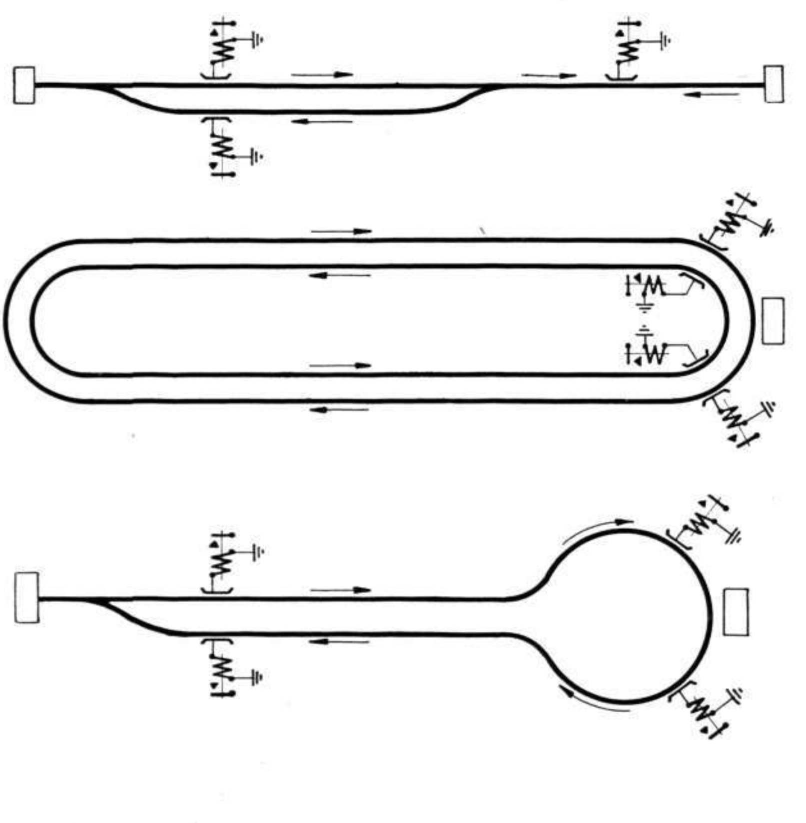


Fig. 6 X 5247
Time-table supervision, adapted to tramway lines of various types

New Type of Electric Radiator

A. KVAM, A/S ELEKTRISK BUREAU, OSLO

A/S Elektrisk Bureau, Oslo, has placed on the market a new type of electric radiator, REX-INFRA, which has all the advantages of older types without their defects.

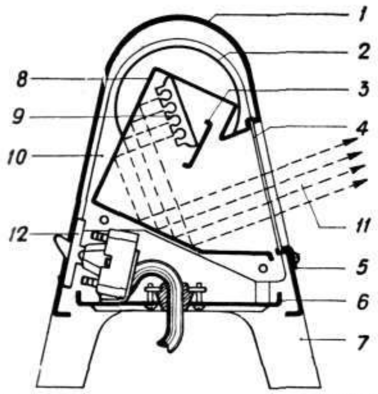


Fig. 1
Cross-section of REX-INFRA radiator
1 cover
2 outer reflector
3 screen
4 mesh screen
5 screw
6 bottom plate
7 side-wall
8 inner reflector
9 heating element
10 reflector side-wall
11 reflected heat rays
12 switch

Electric radiators producing heat in the form of luminous rays are exceedingly popular. That is because the public like to »see the heat», as it gives the same feeling of wellbeing as is experienced when sitting in front of an open fire or a stove.

Existing types of radiators, however, have a very important defect in design, in that the hot-wire spirals of the heating element, in order that they shall be visible, are fitted inside the radiator without any protection, except a coarse mesh screen in front. In this way dust can settle on the spirals, so that there is always an exceedingly disagreeable impression of »burnt air» each time the radiator is switched on. There is moreover the risk that children touching the open element with metal objects may be exposed to dangerous shocks.

In the REX-INFRA radiator these defects are entirely eliminated. Fig. 1 shows a cross-section of the radiator, in which the heating element *9* is protected from touching by the bright-polished aluminium cover *1*. Direct radiation is shielded by the screen *3* and the heat rays *11* are reflected against the metal plate *8* to be finally distributed in the room. The polished plate acts at the same time as a mirror by means of which the light of the glowing spirals is visible on the bottom of the reflector.

In this way luminous heat rays have been obtained with an element which cannot be touched and which by reasonable protection against the deposit of dust avoids »burnt air».

To preserve its mirror action the reflector should be cleaned at intervals, and this is easily done by removing the screen *4*, after loosening the screw *5* at the bottom. To give increased effect the screen at the top is provided with an insulating shield *2*, which at the same time has the advantage that it prevents the outer cover of the radiator from getting too hot.

REX-INFRA is supplied for 500 or 600 W, and its energy consumption can be adjusted to half this value by means of switch *12*. The radiator is connected by a plug to a wall-socket. The dimensions are as follows: length 300 mm, width 165 mm, and height 220 mm. The weight is 2.25 kg. In the course of next year a larger radiator of the same type is to be put on the market, dimensioned for a maximum of 1 200 W.

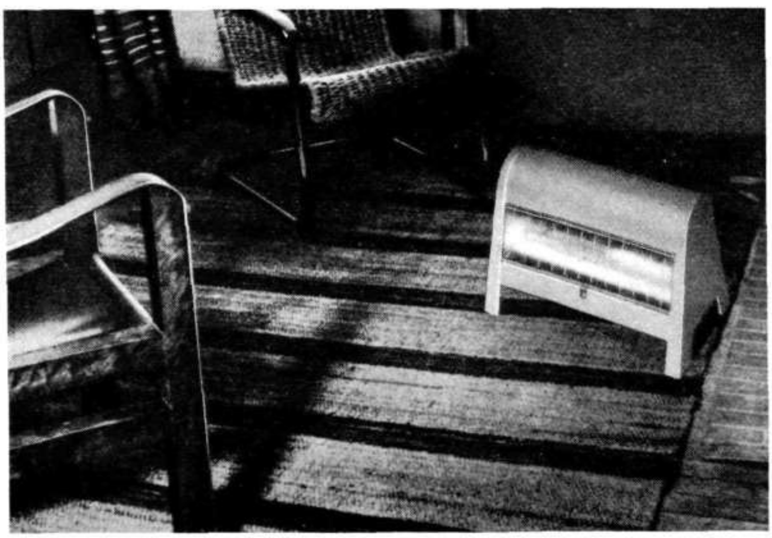


Fig. 2 X 5248
REX-INFRA radiator
installed in a room

New Ericsson Radio Receivers

B. ARVIDSON OCH C. FREDIN, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

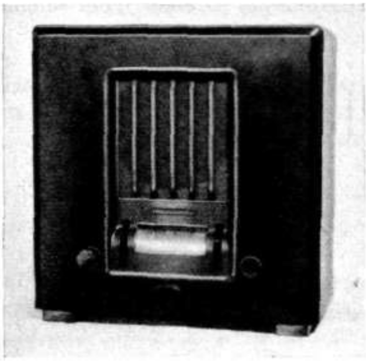


Fig. 1 X 3524
Ericsson 353

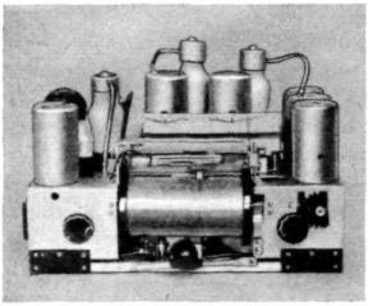


Fig. 2 X 3525
Chassis of superheterodyne receiver, Type 353 V

Fig. 3 X 7088
Diagram of superheterodyne receiver, Type 353 V
or AC, 6 valves including rectifier valve, 8 tuned circuits and oscillator circuit, wave-length range 20—50, 200—570 and 725—2 000 m, intermediate frequency 120 000 c/s, output 3 W

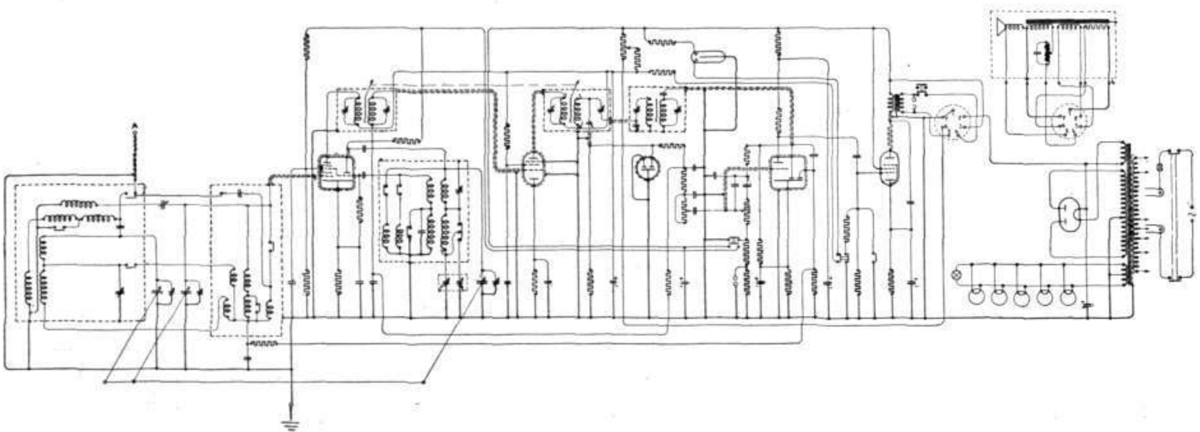
The Ericsson production of radio receivers for the year includes two superheterodyne receivers. The first, Ericsson 353, is an apparatus, combining all the latest improvements, while the other, Ericsson 355, though perfect in technical details, is not equipped for short-wave reception, visual tuning or variable selectivity. In addition, a small model, Ericsson 352, chiefly intended for local reception, has.

Ericsson 353

Ericsson 353, Fig. 1, is a six-valve superheterodyne receiver with 8 tuned circuits. The design to a certain extent follows that of the previous year's type, Ericsson 343, particularly in mechanical respects, see Fig. 2, and details such as silent automatic wave-range commutator remain unaltered in the new production. The object kept in view has been to maintain the good reception qualities and improvements tending to give simplified operation and perfect reproduction, while in other respects developing the receiver in accordance with recent progress, especially as regards valves.

Fig. 3 shows the connection. All valves are of Marconi manufacture. The frequency changer consists of a triode-hexode, *i. e.*, a composite valve with modulator section, the hexode, and oscillator section, the triode. This type of valve has been evolved chiefly with a view to meeting the demand for improved short-wave reception. The heptode valve, which in 1933—34 represented the last word in the sphere of frequency transforming, has certain weaknesses which, while of little importance when working on broadcast waves, may cause trouble when dealing with short waves.

One of the weaknesses of the heptode is that the potential of the control grid affects the oscillation frequency, causing reproduction during reception to be weakened periodically in ratio to the variation in the field intensity of the station received, due to the inaccuracy of the tuning. Another disadvantage is that the heptode does not give the same amplification with short waves as with normal wave lengths, on account of the tendency of the oscillator grid inside the control grid to couple the input circuit through the valve to the oscillator circuit. These two disadvantages have been overcome in the triode-hexode by allowing a separate triode section to function as oscillator and locating the oscillator grid outside the control grid. Screening is very much improved in the triode-hexode and this ensures greater



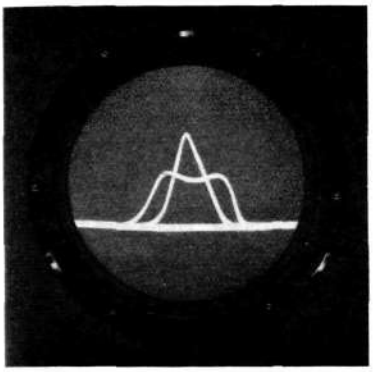


Fig. 4 X 3526
Amplification as function of frequency for intermediate-frequency amplifier, obtained in cathode-ray oscillograph for maximum and minimum selectivity

stability with quieter functioning. Compared with the heptode, moreover, the internal resistance of the hexode is higher and this helps to increase selectivity. The intermediate frequency valve and the detector valve do not depart to any great extent from present or earlier types. The output valves N 41 and N 31 are characterised by unusually high amplification. To obtain full output, 3 and 2 W respectively, they require an AC grid voltage of only 3 V_{eff} as against about 10 V_{eff} with other types.

The wave-length ranges are 200—570, 752—2 000 and 20—50 m; the intermediate frequency f_m is 120 000 c/s. Preselection comprises two tuned circuits with litz-wound coils having cores of high-frequency iron, and includes an arrangement for suppression of image frequencies. These might otherwise arise because, as the apparatus is designed for receiving a frequency f and the oscillator frequency is thus $f + f_m$, a frequency $f + 2f_m$ also reaches the control grid of the modulator valve. The image-frequency eliminator consists in principle merely of compensation for the small balance of the frequency $f + f_m$ which may get in through the two selective circuits from a strong disturbing station.

The intermediate-frequency amplifier contains six tuned circuits, composed of two band filters of 2 and 4 circuits respectively. The coils are provided with high-frequency iron cores of ample dimensions by which the quality of the circuits, wL/R, is raised to something over double that of air-core coils of the same size. The many good circuits ensure extremely good selectivity.

The variability of the coupling, with its effect on the band width, is, as will be explained later, a great advantage as regards reproduction. This variable coupling consists of a loose high-frequency iron core located in the coil of each filter, its movement being controlled by the volume-control knob. As this core moves in between the parts of the coils, two copper discs approach and introduce attenuation in the circuits in proportion to the tightness of the connection and also compensate for difference in inductance caused by the iron core. Adjustment of these band filters would take up a considerable time if it were not done by modern methods. At the factory cathode-ray oscillographs are used for this purpose by means of which the amplification of the intermediate-frequency amplifier is made visible, see Fig. 4.

Fig. 5 X 3527
Attenuation as function of frequency
—— maximum selectivity
- - - - minimum selectivity

Rectification of the intermediate frequency is carried out by a diode detector connected in the last intermediate-frequency circuit, from which a wire is taken out to the diode rectifier which delivers regulating tension to the delayed automatic volume control. High-frequency energy for separate rectifier valve is taken out from the third circuit of the intermediate-frequency amplifier. The audio-frequency component obtained passes a resistance-condenser filter which cuts out the higher frequencies in speech or music but leaves the bass register unchanged. By means of the tone control the possibility occurs later of transmitting energy from this extra rectifying device to the grid of the low-frequency valve, thus allowing of bass register in the reproduction from the loud-speaker to be obtained at will.

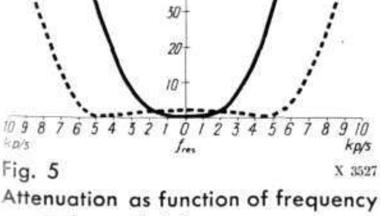


Fig. 6 X 3528
Sound level as function of frequency within audible frequency range

With ideal reception, such as undisturbed reception from a local station, the high selectivity is only a drawback to the rendering. All the harmonies and even a part of the fundamentals in the upper register are cut out, the music is without tone and speech is poor in intelligibility because of the elimination of s and f sounds. A device which continuously varies the selectivity may be adjusted to ensure the best results possible with the prevailing reception conditions. The curves, Fig. 5, indicate the selectivity in the maximum and minimum positions. To secure full register the bass register must, however, be corrected as well. This is done by means of the volume control which is combined with the selectivity control. This device, when adjusted for the greatest register gives a tone register curve as in Fig. 6. The curve shows the tone reproduction properties of the apparatus as a function of the frequency. As will be seen, the receiver is capable of reproducing tones with from about 30 to over 7 000 c/s. The lowest tone of the bass tuba has a frequency of 40 c/s and the highest tone of the violin is about 3 100 c/s. The volume-control knob also operates the on-off switch and the tuning, by which the visual indicator is switched in and the low-frequency amplification reduced.

The loud-speaker comprises a specially impregnated cone with floating suspension, which ensures good reproduction of the whole tone register. Both the AC and the universal types have terminals for pick-up and extension loud-speaker. There is a switch for disconnecting the loud-speaker of the apparatus.

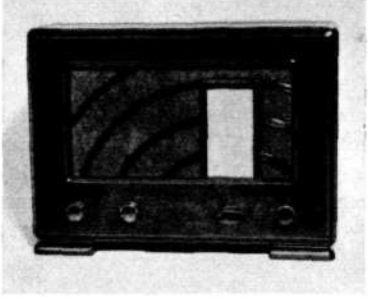


Fig. 7 X 3526
Ericsson 355

Ericsson 355

Ericsson 355, Fig. 7 and 8, is a five-valve superheterodyne of the same high class as Ericsson 353, but without some of its finer points: short-wave reception, variable selectivity and visual tuning. It is attractive in appearance and handy in size, being of the horizontal type, with loud-speaker alongside the station scale. Tuning in to stations is exceedingly simple: the stations are listed on two divisions of the scale window and the tuner consists of a luminous line which is moved up and down by turning the station knob. The line moves across to one or other of the scale-window divisions according to the wave-length range selected. The wave-length switch is combined with the on-off switch and the pick-up connection. Volume control is continuously variable and combined with interference suppressor.

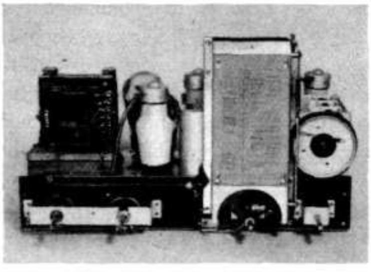
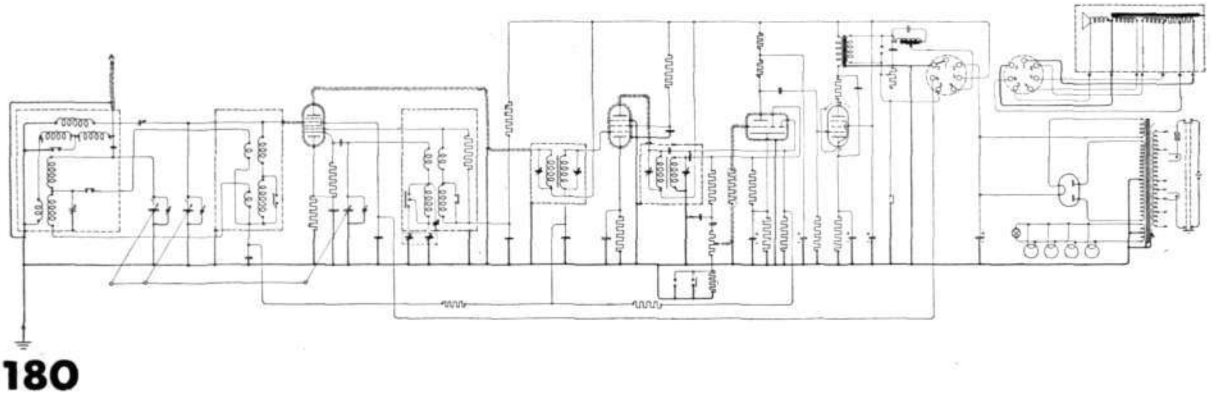


Fig. 8 X 3530
Chassis of superheterodyne receiver, Type 355 V

Ericsson 355 is made for both AC and universal and is effectively shielded from mains hum, the AC apparatus by a screen in the mains transformer and the universal apparatus by two high-frequency chokes, see the diagram, Fig. 9. The AC apparatus is fitted with 4 V Marconi valves. The mixer valve is a heptode MX 40, the intermediate-frequency amplification is obtained from a high-frequency pentode VMP4G and rectification and low-frequency amplification in MHD4 which last feeds the final pentode N 41. The universal receiver is equipped with the corresponding universal valves, X 30, W 31, DH 30, N 31 and U 30. When current is switched on, the valves and the scale lamp are protected by a delaying resistance which has an exceedingly high resistance when cold, dropping to a few ohm when heated. In other respects the two receivers are almost identical as regards connection. Both are fitted with high-efficiency band filters with ample band width, so that the loss of high tones is insignificant.

The delayed automatic volume control keeps the loudspeaker output practically constant notwithstanding fading in the station received. The volume control is combined with a tuned circuit, providing silent tuning between stations and interference suppression. In addition, the receivers are fitted with connections for extra loud-speaker and pick-up.

Fig. 9 X 7089
Diagram of superheterodyne receiver, Type 355 V
for AC, 5 valves including rectifier valve, 6 tuned circuits and oscillator circuit, wave-length range 200—570 and 725—2 000 m, intermediate frequency 120 000 c/s, output 3 W



Ericsson 352

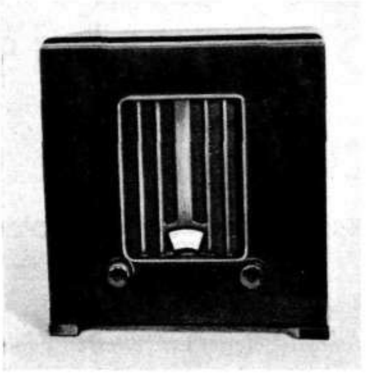


Fig. 10 X 3531
Ericsson 352

Ericsson 352, Fig. 10, is a single-circuit receiver made in three models: AC, universal and battery. All the models are provided with moving-coil loudspeakers and scales giving the names of selected stations. The great sensitivity combined with highly developed selectivity ensures first-class reception, not only of local stations but also of the more powerful stations of other countries. In each of the three models the controls consist of a knob for tuning and for switching from medium waves 190—600 m to long waves 700—2 000 m, a knob for reaction, a switching arrangement with jacks and plug for altering the aerial connection according to the selectivity required.

The mains-connected receivers contain a high-frequency pentode as detector. The sensitive 8 W output pentode gives the receiver its unusually high sensitivity and output. The diagram for the AC receiver is shown in Fig. 11. The battery receiver is equipped with 3 valves. The class-B final stage gives the receiver almost as great an output as a mains-operated apparatus, in spite of the fact that when no signal is being received it only takes 6 mA anode current with a 120 V anode battery.

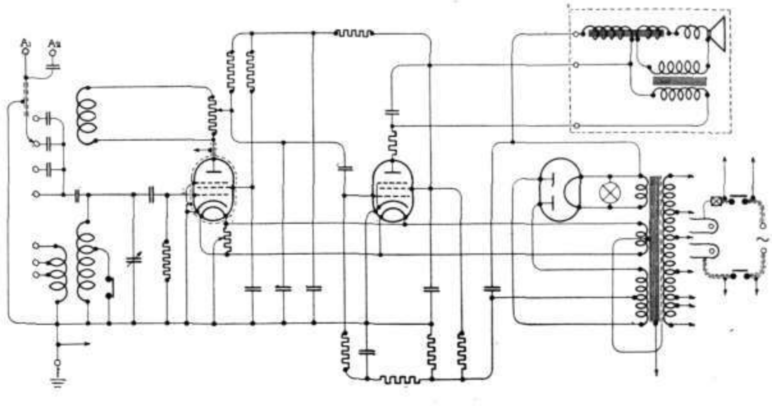


Fig. 11 X 5252
Diagram of single-circuit detector receiver, Type 352 V
for AC, 3 valves including rectifier valve, wavelength range 190—600 and 700—2 000 m, output 2 W

Time-Recording Apparatus with Signal Mechanism

N. SUNDEVALL, TELEFONAKTIEBOLAGET L.M. ERICSSON, STOCKHOLM

It is now more than 15 years since Telefonaktiebolaget L.M. Ericsson began to make recording apparatus for timekeeping in industrial establishments. In the time which has elapsed many of the largest industrial concerns of Sweden have been furnished with time-recording installations on the Ericsson system, while the market abroad for these recorders has continually expanded.

In recent years, however, interest in rationalisation has also spread to the smaller undertakings. While it was at one time considered that time-recording installations were an economical proposition only in the case of concerns employing 200 hands or more, undertakings with as few as 25 hands are nowadays finding that it pays to make use of time recording. With these smaller undertakings, however, for which one or two recorders might be sufficient, the mechanism included in larger installations, for sending out time signals and adjusting the recorders to suit varying working hours, would be too complicated and expensive, and for this reason a new recorder with built-in signal mechanism has now been put on the market.

The Ericsson recorders have been described in Ericsson Review on previous occasions, so that it is unnecessary here to go into the design. The special advantages which they present over all other recorders are briefly as follows: the adjustment of the position of the cards is automatic in all respects—arrival, departure, overtime and leave are always entered in the proper space, no matter what time the recording is done; late arrival, early departure, overtime and leave are recorded in red, other times in blue. The arrangement of the recording is such that the reading of the cards and the reckoning of the time worked is very much simplified. For example, if the two-colour ribbon change is set for a 48 hours' working week, and if a card is provided with four blue recordings per day, the record thus forming a rectangle with all sides one colour, there is no further need for checking the time recorded and the card may be automatically endorsed for the total working time, 48 hours.

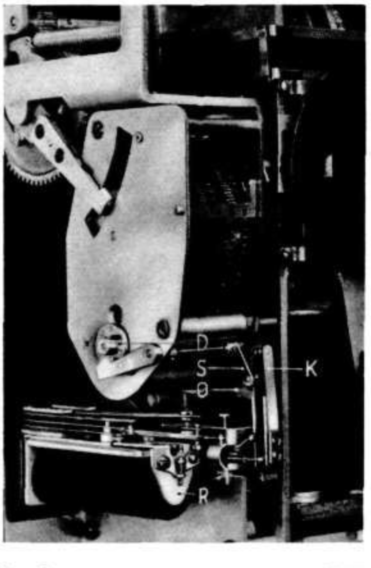


Fig. 1 X 3535

Signal mechanism built in recorder

- D programme-wheel
- K contact spring
- O switch arm
- R signal relay
- S disconnecting lever
- t signal contact
- T time-limiting device

In the system produced by Ericsson for large undertakings requiring several recorders, these apparatus are operated from a common master clock of extreme accuracy, thus ensuring uniform time throughout the factory. A further advantage of this is that installation contains only one clock mechanism which may be located at some spot not exposed to vibration or shocks. The recording mechanism is driven by means of impulses transmitted from the master clock by a simple electro-magnetic device and thus includes no delicate clock movement. Secondary clocks with signal device are connected up to the master clock, and these take care of the signalling of rest periods and the beginning and ending of working time. An installation of this kind is described elsewhere in this issue.

Such a system would, however, be rather too expensive in a smaller installation for which a single time recorder may be sufficient. For this reason the

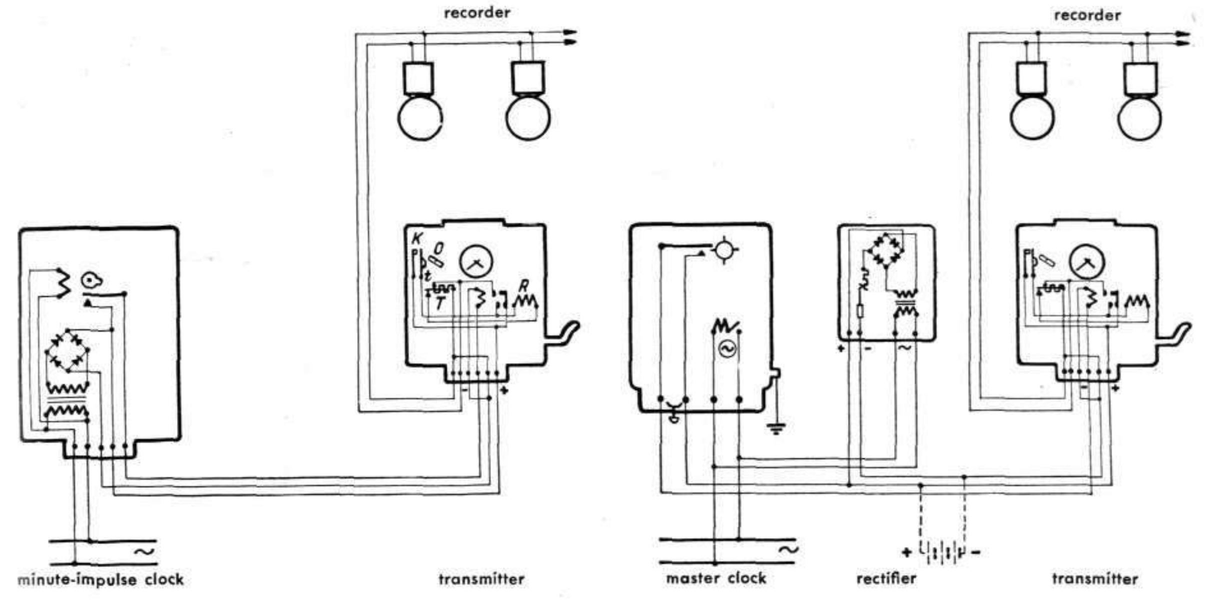


Fig. 2 and 3 X 1487 X 1488

Diagrams of time-recorder installations for small undertakings

left, for connection to frequency-controlled AC mains

right, for connection to non-frequency controlled AC mains

programme device and the signal clock have been simplified so that they can be combined in the time recorder itself.

Fig. 2 and 3 show examples of time-recording installations. As may be seen from Fig. 1 the time recorder, Type KC 110, is provided with a device for regulating signals. The programme mechanism of the recorder, which changes the printing ribbon from blue to red and vice versa, also operates the signals, indicating the working schedule. On change of ribbon colour the arm *O* is actuated by one of the pins in the programme wheel and falls or rises, according to what its previous position was. During this movement the contact *K* is momentarily closed, on which relay *R* is energised and remains energised, whereupon the signal bells are connected. An arm *S*, which is actuated by the wheel *D* in the programme mechanism and holds the springs *K* apart so that the contact is not closed when the arm *O* acts on the springs, disconnects the signal circuit for Sundays. Simultaneously with the energising of relay *R*, the time-limiting device *T* is connected. This consists of a bimetallic spring encircled by a thermo spiral which after being under current for a certain time bends the spring and breaks contact *t*, breaking off the signal. An adjusting screw on the time-limiting device allows of regulation of the length of signal between approximately 5 and 20 s.

An installation like Fig. 2 is driven direct from AC mains by means of an impulse transmitter. This consists of a synchronous motor with minute-impulse contact along with transformer and rectifier. The transformer changes the mains voltage to 24 V, after which the current is rectified and operates the driving magnets of the recorder over the minute-impulse contact. Tension for the signal device and the signal bells is taken from the same rectifier. This type of installation can only be employed with mains having controlled frequency and seldom liable to interruptions of current.

An installation like Fig. 3 is, as the foregoing, operated direct from the AC mains via a rectifier, but the minute impulses are delivered from an special clock with automatic electrical winding. On interruption of current the tension is delivered by an accumulator battery in floating connection. Without accumulator this type of installation is suitable for AC mains without frequence control where the risk of current interruption is minimum, and with accumulator for all AC mains where there is risk of current interruption or in workshops where the current is shut off at the close of the working day.

Impulse Repeaters for Subscribers' Lines

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

It happens many times that subscribers' lines have to be connected to an automatic exchange, which have not the electric properties required in lines directly connected to the normal line equipment of the exchange. To make this connection possible Telefonaktiebolaget L.M. Ericsson has produced the impulse repeaters described below.

On automatisation of existing telephone networks the whole of the subscribers' line network is not as a rule found to be in such a state that it can be connected without alteration to the new automatic exchange. The demands are heavier on an automatic network than on a manual one, seeing that, in addition to calling and clearing signals, dialling impulses have also to be transmitted with adequate reliability. The standard Ericsson automatic system with machine-driven 500-line selectors, for example, requires that the line resistance of the subscribers' lines shall not exceed 1 500 ohm and the insulation shall not be below 20 000 ohm. It might happen, however, in some circuits that the cost of reconstruction to comply with the conditions of the automatic system in respect of line resistance and insulation would be unreasonably high. Moreover, in smaller networks there are often subscribers' instruments situated at a distance, which are connected by single-wire circuits with earth as return circuit.

DC Repeater

For connection of circuits of the above nature Ericsson has produced *impulse repeaters for DC* which have now been in practical operation for some time and have proved to operate satisfactory and to fill a real want. The repeater, Fig. 1, consists only of an additional equipment at the exchange for each of the lines in question. It comprises a transformer *T*, see the diagram, Fig. 2, designed for the passage of vocal frequencies, which separates the subscriber's line *L* from the exchange line *L* connected to the normal line-relay equipment at the exchange. The subscriber's line is connected to the exchange battery over the line winding of the transformer and a sensitive impulse relay *R1*. The operating contact of this is connected in the exchange line in series with the exchange winding of the transformer. Further there is connected to the exchange line the signal relay *R2* in rectifier connection and in series with the condenser *C*. When call is made from the subscriber's instrument the relay *R1* is actuated and closes the loop on the exchange

Fig. 1 X 7090
Signal repeater for subscribers' lines
Left, from left to right, impulse relay, signal relay, transformer and condensers

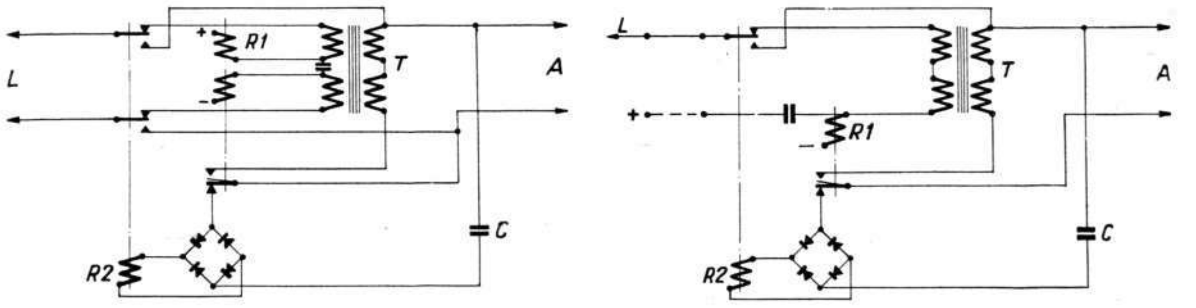


Fig. 2 and 3
Diagrams for signal repeater
Left, for two-wire subscriber's line
right, for single-wire subscriber's line

X 1489
X 1490

side, whereupon normal call is made in the automatic exchange. On dialling the relay *R1* repeats the impulses in this loop and the connection of the call proceeds in the normal way. When call is sent out on the subscriber's line it actuates relay *R2* which shunts the repeater and connects the subscriber's line direct to the exchange line which then sends out calling signal in the ordinary way. The transformer *T* therefore does not require to carry the ringing current and its size may then be kept small. It is mounted as a single-coil relay, see Fig. 1.

With single-wire subscribers' lines, see the diagram, Fig. 3, the line is as a rule two-wire in the exchange, where it most often is laid in a cable to avoid cross-talk. Earthing of the branch which is not continued to the subscriber's instrument is then carried out at the far end of the branch; to prevent the current from the exchange battery from leaking along this conductor, it is connected over a condenser to relay *R1*. With two-wire lines which are not too long and with single-wire lines the current feed to the subscriber's instrument may be taken over the impulse relay *R1*. On the other hand with two-wire lines of considerable length local feed should be provided in the subscriber's instrument to ensure satisfactory microphonic feed.

By the use of this repeater it is possible to connect lines with a line resistance up to 2 000 ohm to the Ericsson automatic system. Ericsson has also produced an impulse repeater for DC, which has a more sensitive impulse device than the foregoing and which therefore permits the connection of lines with still lower electrical properties. This repeater enables lines with over 2 000 ohm resistances and insulation resistances down to 5 000 ohm to be connected to the automatic system.

AC Repeater

In special instances it may happen in an automatic telephone installation that the utilisation of a phantomised or loaded line section is necessary for carrying isolated subscriber's lines. To meet such cases Ericsson has produced an *AC repeater*. While the DC repeater does not require any extra equipment to the subscriber's instrument, this AC repeater comprises relay equipment both at the subscriber's instrument and at the automatic exchange. Signalling over the line is carried out with low-frequency AC, 20—60 c/s, and with a voltage suited to the length of the line.

Fuse with Separate Alarm Contact

S. ANDERSON & H. STERKY, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

A new fuse with separate alarm contact has been designed by Telefonaktiebolaget L. M. Ericsson to meet certain requirements chiefly noticeable in long-distance telephone technics. Special attention has been directed to the possibility of separating the main circuit from the alarm circuit, avoidance of loose contacts without using screw terminals, together with high contact pressure in the alarm circuit in spite of the use of thin wires in the main circuit.

When designing a fuse for telecommunication purposes other requirements must be considered than in the case of power and lighting plants. The majority of fuses in telephone practice are required to deal with a lower operation voltage so that the demand for break capacity is not of such great importance, and also the dimensions of the telecommunication fuse must be kept down in an altogether different manner than for power installations. In addition there is the desire for audible or visible alarm, in view of the fact that even a momentary break in current entails serious interruption of operation.

The fuses usually employed up to now in telephone practice have been made either with fine fuse wires enclosed in glass tubes and soldered to metal sockets fixed to the tubes, similar to the fuses used for electric energy supply, or with fine fuse wires stretched between springs which latter in case of over tension exercise a pull on the fuse wire. In the former case there is no possibility of alarm, while the latter type is most often provided with a contact device which closes when the spring is released by the fusing of the wire.

Neither of these types, however, is suitable for use at long-distance exchanges fitted with modern telephone or telegraph equipment, such as two-wire and four-wire repeaters, carrier-frequency apparatus for multiple telephony and telegraphy, telegraph relays, etc. A new type of fuse has therefore been produced which not only meets the demands that have always been imposed on telecommunication fuses but also satisfies the following requirements:

1. there should the possibility of giving alarm. For this it is desirable that the alarm circuit does not come into metallic connection with the main circuit, whether this be closed or open. In this way the alarm devices may be arranged for the voltage most suited to them, no matter whether the fuse is fitted in an anode, a filament or a grid circuit in a vacuum tube, in a ringing-current circuit or in a telgraph-receiver circuit. It is, for instance, often undesirable to take out the necessary current for alarm from dry batteries or small accumulators connected in the main circuit;

2. false alarm must not be given even if the fuse is loaded for at considerable period with a current approaching the limit intensity;

3. loose contacts, particularily dangerous in grid and anode circuits, must never arise between fuse and holder. In spite of this the fuses must be easy to replace, without having to bother with screws and nuts;

4. it must be possible to change the fuses quickly without the hand touching or coming in dangerous proximity to parts under tension, since voltages up to 240 V occur in the anode circuits of vacuum tubes;

5. the fuses must be designed so as to allow of fuse wire for limits of 0.3—5 A to be employed.

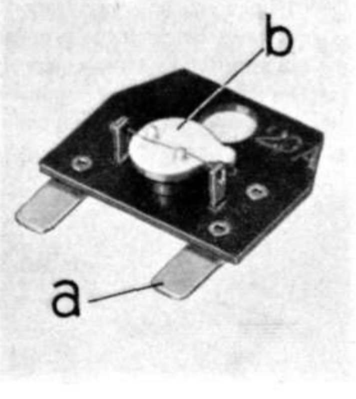


Fig. 1
Fuse
a contact pin
b eccentric

X 3516

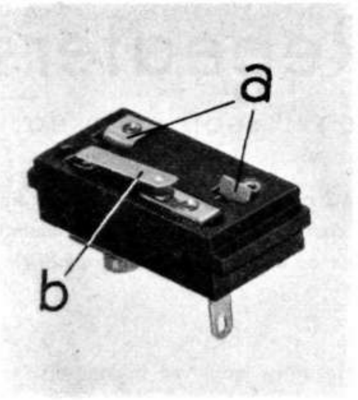


Fig. 2 X 3517
Socket
a contact sockets
b alarm spring

Construction

The new fuse is made in two parts: the fuse and the socket. When designing the *fuse*, Fig. 1, the main problem, as stated above, consisted in producing a device which imposed but small mechanical load on the fuse wire while at the same time ensuring a sufficiently strong effect on the alarm contact on release, *i. e.*, on fusing of the wire.

It was obvious that for this some form of gearing was needed, and the choice fell on an *eccentric* which rotates on the fusing of the wire and actuates the alarm contact. As the contact spring only requires to move through 1 mm and the eccentric makes a half revolution, it is easy to see that with such a device there is obtained considerable gearing and sufficient contact pressure. In order to provide a suitable mounting for the eccentric device and to meet the requirement respecting ease in changing, the fuse, as may be seen from Fig. 1, is made in the form of plug, consisting of a small paper-bakelite plate $28 \times 35 \times 1.5$ mm with finger grip and two flat contact pins, Fig. 1a, between which the fuse wire is soldered.

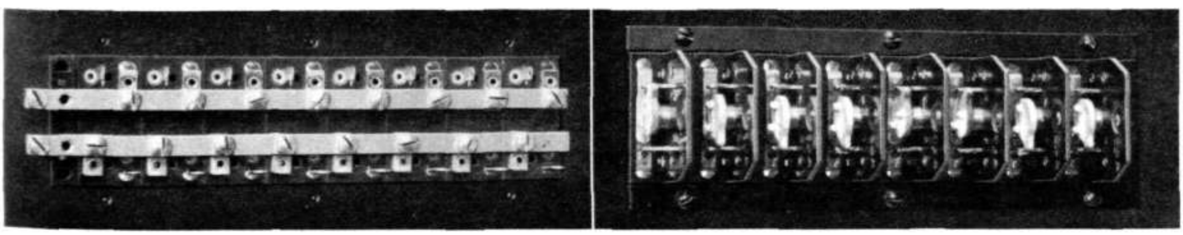
The eccentric, under pressure from a spiral spring, Fig. 1 b, also rests on the plate in such a way that two studs on its front are one above and the other under the fuse wire. This ensures that no one-sided or uneven pressure occurs on the fuse wire; according as the spiral spring tends to turn the eccentric the fuse wire is stretched uniformly between the two studs. Another advantage with this device is that any lengthening of the wire due to heat of the current need not entail any risk of false alarm, since the movement of the eccentric is so great that it requires a half turn for alarm to be given. To provide the requisite insulation and resistance to heat, the eccentric is made of glazed porcelain which also reduces friction in the bearings and against the alarm spring. Notice that a fuse wire has fused is given not only by the alarm contact but also by the eccentric which as it rotates shows a surface coloured blue, yellow, red, etc. according to the limit intensity of current.

The socket, Fig. 2, is made of moulded bakelite $10 \times 18 \times 40$ mm and provided with two rectangular contact holes, Fig. 2 a, in which strong phosphor bronze springs press against the contact pins of the fuse. Alongside the two contact holes is placed the alarm-spring group, Fig. 2 b, which consists of two springs which close a circuit when the eccentric above the spring group rotates and presses down the upper spring. All connections are taken out at the back of the socket in such a way that there is a soldering and a screw terminal both for the main and for the alarm circuit, enabling a number of sockets to be connected together on common busbars, for each of the alarm and main circuits, see Fig. 3.

Moreover the sockets are made with flanges at the ends to facilitate mounting on iron panels. For mounting, the sockets are laid in a rectangular slot in the panel where they are held by two guides running parallel with the slot, see Fig. 4, the lower of which may also serve as designation strip. All connections, as stated above, are from the back.

The fuse may be provided with fuse wires for various current limits between 0.3 and 5 A. When the smaller diameter of wire is used the initial tension in the eccentric spring is reduced by moving one end of the spring from one hole to another in the fuse plate. A fuse which has burnt out can easily be detected by the colour shown by the eccentric. The fuse may be taken out readily and replaced by a fresh one, after which the burnt out fuse can be repaired by soldering in new wire.

Fig. 3 and 4 X 7087
Fuses, mounted on panel
left, rear view with busbars, right, front view with fuses, of which the first, fifth and sixth have fused



AC Relay for Signal Repeaters

C. O. SOHLBERG & H. STERKY, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

The following article deals with a new AC relay for 16—50 c/s, which has the following features: both the magnet core and the armature are laminated, the armature is balanced and the flux of the only two air gaps arising is utilised for mechanical work.

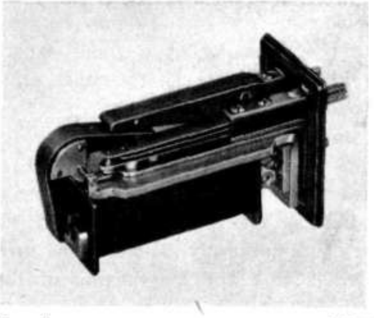


Fig. 1 X 3507
AC relay

In two-wire repeaters and certain other apparatus employed in long-distance practice are included relays for receiving AC signals with a frequency ranging from 15 to 50 c/s. As a rule such a relay is connected parallel with the circuit, either direct or over a condenser of such capacity that series resonance for signal frequency is obtained with the inductance of the relay. In certain cases also sensitive relays connected in a similar manner are required for the reception of AC signals over long local or rural subscriber's lines. On this account the relay will also shunt the line when transmitting voice frequency, so that a condition is that the relay's impedance to voice frequency shall be as high as possible. At the same time, in this as in other cases, high sensitivity to signal frequency, usually 20 c/s, is desired. It is not a light matter to meet these requirements if the cost of the relay is to be moderate and it has to work with ordinary contact pressure of 15—25 g. On the other hand there is no necessity to provide the AC relay with several contact springs, it being sufficient if it is provided with a make, break or commutation contact, for the repeaters or signal receivers always have other relays of ordinary DC type, which can deal with any more complicated switching that may be necessary. As a convenient compromise between the demands for high sensitivity and for high contact pressure it is usual to adjust an AC relay for the purposes in question so that it has a contact pressure of 5—15 g. As a result of this the relay becomes sensitive to vibration, so that the design should include balanced armature. Otherwise intermittent connection or false signals may be obtained, particularly if the relay is mounted on a loose frame exposed to shocks.

Construction

Outside measurements, mounting and connecting of the new AC relay, Fig. 1, do not differ from the Ericsson standard relay of the single-coil type for 40×60 mm division. The cover as also the soldering tags and the springs are also of ordinary type. The last-named are made either for low contact pressure 5—15 g, or for higher 15—25 g. The relay bracket differs only from the standard bracket in the lugs bearing the armature.

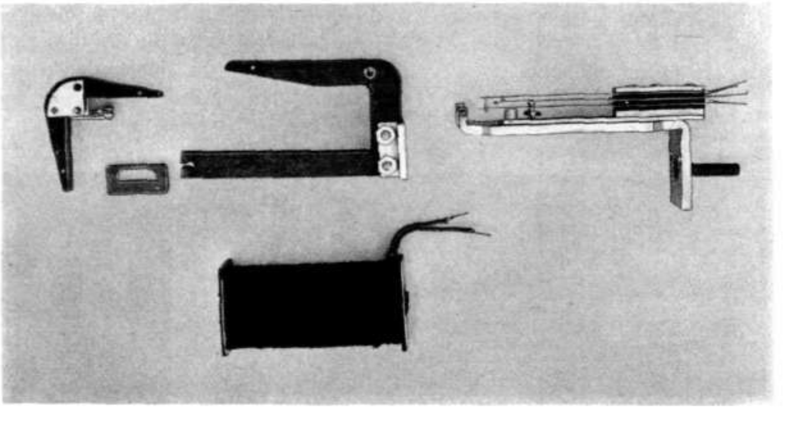


Fig. 2 X 5243
Parts of the AC relay
above, left to right, armature, damping ring, core, and bracket with spring group
below, coil

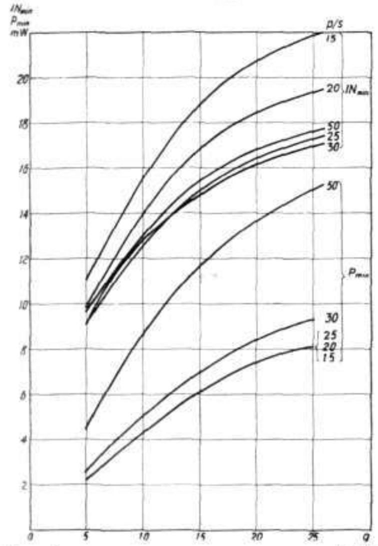


Fig. 3 X 3520

Minimum input and ampère-turns as function of contact pressure for reliable attraction at different frequencies

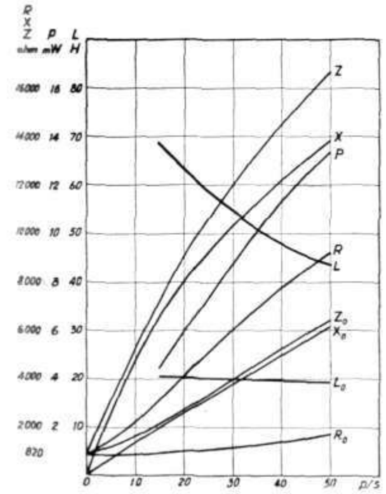


Fig. 4 X 3521

Impedance, resistance, reactance, inductance and input as function of the frequency, at 10 g contact pressure and 1.2 mA current, corresponding to reliable attraction

The upper curves are measured, the armature being attracted

The lower curves are measured, the armature being at rest and locked

As stated above, the magnet core and the armature are not of the customary relay type. From Fig. 2 it will be seen that the *core* is U-shaped and fixed to the relay bracket with two small angles in such a way that one shank comes on either side of the relay bracket. The core is made of laminated ferro-nickel plate 0.35 mm thick, by which a low magnetic resistance is obtained in the core, and the inductance of the relay for weak currents and voice frequency is high. The lower shank holds the coil. The whole of the winding space below the relay bracket is effectively utilised. The upper shank along with the soldering tabs and the springs fill up the space above the relay bracket.

The shape of the *armature* is dictated by the desirability that it shall be balanced and of comparatively large mass. Balancing is necessary, as stated, with a view to preventing faulty attraction due to vibration in the suspension arrangements. The comparatively large mass of the armature tends to make the relay quiet when attracting and repelling. With the same object the core has been fitted at one of the air gaps with a damping ring of solid copper which surrounds half the core area and thus produces such a phase shift in a part of the field that the pull never sinks to zero. Moreover the L-shape of the armature allows of the utilisation in a simple manner of the flux of the two air gaps for active work. The armature, which is also laminated, is fastened in between two shields in which the axle is fitted. The shields also hold the screws for regulating the stroke and the upward movement of the springs. The short distance from the armature's pivot to the impact point of the lifting stud should be noticed. As the stud moreover acts on the spring right under the contact, the attraction of the armature at the poles is trebled at the contact.

Functioning

A model of the new AC relay has been submitted to a series of tests in which it has shown itself superior to relays previously used for the same purposes. Measurements have been carried out for two different windings with about 800 and 8 000 DC resistance at frequencies 15, 20, 25, 30 and 50 c/s for 5, 10, 15 and 25 g pressure on the switching spring in the spring group. The resulting stroke of the armature has been 1.4 mm, measured at the centre of the lower air gap. This stroke corresponds to a 0.4 mm movement of the switching spring. In all cases the minimum current required for reliable making of contact has been measured and on the basis of this the minimum pull and the ampère-turns have been calculated. In addition the relay's impedance, resistance, reactance and inductance with armature repelled and attracted have been measured and calculated for the frequencies 15—50 c/s.

As examples of the results obtained there are given in Fig. 3 and 4 certain curves for a relay with 13 000 windings, corresponding to a DC resistance of 820 ohm. The curves, Fig. 4, for example, demonstrate that the impedance of the 800 ohm relay at 20 c/s and with repelled armature is 2 800 ohm, $+ 68^\circ$. With attracted armature the corresponding figure for impedance is 9 000 ohm, $+ 63^\circ$. The impedance rises in repelled state to 58 000 ohm, $+ 72^\circ$, at 800 c/s, which shows that there is no need to apprehend that the relay connected in shunt to a circuit for voice frequency will have any noticeable effect on the characteristic impedance of the circuit and therefore it will not impair the balancing of two-wire repeaters. On account of the convenient shape of the coil bobbin the internal capacity of the relay is low, about 40 $\mu\mu$F, so that the relay may be used for high-frequency circuits.

Ericsson Technics

Ericsson Technics No 5, 1935.

R. Stålemark: Theory and Application of a New Eight-Terminal Network.

Recent developments in long-distance telephony, particularly for carrier systems, have rendered necessary a very accurate matching of the equipment connected with the lines, in order to avoid crosstalk. Considerable attention has therefore been directed to the problem of getting the impedances of the lines and of the line filters as equal as possible, by the use of line equalizers.

Ericsson has solved this problem by designing the line filters as a terminal network consisting of eight terminals, having different properties in respect of attenuation and impedance.

The present article describes this new method of filter connection, first giving general equations, then treating of an eight-terminal network with directional effect and finally citing a few typical examples of the computation and the practical use of the network.

The article shows that such a terminal network not only provides an excellent matching to the line, but also presents a few other valuable properties.

Ericsson Technics No 6, 1935.

H. Sterky: Affaiblissement composite et rendements des transformateurs téléphoniques.

The dimensioning of a transformer having iron and copper losses is considered from quite different points of view by the power engineer and the telephone engineer. The present article deals with the causes of this and seeks to express the similarities and differences between these two aspects of the problem.

The formulae deduced for the computation of the working attenuation and the efficiency show how a transformer should be dimensioned for obtaining the lowest working attenuation and the highest efficiency. Further, approximative formulae and curves are given permitting an easy computation of the variation of the working attenuation and the efficiency with the frequency, the coupling degree and the losses.

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