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On cover: Exterior of the new building for offices and laboratories, with wireless tower, at L M Ericsson's head factory, Midsommarkransen, Stockholm.

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L M Ericsson's Laboratories

H BLOMBERG, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.317.2

Ever since the middle of the nineteen thirties intense activity has been going on to extend and modernize the Swedish establishments of the LM Ericsson group, with a view to setting them in a position to meet the constantly growing demands for development work and production. The first big step was taken by the erection at the close of the thirties of the parent company's big new establishment at Midsommarkransen, Stockholm. Since then a number of new plants have been added in both the parent and the subsidiary companies and many others are in course of construction. In the next few numbers of Ericsson Review, brief accounts in word and picture will be given of the most important of these additions.

The move of Telefonaktiebolaget L M Ericsson in 1940 from its old factory and office buildings in the centre of Stockholm to the present up-to-date establishment at Midsommarkransen on the outskirts of the city meant that vastly improved laboratory resources could be made available for development work.

The old laboratories had been housed in an office building which was but little suited to the purpose. With the great expansion of the company's activities, conditions grew more and more cramped and in spite of every effort to make the best use of the space available, the premises became increasingly out-of-date. So, when the new establishment at Midsommarkransen was being planned, an important consideration was to ensure the provision of development laboratories that would satisfy much more exacting demands than hitherto. The most thorough study was devoted to the planning of the fittings and equipment for these new laboratories and several new and interesting ideas were incorporated. As a result, when these new laboratories were ready for use nearly ten years ago, it is no exaggeration to say that they represented

Fig. 1 X 7519
Head factory at Midsommarkransen, Stockholm

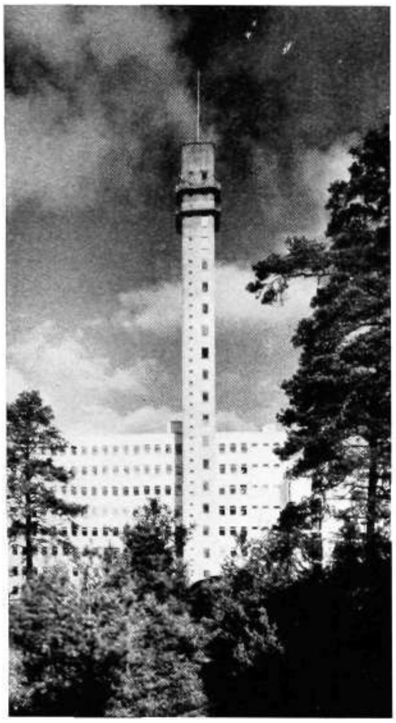


Fig. 2. X 4622

The latest office and laboratory building, with the wireless tower used, amongst other things, for micro-wave experiments

the highest point attainable as regards suitability for their work and the most up-to-dateness available at the time in the field of telecommunications.

These new laboratories were estimated to satisfy requirements for ten years to come. Nevertheless, owing to the rapidity of developments and the expansion of telecommunication technique, it was found when only five years had gone by that this was not the case and that considerable extension was necessary. Plans were therefore drawn up for a new office and laboratory building alongside the original building at Midsommarkransen, and this was erected in 1947—48. When the new addition was ready for use at the end of last year, supplementary office and laboratory accommodation had been provided to the extent of not less than 40 %.

The range of laboratories now at Midsommarkransen comprises

electro-acoustics laboratory,
electro-physics laboratory,
electronics laboratory,
telephone instruments laboratories,
telephone exchange laboratories,
long-distance telephony laboratories,
micro-wave laboratory,
chemical laboratory,
materials laboratory,
signal plant laboratory.

The new premises consist of an 8-storey building possessing direct communication with the offices and laboratories located on the top or third floor of the original building. Fittings and fixtures are much the same as those put in ten years ago.

In conjunction with the building extension a wireless tower has been erected, which deserves some description.

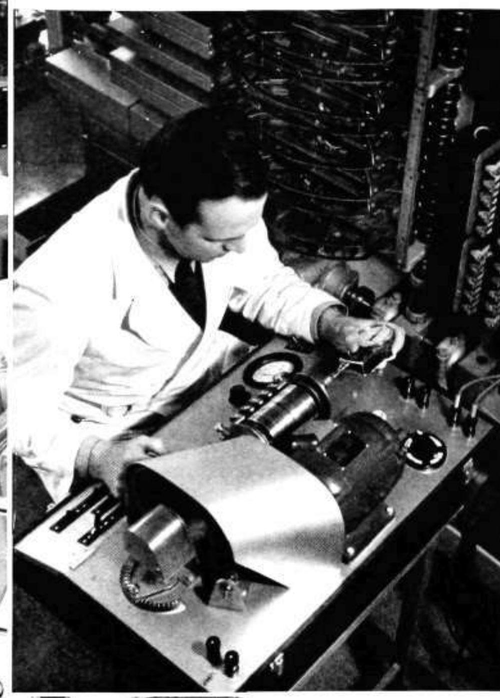
The site at Midsommarkransen has a lofty situation in the south-western part of Stockholm. Thus, when it was found advisable for the L M Ericsson group to put up a wireless tower as an aid to research work, experiment and practical operation in the field of wireless, particularly the high frequency bands, it was only natural that the tower should be built at Midsommarkransen. In this way a tower not too great in height would suffice to obtain the high altitude required for the wireless aerials, particularly for micro-wave communications. By constructing the tower in conjunction with the new extension, convenient communication between the laboratories and the wireless equipment in the tower has been ensured.

The wireless tower is 72 metres above ground and is constructed of reinforced concrete. It is quite slender, having a rectangular section of only 5×6 metres. It comprises 21 floors, each containing one room, these rooms being devoted to various purposes. The pouring of the concrete which is well anchored to the rock foundation was done in sliding forms, raised progressively as pouring proceeded. The pouring took up only 3 weeks.

The height of the tower top above sea-level is 109 metres. On the top of the tower there is an aerial mast, the tip of which is 124 metres above sea-level, a height that is not surpassed on any other building in Stockholm. The tip is in fact visible at not less than 57 kilometres distance from a point to the west of the city. The mast can be lowered by a winch down into the tower, thus enabling different aerial designs to be fitted without trouble. Balconies run round the top floor of the tower and from these the micro-wave aerials mounted on the tower are easily accessible. Continuous investigation of the spread of the micro-waves under varying weather conditions have now been going on for a year.

Some views of LM Ericsson's laboratories

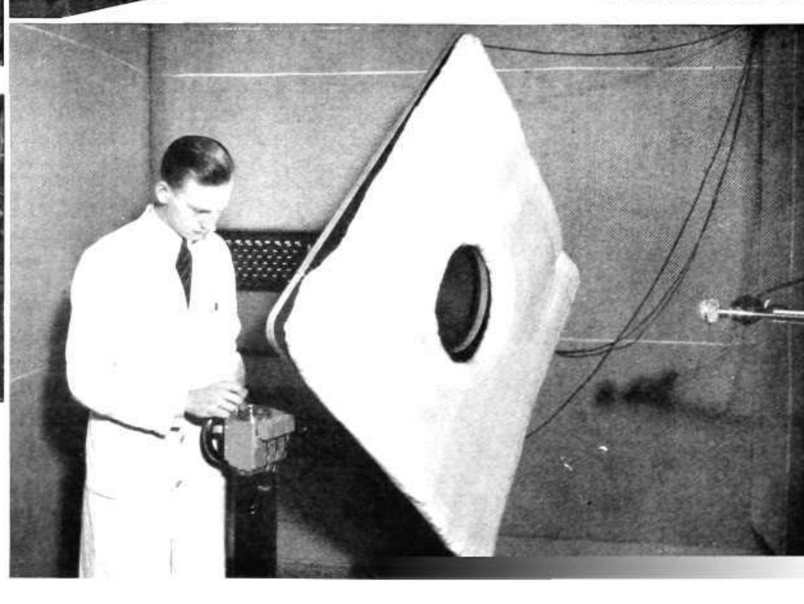
Left, an inside view of one of the telephone exchange laboratories; below, testing the permanence of carbon granules in handsets at one of the telephone instrument laboratories; below that, checking at an exchange laboratory the speed of an impulse machine for setting selectors in various positions.

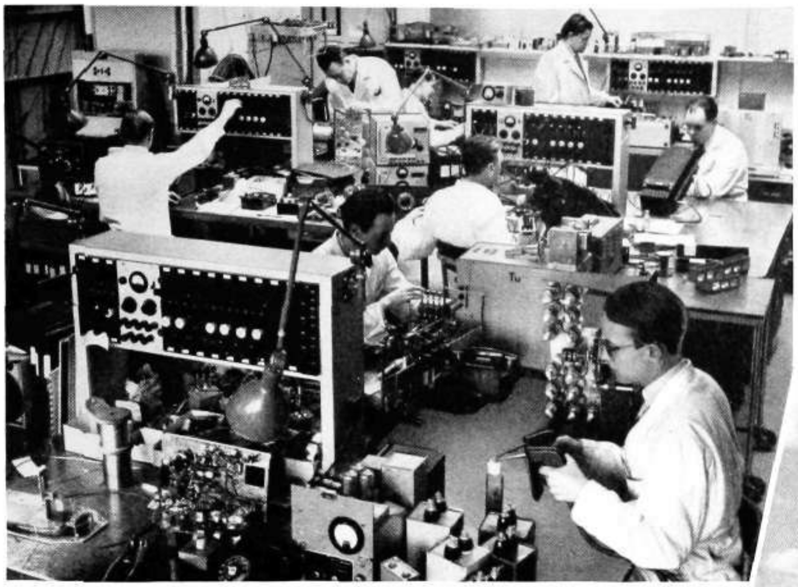


Left, a telephone exchange laboratory: connection tes in an automatic telephone test rack.

Below: Determining the nitrogen content of steel at the chemical laboratory.

Below: transmitter test in the »silen room» at the electro-acoustics laboratory.

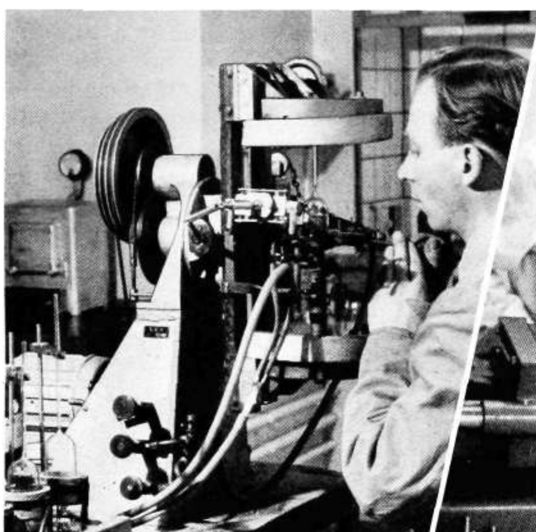




Left, inside view of the micro-wave laboratory.

Right, parabolic antenna mirror for 3 cm multiplex communication, mounted on the wireless tower.

Below, left, fusing in electron valves at the electronics laboratory; right, an injection press at the plastics laboratory.



Below, left: microscopical examination of iron, steel and other metals at the chemical laboratory; right, inside view of one of the longdistance telephony laboratories.

A New Wall Instrument

K W NILSSON, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.721.3

Since the addition of the new table telephone instrument, type DBH 14—15, described in Ericsson Review No 3, 1947, LM Ericsson has designed a wall instrument which has been given the designation DBN 12—13.

The new instrument, which will be put into mass production this year, is intended to replace the wall instrument DBN 10—11 that has been in manufacture since 1933.

In the last few decades, technical progress in most fields has made rapid strides, these finding expression in partial or complete revolution of the tools of man in industry, communications, arts and crafts etc. The developments of telephone instruments, however, have seemingly made slow progress.

The constant desire has always been for a decrease in the telephone instrument dimensions, the production of a lighter handset, the obtaining of an attractive appearance for the instrument on the lines of modern ideas of form etc.

As regards the dimensions of the telephone instrument, however, these depend on the human being himself. The length of the handset is of course determined by the distance between the ear and the mouth, the size of the hole plate in the dial by the fingertips. If a ringing signal is to be heard clearly the gongs of the bell must be of ample size. Moreover, the handset when replaced must

Fig. 1 X 6393

L M Ericsson's new wall instrument, type DBN 12—13

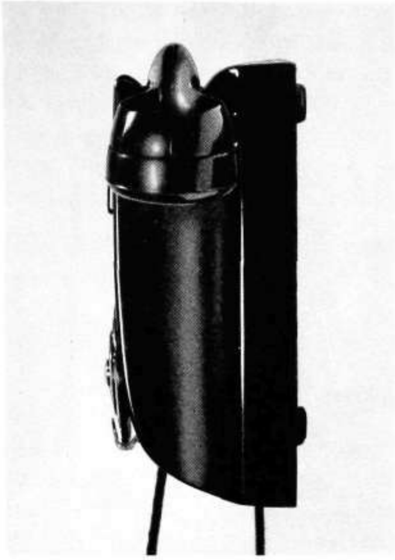


Fig. 2 X 4618

The new wall instrument

side view. The dial has been recessed so that the dial hole plate is flush with the frcnt of the case.

perform a certain work, *i. e.*, actuate the hook switch by its weight even under unfavourable conditions. In addition, consideration must be given to the fact that generally one is not so careful in handling a telephone instrument as, for instance, a radio receiver.

Consequently a telephone instrument must be of robust construction and able to stand mechanical stresses, besides being made of durable material.

Another desire has been for the ability to use one and the same instrument on desk or on wall with the least possible alteration. So far no good solution of this problem has been arrived at. The results achieved have not constituted really satisfactory designs and it has not been possible to meet all the demands made in the various types.

Moreover, a combined desk and wall instrument loses in appearance. On fitting on the wall it projects too far out and the handset does not have a protected position.

When mounted on a wall the telephone instrument must be firmly screwed to the wall. In most cases it is necessary to employ fairly heavy screws, owing to the nature of the wall. When the base-plate of the instrument is screwed firm, it gets more or less askew — even with three-point fixing. This in turn may have an adverse effect on the adjustment of the bell and the spring contact assembly, and may even make it difficult to fit the plate to the case.

L M Ericsson's new wall instrument *DBN 12—13*, see Fig. 1, like the 1933 type, has been shaped with the sole aim of constituting a really satisfactory type of wall instrument, which at the same time can utilize without alteration most of the component parts included in the new table telephone instrument DBH 14—15.

The following parts are exactly like those fitted in the new desk instrument, viz:

handset with flexible cord,
dial except for the cord,
bell mechanism and gongs,
transformer,
condenser,
spring contact assembly and switch sheath,
terminal block and bushing for cord,
number frame, pillar in case,
fixing pieces and sundry screws.

The case, the base plate and some small fixing parts have been newly designed for this wall instrument. In addition, the dial has a rather longer connecting cord.

Case

The case is made of pressed phenon plastic with soft lines and rounded edges. In designing the shape of the case the aim has been to make it as compact as possible — it should »hug» the wall — and free from projections. The outside surfaces have a high polish and the join at the switch hook on the upper part of the case is indistinguishable. This has been possible because of exceptional tool design combined with skilled and sound tool work.

The case is attached to the base plate by two hooks, which are held tight together by recessed undetachable screws in the upper and lower sides of the case. Thus the screws are not visible either from front or sides and besides the upper screw is not in the way of the fingertips when the handset is lifted.

The dial, of the construction described in Ericsson Review 3/1947, has been recessed so that the finger plate is level with the front of the case, Fig. 2. The recess has an opening below, to enable the dial easily to be cleaned of dust and the like. This improves the appearance of the instrument, besides providing the dial with protection against shocks and jars. This arrangement is an innovation and fills a want that has long been felt, but which could not be realized owing to the dust that would collect in a completely closed recess.

The curved surface of the case makes it harmonize with the soft lines of the handset and also makes it not noticeable if the instrument is slightly crooked on the wall.

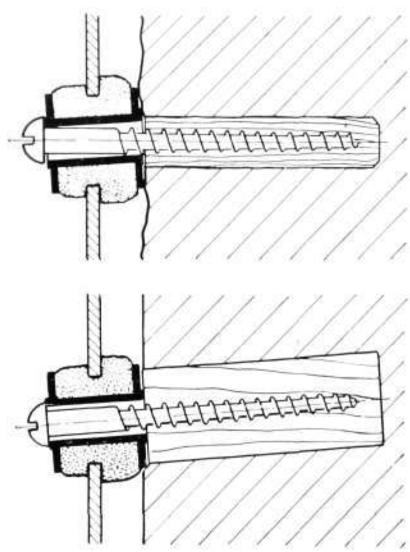


Fig. 3 X 4615

Cross section

showing the function of the rubber stud in the fixing of the base plate; above: on uneven wall; below: on wall with plug at an angle

The Instrument's Floating Suspension

All wall instruments hitherto designed have had the drawback that the vibrations of the bell mechanism and to some extent those of the dial have been transmitted to the wall through the fixing screws of the instrument. Moreover, as stated earlier, is is easy to deform the base plate when screwing it onto the wall. Still another wish has come forward, namely to have the instrument completely insulated from the earth. This last demand has been brought out by research concerning protective devices for surge voltages in case of lightning.

On the new instrument, therefore, the fixing points of the base plate have been furnished with metal protected damping studs of soft rubber, Fig. 3.

This arrangement does away with the above drawbacks, besides ensuring satisfactory insulation between the instrument and the wall.

As a result it has been possible to fit the instrument's internal parts, such as bell mechanism with gongs and switch sheath with spring contact assembly, direct on the flat base plate without fear of their being disturbed when fixing the instrument on the wall.

The apparent expense which the rubber studs may cause is entirely compensated in that the extra inset required with previous wall instrument types has been dispensed with.

AC Bell

The build up of the bell mechanism is in principle the same as on the old instrument DBN 10—11. Some parts, however, have been modified and simplified, such as the parts for the armature suspension, for the attachment of the magnet and for the fitting of the guide springs, where these are necessary.

There has been added a screw for adjustment of the armature stroke, so that the air gap between the armature and the coil cores may easily be varied, Fig. 4.

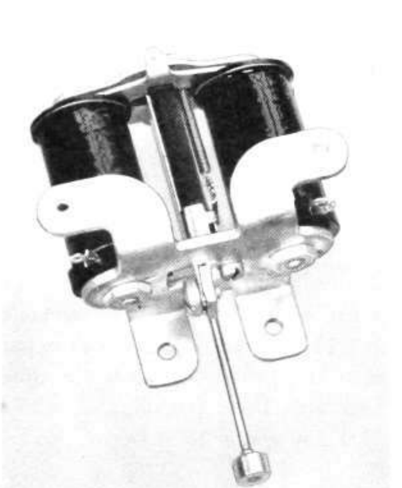


Fig. 4 X 4616

View of bell mechanism

with screw for adjusting the armature stroke

Switch Hook

The switch hook operates in the same manner as in the new table instrument, *i. e.*, it actuates the spring contact assembly in parallel with the pillar of the case. The component parts are the same as in the new table instrument, but they are fitted on an angle iron, which is attached by screws to the bell mechanism frame.

The idea embodied in the switch, which is patented, differs appreciably from previous designs for wall instruments. The actual slide, which is moulded in one piece of phenoplastic, has been formed with striking surfaces for the pillars in the case and a wedge which actuates the spring group assembly, as also an arm which runs in a groove. The groove acts as guide and for limiting the movement of the slide. The slide has two bearings well apart from each other, pivoting on a shaft riveted to the fixing angle. A cylindrical spiral spring is fitted on the shaft below the slide.

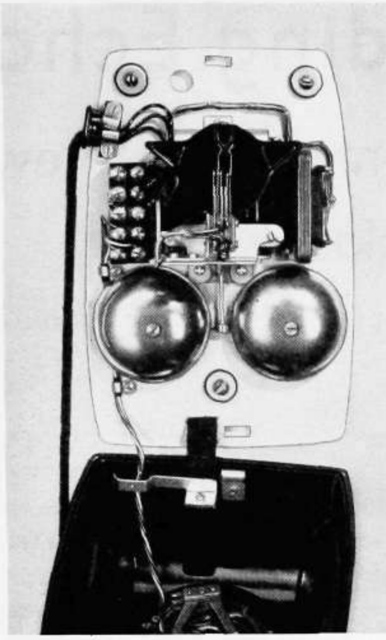


Fig. 5 X4617

Inset

with case dropped; left to right: terminal block, switch hook with spring assembly, transformer; at bottom: gongs

The spring contact assembly is fitted vertically on a section adjustable laterally, this being shaped to form the above-mentioned groove for the slide. The contact springs are made of extra spring-hardened phosphor bronze and provided with double contacts. The contact springs are broad and tapering in shape and relatively thin, so that they can sustain careless treatment without being deformed. The springs are ready bent and have a frame to fix their position. The contact pressure is 50 g.

The switch hook works with extreme reliability and the moment of friction has been reduced to a minimum.

The dial is screwed in the case in the same manner as with the table instrument and it is connected to the terminal block of the inset by a flexible cable.

When fitting the instrument on a wall, the case is dropped downwards, Fig. 5, being held suspended by a band fastened between the case and the base plate. In the case below the pillars there are cylindrical spiral springs of stainless steel, to hold the pillars up when the case is removed.

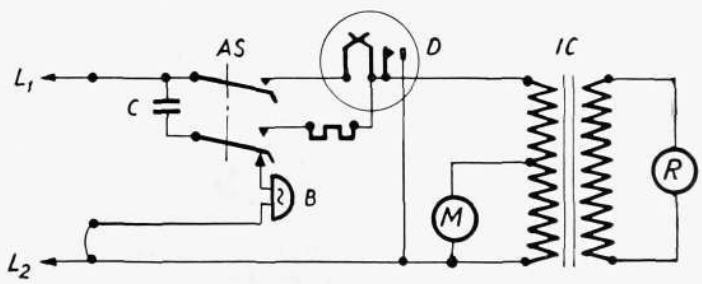
The base plate is furnished with sound hole beneath the gongs of the bell, as with the desk instrument.

There is arrangement for the connection of extra receiver.

The instrument can also be made insect proof.

The circuit diagrams, Fig. 6, agree with those for the new table instrument.

This new wall instrument now put on the market has been designed with the sole idea of providing the highest quality combined with the greatest simplicity which present-day technical practice can supply.



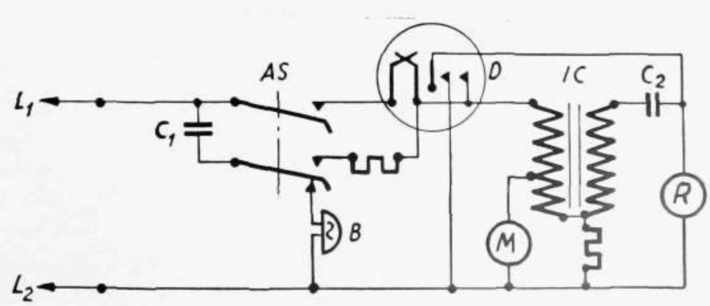


Fig. 6 X 6294 X 6295

Diagram

of connection with transmitter inset; above RLA 1820, below RLA 1810

AS switch hook
B bell
C condenser
C_1, C_2 condensers
D dial
IC transformer
L_1, L_2 subscriber's line
M transmitter
R receiver

Indicating and Recording Echo Sounder PEK-3G — an Interesting New Design from Svenska Radioaktiebolaget

S von MELSTED, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 531.719.35

When the Swedish America Line's new vessel M/S Stockholm — the biggest passenger ship ever built in Sweden — started out on her maiden voyage in the Spring of 1948, there was included in her hyper-modern technical navigation equipment the first example of Svenska Radioaktiebolaget's newly designed echo sounder PEK-3G. This sounder, which performs both visible indication of the depth beneath the vessel's keel and graphical recording on a graduated paper band of the contour of the sea bottom, represents an appreciable improvement compared with previous constructions of echo sounders.

In the following article there is given a brief account of the range of applicancies for echo sounders, their operation and construction together with a description of the new echo sounder.

Range of Applicancies for Echo Sounders

In our days a navigator has at his disposal an impressive array of instruments, all designed to facilitate his task of taking the ship safely and quickly to its destination. The echo sounder has an important place among these up-to-date appliances. The navigating officer has only to cast a glance at the echo sounder's scale of depths to be able to read the exact depth in a vertical line from the ship's bottom. He no longer requires heaving of the lead — the depth is indicated automatically and continuously by a depth indicator located in the chart house. As many soundings as used to take half an hour are now at his command in a second. No matter what the speed and the weather he can always read the depth of water beneath the keel, even if it be a thousand metres and more.

In the modern echo sounder, technical research has not only endowed shipping with a first class instrument in the service of navigation. The echo sounder has facilitated the charting of ocean depths, thus ensuring improved charts. The new method employing the echo sounder proceeds much more rapidly, furnishes more accurate results than formerly and finally it ensures that no shoal is left out, since the echo sounder emits its sounding shots in too close succession for any shallow spot to be passed unobserved.

The greater correctness that can be ensured in the sea charts owing to employment of the echo sounder in taking soundings has in turn resulted in increasing the importance of the echo sounder itself for navigation. In many sea lanes the bottom is of an extremely varying nature. There are peaks, valleys and sharply marked geological faults and cracks. These bottom conditions furnish an excellent guide to navigation and enable very good fixing of position to be made, especially if the ship is fitted with a recording echo sounder, giving a curve of depths which constitutes a profile of the sea bed. This is particularly valuable for navigating in darkness or fog, when neither terrestrial nor astronomic observations are possible.

Lately, the echo sounder has been enlisted in the localization of shoals of fish, as reported by various articles and notices in journals and newspapers. Very promising results have been achieved and there is not the slightest doubt that the echo sounder has found here yet another important field of employment.

Principle of the Echo Sounder's Operation

It is a matter of common observation that if one shouts in the open the sound often comes back as an echo. The echo is thrown back to the caller by the face of a rocky slope. The same conditions prevail in the water. The echo answers in water just as well as in the air, but about four times as quickly, and it is on that the design of the echo sounder is based. Thus, if a sound wave is thrown out from a ship to the bottom of the sea, the wave is reflected and returns to the ship in the form of an echo. The interval elapsing from the moment the sounding wave is emitted until the echo returns constitutes a measure of the depth of water under the ship, Fig. 1.

The echo sounder works very rapidly, as the velocity of sound in the water amounts to app. 1450 metres a second. Thus a depth of 100 metres is sounded in approx. $^1/_7$ second. This means that one must have a special meter to be able to measure so short an interval with sufficient accuracy.

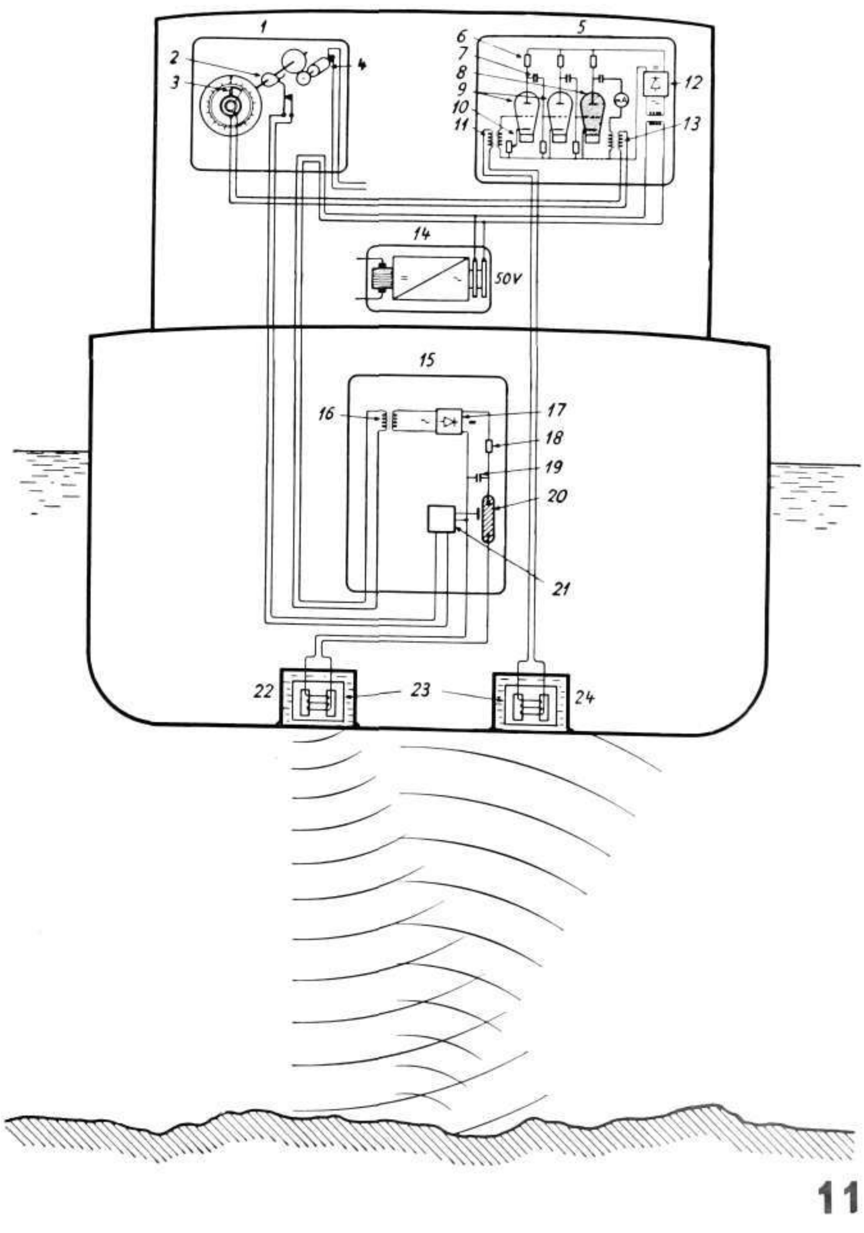


Fig. 1. X 6392

Diagram of echo sounder operating with magnetostriction

1 depth indicator
2 pulse contact
3 neon tube
4 motor
5 *amplifier*
6 resistance
7 condenser
8 relay valve (gas triode)
9 amplifier valve
10 gain control
11 input transformer
12 rectifier
13 output transformer
14 *converter*
15 pulse generator
16 transformer 50/1 000 V
17 rectifier
18 charging resistance
19 transmitting condenser
20 discharge valve
21 trigger circuit
22 *transmitting projector*
23 oscillators
24 *receiving projector*

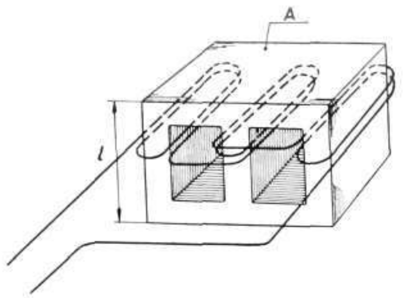


Fig. 2 X 4603

Principle of the echo sounder's oscillator

A active surface of oscillations

l height of plates (determining frequency)

Problems of Design

The first echo sounder was designed during the first world war. Nevertheless, many difficulties had to be surmounted before the sounder assumed such a shape that it was of practical service. It was particularly troublesome to find suitable transmitters and receivers for the sounding shot, that is the sound wave thrown out from the ship to the sea bed.

With one of the first designs — the Hammer Sounder — use was made of a hammer which, held by a spring, was made by electromagnetic means to strike at regular intervals on a diaphragm inserted in the ship's plating. The receiver was then a microphone, also inserted in the ship's plating. With another design the sounding shot was obtained by dropping an explosive cartridge overboard. The cartridge was set to explode when it struck the sea bottom. The sound thrown back was then, as with the hammer sounder, received by a microphone. The depth was obtained by noting the time from the dropping of the cartridge to the reception of the sound and multiplying it by the velocity of sinking of the cartridge, which was known. Echo sounders have also been made with transmitters and receivers, working on piezo-electric principle.

Now, however, practically all transmitters and receivers are made on the magnetostriction principle, a method which has proved its superiority in respect of submarine signalling.

Magnetostriction

Magnetostriction is the term used to designate the phenomenon that a ferromagnetic body, *i. e.*, a nickel rod, when exposed to a magnetic field changes in volume. How this can be utilized for the design of transmitters and receivers is illustrated by Fig. 2. The illustration shows a bundle of nickel plates, made in much the same way as the laminations of a transformer core. The bunch of nickel is provided with a wire winding and the requisite magnetic field is obtained by passing a current through this winding. If an AC source is connected to the winding, the bunch of nickel will be alternately compressed and expanded, *i. e.*, put into mechanical oscillation.

Thus with the aid of such a nickel bunch it is possible to convert electric oscillations to mechanical. These oscillations are apparent to us as sound waves — acoustic oscillations — if their frequency falls within the range of the frequency band that is audible to the human ear. Such a converter of electric oscillations to acoustic oscillations is generally called an electro-acoustic transducer. As the use of the magnetostrictive element is based on its oscillating properties it is called the oscillator of the echo sounder. The oscillator can also operate in the reverse direction and convert acoustic oscillations to electric. Thus if an oscillator magnetized by a permanent magnetic field receives the impact of sound waves, electric tension is generated in the winding surrounding the nickel bunch. Because of this the magnetostrictive oscillator may be used not only as a transmitter but also as a receiver.

The oscillator is most effective if the magnetizing current or sound impulse is given a frequency that is the same as the oscillator's own frequency in a given direction. The oscillator works with extremely small amplitudes but with great power. This makes it specially appropriate as a sound generator in water.

Directional Properties

The magnetostrictive oscillator, however, has yet another property which is of great value for echo sounding; it can generate oscillations of extremely high frequency, *i. e.*, short wave lengths. This is the necessary condition for transmitting a narrow beam of sound.

The pulse or sound wave emitted by the oscillator is directed vertically to the sea bottom. Otherwise the sound wave would be reflected from all directions, such as nearby cliffs, passing ships etc. Several echoes would be received and it would be difficult to decide which of them was the right one.

In order to give direction to the wave front discharged, the wave length must be of the same order of magnitude as the border lines of the surface generating the oscillation. The sound waves discharged from various points on that surface amplify each other in the direction at right angles to the surface but oppose and cancel out each other more or less in other directions. For a given sound radiating surface the sound beam is made sharper if the wave length is made smaller. With the latest sounders there are employed such short wave lengths, *i. e.*, such high frequencies, that the human ear is not capable of catching the sound impulses transmitted. Naturally it is an added advantage to avoid the irritation of hearing sounding shots discharged continuously in rapid succession.

A Modern Echo Sounder — Its Construction and Operation

SRA's echo sounder *PEK-3G* works on the above-described magnetostriction principle and performs both optical indication and rectangular graphical recording of the depth of water beneath the ship's keel. The sounder has two sounding ranges, a lower one, 0—100 metres (0—50 fathoms), intended for use in coastal waters and a higher one, 0—1000 metres (0—500 fathoms) for use when sailing the open sea.

The echo sounding equipment comprises four main components *viz.:*
Indicator unit with terminal box, pulse generator (including converter) and the projectors containing the oscillators.

The principle of the echo sounder's operation is as follows, see Fig. 1. When the neon tube on the rotating dial of the depth indicator passes the zero point of the scale, the pulse contact on the indicator's shaft produces a pulse which

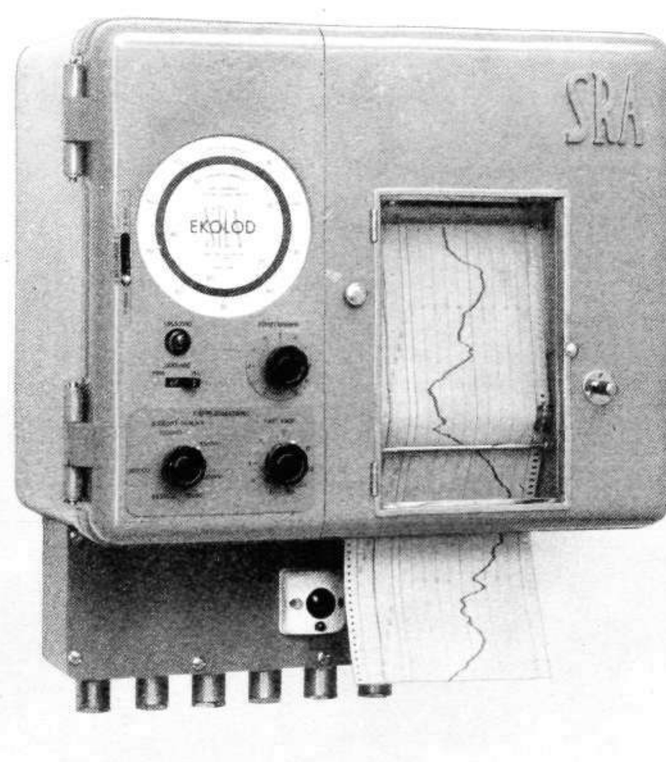


Fig. 3 X 4608

Indicator unit

left, the dial for the optical depth indicator, right, echograph with paper strip; at bottom, terminal box

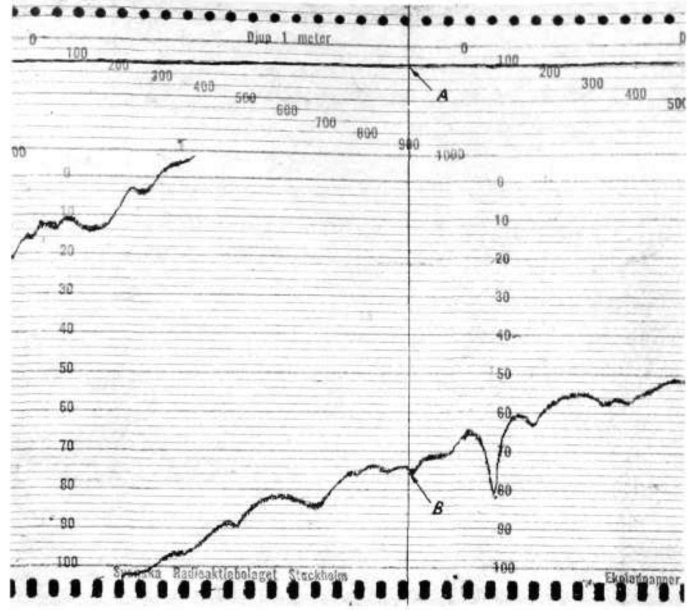


Fig. 4 X 6395

Echo sounder paper strip with depth curve recorded

A depth curve in 1 000 metre range
B depth curve in 100 metre range
The depth shown on the line A-B is therefore 174 metres.

is transmitted to the trigger circuit of the pulse generator and the discharge valve fires. The transmitting condenser is then discharged through the transmitter and this gives rise to electric oscillation which is converted to a beam of sound thrown out towards the sea bottom. The returning echo from this oscillation strikes the receiver where it is transformed into an electrical pulse again. This pulse is then amplified so that a light flash is produced in the neon tube of the depth indicator. In the time elapsing from the discharge the neon tube has rotated in a certain angle from the zero point on the scale. Thus the flash is seen on the division of the scale which corresponds to the depth of water at the time.

The Indicator Unit

The indicator unit consists of depth indicator, echograph and amplifier and all this apparatus is housed in a case of light metal, see Fig. 3. All controls are on the indicator unit and easily accessible. Indeed, the sounder is exceedingly easy to use, as it has only three main controls *viz.:* cut-off, gain control and switch between the two sounding ranges. These controls are located on the front of the indicator unit.

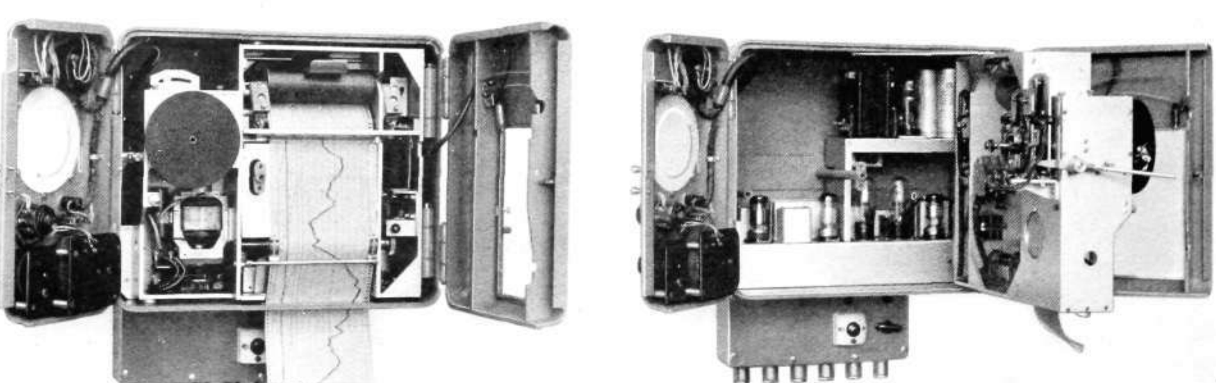
Depth Indicator

The depth indicator has an easily read dial, with divisions of 0—100 metres and 0—50 fathoms. The indication is produced by a neon tube fitted on a rotating disc throwing a flash for each sounding shot on the figure corresponding to the depth fathomed. For the range 0—1000 metres the depth is

Fig. 5 X 7516

Indicator unit

with doors of depth indicator and echograph open. The left-hand picture shows, from left to rigth, neon tube disc with depth indicator and driving motor, echograph with paper strip. The picture at the rigth shows the echograph unit swung out; the amplifier chassis may be seen in the case.



obtained by multiplying the figure read by 10. The neon tube is coupled to the amplifier's relay valve by means of a rotating transformer and this gives the great advantage that there is no kind of brush or slip-ring, which might possibly cause contact fault. The proper sounding range connected is apparent at a glance, besides the marking on the indicator unit panel, there is the great difference in the frequency of sounding shots, *i. e.*, the neon tube's rate of flash. For the lower range, 0—100 metres, 4 shots a second are fired, whereas with the higher range, 0—1000 metres, the interval between two successive shots is about 1.4 seconds.

The sounding pulse is triggered by a cam disc fitted on the depth indicator shaft and provided with a spring contact at the instant the neon tube passes the zero point of the scale. The moment of the triggering as well as the zero blocking can be adjusted by a couple of set screws, which are accessible from outside. Thus adjustment can be performed while the sounder is in operation.

The Echograph

The echograph, or recorder, employs dry waxed paper with two adjacent graduated scales, 0—1000 metres and 0—100 metres. The 0—1000 metres scale takes up 25 mm and the 0—100 metre scale 90 mm of the width of the paper. The recording proceeds by the echograph marking simultaneously two curves, one in each scale. The curve in the 1000 metre range, with 100 metres represented by 2.5 mm, is intended for reading the 100s of the depth, while the tens and units of the depth are obtained from the curve on the 100 metre range, where 1 m depth is equivalent to 0.9 mm of the paper strip. As a matter of fact, the echograph has 10 measurement ranges: 0—100, 100—200, 200—300 metres and so on up to 900—1000 metres. It goes over automatically from one range to the other, without any kind of switching, and the range employed is similarly recorded automatically direct on the paper. The depths recorded can be seen through a window in the cover.

The paper runs over rollers and is driven by means of a cog-wheel from an pulse motor, the speed of which is continuously adjustable for a paper feed of 0.1 to 2 metres length of paper per hour. The paper speed is set by two knobs, graduated in knots and sea chart scale. Thus, if the knob for knots is set at a knot figure corresponding to the ship's speed, and the knob marked CHART SCALE on, say, $1 : 1 \times 10^5$, then while the ship covers one nautical mile a length of paper equivalent to one nautical mile on a chart to scale 1 : 100000 is moved forward.

It may sometimes be important to refer to the depth curve recorded during a certain interval of time. This can easily be done by pressing a button marked MARKING. There is then drawn a horizontal line and it is easy to write in the time on this line. After the desired interval another line is drawn. The space between the two lines then marks the contour of the bottom passed during that period. The sounder may also be connected to a distance log of the type that makes a contact for, say, each nautical mile covered. There is then obtained on the recording paper direct a grading in nautical miles.

The paper runs out through a slit in the bottom of the case. It is visible through the window for a length of about 200 mm and on its exit from the indicator unit it is only screened for about 10 mm, so that practically the whole depth curve can be read for an unlimited time backwards. The insertion of fresh paper is extremely simple.

Amplifier

The amplifier, which is housed in the indicator case and located behind the depth indicator and echograph, Fig. 5, amplifies the echo that is converted by the receiver, so that the tension generated is great enough to produce a flash of light in the neon tube. The amplifier has two stages, consisting of high frequency pentodes coupled to tuned circuits, with selectivity adjusted to ensure the most favourable signal to noise ratio, and two gas triodes acting as relay valves. The amplification is continuously adjustable by a knob on the front of the depth indicator. There is also zero blocking and automatic gain control. Filament and anode tension, as also grid tension, are obtained from a power unit, built onto the amplifier.

Terminal Box

The indicator unit is fitted on a special terminal box. It has been found by experience that, when laying up for the winter and generally with thorough inspection of a ship, it is often advisable to take on shore the rather delicate indicator unit for storage or inspection. It has therefore been considered best to make the terminal box and the indicator unit detachable from each other. The incoming cables are drawn, therefore, to a terminal strip in the box and short leads are taken to the indicator unit from the screw terminals. If the indicator unit has to be removed, only these leads are uncoupled. When the indicator unit is lifted off a special protective cover can be laid on the terminal box. This cover is normally kept inside the box and is thus always handy.

Pulse Generator

The pulse generator contains a high tension rectifier, transmitting condenser, charging resistor, triggering circuit and cold cathode discharge valve. The DC/AC converter necessary is also housed in the pulse generator unit.

Transmitting and Receiving Projectors

The oscillators consist of nickel bunches furnished with magnetizing windings. The frequency is app. 22000 c/s. The nickel cores are made up of thin sheets insulated from each other, which gives low eddy current losses and therefore good efficiency.

The oscillator which serves as receiver depends for its good operation on the permanent magnetism in the nickel bunch. This magnetism fades with time, however, and it has therefore been found advisable to re-magnetize the nickel bunch at least once a year. The re-magnetization is done merely by turning a switch on the terminal box, an unique feature of this sounder.

Power Supply

The depth indicator motor is fed with DC, while the amplifier and the relay box high frequency rectifier receive 50 V AC from the converter. The plant may be supplied for connection to 220, 110 or 24 V DC and the total power requirement amounts to about 225 W.

Operating Reliability and Service

Great value is at stake in the navigation of an ocean going vessel. Consequently it is of the very greatest importance that the apparatus of the navigator should be as reliable as possible. Thus if any fault arises in the echo sounder it must be easy to put right. This point also has been kept in mind when designing *PEK-3G*. All vital parts where any fault may be expected to arise have been made easy to replace. Moreover there is tapping for current supply from a service generator, to facilitate check measurements on the sounder.

New Private Automatic Exchanges with XY-selectors

O SIEWERT & S ELLSTAM, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.24

L M Ericsson has recently completed a new series of private automatic exchanges with XY-selectors. The exchanges have been given the designations AHD 90, AHD 94 and AHD 96 and they are mainly designed for medium-sized private telephone plants. The exchange type AHD 90 has a maximum capacity of 100 extensions, while the two other types can be built out for a maximum of 200 extensions. AHD 94 is chiefly for plants with normal traffic density and AHD 96 for plants with very large internal telephone traffic.

Private automatic telephone exchanges find their chief employment in those undertakings and public administrations which have a big need for internal telephone traffic but comparatively little traffic with the public telephone system.

The private automatic exchange can then either entirely deal with all internal telephone communications inside the undertaking, with the relatively few external calls made over instruments directly connected to the public system, or they may constitute supplementary telephone plants for a private manual or automatic branch exchange with exchange lines to the public system.

For a long time L M Ericsson has been making many types of exchanges for plants of this kind, such as *OL 45* and *OL 550*. These types of exchanges have been built up of 25-line step-by-step driven selectors as basic elements. When some years ago a new 100-line selector, known as the XY-selector, was designed and at the same time many other new connecting devices for telephone exchanges were developed, it was considered desirable to design a new series of private automatic exchanges, utilizing the new connecting devices.

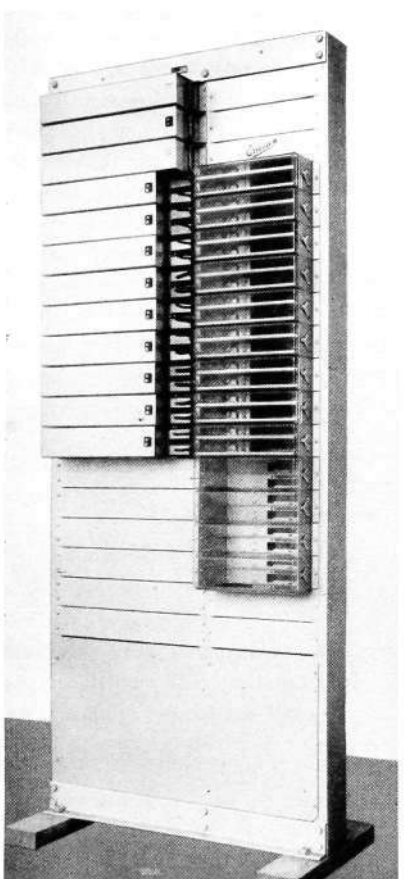


Fig. 1 X 4612
Private automatic exchange AHD 94
with 100 extensions and 9 link circuits

In view of the XY-selector's capacity of 100 lines, the new types of exchange have been built up in 100 units, the type *AHD 90* consisting of one rack being intended for a maximum of 100 extensions, whereas the two other types *AHD 94* and *AHD 96* consist of two identical 100-line racks and thus can be built out to a maximum of 200 extensions. The exchange type AHD 94, Fig. 1, is intended for normal telephone traffic, equivalent to 9 or 10 simultaneous calls per 100 extensions, whereas exchange type AHD 96 is for high call frequency corresponding to 13 or 14 calls per 100 extensions at one time. The exchange type AHD 90, designed for smaller telephone plants, is made for 8 simultaneous calls per 100 extensions.

The employment of XY-selectors in these exchanges has made possible extremely simple design for the exchanges both mechanically and in diagram. They take up little space and are easy of maintenance. The establishment of connections proceeds very quickly, as the dialling tone from the exchange is heard almost immediately on lifting the handset and the first ringing signal is emitted at the instant the last digit of the wanted number is dialled.

Extension call numbers for AHD 90 are two-digit and consist of the numbers 10—99, 00—09. For exchanges AHD 94 and AHD 96 they are normally three-digit, 100—299, but they can by a simple re-wiring be made two-digit, as long as the exchanges are not enlarged to over 100 extensions.

The capacities and dimensions of these three types of exchange may be seen from the table below:

type of exchange	number of racks	capacity			dimensions per rack		
		extensions	connecting circuits	second final selectors	height	width	depth
					mm	mm	mm
AHD 90	1	100	8	—	1590	845	500
AHD 94	2	2 × 100	2 × 10 (2 × 9)	2 × 6 (2 × 8)	2070	845	500
AHD 96	2	2 × 100	2 × 14 (2 × 13)	2 × 8 (2 × 10)	2070	845	500

Traffic Facilities

All Calls Connected Automatically

Calls between extensions connected to the exchange are established automatically. Immediately dialling tone comes from the exchange the two or three digit call number of the wanted person may be dialled, after which the exchange emits intermittent ringing signal if the wanted line is not busy. If it is busy, the usual busy tone is sent out to the caller.

Selected Extensions May be Given Priority

A certain number of extensions may be allotted the facility of always getting connection with a wanted extension, even if this should be busy with a call. This facility may suitably be extended to higher executives, for whom it is often important immediately to get in touch with a particular person. When an executive makes a call from a priority instrument to a person who is busy with another call, the executive is immediately connected in on the called line. A warning tone is sent out which is heard by the three persons now in conversation. If the executive's talk is brief — he may perhaps only want a piece of information — he replaces his handset as soon as he has learnt what he wants to know and the original conversation can proceed. If, however, he wants a longer talk he can request the two who were talking to replace their handsets and after this has been done the wanted extension is rung up automatically. When the called party again lifts his handset, he is in normal connection with his chief. This facility is included as a standard in exchanges AHD 94 and AHD 96, but in AHD 90 it is only supplied on request.

Selected Extensions May be Called by a Common Number

If certain persons, each having a line of their own, perform similar work, such as a pool of stenographers, it may be desirable to be able to call these by a common number, known as a group number. When such a number is dialled, it is the first free line in the group that is called. Nevertheless, any extension in such a group may be called by its individual number, in which case only the wanted instrument receives the call. All the types of exchange here described may be furnished with this facility on request.

The Exchanges May be Provided with Automatic Staff Location

The exchanges may be supplemented by a relay set for automatic location of up to 31 persons. When a person is to be located, there is first dialled on any instrument a number common to staff location and then the wanted person's own call number. On lamp boards set up at suitable spots on the premises there then lights up a combination of lamps representing the wanted person's call number. When the wanted person observes the lamp signal, he dials on the nearest instrument a common answering number for the staff locator plant and thus comes into communication with the person seeking him.

Conference Facility for up to 10 Participants

Another relay equipment which can be included in the exchanges on request enables conference calls to be arranged between a number of persons. The equipment is constructed for the connection of 10 extensions, and these then have the facility of carrying on conference talks between themselves. Their telephone instruments must be furnished with a key for momentary grounding of one line wire.

A conference is arranged by the person calling it ringing up in turn each of the persons who are to take part and asking them to press the key for a moment in their instruments. When he has thus called all the participants he presses the key on his own instrument, after which all those concerned are connected together in the conference equipment and their lines are marked busy in the exchange.

Junction Lines to Other Exchanges May be Connected

These exchanges may be furnished with junction equipment to other private automatic or private automatic branch exchanges, enabling calls to be connected automatically in both directions.

Telephone Instruments

For ordinary extensions, standard telephones of the types DBH, DBK or DBN may be used. But for extensions with conference facility the instruments must be provided with an earthing key. If desired, loudspeaker instruments, chief and secretary instruments or instruments with automatic repeating of calls to a given sub-instrument after two signals may be connected.

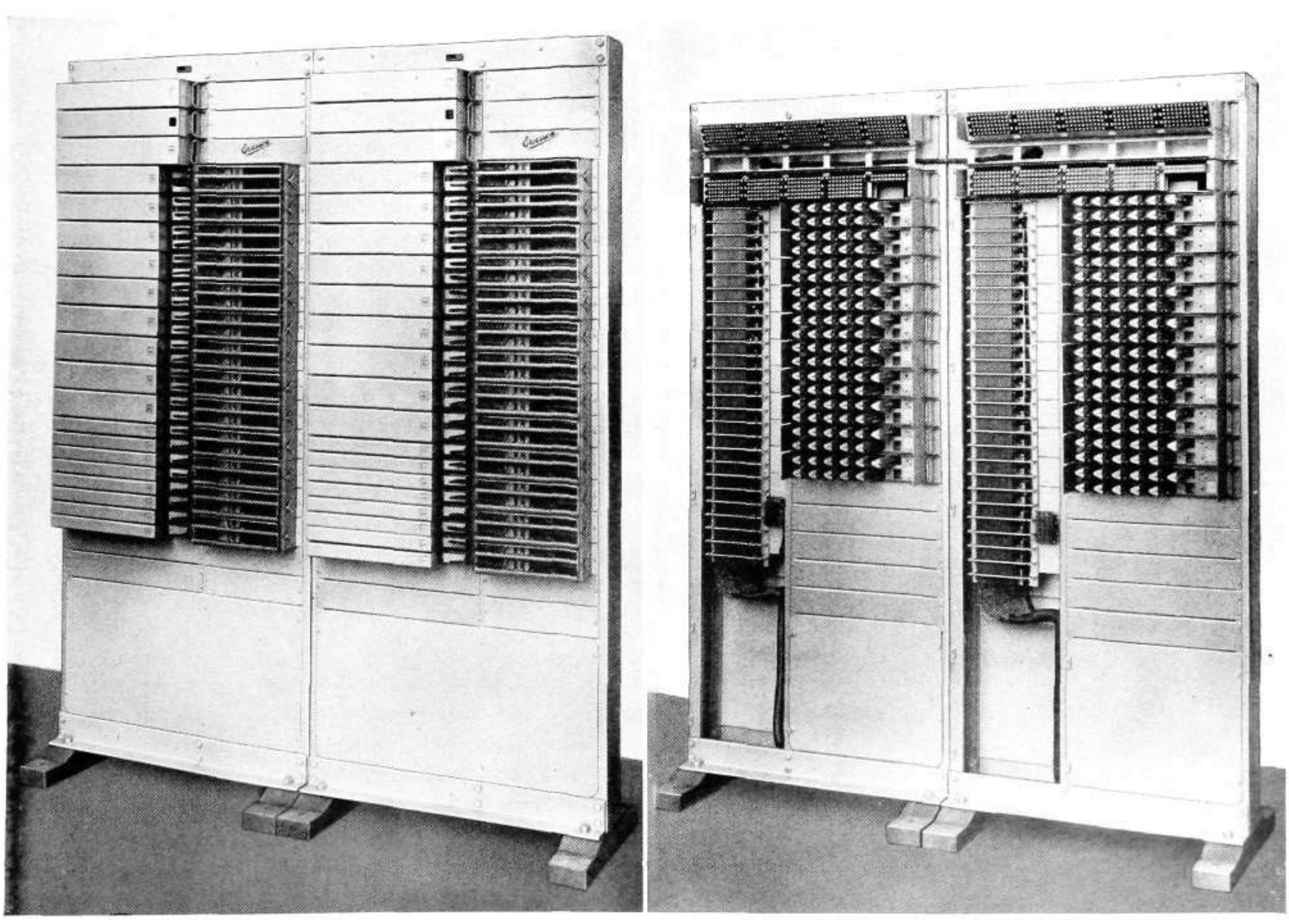


Fig. 2 X 6394

Private automatic exchange AHD 94

with 200 extensions, 2 × 9 link circuits and 2 × 8 2nd final selectors; left, front view; right, back view

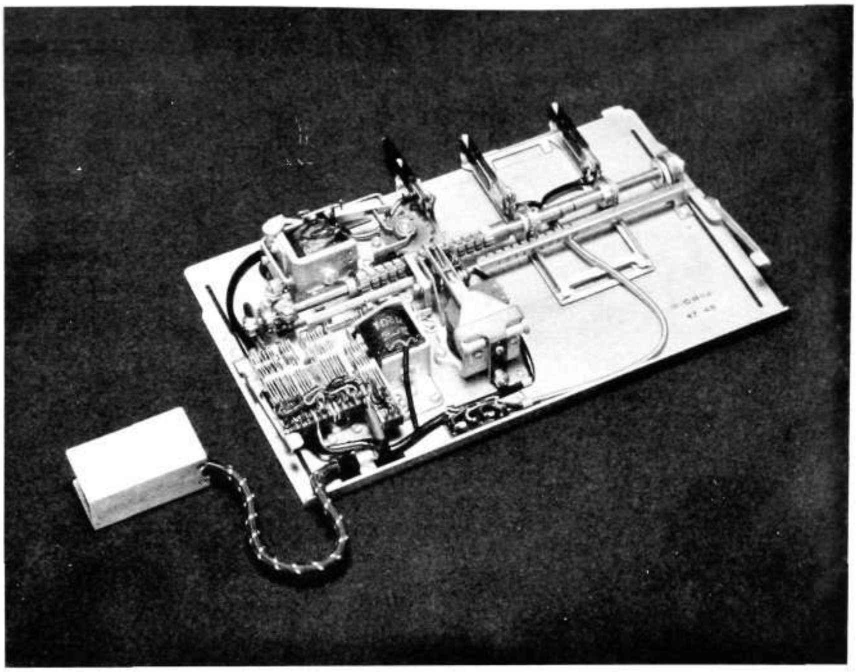


Fig. 3
XY-selector
or 100-line selector

X 6391

Mechanical Construction

As stated above, the exchange AHD 90 consists of one 100-line rack, whereas each of the exchanges AHD 94 and AHD 96 consists of two 100-line racks, Fig. 2. The two last-named racks are identical in mechanical respects. They are wired in the same manner and it is only the connection of the rack wiring to a given multiple frame which determines the number series for the rack.

The rack is aluminium painted and made of pressed sheet-iron of light-weight construction. All internal wiring is done at the factory.

The connecting devices of the exchange are divided up into relay sets with plugs for corresponding jacks in the rack, and XY-selectors which are plugged into the jacks of their associated relay sets. Thus both relay sets and selector can be inserted and removed from the rack without any soldering being necessary. Consequently there is no need at the beginning to furnish the exchange with any more connection devices than are required for existing needs, but as traffic grows the exchange can be enlarged until it reaches full capacity.

The selectors are placed at the right in each rack on a separate selector panel, which also contains the bare wire selector multiple. The relay sets are located at the left of the rack on both sides of a relay panel. On the front of each relay panel, reckoning from top downwards there are located a fuse strip, a signalling unit, an allotter and a number of link circuits.

In exchange types AHD 94 and AHD 96 there are fitted beneath the link circuits the relay sets for the 2nd final selectors and below these there is space for a conference unit and a staff locator unit.

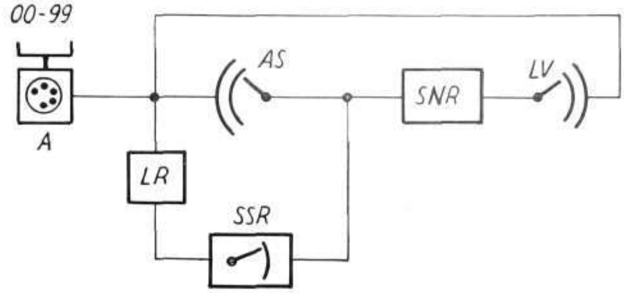
A link circuit relay set takes up in height the same space as two selectors, and one relay assembly for 2nd final selector the same space as one selector. Line finders and final selectors of each link circuit are placed on a level with the relay set concerned and each 2nd final selector is also on a level with its relay set. This makes them easy to look over and facilitates maintenance work.

At the back of each rack there is at the top a main distribution frame which stretches over both the relay and the selector panels and below it there are

Fig. 4 X 6387

Traffic lay-out for AHD 90

A extension
AS line finder
LR line relay
LV final selector
SNR link circuit relay set
SSR allotter



10 line relay sets, each with 10 line relays. In exchange types AHD 94 and AHD 96 there is space below these for extra relay sets, such as for junction circuits to other exchanges.

The selector devices, as stated, consist of step-by-step driven 100-line selectors, built up on a flat base plate where all components are easy of access for inspection and cleaning, Fig. 3. In the rack the selectors are fitted in separate cells on the back of which the bare wire multiple for the selector is fitted.

When the selector is actuated, the wipers carry out two movements at right angles to each other. Thus they are first moved along the face of the multiple, the *X*-movement, and thereafter into the selected multiple frame, the *Y*-movement. Restoration to home position is done instantaneously by spring action. All selectors in the exchange are identical in construction.

The relay sets are covered back and front by close fitting sheet iron covers and the selectors are covered in front by transparent covers, through which the setting of the selectors can be observed. The whole back of the selector multiple is covered by a masonite board, thus ensuring effective protection against dust and mechanical strain.

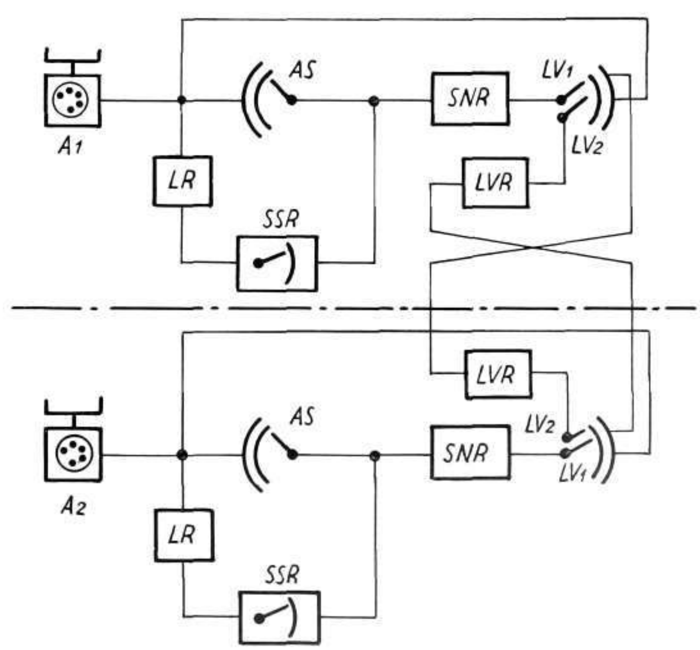
Circuit Diagram

The circuit diagram of AHD 90 may be seen from Fig. 4 and that of the two other types AHD 94 and AHD 96 from Fig. 5. As the diagrams show, these types only differ from each other in the two last types being equipped with 2nd final selectors providing inter-traffic between the two groups of 100, while the switchboard type 90, not being intended for more than 100 lines, is

Fig. 5 X 6386

Traffic lay-out for AHD 94 and AHD 96

A1, A2 extensions
AS line finder
LR line relay
LV1 final selector
LV2 2nd final selector
LVR relay set for 2nd final selector
SNR link circuit relay set
SSR allotter



without this 2nd final selector. It should be observed that 2nd final selectors for switchboards AHD 94 and AHD 96 are only installed when the switchboards are made with two racks and more than 100 extensions are to be connected to the switchboard.

As all the switchboard types here described work in the same way, except that the two-rack switchboards also are made for inter-traffic between the two 100-line groups, only the connecting process for the latter will be described, *i. e.*, according to Fig. 5. The upper part of the figure shows the diagram for the first rack with call numbers 100—199 and the lower part that of the second rack with call numbers 200—299. *SNR* represents a link circuit to which belongs a line finder *AS* and a final selector *LV 1*. *LVR* constitutes the relay set for the 2nd final selector *LV 2*. The individual line relay for each extension line is designated by *LR* and the relay set of the allotter with its selector by *SSR*.

Establishment of Calls Between Extensions Connected to the Same Rack

On call the calling subscriber's line relay *LR* attracts and marks the corresponding line in the line finder multiple, at the same time setting in motion the allotter. This hunts for an unoccupied link circuit *SNR* and then transmits a train of impulses which moves the line finder belonging to the link circuit in the X direction so that it reaches the multiple frame to which the calling extension is connected. The allotter then sends out a new train of impulses which moves the line finder in the Y direction until it comes to the calling line.

The allotter is so designed that its selector for each fresh call always moves one step and tests if the link circuit next in order is unoccupied. In this way the link circuits are made use of in turn, thus ensuring even wear on all link circuits and eliminating the risk of time and again encountering the same defective link circuit.

When the line finder has found the calling line, the link circuit transmits dialling tone, after which the wanted number may be dialled. If the call is for an extension in the first rack the hundreds digit will be 1. For this digit *LV 1* is set one step in the X direction, but returns immediately to home position. For the tens digit *LV 1* is again set in the X direction, as many steps as correspond to the impulses in this digit. For the units digit *LV 1* is moved in the Y direction and reaches the line wanted. If the line is not busy, intermittent ringing signal is transmitted and when the call is answered conversation is established.

If the rack is wired for two-digit call numbers, which is always the case with AHD 90, and can also be arranged if desired for the switchboards AHD 94 and AHD 96, the final selector *LV 1* is moved in the X direction for the tens and in the Y direction for the units digit, thus reaching the wanted line.

Establishment of Calls between Extensions Connected to Different Racks

Let us assume that a call is to be made from an extension in the first rack to an extension in the second rack. After dialling tone has been received from a link circuit in the first rack in the manner described above, the hundreds digit 2 is dialled. The final selector *LV1* concerned is then set two steps in the X direction, but as with connection in the same rack returns to home position. In this case, however, there occurs a switching in the link circuit, with the result that the selector executes a rapid Y movement in the so-called home position frame and hunts for a free 2nd final selector in the other rack. This Y movement is so quick that it can be completed in the pause in dialling between the hundreds and the tens digits. The 2nd final selector when found is moved in the X direction for the tens digit and in the Y direction for the units digit and thus reaches the wanted line. When the call has been established it remains connected over *AS*, *SNR* and *LV1* in the first rack and *LVR* and *LV2* in the second rack.

Fig. 6 X 4612
Inserting relay sets

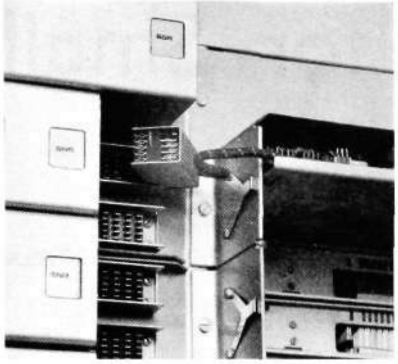


Fig. 7 X 4613

Plugging of XY-selector in its associated relay set

Working Properties

The normal working voltage of the switchboard is 24 V, but the connecting devices are so designed that the voltage may be permitted to vary between 22 V and 28 V. For power supply a rectifier with charging controller and accumulator is normally used. But battery eliminators may also be employed.

The resistance in the two-wire extension lines may amount to not more than 500 ohm in loop, equivalent to a two-wire cable line with 0.5 mm copper conductors and about 2.5 km long. The leakage resistance must not be less than 20000 ohm.

Erection

Particular care has been taken to make the switchboard so that the erection on the spot will be as simple as possible. As all wiring inside the rack is carried out at the factory, all that need be done when installing the switchboard is to screw the rack to the floor and if necessary to solder the laced cable between the racks, to connect in the extension lines and to insert the connecting devices in their places, Figs. 6 and 7.

As both the racks and the loose connecting devices are carefully tried out at the factory before delivery, no lengthy testing work has to be done before putting the switchboard into service.

Fire Alarm Telegraph for Small Communities

A HEDÉN & E LINDGREN, TELEFONAKTIEBOLAGET LM ERICSSON, TELESIGNAL FACTORY, STOCKHOLM

U.D.C. 654.147.6

Telefonaktiebolaget LM Ericsson has so far put on the market two systems for the calling of fire brigades in towns and small communities, the inductor system and the Morse-supervisory current system. The former is not suited for plants requiring more than six fire-alarm boxes and the latter is comparatively expensive for plants having fewer than about 20 fire alarm boxes.

To meet an ever-growing demand for plants of medium size, a new and simplified Morse supervisory current system has been designed.

Build up

A fire alarm telegraph plant on this new system consists of a *central instrument*, two *fire alarm box loops* in which the *fire alarm boxes* are connected in series with each other, a *supervisory battery*, a *signal battery* and a *charging appliance* for the last-named. To give alarm to the fire brigade personnel in their dwellings or other places outside the fire station, *AC bells* may be connected in the fire alarm box loops and for alarm in the fire station itself DC or AC bells may be inserted in a separate loop connected to the central instrument. The plant may be furnished with one or more control instruments for remote supervision and for alarming the fire brigade personnel.

Up to 20 fire alarm boxes and 30 AC bells may be connected in each fire alarm box loop. The resistance in each loop, including bell resistance, must not exceed 300 ohm.

Operation

In principle the system operates in the same manner as the larger Morse supervisory current system and offers the same reliability as regards alarming and control.

The fire alarm box loops are single wire and are controlled by a supervisory current of about 10 mA.

Alarm signals are transmitted from the fire alarm boxes, when their signal mechanism is actuated, by repeated interruption and earthing of the loop and this is done in a distinctive manner for each box. On alarm occurring, a lamp lights up and a bell rings in the central instrument. At the same time the signal is recorded on a telegraph tape, which marks the number of the fire alarm box calling. The central instrument may also be provided with a time recorder, which automatically stamps the time of the alarm on the telegraph tape.

When alarm comes in, an automatic alarm switch built into the central instrument immediately transmits alarm signals to the bells in the fire alarm box loops and the separate bell loops. The alarm signal consists of 7 signals of 5 seconds duration with 10 seconds pause between signals.

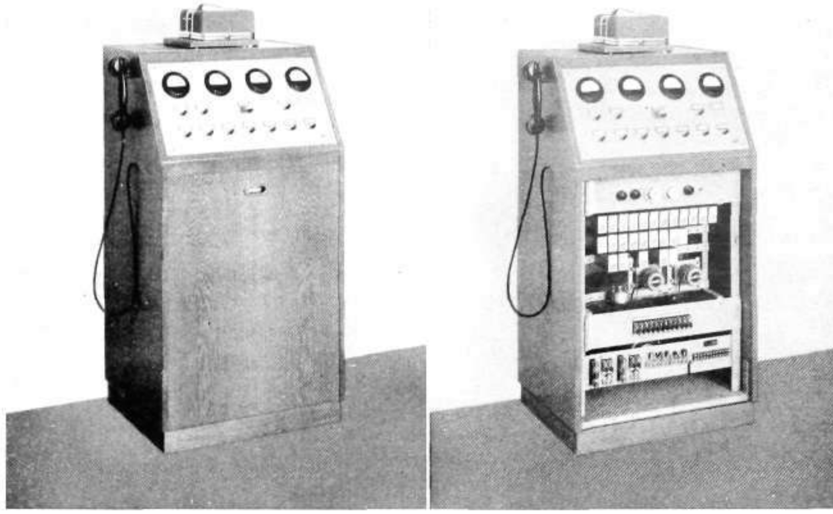


Fig. 1 X 6390

Central instrument KBC 1101

right, with cover removed: from top downwards: telegraph instrument, volt and ampere meter, switch, lamps, relays and selectors, with connecting terminals right at the bottom.

There can also be connected to the central instrument a pilot instrument for giving alarm by sirens, these being started at the same time as the bells.

Interruption or earth leakage of the loops, even if they occur at the same time, or shortcircuiting over a fire alarm box, does not interfere with the receiving and recording of the alarm signal. Simultaneous alarms from two fire alarm boxes are received and recorded separately if the loop is without fault.

Fault signal is marked in the central instrument, both by ringing signal and by separate lamp signals for the following causes of fault: break in the fire alarm box loops, earth leakage, direct earthing, fuse fault and insufficient tension in either supervisory current or signal battery.

Central Instrument

The central instrument, *KBC 1101*, Fig. 1 and 2, is made as a desk and is intended for standing on the floor. The frame is of polished oak and the dimensions are: height 1170 mm, width 612 mm, depth 500 mm.

The telegraph instrument on which alarm signals are recorded is set above the desk. It is a two-line telegraph instrument of L M Ericsson's latest construction, such as was described in Ericsson Review No 2/1948.

The control panel is provided with the following equipment: a voltmeter for control of battery tension, two milliamperemeters for the supervisory current, one amperemeter for control of the signal battery's charging current, signal lamps for fault and alarm signals and switch for alarm, test and the necessary restoring after alarm and fault.

On the front of the desk there is a detachable door. When this is removed the terminals, fuses and relays and selectors are easily accessible. The relays are assembled on a swing out relay frame, behind which a battery-driven bell converter and the charging appliance for the supervisory current battery are fitted and easy of access.

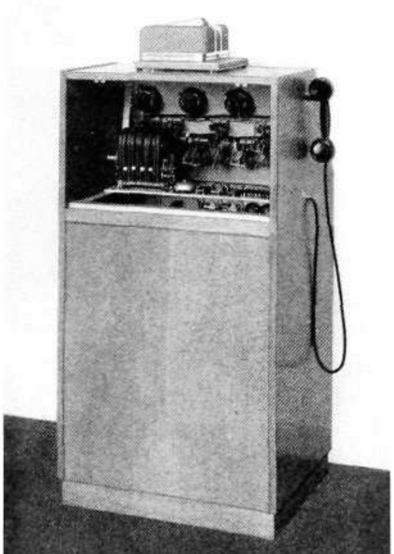


Fig. 2 X 6391

Central instrument

back view with inspection door removed

At the back there is another detachable door, giving access to the back of the control panel and a hand generator. The hand generator constitutes a reserve for the ringing current converter and is operated by a crank on the right-hand side of the desk.

At the left of the desk there is a handset for speaking to the fire alarm boxes during fault location and testing.

Fig. 3 X 4611
Fire alarm box KEC 0013

Fire Alarm Box

The fire alarm boxes are of type *KEC 0013*, Fig. 3. Suitable alarm box lights are *KNH 1102*, Fig. 4, for mounting on walls and *KNH 1302* for mounting on pole.

For talking to the central instrument a portable telephone instrument, type *DPA 10X07*, may be connected to the fire alarm box.

Supervisory Current Battery

Each plant requires one supervisory current battery for 36 V, 10 Ah, with centre point earthed.

The battery is charged continuously from the charging unit built into the central instrument, adapted for connection to 110/127/220 V, 50 c/s AC mains. The battery tension is controlled by a battery control relay which signals battery fault for insufficient tension in the battery.

Signal Battery

The signal battery, of 24 V and 30 Ah, is charged from a separate rectifier. The charging current is switched on over a relay which is controlled from the central instrument. The battery tension is controlled by a battery control relay which signals battery fault for insufficient tension in the battery.

Fig. 4 X 4609
Fire alarm box light KNH 1102
with bracket for mounting on wall

Alarm Bells

For insertion in the fire alarm loops, AC bells with a DC resistance of 2 ohm, e. g., *KLA 1401*, with sheep gongs are used. In the separate bell loop there are used either the same bells as in the box loops or DC bells for 24 V, e. g., *KLD 1506*.

Control Instrument

One or more control instruments, Fig. 5, may be connected to the central instrument over a 3-wire circuit. All ringing signals coming to the central instrument are transferred to the control instrument. In addition, the control instrument issues signal if break or shortcircuit occurs in the line between it and the central instrument. The fire brigade personnel may also be alarmed from the control instrument by remote starting of the central instrument's alarm switch.

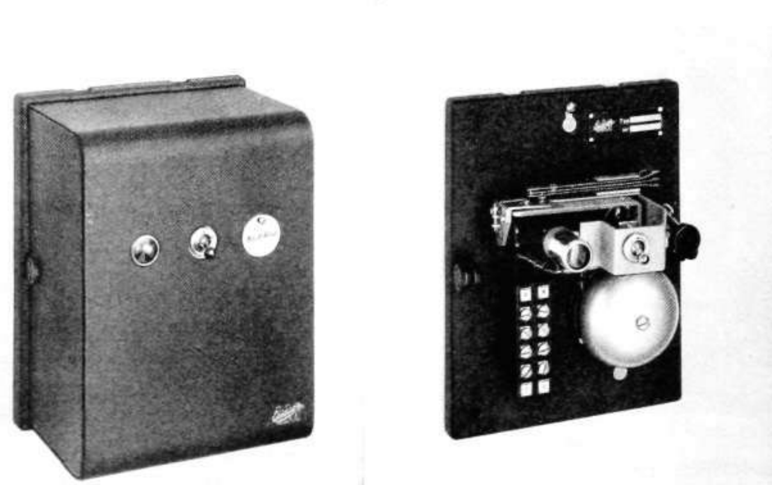


Fig. 5 X 6388
Control instrument 351033
left, with case removed

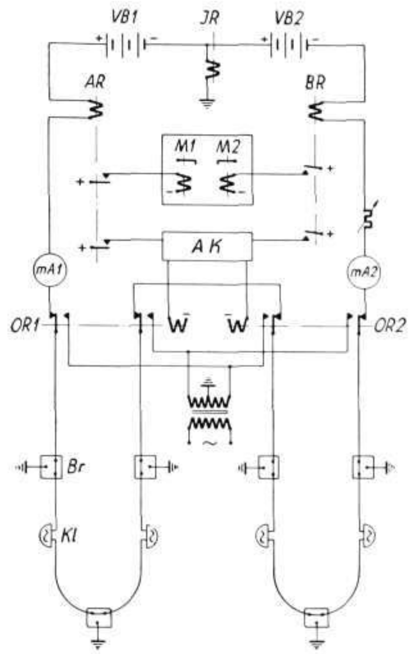


Fig. 6 X 4620

Skeleton diagram

AK automatic alarm switch
AR line relay
BR line relay b
Bu fire alarm box
JR earth fault relay
mA1 milliamperemeter 1
mA2 milliamperemeter 2
M1 recording magnet 1
M2 recording magnet 2
OR1 switch-over relay 1
OR2 switch-over relay 2
VB1 supervisory current battery 1
VB2 supervisory current battery 2

Thus in a plant with control instrument there is no need for the central instrument to be constantly attended.

The control instrument is made for wall mounting and has the dimensions: height 200 mm, width 150 mm, depth 102 mm. At the left of the instrument there is a flash indicator which shows white when all is in order. In the middle there is a switch for disconnection of the instrument's bell on fault signal from the central instrument. The bell cannot be disconnected while the plant is free from fault. Far to the right there is a swing out plate, marked ALARM, behind which is located a press button, to start the automatic alarm switch when alarm is received otherwise than from a fire alarm box.

Skeleton Diagram

The skeleton diagram of Fig. 6 is much simplified and shows only the basic principle. Normally the fire alarm box loops are traversed by a supervisory current from *VB1* + through relay *AR* — milliamperemeter *mA1* — over contact on relay *OR1* — through fire alarm box *Br* and bell *KL* — contact on relay *OR2* — milliamperemeter *mA2* — relay *BR* to *VB2* —. The low ohmic relay *AR* is not actuated by the supervisory current. Relay *BR* is high ohmic and therefore lies normally attracted.

On break in the loop, relay *BR* falls and gives fault signal.

A sensitive relay *JR* is inserted in the supervisory current battery earthing circuit, which is attracted if there is weak leakage to earth and then gives fault signal.

On alarm the loop is broken and connected to earth and the relays *AR* and *BR* then pulse in time to the code on the code wheel of the signal mechanism. The magnets *M1* and *M2* of the telegraph instrument receive current over contacts on *AR* and *BR* and mark the signs on the telegraph tape.

The relays *AR* and *BR* transmit impulses to the alarm switch.

The independent plus and minus signs on the diagram represent the poles of the signal battery.

The Laminated Contact — a New Type of Contact and its Application to Certain Important Forms of Switching Devices

Å JOHANSSON, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.65

The laminated contact, which is an entirely novel form of contact, was originally designed by the Telefonaktiebolaget L M Ericsson to replace the soldered connections formerly necessary between frame cables and panels in equipments for long-distance telephony, and thus provide a detachable connection between these parts, consisting of a plug and socket. It was clear from the outset that the demands made on such a contact would be of a very exacting nature — it must function with practically the same reliability as a soldered connection — since several hundred long and expensive lines would be dependent upon its reliable functioning, particularly in multiple channel systems. Consequently it would have to have a low contact resistance and, first and foremost, a resistance remaining constant in the course of time. Furthermore, it must be of small size in view of the multi-pole plugs which would be employed, and finally, it must be suitable for mass production.

The first contact designed to meet these requirements was of the flat pin type and consisted of a flat solid contact pin and a socket portion built up from a number of individually resilient laminations of sheet metal in order to provide a large number of contact points. This principle of employing individually resilient sheet metal laminations was also found to be applicable to circular contact pins and sockets and also to rotary change-over switches, so that a series of new switching devices has been progressively produced. The following article gives a description of the more important of these devices.

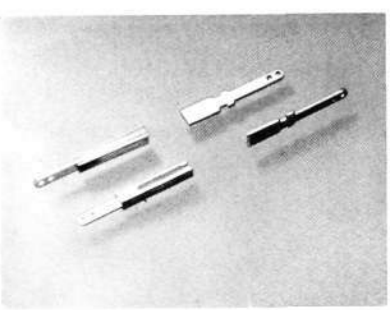


Fig. 1 X 4602
Laminated contact with flat contact pin

The Flat Pin Contact

The socket portion consists of thin sheet metal laminations of phosphor bronze, cut with two limbs in the shape of a fork, these being assembled to form a packet of 10 laminations combined at their base by spot welding, Fig. 1. When the flat contact, which is bevelled at the point, is inserted in the gap between the limbs, the latter spread outwards individually and resiliently, thus providing 20 points of contact which are well defined by the shape of the limbs. The two centermost laminations in the packet are extended at their rear end to form a soldering tab. All laminations are silvered before they are welded together. Although the laminations are only 0.3 mm thick, the assembled packet possesses excellent stability on account of the fact that the laminations support one another so that the limbs are only resilient in the plane of the laminations.

The special nature of the resilience ensures satisfactory contact pressure from each lamination and therefore such friction against the contact pin that even heavy oxidation or other impurities will be scraped off, so that good contact is obtained immediately. In consequence of the numerous points of contact, the contact resistance is extremely low and has excellent prospects of remaining constant in view of the relatively high specific contact pressure.

Fig. 2 X 4603
10-pole plug with laminated contacts dismounted

The laminated contacts described above have been constructed in the form of multi-pole plugs *RPV 16* and *RPV 17* and corresponding jacks *RNV 160* and *RNV 170*.

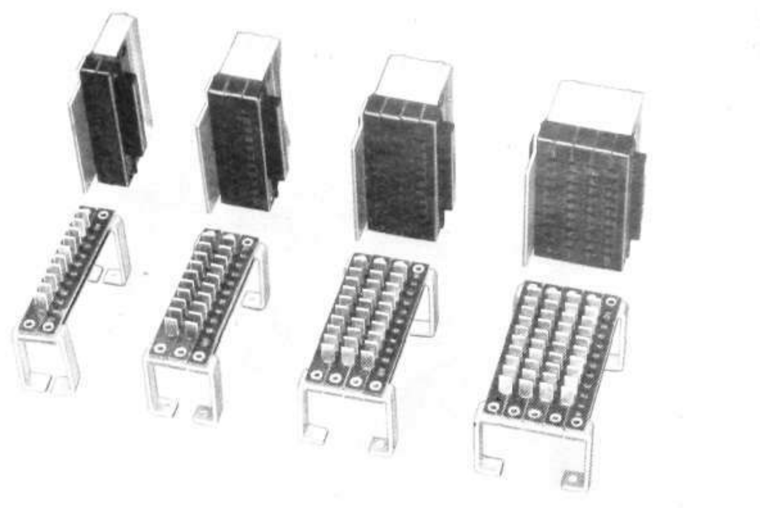


Fig. 3 X 6382

10- to 40-pole plugs and jacks with laminated contacts and flat contact pins

The plugs are provided with guide plates and protection against contact for the soldering tabs.

It should be noted that owing to the commonest form of installation adopted, the movable plugs have laminated contacts whereas the fixed jacks have contact pins.

The plugs are composed of a number of bakelite sections. The laminated contacts lie in the partitions formed between the sections which are so dimensioned that the contacts have a certain freedom of movement. Fig. 2 shows a 10-pole plug dismounted.

The number of contact rows can be multiplied by inserting one or more partitions between the similar outer halves, thus enabling 20-, 30- and 40-plugs, etc., to be produced. The guide plate on one side of the plug is fixed by means of the screws which draw the plug together; this plate also prevents the plug from being employed incorrectly when it is inserted in the jack. Supporting strips are provided on the outside of the plug by means of which the cable can be fixed. A simple protection against contact is placed over the soldering tabs.

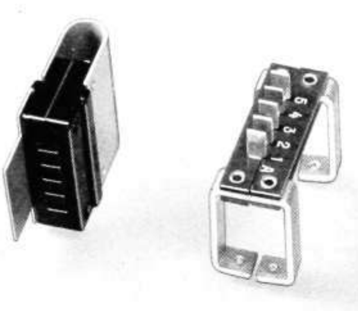


Fig. 4 X 4604

5-pole plug and jack

The plug is provided with a guide plate and protection against contact for the soldering tabs.

The jacks are composed of strips of bakelite paper between which the contact pins are held, some freedom of movement being allowed here also. They can be combined with several rows of pins corresponding to the number of the plugs, see Fig. 3.

A 5-pole plug and jack are shown in Fig. 4.

The form of construction, with individually movable contacts in combination with well-rounded openings in the bakelite parts and laminated contacts, enables the pins to find their way in to the contact positions with certainty, so that it is unnecessary to adhere to tolerances within very narrow limits for the component parts.

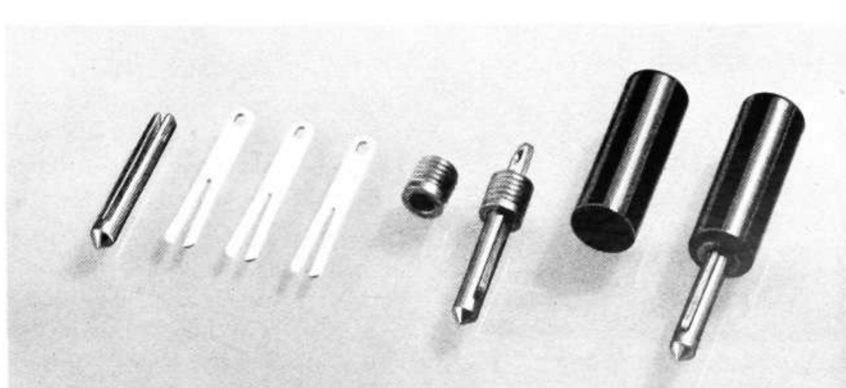


Fig. 5 X 6383

Banana plug and parts

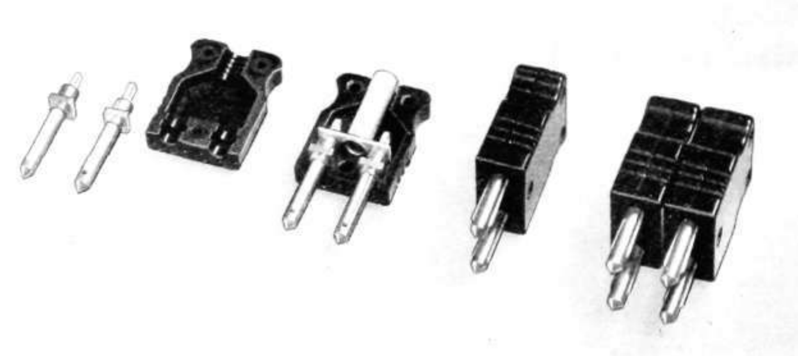


Fig. 6 X 6384

Two- and four-pole unshielded plugs (U-links)

For many years past the plugs and jacks described have formed part of L M Ericsson's equipments for long-distance telephony. In consequence of the ever-increasing concentration in constructional methods the boards have become separately. The plugs and jacks therefore find their most important form of application in the erection and connecting up of these equipments as well as for the connection and disconnection of certain stand-by units.

Banana Plugs

When constructing circular contact pins and sockets with individually resilient laminations of sheet metal in accordance with the principles set out above, it is naturally necessary to reduce the number of laminations. The new banana plug *RPT 330*, Fig. 5, is constructed with three such laminations which produces six points of contact with the socket. It consists of a circular pin having a diameter of 3.8 mm with a groove milled along its length. The three laminations are placed in the latter and are locked in position by a metal sleeve which is driven over them. The width of the laminations over the resilient limbs is greater than the diameter of the pin. The metal sleeve is threaded externally to enable it to be screwed into the stem of the plug. The rear end of the laminations takes the form of soldering strips to which the connecting cord is attached by soldering. A metallic connection is thus obtained between the connecting cord and contact springs without necessitating any unreliable joints. The plug springs are silvered. The pin is nickel-plated and pointed at its front end to enable it to penetrate more easily through oxide or varnish for testing or circuit identification. The banana plugs are intended for a 4 mm socket.

The stem of the plug is so constructed that the tensile strain on the soldered joint is relieved. It can be supplied in 4 colours: black, red, yellow or green.

The banana plug has been employed in a somewhat modified form for three different multi-pole plugs.

RPT 300 is an unshielded two-pole plug with a bakelite holder, which can be fitted with a connecting cord or a terminal resistance built into the holder or a short-circuiting strip (in the latter case it is referred to as a U-link). It is most frequently employed as a U-link in the four-pole form, *RPT 310*, in which the pins are connected in pairs.

RPT 302 is a shielded type corresponding to *RPT 300*, with a die-cast metal holder. It is intended for sheathed conductors. The centre pin is connected to the metal casing. *RPT 311* is a shielded double U-link, which also has a die-cast casing connected to the centre-pin. The appearance of the above plugs is illustrated in Figs. 6 and 7.

These plugs in the form of U-links have found a very extensive use in equipments for long-distance telephony in place of standard telephone jacks, where it is necessary to introduce breaks at certain points to enable routine controls to be carried out. With the help of the two-pole plugs it is also possible to connect up testing instruments in parallel through the U-links and reach the connection without opening the latter.

Fig. 7 X 4605

Shielded plug and U-link

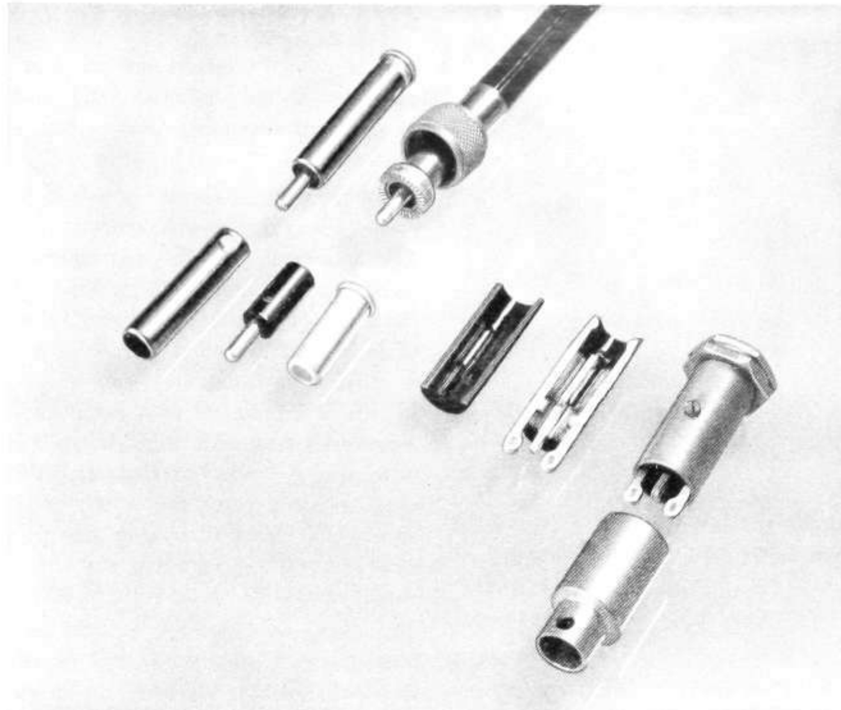


Fig. 8 X 6385
Coaxial plug with and without clamping nut, and coaxial jack

Coaxial Plugs

A special plug and corresponding jack have been designed for coaxial cables, in which the coaxial character of the connection is retained in the contacts.

In this case the plug *RPT 151* is of a very simple type, consisting of a central circular pin insulated from a metal socket by a trolitul bushing. The inner conductor is soldered to the pin, the sheath being soldered to the socket.

The jack *RNT 151* contains the resilient parts of the contact. The centre contact consists of three fork-shaped laminated springs located in a compartment inside a trolitul bushing comprising two similar halves. The outer contacts, which here consist of two separate packets each having three resilient laminations, are placed in two grooves arranged diametrically in the bushing. The complete assembly is laid in a circular metal casing and fixed by two screws. The inner conductor of the cable is connected to the centre contact by soldering, its sheath being soldered both to the two outer spring packets and to a metal tube which is threaded on the metal casing. The diameter of the tube at its rear end is adapted to the diameter of the cable.

The plug can be provided with a threaded clamping nut which fits onto the outer thread of the jack and serves the double purpose of locking the cable and shielding the gap otherwise formed between the plug and jack. Actual conductive contact is established by the spring packets however.

Fig. 8 illustrates some forms of construction for the plug and jack.

Fig. 9 shows a coaxial U-link with parallel sockets in which the above-mentioned coaxial plug fits.

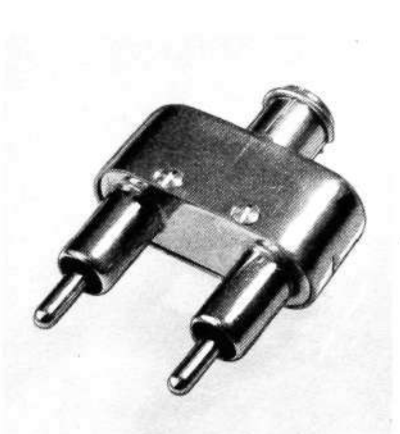


Fig. 9 X 4607
Coaxial U-link

Valve Holders

A simple and reliable form of valve holder *RNK 902* for electron valves is illustrated in Fig. 10. The contacts consist of three specially shaped laminated springs which are held tight and guided with a certain amount of free play by two identically similar stamped plates of paper bakelite.

Rotary Change-over Switches

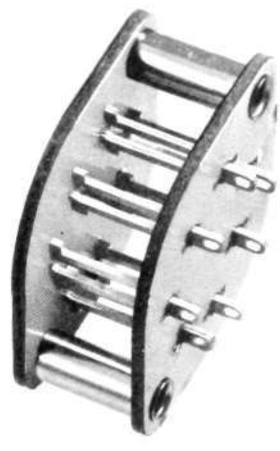


Fig. 10 X 4607

Valve-holder with laminated contacts

The laminated contacts described at the beginning of this article have been employed in an unaltered form in a rotary change-over switch of original design used for measurement purposes and designated *RMH 60*, Fig. 11 on the left.

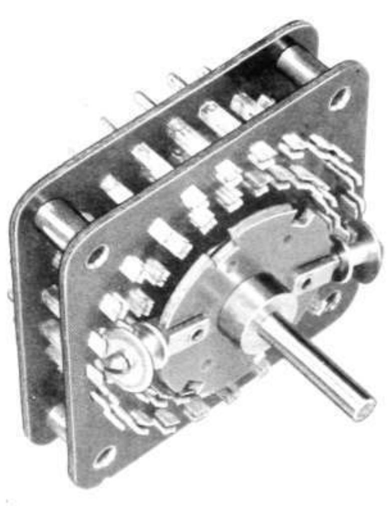
The supporting structure consists of two square, stamped plates of pertinax, placed a certain distance apart and held together at the four corners by rivets. The laminated contacts are rivetted in pairs and arranged in two concentric circles on one plate and guided by the other one. The moving contacts take the form of rollers comprising a brass hub with two circular end members of pure silver rivetted and soldered to the hub. These rollers are supported in such a way that they can rotate on radially arranged spindle-ends, which in turn are attached to a pertinax disc rotated by the switch spindle. Their dimensions are such that the circular end members each engage a contact in a pair of laminated contacts, thus establishing a connection between these contacts. On turning the switch spindle the rollers, while rotating around their spindles, are caused to leave one pair of contacts and find their way into the next pair without entailing any risk of deforming the laminated springs which would otherwise occur with fixed contact blades.

The change-over switch can be constructed with as many as eight contact rollers and is provided with a marking for each contact position in the form of a ball notching device. The number of pairs of contacts is 24.

Owing to the suitable choice of material the properties of the contacts and their resistance to wear are excellent. Following forced wearing tests carried out backwards and forwards 100000 times, the contact resistance was found to remain practically constant with a value of three mohms measured at the soldering tabs between the pairs of contacts.

By the employment of stamped parts for the supporting structure, it is possible to produce switches which to all intents and purposes are identical in every instance. Thus, where several switching combinations are required, a number of switch sections can be combined by passing bolts through the holes in the corners and driving all the contact rollers by means of a continuous spindle. Fig. 11 shows at the right a combination of this kind with no fewer than 9 switch sections. The change-over switch also possesses the advantage that the rollers, which are constructed of the loosest material, can be conveniently replaced if they are subjected to very heavy wear.

The lubricant is drawn up between the contact laminations and is distributed to the contact rollers when the laminations are spread out. In this way the lubricant is used more economically than was the case in change-over switches with flat contacts of the type hitherto employed, whilst at the same time the maintenance of the switches is simplified owing to their self-lubricating property.



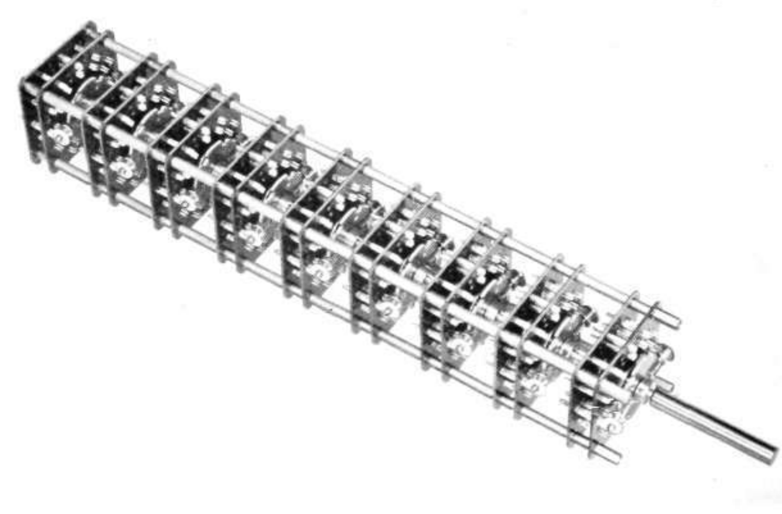


Fig. 11 X 7514

Change-over switch with laminated contacts and two contact rollers

On the right, nine similar switch sections with a common spindle for operating all contact rollers.

Svenskradio 490 BAT. — a New Battery Receiver

C FREDIN, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.396.62—182.4

Svenska Radioaktiebolaget has put on the market a new wireless receiver for battery operation, possessing extremely good reception properties despite its small size.

This new receiver is a great advance on earlier models. Below will be found a brief description of its new features.

The new receiver, with the designation *Svenskradio 490 BAT.*, Fig. 1, is small in size, low in weight and sparing of current, while yet being sensitive and giving good sound volume, see table of technical data. It is equipped with four valves of miniature type and has also loop antenna for all wave ranges.

Like earlier models the new *Svenskradio 490 BAT.* has been designed as a small case with handle. The receiver is crepe enamelled and the surface is unaffected by shocks and cracks and very easy to clean. These latter points are obviously of great importance, as such a receiver is often used outdoors, on bathing beaches etc.

The batteries in a wireless receiver are important. It should use standard type batteries, easy to exchange, cheap to buy and possessing long life. In the *Svenskradio 490 BAT.* the valves are fed by three standard flashlight batteries coupled in series. Batteries can be changed with great ease by anybody. A rod battery will last as a rule for 80 hours at the rate of 2 hours' operation a day. The 400 hours which the anode battery lasts before the voltage falls to the half should meet the demand usually made, namely that the anode battery should last the whole summer. The mean load on the receiver's 90 V anode battery is about 4 mA.

Valves

The »red» valve series employed in earlier models has now been replaced by a more up-to-date series of miniature type valves. The data for the valves are practically unchanged, except that the audio frequency valve has been changed to a pentode. The change brings an increase in amplification not to be despised.

Fig. 1 X 6389

Svenskradio 490 BAT.

On the left-hand end of the receiver may be seen the lid of the battery holder holding three batteries, at right reading downwards: combined batteries- and wave change switch (on the picture the short wave range is switched in), scale of stations, volume- and station controls.

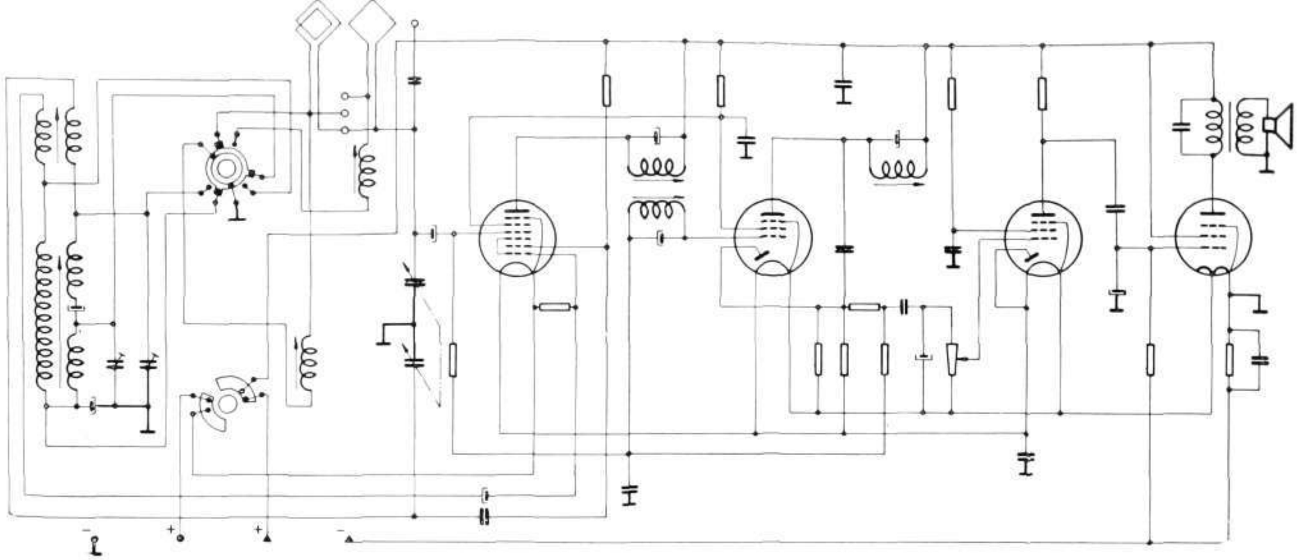


Fig. 2 X 7515

Circuit diagram for Svenskradio 490 BAT.

The frequency conversion is performed by the octode *MDK 40*. In the second valve *MDAF 40*, a diode pentode, the intermediate frequency signal is amplified and rectified. The audio frequency amplifier works with the pentodes *MDAF 41* and *MDL 41*.

The valves will operate satisfactorily down to a voltage of 45 V in the anode battery and 1 V per cell in the flashlight battery. At these voltages, of course, the batteries are almost finished.

Controls

A practical feature with *Svenskradio 490 BAT.* is the battery switch indication, which shows even at a distance whether the receiver is switched on or off, Fig. 1. Battery receivers are usually very quiet and without crackling, so it is easy to omit switching them off when finished with. When the switch above the scale is horizontal, parallel with the top of the receiver, the current is shut off. In all other positions one of the wave ranges, short, medium or long wave, is selected. The switch is visible from a long distance and its positions are so clear that they are easy to distinguish.

An arrow on the scale below the switch indicates which range is switched in.

The left of the two knobs on the front of the receiver is the volume control. Tuning control is placed to the right.

Loud-speaker

It seems most natural to try to get the greatest possible output from the output valve and in that way get the greatest loudness possible. This method, however, is very expensive for the owner of the receiver, causing as it does high battery costs. Besides, the output valve is quickly exhausted if kept under maximum load.

A method more costly for the manufacturer and harder to realize is to raise the efficiency of the loud-speaker. Svenska Radioaktiebolaget after a thorough series of experiments and trials has succeeded in solving this problem by designing a new type of loud-speaker, Fig. 3. The magnet for this consists of a highly effective magnetic alloy, which on magnetization gives a field intensity in the air-gap exceeding 11000 gauss. The output of 50 mW is regarded as normally constituting the loudness for an ordinary living room. For purposes of comparison, it may be stated that *HP 1113*, as the new loud-speaker is called, delivers a similar sound intensity even for so low an output as 10 mW.

Fig. 3 X 4611

Loud-speaker type HP 1113

sensitivity				30 μV
selectivity				35 kc/s
output				100 mW
loud-speaker				
effective cone area				80 cm²
field intensity in air-gap				11 000 gauss
wave-ranges				
short wave				16.7—51.5 m
medium wave				193—517 m
long wave				715—2000 m
valves	fil. curr. for 1.4 V	anode curr. for 90 V		
detector 1 and oscillator	50 mA	1.6 mA	octode	MDK 40
detector 2 and intermediate frequency valve	25 mA	0.7 mA	diode pentode	MDAF 40
audio frequency valve	25 mA	—	diode pentode	MDAF 41
output valve	50 mA	2.2 mA	pentode	MDL 41
number of valve functions				6
dimensions				
height				173 mm
width				282 mm
depth				123 mm
weight incl. batteries				4.5 kg
batteries				
anode battery, dim. 255 × 110 × 45 mm				
voltage				90 V
anode current				4.5 mA
duration				app. 400 hrs.
filament battery, 3 series-coupled flashlight batteries				
voltage				4.5 V
filament current				50 mA
duration				app. 80 hrs.

LM Ericsson Exchanges 1948

During 1948 the following exchanges on the LM Ericsson automatic telephone system with 500-line selectors have been put into service:

town	exchange		number of lines
Argentine			
Tala			400
Tucumán		(extension)	1000
Brazil			
Campina Grande		(extension)	200
Fortaleza		(extension)	3000
Natal		(extension)	500
Santos	PAX		500
Uberaba		(extension)	500
Vassouras			500
Colombia			
Armenia		(extension)	1000
Bogotá	Centro		15000
Bogotá	Chapinero		3000
Bogotá	Teusaquillo		2000
Manizales		(extension)	1500
Iceland			
Reykjavik		(extension)	2000
Italy			
Bergamo		(extension)	1240
Bergamo	PABX		210
Caltagirone			500
Cremona		(extension)	500
Foggia			1000
Genova	PABX		400
Matera			500
Napoli	Chiaia		5000
Novara		(extension)	500
Padova		(extension)	1000
Treviso		(extension)	500
Venezia	Centrale	(extension)	1000
Venezia	Murano	(extension)	100
Verona		(extension)	1500
Verona	PABX		220
Vicenza		(extension)	500
Mexico			
Durango		(extension)	500
Guadalajara		(extension)	1000
León		(extension)	500
Mexico, D. F.	Apartado		5000
Mexico, D. F.	Chapultepec	(extension)	1000
Mexico, D. F.	PABX		420
Mexico, D. F.	Piedad	(extension)	500
Mexico, D. F.	Roma	(extension)	500
Mexico, D. F.	Tacubaya	(extension)	500
Mexico, D. F.	Valle	(extension)	1500
Mexico, D. F.	Victoria	(extension)	2500
Toluca		(extension)	500
Veracruz		(extension)	500
Morocco			
Tanger		(extension)	500
Netherlands			
Rotterdam	Noord	(extension)	4000
Rotterdam	3 PABX		640
Peru			
Arequipa		(extension)	2500
Spain			
San Sebastian		(extension)	2000
Sweden			
Enköping			3000
Göteborg	Drottningtorget	(extension)	3000
Göteborg	Tranered	(extension)	1000
Hälsingborg		(extension)	1500
Karlstad		(extension)	2300
Krylbo			800
Norrköping		(extension)	2000
Skara			2500
Stockholm	Namnanrop	(extension)	1500
Stockholm	Södra Vasa	(extension)	1000
Stockholm	Östermalm PBX	(extension)	500
Stockholm	Hanviken		1000
Stockholm	Lidingö	(extension)	3000
Stockholm	Lidingö-Skärsätra	(extension)	300
Stockholm	Lännersta	(extension)	1000
Stockholm	Mälarhöjden	(extension)	1000
Stockholm	Roslags-Näsby	(extension)	1000
Stockholm	Sundbyberg	(extension)	2500
Stockholm	Tyresö		1000
Uppsala		(extension)	2000
Västerås		(extension)	2000
Örebro		(extension)	2000
Östersund			7500
		Total	113 730

During 1948 the following exchanges and switchboards with 100-, 25- and 12-line selectors have been delivered. Extensions to existing plants are not included in the figures.

	number	number of lines
Exchanges with 100-line selectors	7	3060
Switchboards with 100-line selectors, system AHD	50	3740
Switchboards with 25- and 12-line selectors, system OL	333	7457

U.D.C. 621.317.2

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A brief account in word and picture of the laboratories at the Telefonaktiebolaget LM Ericsson, Midsommarkransen, Stockholm.

U.D.C. 621.395.721.3

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Description of the new LM Ericsson wall instrument DBN 12—13, a successor to the wall instrument DBN 10—11 that has been in manufacture since 1933.

Case. — The Instrument's Floating Suspension. — AC Bell. — Switch Hook. — Principle Diagrams.

U.D.C. 531.719.35

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A brief account of the applicancies of employment for echo sounders, their construction and operation. Description of the new echo sounder PEK-3G.

U.D.C. 621.395.24

SIEWERT, O & ELLSTAM, S: *New Private Automatic Exchanges with XY-selectors.* Ericsson Rev. *26* (1949) No 1 pp. 17—23.

Description of a new series of private automatic exchanges with XY-selectors, put in the market by Telefonaktiebolaget LM Ericsson. The exchanges have been given the designations AHD 90, AHD 94 and AHD 96 and are mainly designed for medium-sized private telephone plants.

Traffic Facilities. — Mechanical Construction. — Circuit Diagram. — Working Properties. — Erection.

U.D.C. 654.147.6

HEDÉN, A & LINDGREN, E: *Fire Alarm Telegraph for Small Communities.* Ericsson Rev. *26* (1949) No 1 pp. 24—27.

Description of the build up and operation of a fire alarm plant of medium-size on a new simplified Morse-supervisory current system with connection possibility for up to 20 fire alarm boxes.

U.D.C. 621.395.65

JOHANSSON, Å: *The Laminated Contact — a New Type of Contact and its Application to Certain Important Forms of Switching Devices.* Ericsson Rev. *26* (1949) No 1 pp. 28—32.

Description of some switching devices with laminated contacts of LM Ericsson's design.

The Flat Pin Contact. — Banana Plugs. — Coaxial Plugs. — Valve Holders. — Rotary Change-over Switches.

U.D.C. 621.396.62—182.4

FREDIN, C: *Svenskradio 490 BAT. — a New Battery Receiver.* Ericsson Rev. *26* (1949) No 1 pp. 33—35.

Description of a new battery receiver Svenskradio 490 BAT. put in the market by Svenska Radioaktiebolaget.

The Ericsson Group

Associated and Cooperating Enterprises

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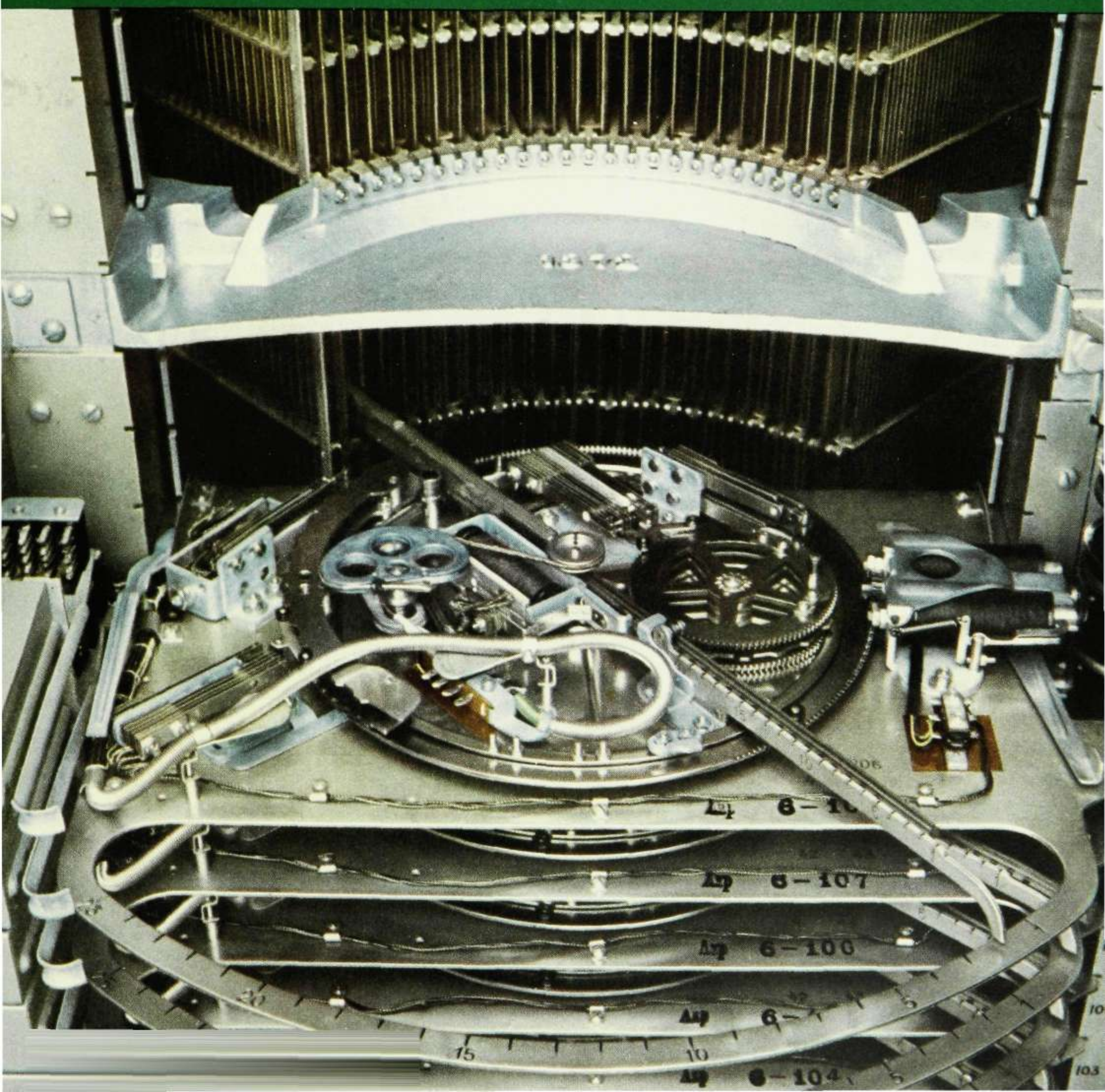

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On cover: Panel with machine-driven selectors for L M Ericsson's automatic telephone system with 500-line selectors, installed for up to 1 500 000 lines in exchanges all over the world.

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The Crossbar Switch and the Development of Crossbar Systems in Sweden

S VIGREN, ROYAL BOARD OF TELEGRAPHS, STOCKHOLM, and W BROBERG, TELEGRAPH ADMINISTRATION WORKS, NYNÄSHAMN

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It is now 30 years since the first crossbar switches were put into practical operation in Stockholm. It took rather a long time, however, for the unsurpassed operating qualities of the crossbar systems to be generally recognized, but now there is pronounced interest in them in a large number of countries. The Telegraph Administration in Sweden directed its attention right from the beginning to the properties of the crossbar switch and, in view of the important pioneer work carried out by Swedish engineers in this field, it may be interesting to review developments in Sweden.

Brief Survey

Teletechnics as we know it today is the result of developments that are unique in their way. The fundamental principles and laws on which the whole of electric circuit technique rests have, indeed, only been known for about a century and a half and we still have some years to go before we celebrate the hundredth anniversary of the telephone.

The practical application of teletechnics, however, called for a number of apparatus of various kinds right from the start. Even if the modern telecommunication industry, both as regards design and manufacture, has followed its own paths in many important respects and has established a new technique, yet the rapid expansion it showed from the very beginning could not have been possible without access to the closely related technique in the production of precision instruments, which was already comparatively highly developed. It is therefore rather natural that at the beginning teletechnical instruments were precision mechanical products much more than electrotechnical, for example the Morse instrument with its delicate clockwork.

Only a few years after the invention of the telephone, people began to speculate on the establishment of telephone calls by automatic means. The realization of the idea of automatic connection between telephone subscribers did not come until towards the close of the 19th century and is inseparably associated with the name of Strowger. The principles and designs bearing Strowger's name are still employed today to a great extent in automatic telephony.

In view of previous developments it was, of course, only natural that Strowger employed *mechanical ideas* and built his system up in such a way that it may be said to be an imitation of the decimal number system. Even Strowger's selector is a mechanical instrument, driven by an electromagnetic step-by-step mechanism, see Fig. 1.

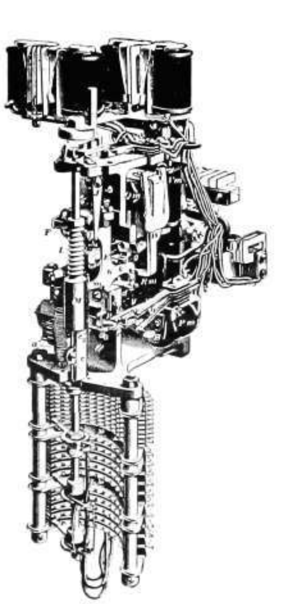

Fig. 1
Strowger selector

A step-by-step system first lifts the spindle carrying the mobile contacts, after which another system rotates the contacts in the multiple field. The step-by-step movement involves great mechanical stress and wear, however.

Around the turn of the century a number of new principles appeared in automatic telephony, including machine-driven selectors with setting by registers (Lorimer). Obviously the machine-driven selectors offered a number of advantages, mainly owing to greater capacity, but at the same time this represented in fact a still greater »mechanization» of the principle for building up the selectors.

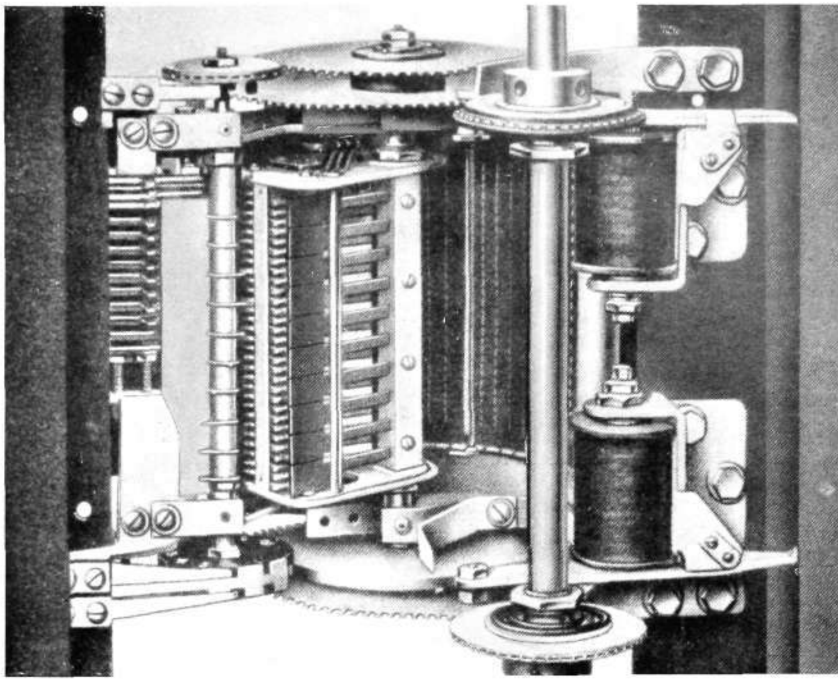

Fig. 2 X 6413

Rotary selector

The wiper row is selected by the shaft at the left, after which the wipers are rotated in the contact field to the proper position. The rotary selector constitutes a typical mechanical selector design. Nevertheless, the quiet smooth running which distinguishes the machine-driven selectors, in contrast to the step-by-step driven selectors, is an advantage from the mechanical point of view.

On the other hand, the introduction of the register allowed of greater freedom in the circuit lay-out, chiefly because the capacity of the selectors did not need to be tied to the decimal number system, but also because the number of impulse receiving devices and operating devices could be decreased.

The First Relay System

Obviously the complicated mechanical devices called for considerable inspection and maintenance and, moreover, operating reliability and rapidity of action generally left much to be desired. It was soon realized that the electromagnetic relay switches used in automatic systems had appreciably better reliability than the selectors.

It would appear that Charles J Eriksson's American patent 1586033, application dated 14th November, 1905, covers the first selector with relay contacts and crossing operating devices, in other words a crossbar switch.

An electromagnetic relay switch can of course be regarded as a fairly distinctive electric instrument. The mechanical movements are small, the operating speed is high and the wear is inconsiderable. In addition, it is possible to provide such a switch with precious metal contacts having high contact reliability. From the purely theoretical point of view, a switch consisting of such relays should therefore have the best operating properties conceivable.

The idea of building a system consisting solely of relays might then really be regarded as natural and in 1908 Clement took out a patent for such a system[1]. It seems, however, that the idea was not realized in practice.

Reynolds' Crossbar Switch

On 10th May, 1913, the American Reynolds filed a patent application for a selector with relay contacts, actuated by a system of crossing bars[2], Fig. 4. The device was named »Crossbar Switch» and the principle is the same as that employed today in selectors of this kind.

The feature of the device is a system electromagnetically actuated crossing bars which, by operation of horizontal and vertical bars, directly and momentarily produces contact at the points of intersection between the contacts of the multiple field and a system of fixed contacts. No contact movement such as occurs in step-by-step driven or machine-driven selectors takes place.

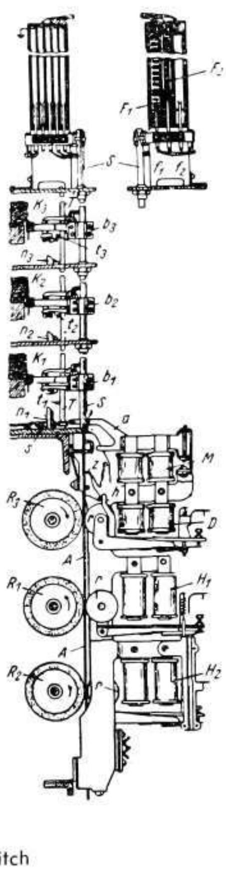

Fig. 3

Panel switch

The driving system is at the bottom. First the wiper set b belonging to the contact field K concerned is hunted. Then the bar is raised until the wipers stop at the proper contact in the field K.

[1] The figures refer to list of literature on page 51.

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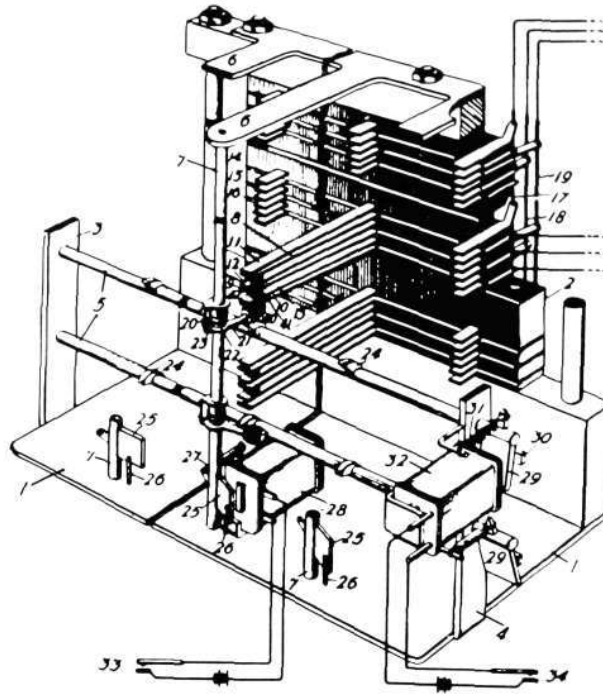


Fig. 4 X 6409

Reynolds' crossbar switch, as per U.S. patent 1139722

A vertical bar indicates vertical row on energizing of the electro-magnet and then the ridge on the horizontal bar raises the spring assembly at the point of intersection of the horizontal and vertical rows. The vertical bar's *selecting finger, a small spring coil*, allows the vertical bar to return to home position after the coil has been gripped between the ridge of the horizontal bar and the spring assembly concerned. The patent specification gives but little information respecting details of construction, but the device shown would be quite troublesome to manufacture.

It has been reported that the switch was employed in small switchboards. Interest in the switch was but slight, however, even though further American patents were taken out for selectors of this type in the next few years[3].

It is outside the scope of this article to go more closely into developments respecting the crossbar systems in America, but it may be mentioned that Swedish crossbar exchanges were studied by experts of the Bell Laboratories at the beginning of the thirties and that work on crossbar systems was taken up again, largely following Swedish patterns[5, 11]. The first exchange on the crossbar system was opened in America in 1938, »Murray Hill Six», and now such systems are being made at the Western Electric's factories on a vast scale[6].

The reasons why the Reynolds design when it appeared did not meet with much interest seem to have been many. For one thing large amounts of capital were invested in the development and manufacture of mechanical selectors. Another reason appears to have been that the Reynolds selector, at least according to patent specifications available, was rather complicated and probably expensive to manufacture, compared with mechanical selectors of equivalent capacity. The crossing bars had quite large freedom of movement and the operating speed does not seem to have been great. As far as can be judged, Reynolds designed his »crossbar switch» as *a selector* and there does not appear to have been available any appropriate system with which it was possible economically to exploit the switch. This in fact is not possible when using systems built on mechanical principles. The switch is based on electrical principles and is at its best if the system also is on the same basis.

Development in Sweden

Turning now to developments in Sweden, it may be stated that the telephone right from the beginning became extensively used and the telephone density was at an early stage and still is the highest in the world after the U.S.A. This fact must be ascribed above all to the Swedish Telegraph Administration and to L M Ericsson and H T Cedergren, from whose undertaking Telefonaktiebolaget L M Ericsson later arose[7]. Swedish standards both as regards equipment and service have always stood very high and therefore, when the question of automatization was taken up seriously in Sweden around 1910 and studies were made in foreign countries, there was some scepticism as to whether the existing foreign systems would be capable of meeting Swedish demands respecting good service.

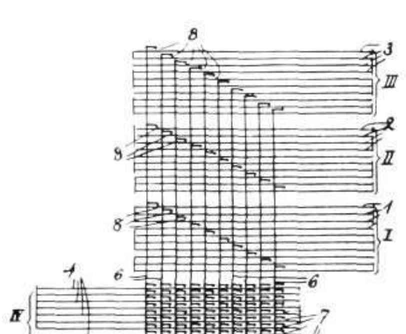


Fig. 5 X 4627

Betulander-Palmgren link system principle, *as in Swedish patent 38514*

This principle is of fundamental importance for all modern marker systems.

Experimental plants of small size had been tried out by the Telegraph Administration since 1899, designed by J P Pehrson, Telegraph Commissary, and G A Betulander, Works Manager of the Administration's workshops. In addition, a trial plant was constructed in 1913 on the Rotary system, but the operating results were not satisfactory[7].

AB Autotelefon Betulander's Relay System

About 1910, G A Betulander obtained leave of absence from the Telegraph Administration and formed a firm of his own, AB Autotelefon Betulander, with a factory at Stockholm. To begin with Betulander and his collaborators, in the first place N Palmgren, worked with mechanical selector designs and it was considered advisable to make them in the form of small selectors of limited capacity and simple construction to ensure sufficiently good operating reliability[8]. In order to be able to employ them in large systems there was developed an entirely new principle, which was very important for future developments, *the system with primary and secondary switches (link system)*[9], Fig. 5. At the same time, it seems to have been clear to the firm that employment of relay groups instead of mechanical selectors would solve the essential problems of operating reliability and resistance to wear, and consequently the patent for the link system principle comprises the employment both of mechanical selectors and of relay groups.

A selector stage, built up of relays on the link system principle both can and should be set momentarily in a very brief time and this led to the operating devices being confined to devices common to each selector stage or to the whole exchange the *by-path principle*, thus providing a saving of material.

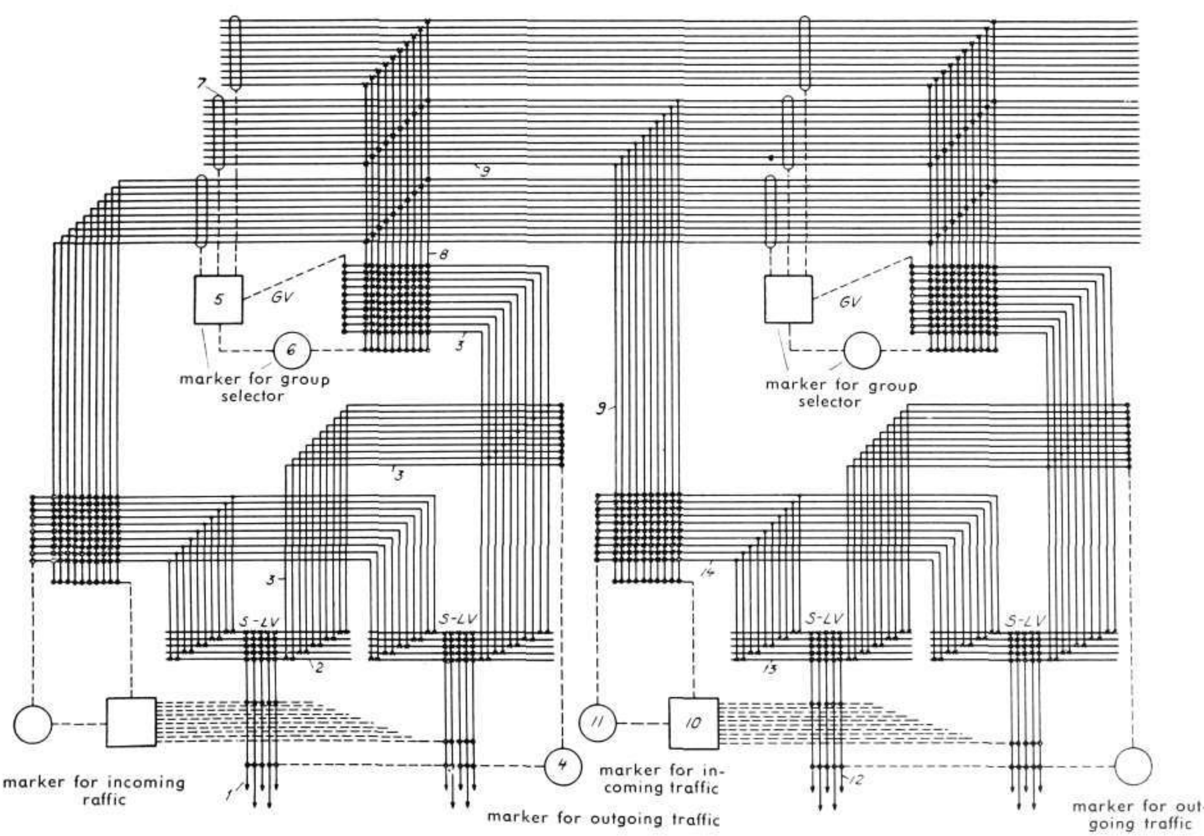
By means of the link system principle it was possible to build up relay systems giving considerably better utilization of the relays than when the conventional systems were employed, and the Betulander Company quickly devoted itself solely to the construction of such relay systems.

Thus an exchange was built in London in 1914 on a system entirely consisting of relays[10], Fig. 6. The selector ranks had common impulse receiving devices

Fig. 6 X 7520

Traffic route lay-out for up to 1000 numbers private branch exchange according to AB Autotelefon Betulander and employed in an exchange in London 1914

Original diagram, interesting because of the absence of mechanical symbols for the selectors (still often employed even in the crossbar systems). The exchange in question has impulse receiving device and marker common to each selector stage, a principle which is utilized in the Telegraph Administration's new marker system.



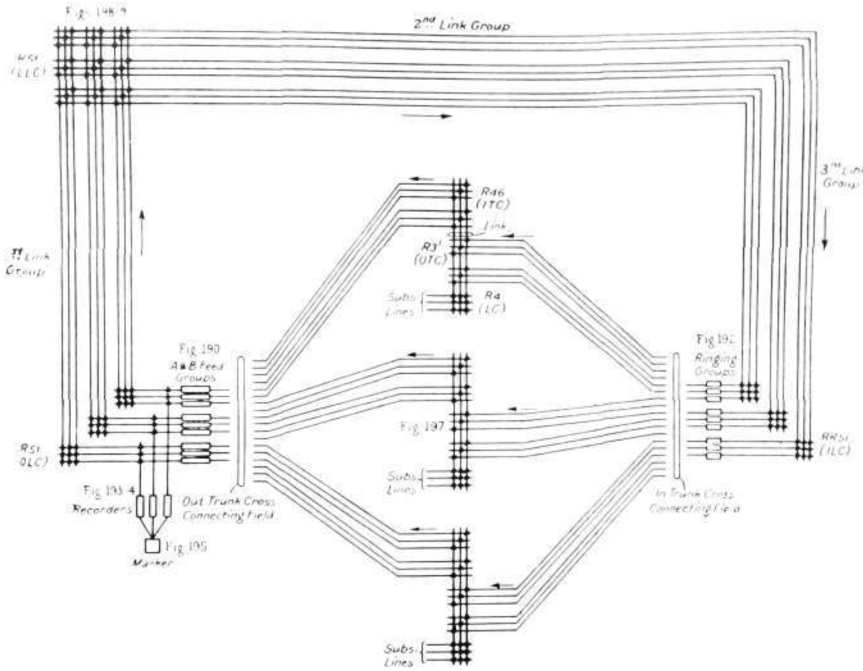


Fig. 7 X 6410

By-path system with relays

according to Betulander-Palmgren, with common marker[3]. Selector ranks in the usual sense are absent. The latest American systems are built on similar principles.

and were connected up on the link system principle, besides being set momentarily after the requisite number of impulses had been received from the dial.

The system was carried still further, however, and the common devices became still more concentrated[11]. Thus there were introduced a marker common for the whole exchange and a number of registers corresponding to the traffic. After receiving impulses the register was connected an instant to the marker, which momentarily coupled up through the whole exchange. Fig. 7 shows a diagram for such a system, which was also employed by the English firm, The Relay Automatic Telephone Co. Ltd, which had acquired the rights to AB Autotelefon Betulander's designs[3]. Typical features of the system are the following:

1. Relay Selectors Throughout

All selectors are built up of relays or of devices working on the relay principle. This ensures high operating and contact reliability, high speed and insignificant wear. Both operation and control of the selectors is done electrically and disconnection of calls, for instance, is executed by breaking of the different holding circuits. Such a system can hardly be troubled by mechanical sticking.

2. Link System, Bare Wire Connection

The selectors consist of relay groups, connected by intermediate circuits, links. (For this reason the name »link system» is employed.) The relay groups and later also the crossbar selectors were connected by bare wires.

3. Common Marker, By-path Principle

Setting of the selectors is done by the by-path principle, by means of a marker common to the whole exchange. This receives indication of the wanted subscriber from the register, after which the selectors are set all in the same moment in a fraction of a second, when the wanted traffic route has been indicated or hunted for automatically.

4. Combined Line Finder and Final Selector

Subscribers have the same incoming and outgoing selector. Besides saving of material compared with other systems having separate finders and finals, this gives the advantage that each subscriber is only connected in the system at one spot.

5. Registers

The selectors have no device of their own for receiving impulses, this enabling savings to be made. These devices are instead concentrated in a number of registers, which can thereby be utilized effectively.

A glance at the diagram will show that we have here something quite different from the automatic technique of the time. The »mechanical» symbols for selectors with moveable contacts are absent and instead we get an electric circuit system, consisting of intersecting circuits (»links») which can be connected with each other at the points of intersection.

The selector constructions of the mechanical systems which were often different for different purposes are entirely replaced by devices made up of a single simple basic component: the electromagnetic relay.

It is obvious that most of the more or less mechanical principles hitherto employed in automatic telephony had been departed from and that the system in question is entirely based on electric principles, both as regards the components used and in respect of principle of build up and method of operation. The setting of the switch is done momentarily by electrical marking and the sole »mechanical» principle actually remaining, is the setting of the register by the subscriber by means of trains of impulses.

The advantages expected from the relay systems were realized in practice. A number of small plants were made in England by the above-named firm, which however gave up its activities very soon. There still remains, at Fleetwood in Southern England, an exchange that is in operation, stated to have about 1200 subscribers[12].

The principles applied, however, were far too new and revolutionary for their time and it appears therefore that the system did not arouse any great interest in other countries, where mechanical principles were still being used. The reason was the same as for the Reynolds crossbar switch. Moreover the relation between cost for plant and for maintenance were not taken sufficiently into account, partly owing to the fact that manufacture and maintenance were usually not in the same hands.

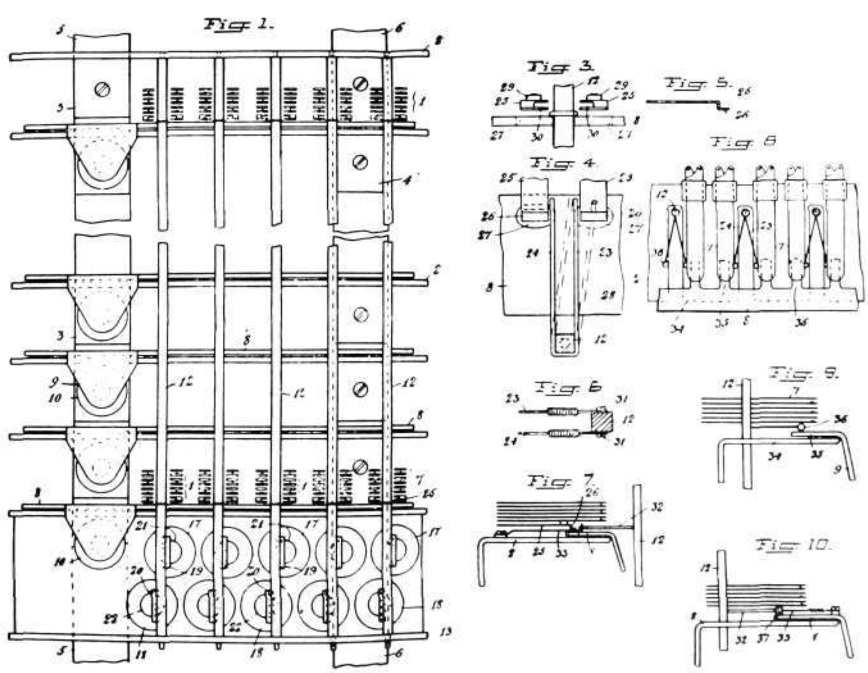


Fig. 8 X 6411

Betulander-Palmgren crossbar switch as per Swedish patent 49816

The switch has 5 vertical bars with double-sided movement. Indication is done by a spring selecting finger. The horizontals consist of far stretching relay armatures which extend under 10 spring assemblies. This early drawing suggests already the relatively simple build up typical of Betulander's switch and adopted from relay assemblies.

AB Autotelefon Betulander's Crossbar Switch

Betulander had realized at an early stage that a competitive relay system required cheap relays and relay assemblies, and obviously it would be most natural to try to replace the relay assemblies by a cheaper device having the same properties. At the beginning of 1919 Betulander learned about Reynolds' invention. That he immediately recognized the importance of the invention is simply due to the fact that he had himself a system in which the Reynolds type of selector could be utilized to the full. Experiments with the invention were put in hand at once and were carried on with great energy[2]. In April 1919, an application[13] was made for a patent covering the new design, Fig. 8, and by September of that year the first switches were in operation at Betulander's trial exchange (of which more later), Fig. 9. By the end of the year at least some small number of the switches appear to have been in service for public traffic. In so short a time to have designed and manufactured switches which were not only simple and reliable but also from the manufacturing standpoint were surprisingly well thought out must be regarded as an extremely good achievement, especially in view of the firm's small resources.

The design was considerably simpler than that of Reynolds and among other things the shape of the armature and the arrangement of the spring sets clearly show that the switch was designed on the basis of relay groups in the relay system. Betulander's selector has small movements as in a relay and the high speed of operation resulting from this is one of the greatest advantages of the crossbar switch. The device was given the name of »combination group» to begin with. It was only later when it came to be employed as selector in a Strowger system that it acquired the name of crossbar switch or selector.

The Telegraph Administration's Trials with Various Systems

As has been said, the Telegraph Administration took up the question of automatization seriously in 1910, and around 1915 plants were ordered for practical trial, including one on the Hultman machine-driven system with bare wire multiple, manufactured by L M Ericsson, and one on the Betulander relay system with link system connected stages and marker, made at AB Autotelefon Betulander's factory. The exchanges were in trial operation in the years 1917—1919[7, 8].

Betulander's trial exchange was made with relays only to start with, but as stated the first crossbars were fitted and thus this year marks 30 years since the crossbar switch was employed for the first time in practical operation. The operating results with the crossbar switches were strikingly good.

Fig. 9 X 7527

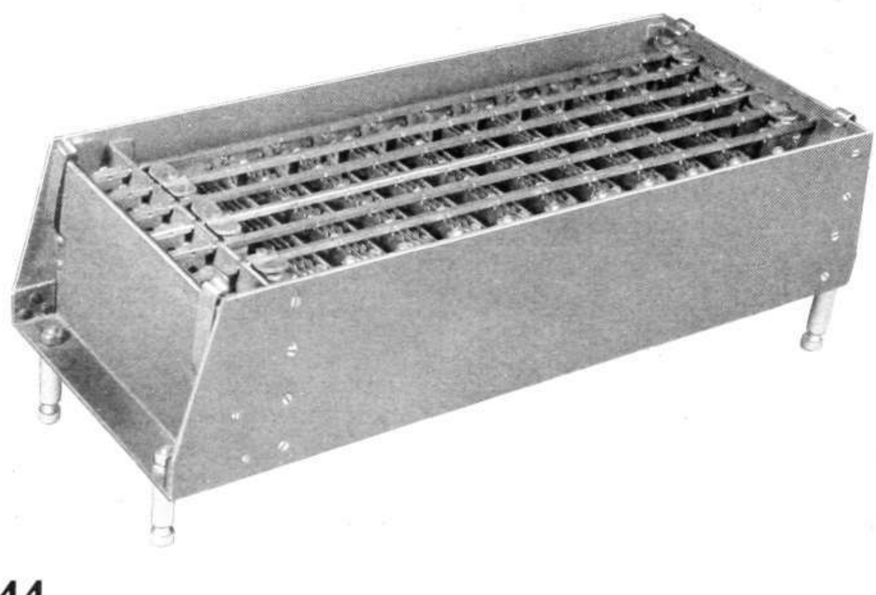
AB Autotelefon Betulander's switch

used in Stockholm in 1919. Right, detailed illustration.

The selector is fitted with the bars upright.

The selector has a sixth bar for indicating two separate inlets. Each »vertical unit»* thus constitutes a unit selector with two inlets and 10 outlets. The frame was sturdy, the selector units were inserted in guides in the side plates, and the front was entirely covered by a glass sheet. The switch consists of fairly simple, mainly pressed parts.

* To obtain a uniform nomenclature the term »verticl unit» is used even when the switch is mounted in such a way that this seems to be inadvertent.



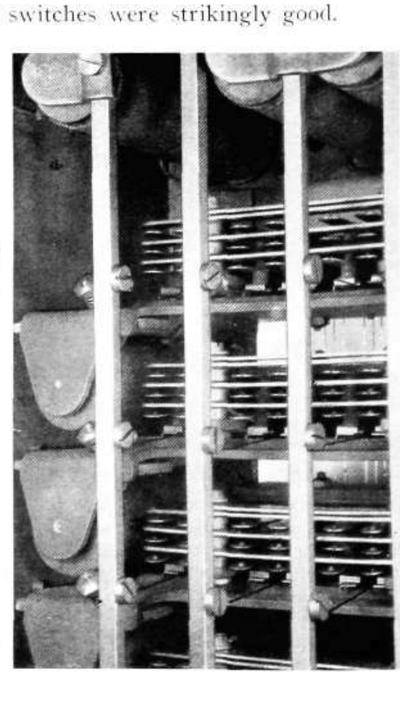
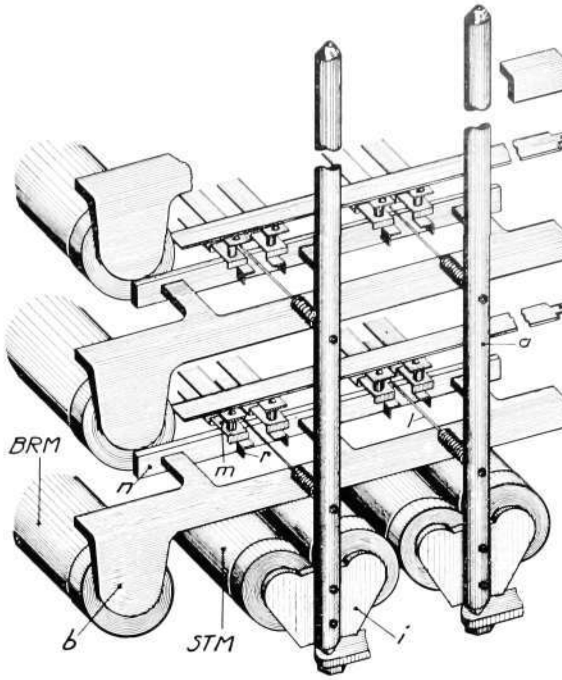


Fig. 10

Skeleton drawing

of the action of the multiple spring sets in crossbar switches of the Telegraph Administration's first type, »the Sundsvall type».

When the electro-magnet *STM* is magnetized the bar *a* is rotated by the armature *i*. All the selecting fingers *l*, with spring attachment to the bar, then go under the respective rows of operating springs *m* and are stopped by the dogs *r*. When the electro-magnet *BRM* is magnetized the armature *b* is magnetized and the lifting bar *n* lifts the operating spring *m* by means of the finger *l* which is gripped firm between *m* and *n*, after which the bar *a* can return to home position. The operating spring *m* presses the contact springs above against the fixed contact strip, as long as *BRM* remains magnetized. When magnetization ceases the armature *b* falls and the selecting finger *l* returns by spring action to home position midway between two operating springs *m*.



The Telegraph Administration's Decision Regarding System for Large Exchanges

By 1921 the Telegraph Administration had assembled the necessary operating results and calculations for determining the choice of automatic system. The first question was the automatizing of Stockholm, Gothenburg and others of the larger towns and for this purpose it was considered that the machine-driven 500-point selector system, worked out by Telefonaktiebolaget L M Ericsson on the basis of Hultman's principles was the most suitable[7]. The trunking scheme of this system is certainly based on conventional principles, but it differed at that time from other systems by having bare wire multiples and detachable connecting devices, so that it could more easily be adapted to the needs of traffic, Fig. 17.

The decision arrived at by the Telegraph Administration was certainly well justified at the time. L M Ericsson's system has found extensive employment in the larger towns of Sweden and abroad and has given very good operating results[20]. It would seem to be the only system which can seriously compete as regarding operating reliability with crossbar switch systems.

The Telegraph Administration's Decision Regarding Crossbar Systems

The Telegraph Administration had, however, been studying with great interest Betulander's relay system, directing attention particularly to the good operating properties of the crossbar switch. It was decided that the Telegraph Administration should continue experiments and manufacturing of systems with crossbar switches.

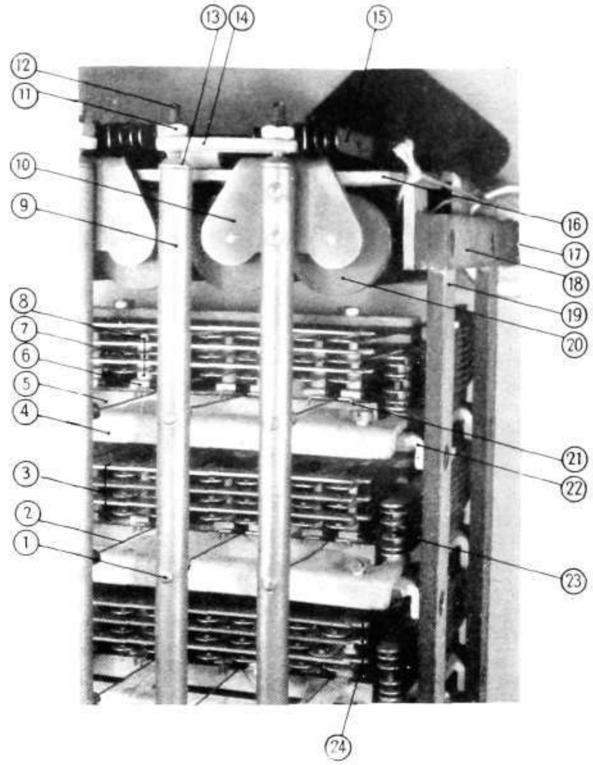
Betulander's marker system with the key functions concentrated at common points and the difficulty of surveying and estimating the selector stages connected on the link system was at that time regarded with justified scepticism. Experience was lacking of such a new system and of the consequences of adopting it in large towns. Moreover relay technique was not developed enough for it to be possible to execute the common devices with sufficient operating reliability. Single contacts only were used (general change-over to twin contacts in the Telegraph Administration's crossbar system was carried out in 1931)[14], nor was the spark quenching technique adequately worked out.

Fig. 11 X 6414

Close-up picture of the Telegraph Administration's first type of crossbar switch »The Sundsvall type».

The switch is fitted with bars vertically. Ther ten multiple spring sets on each vertical unit may each be connected to a system of fixed contact strips. Thus each unit constitutes a selector with ten inlets and one outlet, or vice versa. With ten units there are obtained ten 10-selectors or alternatively 5 selectors with 2 × 10 spring sets, two selectors with 5 × 10 spring sets and so on (single group principle). Many different types of selector may thus be obtained by different connections of the basic component. If the multiple set is provided with double spring sets, doubling of capacity can be obtained by the employment of a separate external switching relay (double group principle). This has been much used for certain cases.

1 selecting finger base
2 selecting finger
3 multiple spring set
4 holding bar armature
5 holding bar
6 operating spring
7 multiple spring
8 insulating pieces
9 selecting bar
10 selecting bar armature
11 locking nut
12 bearing screw
13 bearing
14 bearing seat
15 selecting bar spring set
16 end piece
17 fixing screw
18 frame
19 side plate
20 selecting bar magnet coil
21 stop dog
22 vertical unit
23 vertical unit spring set
24 soldering tags for fixed contact strips



It was therefore decided to use the crossbar switch in a direct-driven system of Strowger type. Such a system is easy to survey as regards traffic and moreover each traffic route has its own impulse receiving and setting devices. The system was called the Telegraph Administration crossbar system. The crossbar selectors were provided with auxiliary relays, by which its operating devices, bars and the vertical armatures could either be set directly according to the dial impulses or automatically by successive actuation of operating magnets; thus it functioned as a step-by-step selector, *e. g.* of the Strowger type[7].

Even though later developments concerning the crossbar system show that marker systems on Betulander's original principles, at least where large plants are concerned, were an advantage, yet the Telegraph Administration's decision in selection of system was warranted at the time. The most important point of course was that the *principle of relay selectors* was adopted and that the *crossbar switch* was given an early opportunity to show what it could do.

Design and Manufacture of Crossbar Systems after 1920

The work of design was taken up under the direction of Mr. H Olson, chief of the Telegraph Administration Designing Department, which Betulander had rejoined after AB Autotelefon Betulander ceased to exist. By the beginning of the twenties the first switches were made at the Telegraph Administration workshops and some small exchanges were installed[14]. In the years 1924—1926 a plant for 4000 subscribers was built at Sundsvall on the Telegraph Administration crossbar system, Fig. 10 and 11. The operating results were good and the exchange is in fact still in service. It is the world's first crossbar exchange of considerable size[15].

Around 1930 the Limhamn exchange was opened and about 1933 the Malmö exchange which now has some 40000 subscribers and which is the largest crossbar exchange in the world on the direct-driven system. In subsequent years further exchanges were built of medium-size type.

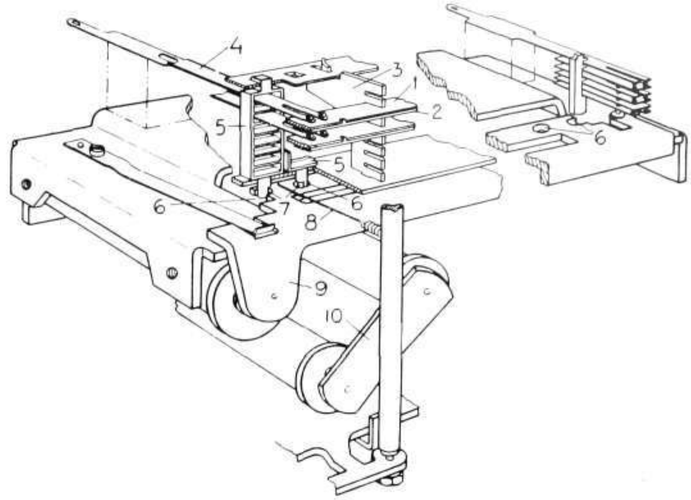


Fig. 12 X 6412

Crossbar switch »Type 41»

Each multiple set is actuated by a lifting ladder 5, common for the whole set, on the rungs of which the springs rest when the spring set is raised. The lower part of the lifting ladder consists of a lug which fits into a free hole 6 in the armature and is thus not affected by the armature's movement. On deflection of the selecting bar armature the selecting finger 8 is pushed into a slot 7 in the lug, so that the holding armature 9 when energized carries with it the lifting ladder and thus the multiple spring set.

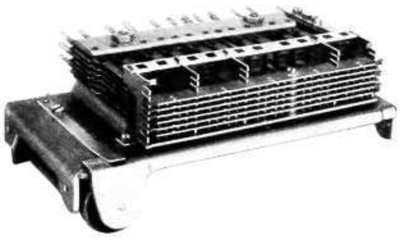


Fig. 13 X 4628

Vertical unit for crossbar switch »Type 41»

This switch unit has double spring sets (2 × 3) and thus has one inlet and 20 outlets (or vice versa).

Rural Automatization in Sweden

About the beginning of the thirties the question of rural automatization became pressing and it was prophesied that the reliable crossbar system with its small demand for maintenance would be extremely suitable. The same principles were largely employed as for bigger plants, though naturally modifications were necessary owing to the exchanges being generally very small. Standardized switchboards in units for 20, 50 and 90 subscribers were designed, while exchanges for over 100 subscribers were made extensible[16]. Automatic private branch exchanges have also been built in large numbers on the crossbar system.

To begin with the manufacture of such small exchanges was carried on by the Telegraph Administration workshops alone. In the middle of the thirties, however, it was planned to build an entire automatized experimental area to obtain experience on a large scale[17]. In this Telefon AB L M Ericsson also participated, building a number of switchboards of the Telegraph Administration's design, the crossbar selectors being made by the Administration's workshops. The experiment turned out well and the experience gained has been of great value for the expansion of rural automatization in Sweden.

Towards the end of the thirties there was begun the design of an improved crossbar system, called Type 41, Fig. 12, and in conjunction with this a re-design of the crossbar switch, Fig. 13. This system is still being manufactured for small rural switchboards[18], Fig. 15.

Employment of the Crossbar Switch in the 500-point Selector System

The crossbar switch has also been largely employed in the L M Ericsson 500-point selector system, Fig. 18[20]. Thus crossbar registers are now being

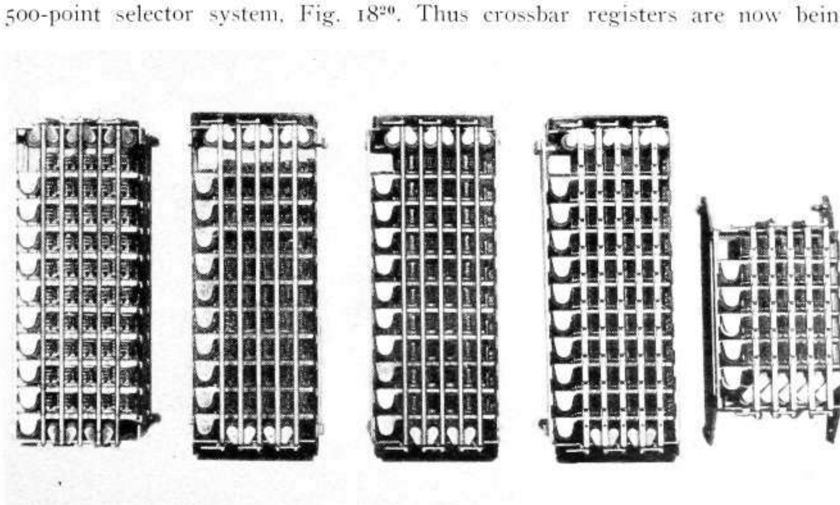


Fig. 14 X 6415

The Telegraph Administration's various types of crossbar switches

left to right, »Sundsvall Model» (manufactured 1920—1928), »Limhamn Model» (manufactured 1928—1934), »1934 Model» (manufactured 1934—1941), »Type 41» (manufactured from 1941). »Type 41» has 2 × 5 × 10 = 100 multiple spring sets and can thus with the aid of a switching relay be employed as 100-line selector. The »Sundsvall» model switch was only fitted with the selecting bars vertically, but subsequent types were almost exclusively fitted with these bars horizontally. The latter method makes the plane of the contact surfaces vertical and thus the contact surfaces are better protected against dust.

**

used, by means of which increased reliability and wear are attained and greater possibilities from a circuit point of view respecting translation are obtained. If a register finder is required, it is built with crossbar switches[19]. This offers great advantages, chiefly because of the increased reliability and wear but also because of the greater circuit possibilities provided by the crossbar switch.

Review of the Range of Employment of the Crossbar Switch in Sweden up to the Present

To give an idea of the diversity which is the feature of the crossbar switch, a brief review will be given of the main ranges of employment up to now.

A. As Switch for the Marker System

The first employment of the crossbar switch was as substitute for the relay groups in a marker system. Later and for some years in succession it came to be used chiefly for direct-driven systems (the Telegraph Administration's crossbar system), but in recent years manufacture of marker systems has again been taken up[5].

These systems have the property that a number of simultaneous calls can be carried on through each crossbar switch. This is obtained by the crossbar switch being divided for a grouping point of view into small unit selectors (verticals) and two or more of these are connected in series for each selector rank and are linked up by intermediate circuits, links. The system offers great opportunity for combining the selector units, enabling various traffic requirements to be satisfied economically.

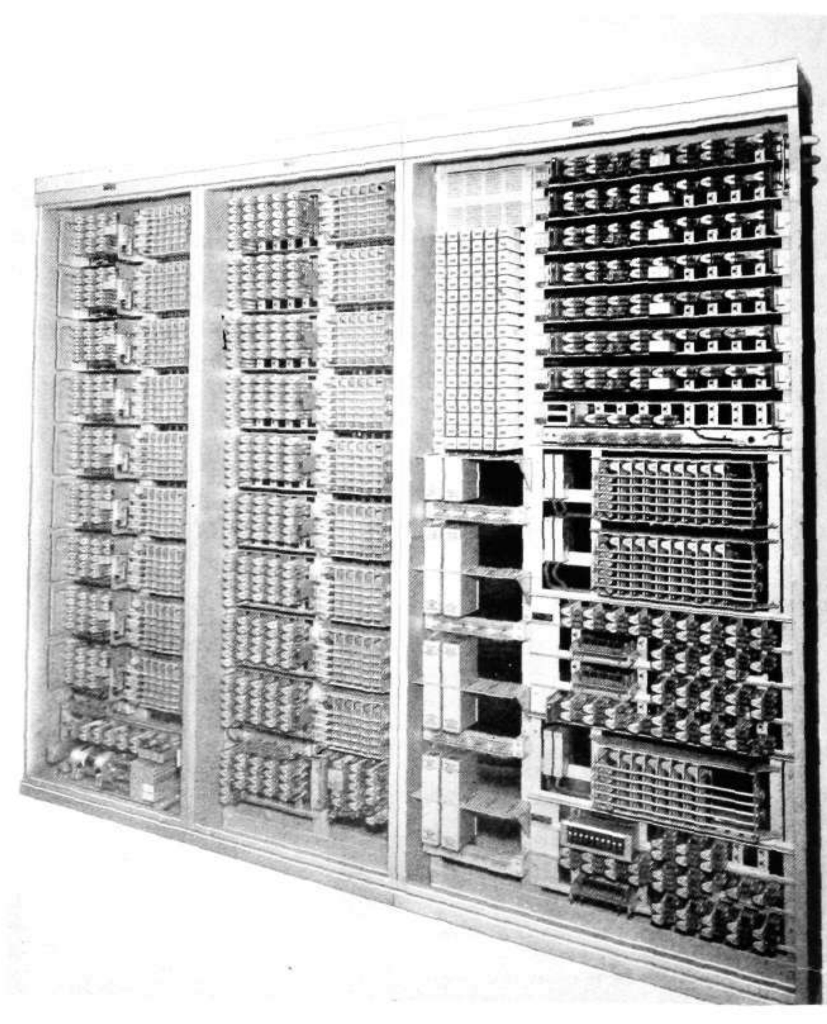


Fig. 15 X 6416

90/100 subscriber rural switchboard, Type 41

Something like five hundred switchboards in sizes from 10 up to a couple of hundred subscribers are working in Sweden. Reliability of operation is extremely high. It is not unusual for a switchboard of the above size to run for years without any fault arising for the special attention of a repair man calling. The switchboards are of course inspected a few times each year and routine tests are also carried out. Without such a reliable system as the crossbar system available it is hardy possible that rural automatization could have been carried through in Sweden on present principles. The distribution of the telephone in rural districts calls for the employment of quite small switchboard units and the great distances involved require reliable plants if the repair staff shall not be abnormally large.

Fig. 16 X 6417

Building for unattended crossbar exchange

B. As Selector in Direct-driven-Systems of Strowger Type (The Telegraph Administration's Crossbar System) [15, 16, 18]

1. Line Finder

It is usually made with 100 inlets and one outlet per selector. On the principle of single group this is obtained with ten vertical units. On the double group principle (see text to Fig. 11) one can with ten vertical units get two 100-line selectors having common bar mechanism; with five vertical units one 100-line selector is obtained.

The crossbar selector may also be divided up in such a way, that each vertical unit represents a line finder with 10 (single group principle) or 20 (double group principle) inlets. This possibility is employed in small switchboards.

Non-numerical setting is done by auxiliary relays.

2. Final Selector

What has been said about line finders applies also to the final selector, which with one inlet and 100 outlets may be said to be a reversal of the line finder. This, however, has numerical setting both of bars and vertical magnets. In some cases this proceeds directly according to the dial impulses, in other cases marking with auxiliary relay assembly is employed.

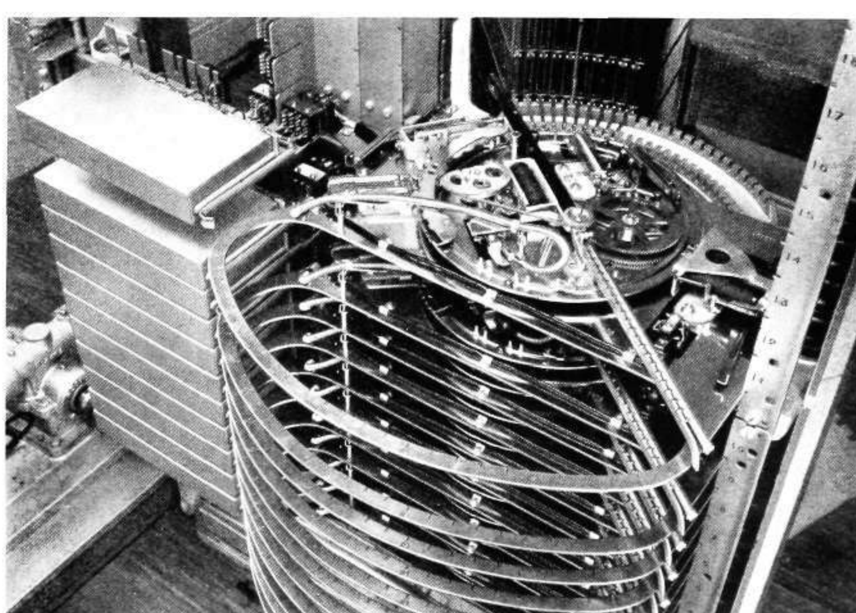


Fig. 17 X 6195

L M Ericsson's 500-point selector

used with great success both in Sweden and abroad. The selector itself is machine-driven but all auxiliary devices, such as setting devices, register finders, registers etc., now consist of relays or relay switches.

There are also some special types, *e. g.*, group final selectors.

3. Group Selectors

Group selectors usually have one inlet and 100—200 outlets, representing 10 decades with 10 to 20 lines in each. The decades are marked by the bars of the crossbar switch, each indicating a multiple spring assembly on each vertical unit. Thus on the single group principle each bar receives one line per vertical unit, on the double group principle two lines.

The bars (decades) are set numerically, while an unoccupied line is hunted for automatically by repeated attraction of the vertical magnets. One connection only can be made in each selector at a time.

In some cases special types are used as well.

4. Pre-Selectors, Secondary Selectors, Routing Selectors etc.

These selectors often have ten inlets and ten outlets. On the single group principle one outlet (or inlet) per bar is obtained, on the double group principle there may be two. The selector may also be divided up in any way desired.

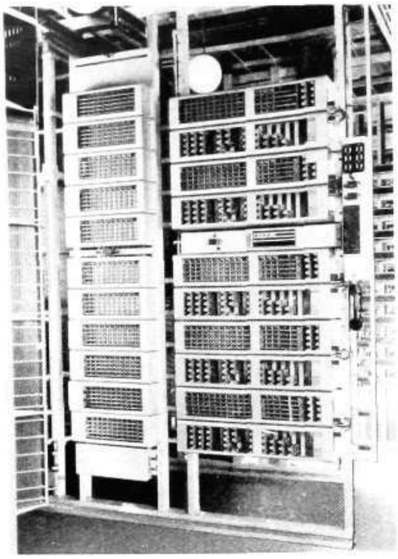


Fig. 18 X 4629

Bays with register and register finders with crossbar switches for 500-point selector system

C. As Storing Device in Registers [19, 20]

An important use of the crossbar switch is for registers, both in crossbar systems and in L M Ericsson's 500-point selector system. The switch is then employed for receiving and storing digits. This usually is done by the bars being set to the figure concerned, either by momentary setting (*e. g.* with keyset in the operator's registers) or by numerical setting according to the dial impulses. Each vertical magnet then corresponds to the position of the respective digit in the decimal system.

D. Special Ranges of Employment

The crossbar switch has also been employed for a number of special functions, *e. g.* in traffic counting devices, for certain purposes in teletype technique etc.

Summary

The American Reynolds was the first to patent a selector covering the fundamental principles on which the crossbar switch is based. This invention, however, met with little interest at the time and the crossbar switch might perhaps have fallen entirely into oblivion if Swedish engineers at an early stage had not, besides giving the selector a form that was considerably simpler and better compared with the Reynolds selector, also designed a system suited to the special features of the switch. Moreover, the Swedish Telegraph Administration showed interest at an early stage in the good qualities of the crossbar switch and the Administration's workshops were alone in the world in manufacturing crossbar systems right up to the thirties.

Mainly because of the increased demand for small switchboards for rural automatization, but also for other reasons, it was found advisable towards the end of the thirties to make crossbar switches of the Telegraph Administration Type 41 at Telefonaktiebolaget L M Ericsson's factories. The work was delayed to some extent by the outbreak of war, but in addition many new aspects had presented themselves in the manufacture of the switch Type 41, and these called for revised design. It was therefore decided that collaboration should be established between the Telegraph Administration and Telefonaktiebolaget L M Ericsson with the object of working out an entirely new type. This collaboration was started in 1943 between representatives of Telefonaktiebolaget L M Ericsson, the Telegraph Administration's Technical Division and the Telegraph Administration's workshops. The work was completed in 1945 and the result was the Model 1945 type of crossbar switch, now being manufactured both by Telefonaktiebolaget L M Ericsson and by the Telegraph Administration workshops. A description of this type of switch will be given in a separate article.

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The Crossbar Switch — Its Design and Manufacture

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U.D.C. 621.395.344

In 1938 Telefonaktiebolaget L M Ericsson began to manufacture for the Swedish Telegraph Administration rural automatic exchanges with crossbar switches, a type of selector which some years later was to be employed in registers for exchanges with 500-line selectors. The switches themselves were then made at the Swedish Telegraph Administration's workshops.

As experience with the Telegraph Administration's exchanges demonstrated the good operating qualities and great adaptability of the crossbar switch and as the Administration's demand for rural switchboards was constantly growing, Telefonaktiebolaget L M Ericsson decided to take up the manufacturing of the crossbar switch.

Before manufacture was put in hand, a critical examination of existing types of crossbar switches, was carried out in collaboration with the Telegraph Administration special attention being directed to experience of operation and manufacture. This led to the development of the type — model 1945 — now being manufactured.

The first exchange — a rural switchboard — with 1945 model switches was delivered to the Telegraph Administration in November 1946.

Developments in automatic telephone technique call for more and more rapid connecting devices, providing high reliability with long life and low maintenance cost. The predominant connecting devices in the building up of the automatic telephone systems are electromagnetic relays and selectors and, as it has been found in practice that a telephone relay is most reliable in every respect, the efficiency of the selectors will largely determine the qualities of telephone systems.

In designing the crossbar switch the aim has been to obtain apparatus having the good qualities of the telephone relay at a cost that is reasonably low for a selector.

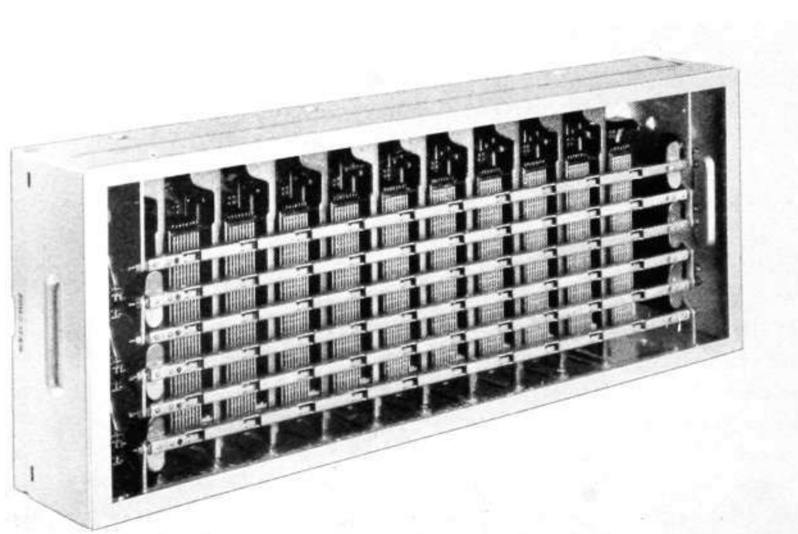


Fig. 1
Crossbar switch RVD 210
with case

X 8418

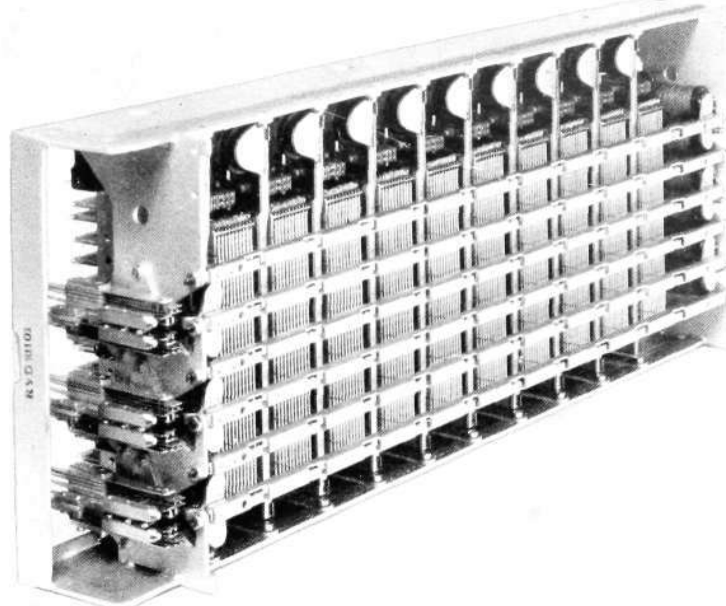


Fig. 2 X 6419
Crossbar switch RVD 210
with case removed

The crossbar switch as a whole may be said to be built up of a number of relays combined with common directing devices for controlling the relay contact sets.

By employing twin contacts of precious metal at each contact point, the best possible contact properties have been ensured. In addition the mechanical components of the switch have been made similar to a telephone relay in shape and operation so that wear will be small and maintenance costs low.

The Crossbar Switch Components

The crossbar switch, Fig. 1 and 2, consists of a welded frame on which is fitted a number of vertical units, 5 or 6 selecting bars with the magnets actuating them and off normal contact spring sets, actuated by the bars. The switch front is covered by a case provided with an observation window.

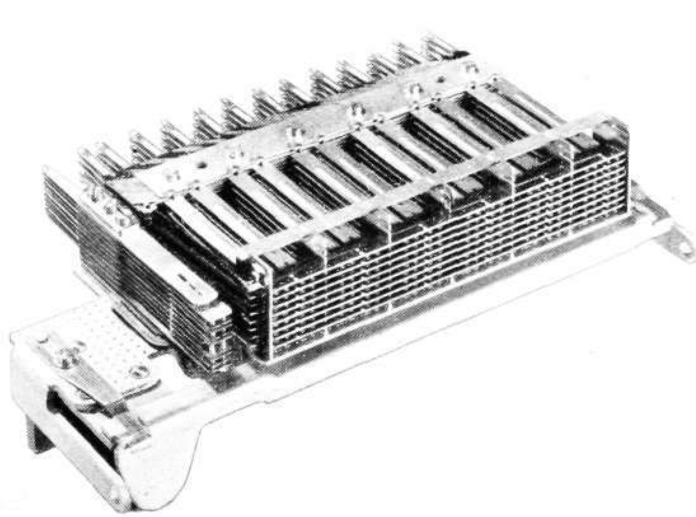


Fig. 3 X 6420
Vertical unit

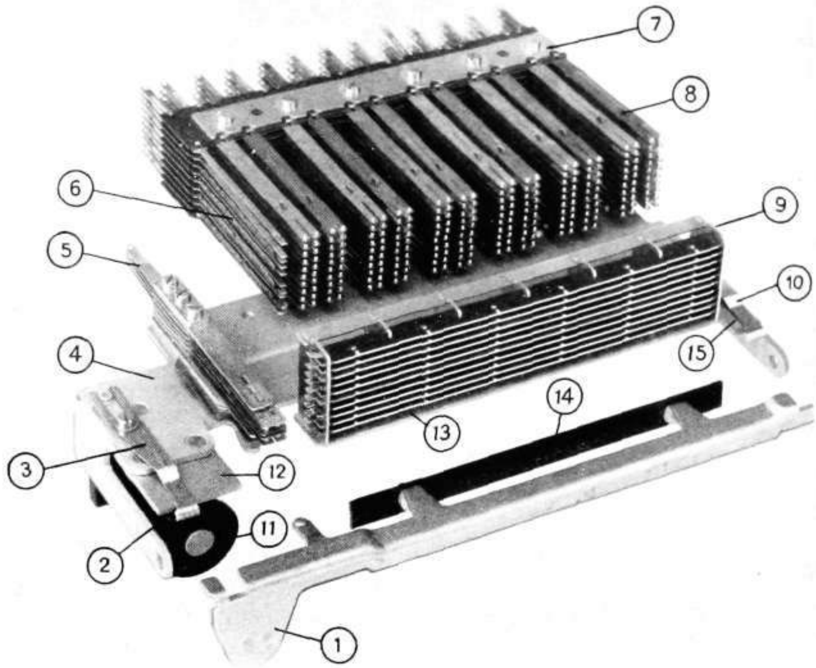


Fig. 4 X 6421

Components of vertical unit

1 armature
2, 15 knife-edge suspensions for armature
3, 10 lock springs
4 vertical unit base
5 off normal contact spring set
6 connecting spring for contact strip
7 contact spring multiple
8 operating comb
9 contact strip rack
11 magnet coil
12 yoke
13 contact strip
14 holding bar

The Vertical Unit

The main components of the vertical unit or the »vertical», see Fig. 3 and 4, are: base plate with magnet system, contact spring multiple, rack with contact strips and off normal contact spring set. The magnetic system shaped to resemble a telephone relay is fitted on the base plate *4* and consists of the yoke *12* and magnet coil *11* together with an armature *1*. The armature is pivoted by two knife edges *2*, *15* and is held in place by the lock springs *3*, *10*. The armature is provided with a bar *14*. When the armature moves the bar can actuate the multiple contact spring sets in conjunction with the selecting fingers of the horizontal bars.

The magnet coil bobbin, Fig. 6 left, is of moulded bakelite and has a recess for spark quench resistance.

The Contact Spring Multiple

The multiple, Fig. 4, consists of 10 or 12 multiple contact spring sets (according to whether the vertical is to be employed for switches with 5 or 6 selecting bars). Each multiple spring set comprises a number (1—10) mobile contact springs having twin contacts of silver. Contact springs in a set are mechanically joined up by an operating comb *8*, which causes the springs to move simultaneously when the set is actuated. The comb is controlled by the operating spring placed below the spring set and by the top spring in the set. In the front part of the operating spring, Fig. 5, which is U-shaped, the holding bar can move freely without affecting the spring sets. The multiple spring sets cannot be actuated by the movement of the vertical unit armature alone. Further information on this point will be found in the description of the selecting finger operation.

When the contact springs are actuated they make contact with the contact strips *13* running the length of the vertical. The number of strips corresponds to the number of contact springs in a multiple contact spring set. The contact strips which are fitted in a common strip rack *9*, are made of silver and attached to plates of insulating material. Each contact strip is soldered to a connecting spring *6*. At the side of the contact multiple there is a separate off normal contact spring set *5*, which is always actuated when the vertical armature is in operation. This spring set is detachable, so that any desired contact combination may be arranged, and it provides the contacts for the necessary common circuits of the vertical unit.

Fig. 5 X 4630

Operating spring

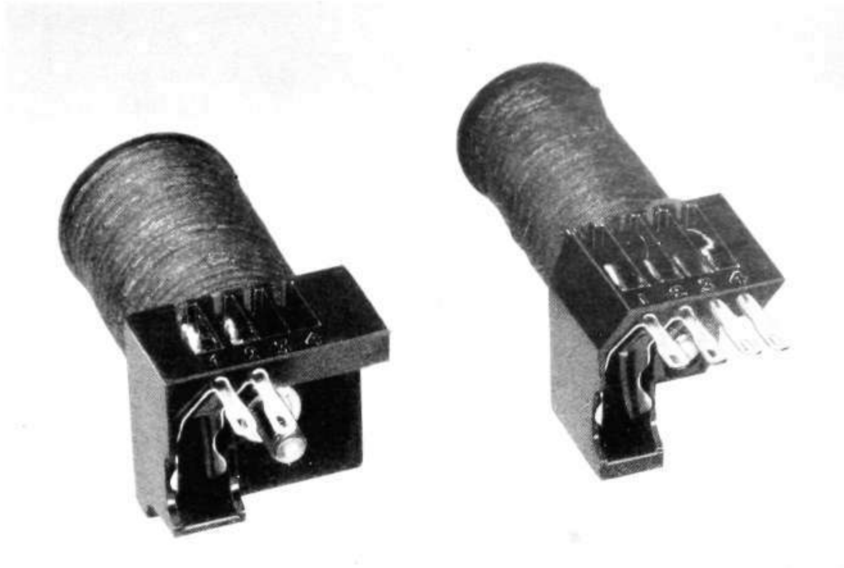


Fig. 6 X 6422

Magnet coils for vertical units and selecting bars

left, vertical unit magnet; right, selecting bar magnet

The vertical unit is fitted in the switch frame by inserting it in grooves on the frame and fixing it by two screws.

Selecting Bars and Associated Equipment

The selecting devices, see Fig. 7, consist of horizontal bars which are furnished with a double-sided armature and as many selecting fingers as the switch contains verticals. Each finger serves two adjacent multiple spring sets. The selecting fingers are made of flexible piano-wire and have the form of a straight wire with one end wound in a spiral. The spiral part constitutes a fixing device for the finger on the bar, besides making the finger flexible. Tongues have been made on the bars, each having a screw welded on. The tongues with screws constitute fixings for the selecting fingers, and the position of the fingers in relation to the multiple spring sets may be regulated by bending the tongues. The finger is attached by threading the spiral part around the screw on the tongue.

The selecting bars pivot with a pin bearing at each end. The bearings are fitted in the brackets of the switch frame. When the bar is fitted in the switch, one selecting finger for each vertical unit will lie in the space between the vertical holding bar and the U-shaped operating springs below the multiple spring sets, Fig. 5.

The double-sided bar armature which from its middle position (home position) can be attracted by one or the other of two electromagnets is provided with a pin, which actuates the bar off-normal spring set as the armature moves.

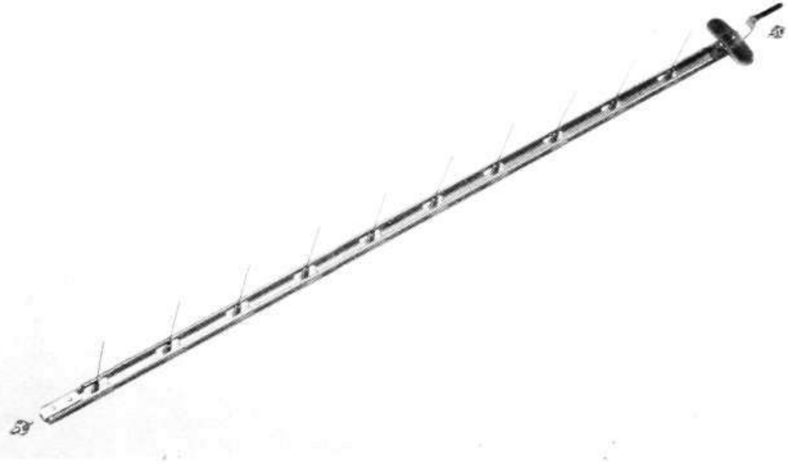


Fig. 7 X 6423

Selecting bar with pin bearings

At both ends pin bearings; from left to right: 10 selecting fingers, bar armature, actuating pin for off normal spring sets.

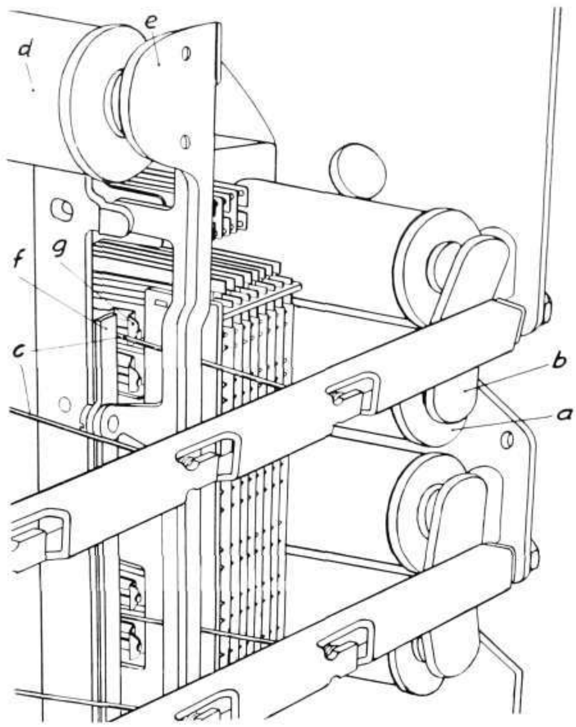


Fig. 8 X 6431

Skeleton drawing of vertical unit and selecting devices

a selecting bar (selecting) magnet
b selecting bar armature
c selecting finger
d vertical unit (holding) magnet
e vertical unit armature
holding bar
g operating spring

The set is detachable, so that various contact combinations can be arranged. In these spring sets, which are built together in pairs and fitted to the switch frame, there are also two centring springs whose purpose is to keep the bar in home position when it is not actuated. The selecting fingers will then be between the two corresponding multiple spring sets. The bar magnets are fitted in the switch frame. Like the vertical magnet bobbins, they are moulded of bakelite and provided with a recess for spark quench resistance, Fig. 6 right.

Crossbar Switch Operation

When current is closed through a selecting magnet *a*, the armature *b* attracts and turns the selecting bar belonging to the magnet, see Fig. 8.

The rotary movement of the bar is determined by the gap between armature and magnet core. When the bar rotates, its selecting finger *c* moves in under the multiple contact spring sets in the horizontal row corresponding to the bar's position. While the bar armature is still attracted, the circuit to a holding magnet *d* is closed. When the vertical armature *e* is attracted, the holding bar *f* moves and lifts all the selecting fingers of the vertical towards the operating springs *g* of the multiple spring sets. Only the set where the U-shaped part of the operating spring is bridged by a selecting finger is raised. The other fingers will move freely in the space between their corresponding multiple spring sets. The springs of the multiple spring set actuated are raised to the contact strips and make contact with them.

The selecting finger that is engaged is gripped between the holding bar and the operating spring and therefore the circuit to the selecting magnet can be broken. When the bar armature releases, the selecting bar returns (with the aid of the centring spring) to the home position with all the fingers not engaged. The bar is then in a position to rotate once more in the same or the opposite direction, so that the unoccupied selecting fingers can be engaged for multiple spring sets on other disengaged vertical units in the switch.

When the armature of a vertical unit is energized a subsequent rotation of the selecting bars cannot cause other selecting fingers to be engaged with this vertical unit. The movements of selecting fingers in the space between the multiple spring sets are then stopped by the sides of the U-shaped operating springs.

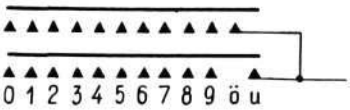


Fig. 9 X 4330

Vertical unit for 20 lines for 6-bar switch

If the circuit is again closed to the same or another selecting bar magnet, the other vertical units of the switch may be connected in one after the other. This means that all vertical units in one and the same switch may be in operation simultaneously.

When the circuit to the magnet is broken, the vertical armature falls, whereupon the holding bar moves away from the operating spring and the grip on the selecting finger is released. The finger has spring action and returns to its home position between the multiple spring sets.

In the type of crossbar switch having 6 selecting bars, each vertical unit has 12 multiple contact spring sets and two selecting bars are operating simultaneously. The contact spring sets are doubled, enabling 2×10 lines to be connected to each vertical unit. One selecting bar of the five ordinary ones selects the pair of lines which includes the line to be connected. The sixth bar selects the right or left hand portion (the upper or the lower portion as per Fig. 9) of the contact spring sets. In this way the wanted line of the selected pair is connected. Thus the sixth bar selects the proper group of ten within the vertical unit which is in this case working as a 20-point selector, Fig. 9.

Manufacture

As regards manufacture the crossbar switch is characterized by the large number of components of the same form comprised in it, these components being possible to produce by pressing tools with a few exceptions.

The switch frame, Fig. 10, which must be extremely stable, is welded. The selecting magnets and bars as well as the bar off normal spring sets are fitted on the end brackets of the frame. The selecting bars are carried on spindle bearings attached to tongues in the brackets and are therefore light in movement. The bar and its armature may be adjusted in relation to the pole ends of the magnets by bending the tongues.

The vertical unit base, Fig. 11, to which the magnet yoke is rivetted, is made of iron and as this frame has to carry the contact spring multiple the contact strip rack etc. it is most important that it should be flat.

The magnet yoke, furnished with holes for attaching the magnet coil, is made of special relay iron.

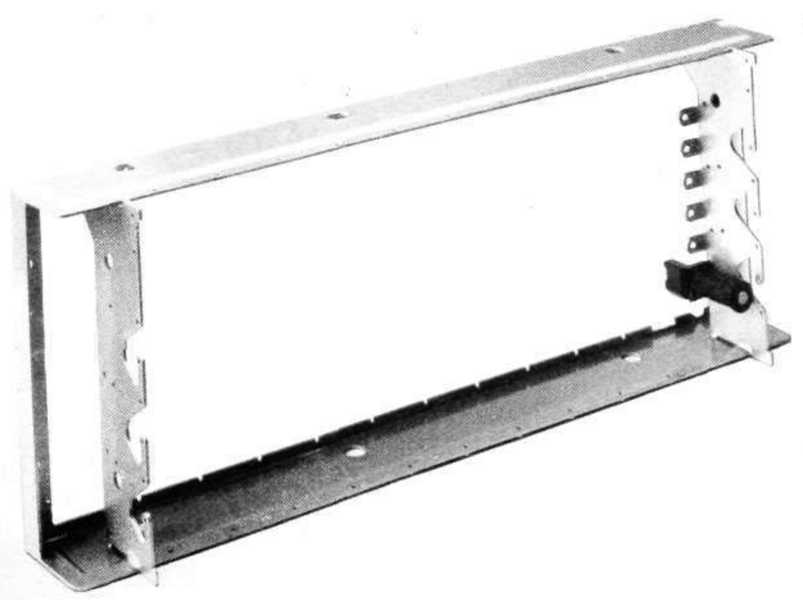


Fig. 10 X 6426

The crossbar switch frame with selecting bar magnet fitted

Fig. 11 X 4641
Vertical unit base with magnet system

The vertical armature, attached at one end to the vertical base and at the other to the magnet yoke, is furnished with an adjustable holding bar. The upper surface of this bar is polished to ensure as little friction as possible when the selecting finger slides against it. The knife edges for suspension of the vertical armature are made with particular care.

The Contact Spring Multiple

Each vertical unit contains a number of contact spring layers, determined by the number of springs required in the multiple contact spring sets. Such a contact spring layer is composed of ten or twelve contact springs assembled on a strip of insulating material. Owing to the large quantities of spring layers required, special manufacturing methods have been developed for this part.

Essentially these methods mean that the principal manufacturing operations (piercing, blanking, embossing etc. as well as contact rivetting and mounting on insulating strips) are being applied to the complete spring layer blank before the individual springs are cut apart.

Beyond the multiple contact springs a connecting spring is attached to the insulation strip securing the connection with the contact strip that corresponds to the spring layer.

As stated it is of the utmost importance that the contacts are of good quality. The aim is to achieve good mechanical rigidity and good contact properties, including freedom from crackle. The multiple spring contacts, which are made of silver alloy wire, are formed and rivetted direct on the springs. Various treatments give the contacts an extremely fine hard surface. The manufacture of the contacts and their rivetting on the springs is done in automatic machines.

The finished contact spring layer is carefully straightened and adjusted, to ensure that any further adjustment in the multiple field containing it is but slight.

The contact spring layers are fitted direct on the vertical base, Fig. 13. Just beneath the base the operating spring is fitted and then the required number of contact spring layers, the whole being then screwed together. After that the operating combs are inserted. These are held firmly by guide holes in the operating spring and in the top contact spring layer.

The contact strip rack is in the shape of a frame, in which a number of spacing pieces with open slots are fixed. The ends of the frame are also provided with slots, these being closed. The contact strips are fitted by inserting them in the slots of the spacing pieces and of the ends and fixing them logitudinally by a pin passing through all the contact strips and one of the spacing pieces, Fig. 14. The pin is secured by bending a lug on the spacing piece over its end. For soldering the contact strip to the connection spring in the contact spring layer, the silver strip is shaped with a flap, Fig. 14. This goes through the one end of the rack and is soldered to the connecting spring on the outside of the rack.

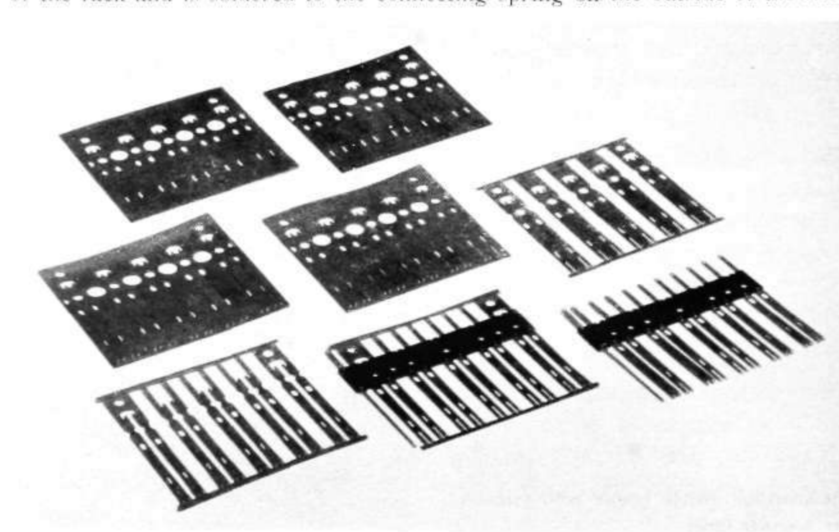


Fig. 12 X 6425
The various operations in the making of the contact spring layers

Fig. 13 X 4632

Mounting contact spring layers on vertical unit base

Test of the Vertical Unit

When the vertical units are assembled complete, they are tested in automatic testing devices. These are so constructed that the test automatically stops if the unit operates incorrectly or if some incorrect adjustment value is obtained, and the test cannot proceed until the faults have been remedied. The tests to which the units are submitted include check of contact pressure and contact distance, check of the magnet operating current and limits for operating and holding current. Finally a high-voltage test is performed between earth, magnet coil and contacts.

Crossbar Switch Assembly

After mounting the vertical units and selecting bars in the switch frame, the bar (off normal) spring sets are fitted and adjusted. The travel of the selecting bar armatures is adjusted by bending the bar bearing arms of the switch frame. The correct position of the selecting fingers in relation to the associated operating springs is achieved by bending the mild steel lips formed in the bars.

The complete switch is examined and tested in a manner similar to the vertical units.

Types of Crossbar Switches

The L M Ericsson crossbar switch is manufactured for working voltages of 24, 36, 48 and 60 V, the following types being included in the L M Ericsson standard range. Within the types mentioned it is possible to vary the number of vertical units fitted in the different types as also the number of contact strips in the vertical units.

type	number of vertical units	number of selecting bars	max. number of contact strips	dimensions in mm			app. weight kg
				width	height	depth	
RVD 100—109	10	5	10 vertical units with 10 strips	583	190	136	12.5
RVD 110—119	10	5	2 » » » 10 » 8 » » » 8 »	535	190	136	12
RVD 130—139	5	5	2 » » » 10 » 3 » » » 8 »	345	190	136	7.5
RVD 210—219	10	6	10 » » » 10 »	583	220	136	13.5

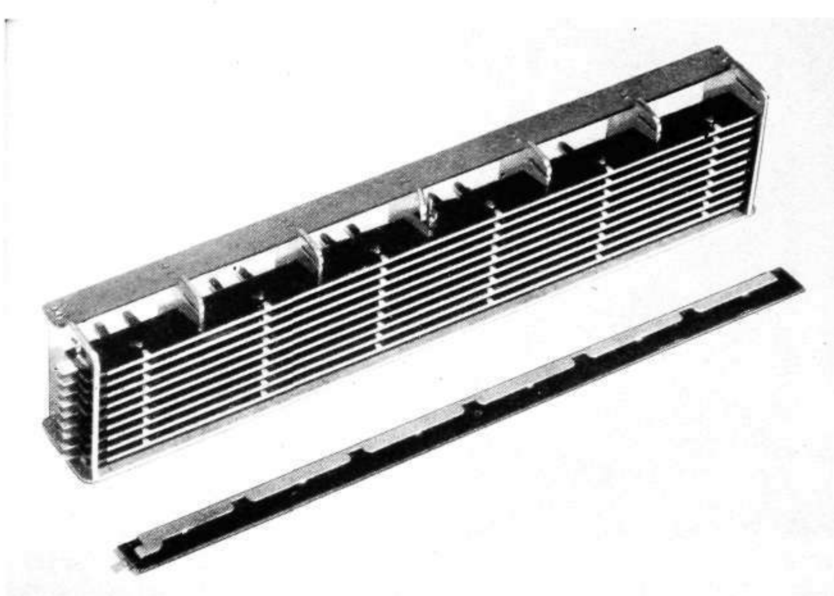


Fig. 14 X 6425

Rack with contact strips

left, lug for soldering the connecting spring; middle, pin for fixing contact strips

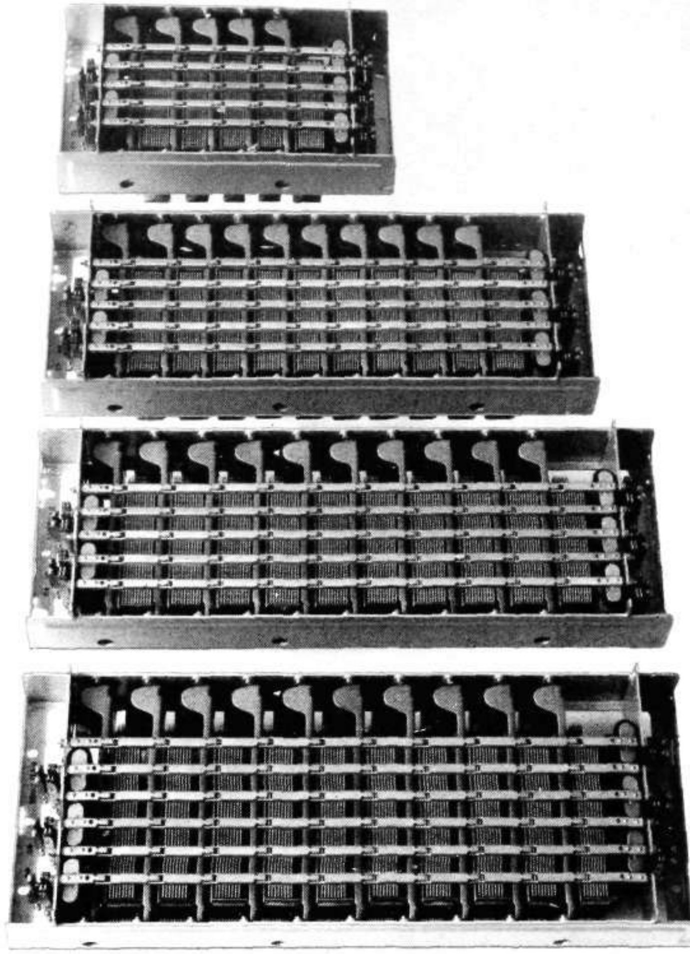


Fig. 15 X 6429

Various types of crossbar switches

from top downwards: RVD 130—139, RVD 110—119, RVD 100—109, RVD 210—219

In the manufacture of equipment with crossbar switches the aim has been as far as possible to keep the production flowing, *i. e.*, the manufacture of parts (except the heavier ones) and the assembly of the crossbar switches, the fitting of these in racks and the wiring and test are executed on the same premises, thus avoiding bulky storage of crossbar switches.

Fig. 16 X 4633

Crossbar switch bays

The crossbar switches are fitted in separate bays, Fig. 16, or in frames along with telephone relays, Fig. 17, which are then inserted in racks and connected by plugs and jacks. After test, carried out with automatic devices, the completed bays are despatched to destination. With the bays sent out ready wired, the work of fitting on the spot is very small.

As will have been seen from the description, the crossbar switch is made up of a number of components, all without exception being simple and uncomplicated. Consequently they can be produced by comparatively cheap manufacturing methods.

The crossbar switch, working as it does on the relay principle and therefore being without the components characteristic of the machine-driven or step-by-step driven switches, such as gears and ratchet wheels, feed and stop pawls, racks etc. involves less trouble for assembly and final adjustment than selectors working on mechanical principles.

A telephone exchange constructed with crossbar switches on conventional lines, *i. e.*, with the switches working on the step-by-step principle, will be

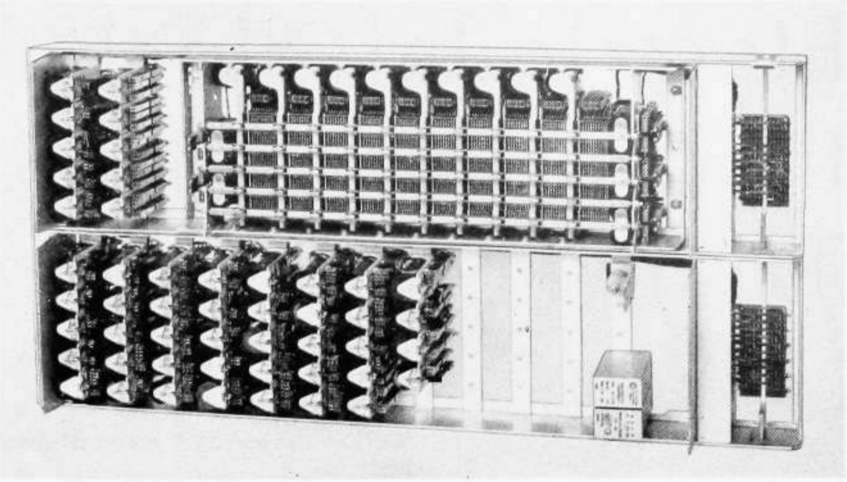


Fig. 17 X 6433
Relay set with crossbar switch

fairly expensive in first cost. By separating the switch into its units, *i. e.,* by employing the vertical units as independent selectors and grouping them on the principle of the link system with primary and secondary selectors, the possibility has been established of making exchanges with crossbar switches at moderate cost. This grouping method considerably diminishes the number of switches required, in some cases to less than half of those required in a step-by-step driven system. The selectors in the above-named link system are controlled by markers, enabling the speed of the crossbar switch to be converted into a quicker connecting process, which is particularly valuable in key-set operated systems. Moreover, considerable advantages are gained from a circuit point of view. The thoroughly good properties of the crossbar switch make exchanges constructed with these switches cheap to run, since they require relatively few maintenance personnel.

Electric Interlocking Plant at the Car Depot of the Stockholm Tramways at Brännkyrka

I BOBERG, STOCKHOLM TRAMWAYS, STOCKHOLM

U.D.C. 656.257:656.4(487.1)

On 15th October, 1945, the Stockholm Tramways opened a new car depot, the Brännkyrka Depot, situated on and south of Hägersten Road between Södertälje Road and Tellusborg Road. It is designed as depot for tramcars on the three south-west surburban lines, as well as for the tramcars and buses serving the city.

When running into and out of the Brännkyrka Depot the Tramway Company's vehicles must cross the fairly busy Hägersten Road and, as it was estimated that traffic at certain times of the day to and from the car depot would be very heavy, it was considered that an interlocking plant at the approaches to the depot would be economically justified. In fact, the only alternative to such a plant was to employ a number of signalmen to operate the points and to hold up the street traffic when necessary.

The build up and operation of the new interlocking plant is described in this article.

As early as 1944 the Tramway Company began in consultation with L M Ericssons Signalaktiebolag to plan an interlocking plant for the approaches to Brännkyrka Depot. However, as the first large interlocking plant of the Tramways Company — at the car depot in Alvik — was about to be put into use experience with the operation of that plant was first awaited. Meanwhile the conditions for the plant at Brännkyrka Depot were partly changed, owing to the track and point positions being altered and to the fact that a larger number of city cars of the most modern type (called »mustangs») began to be housed in the Brännkyrka Depot instead of the buses it had been intended to place there. The tram traffic to and from the depot, already before very heavy, was thus considerably augmented.

The programme for the plant was complete in principle by the beginning of 1947, when the material was purchased from Signalbolaget. The work of installation was executed during 1947 and the beginning of 1948, and the plant was put into operation on 19th April 1948.

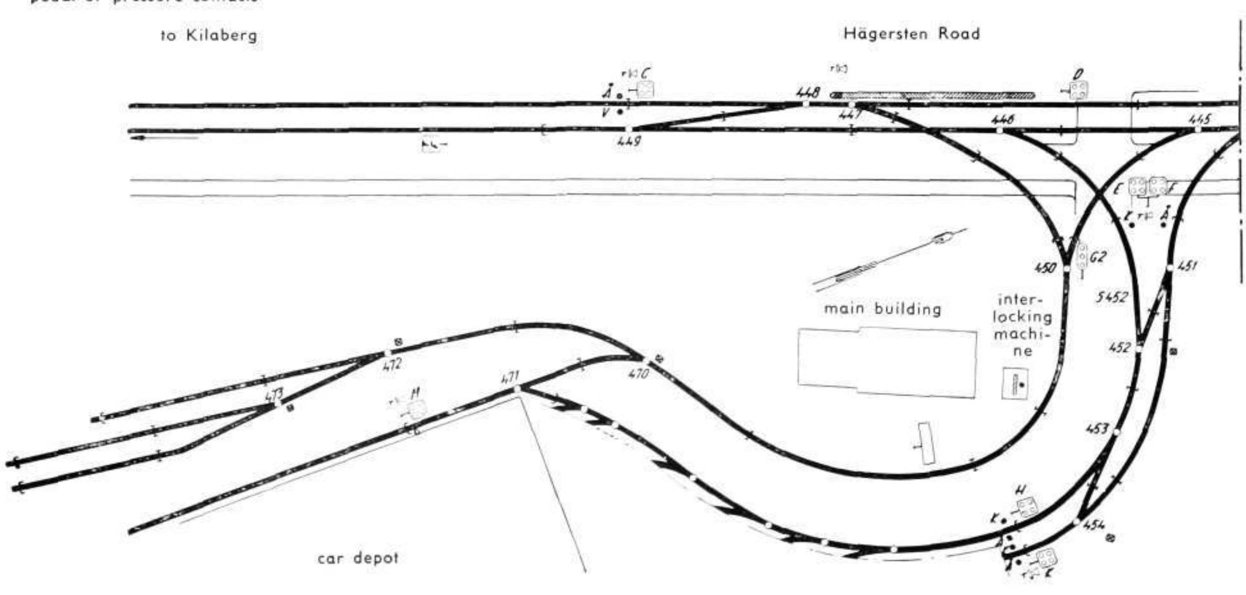


Fig. 1 X 7520 X 7521

Plan of the interlocking plant at Brännkyrka depot

- ⊠ local switches
- T telephone
- • pedal or pressure contacts

Description of the Plant

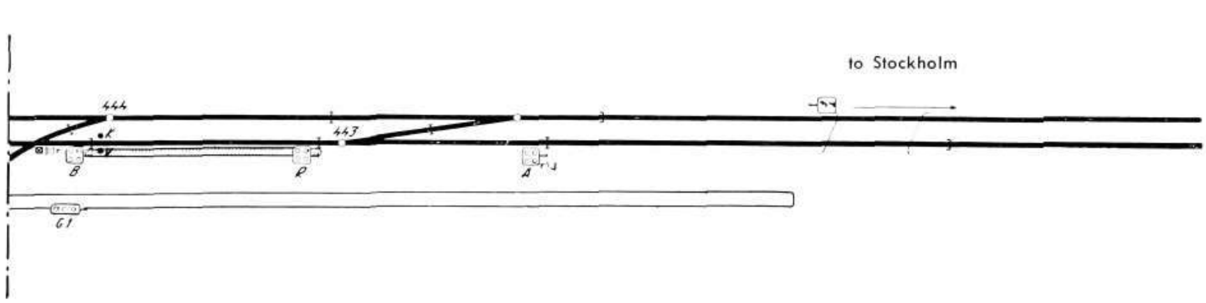
Signals and Points

Fig. 1 shows a lay-out plan of the interlocking plant. It comprises 22 AC track circuits of conventional type, 2 street signals with red, yellow and green lights and 10 position light signals with four white lights. In addition there are 10 motor-driven points, impulses for which can be given either from the interlocking machine or from local switches (7 in number) at the various points or groups of points. Finally, there are 11 pedal contacts, operated with point iron by drivers when they wish to communicate with the interlocking machine attendant or themselves operate points or signals.

A tramset from Stockholm, after passing signals *A* and *R*, Fig. 2, which normally operate automatically but which may also be operated from the interlocking machine, comes to signal *B* and two pedal contacts by which the route can be selected. When the driver presses down one of the pedal contacts, impulse is transmitted either direct to the point lying immediately after signal *B* and to signal *B* or to the interlocking machine, in which case the interlocking attendant carries out the necessary operation. Permission for direct operation is given by a switch from the interlocking machine for the considerable parts of the day when traffic is such that most of tramsets proceed to the suburbs. To keep down as much as possible the work of the drivers and thus the loss of time at the stops, the signal *B* works automatically in such a way that when cars enter the track circuit preceding the signal this switches to clear for straight ahead track, naturally providing that no other tram movement is in the way. Any trams for the car depot, however, may at these times of the day operate point *445* and signal *B* by the pedal contact. After such a tram has entered the car depot area, point *445* is switched back automatically to straight ahead track.

The above relating to point *445* and signal *B* also applies to point *447* and signal *C* for trams from the suburbs. The signal *D* coming next, which is automatic but can also be operated from the interlocking machine, is employed to prevent trams for Stockholm at the stop from continuing when another tram is leaving the car depot on its way to Stockholm.

Tramsets when leaving Brännkyrka Depot are fully equipped as regards both material and crew before they come to either of the signals *H* or *K*. At these signals the required pedal contact is pressed, giving impulse either to the interlocking machine where the attendant performs the necessary operations



or direct to points and signals. When cars reach either of the signals *E* or *F*, Fig. 3, impulse may be given with the pedal contact there, on which the signals are operated either direct or via the interlocking machine. Authority for direct operation is required to be given from the interlocking machine. At times when many cars are leaving the car depot the tramdrivers do not need to transmit impulse at the signals *E* and *F*, as the interlocking machine

Fig. 2 X 6400

Tramset on its way to the suburbs

The set has just passed signal A and is opposite signal R.

attendant sets the signals to clear when the trams have passed either of the signals *H* or *K*.

Signal *G 1*, which alternates from green to red and vice versa over a 3 sec. yellow light, does not normally need to be operated separately as it changes automatically on operation of any of the signals concerned with tracks crossing Hägersten Road. The street signal *G 2* has not been employed up to now but has been normally kept unlit, for the reason that no street traffic proceeds to and from the car depot. The housing of buses at the car depot has not been carried out as planned.

Signal *M* and various points in the area are not of essential interest in the present connection and will therefore not be dealt with.

The Interlocking Machine

The interlocking machine building, the location of which may be seen on Fig. 1, is combined with space for the caretaker and is built on three floors. The basement is used as relay room, the ground floor comprises the caretaker's lodge and the top floor is the operating room. The interlocking machine is a relay machine with press button operation. All the plant's relays are placed in the interlocking machine relay room, Fig. 4 and 5, and four 60-wire EDBL cables connect the relay room with the operating room.

In the operating room, Fig. 6, the interlocking machine is placed on a desk, on one shelf of which the fuses for the point engines are installed. The interlocking machine is built up of vertical panels of standard dimensions, which can easily be exchanged in case of alteration. The interlocking machine attendant can follow the movements of the tramsets and see the positions of points and signals on an illuminated track diagram, Fig. 7, behind the interlocking machine. The track diagram has been placed on the wall between the operating room and a small rest room for the interlocking machine staff. In this way more or less dead space behind the track diagram has been avoided. The diagram has also been made so that it can be opened from the back, Fig. 8, i. e. in the rest room, and thus attention to it can be given without disturbing the work of the interlocking machine attendant.

Fig. 3 X 4624

The driver transmits impulse to the interlocking machine by means of the pedal contact

For each signal there are 3 control buttons on the interlocking machine, one for setting to clear, one for setting to danger and a sealed button for emergency opening of the route. For each point or group of points there are 2 control buttons for switching to plus or minus position. In addition there are switches by which switching over of the points by the devices for local switching placed

Fig. 4 X 6404

Interior of the relay room

Most of the relays are set up on wooden shelves.

alongside the various points or groups of points in the depot area can be made possible. There are separate switches for switching to direct operation from pedal contacts.

Indication on the track diagram of the tramset movements is done by one indication lamp for each track circuit. The track circuit lamp shines when the corresponding track circuit is free from tramsets and is out when the track circuit is occupied by a tramset. For point indication there are three lamps per set of points. One of the lamps is placed on the point tongue and shines when operation is handled from the interlocking machine and is extinguished when authority has been given for local operation in the car depot area. The other lamps indicate the position of the points. The signals as formed on the track diagram show corresponding signal pictures on the depot area. When one of the pedal contacts is actuated this is indicated on the track diagram by a light in the corresponding lamp, provided authority has not been given for direct operation of the corresponding signal and points. The lighting of the pedal contact lamp on the track diagram is accompanied by a buzzer signal to draw the attendant's attention to the fact. Finally the track diagram includes various instruments for measurement of current and voltage.

The interlocking machine attendant can easily reach from his place at the operating desk all the press buttons of the interlocking machine as well as a 20-line telephone switchboard, placed in the immediate vicinity of the operating apparatus. By means of the telephone switchboard the attendant can come into direct communication with most of the signals in the plant and also with the private branch exchange of the Brännkyrka depot.

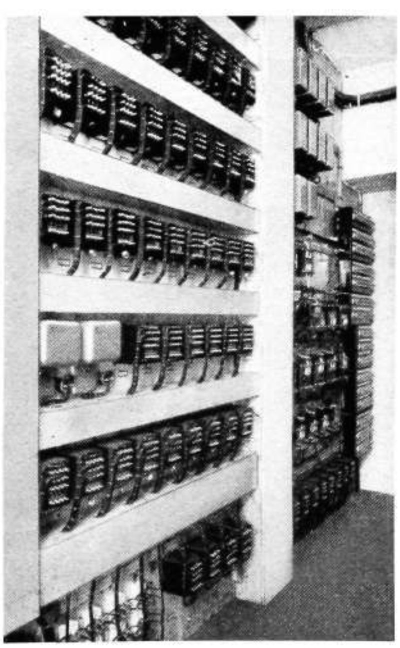


Fig. 5 X 4625

Interior of the relay room

where JRG relays, transformers and fuses are mounted on a wall

Special Problems

It may be considered that this signal plant is unnecessarily complicated. It may therefore be advisable to refer to the special problems which were and are associated with same.

Something will first be said about the tramway traffic to and from the car depot. It is characterized by great lack of uniformity. About 0430 o'clock cars begin to leave the car depot, and this keeps on for a little under two hours. In the next two or three hours there is generally no traffic to or from the depot. Later in the forenoon certain of the extra cars return to the depot and these leave again for the second time in the afternoon, to return after a further couple of hours. Around midnight the ordinary trams begin to run into the car depot and all cars are in about 0100 o'clock. Thus as regards traffic to and from the car depot one may speak of 4 traffic peaks, of which the first and the last are incomparably the greatest. To give the reader an idea of the traffic density during the two heaviest traffic peaks, I shall cite a few examples from the time-table. Between 0503 and 0510 the time-table reads as follows:

0503 from car depot to Stockholm	0508 » » » » »
0504 » » » » »	0509 » » » » »
0506 » » » » »	0509 » » » » Kilaberg
0506 » » » » Kilaberg	0510 » » » » »
0508 » » » » Stockholm	0510 » » » » Stockholm

that is, 10 tramsets in 7 minutes. Altogether 52 tramsets drive out in the hour between 0500 and 0600. During this hour the capacity of the interlocking plant is utilized almost to 100 %. Unfortunately, all tramsets that are to drive to Stockholm (»mustangs») come from the track at signal *H*, whereas most of the sets driving towards Kilaberg come to signal *K*. This crossing over, unfortunately necessary because of arrangements in the servicing hall, lying to the west of the marshalling hall, Fig. 1, is unsatisfactory from the signal point of view, as the capacity of the interlocking machine is decreased thereby.
At the other great traffic peak, concentrated entirely to the hour between 0000 and 0100 a total of 37 tramsets drive into the car depot and the extract below from the time-table gives an idea of the heaviest density. All tramsets come from Stockholm.

time 0025	0030	0033	0039
0026	0031	0035	0041
0028	0033	0037	0041
0029	0033	0037	0045

According to the above, therefore, 16 tramsets drive into the car depot in a period of 20 minutes. It should be noted that in respect of driving in times the time-table is misleading as demonstrating the traffic density, for traffic blocks in this period can easily be formed, so that a considerable number of cars approach the car depot at practically the same time.

During the two great traffic peaks to and from the car depot great demands are imposed on the interlocking machine attendant. Certainly a well-trained attendant can very well manage to operate the signals and points if he continuously prepares himself in the interval between the starting of the different tramsets for the next operation, but there is no appreciable interval.

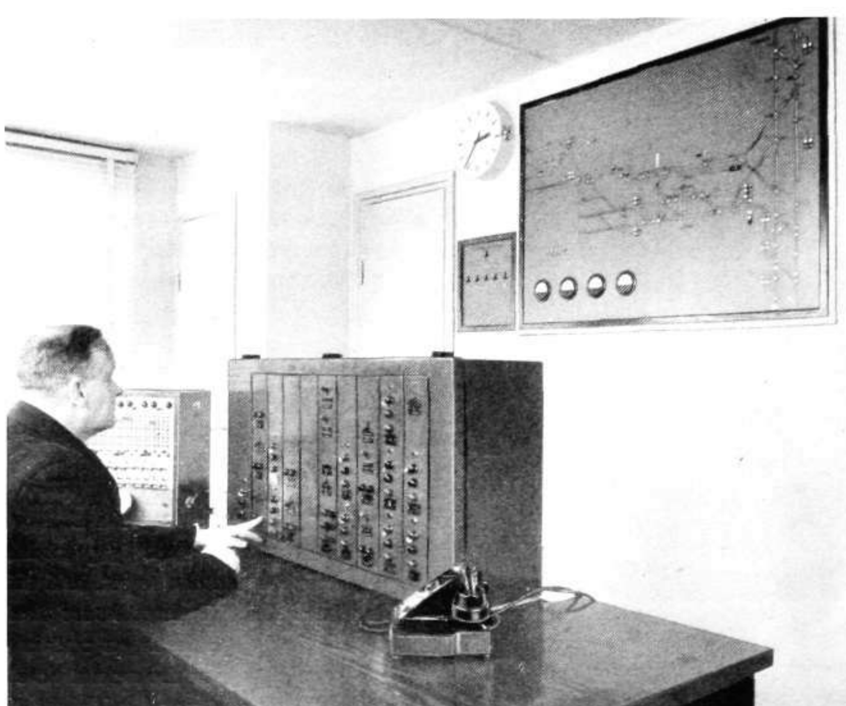


Fig. 6 X 6404

Interior of operating room

left to right: telephone switchboard, control panel for connecting and disconnecting of heating arrangements in the electrically operated points, illuminated track diagram

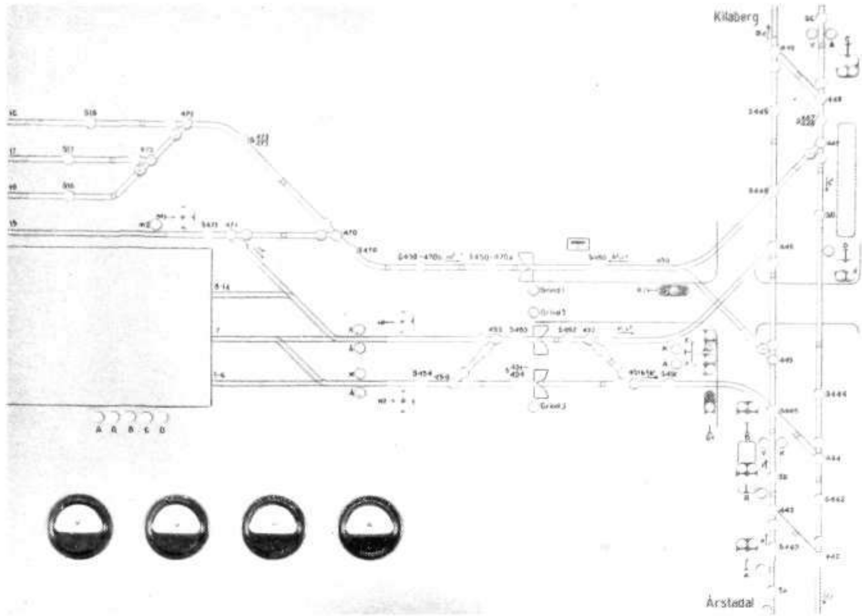


Fig. 7 X 6402

On the illuminated track diagram the routes of the tramsets can be followed and the positions of the points can be seen

At the other times of the day, including the two smaller traffic peaks, the traffic to and from the depot is so small that it is not considered justified economically to have an attendant for the interlocking machine. It was for this reason that arrangements were made to enable the tramdrivers themselves when driving to and from the car depot to operate the signals and points they had to pass. Moreover at these times of the day it is no special inconvenience that the drivers must themselves carry out the operations.

The number and placement of the signals naturally had to be fixed according to the maximum traffic.

In their passage of Hägersten Road with its fairly heavy traffic the drivers must drive very cautiously despite the signal regulating. A street signal does not of course prevent motorcars or other vehicles from going past it and even if the street signals were always obeyed there is the possibility that a vehicle may stop on the tram tracks after having passed the signal. In such cases the Tramway Company always employs position light signals which can display unconditional stop and also permission to proceed. No real clear signal is given, as of course it is never possible to guarantee that the track is free from vehicles. In those parts of depot approaches not affected by the street traffic it is usual to employ coloured light signals. In the signal plant at the Brännkyrka Depot coloured lights should naturally have been employed in the signals *A* and *R*, but it has been considered undesirable to do this, out of consideration for the street traffic which when proceeding along Hägersten Road parallel with the tram tracks might mistake the significance of coloured light signals intended for trams. The circumstance that a more restrictive clear signal than necessary is used, does not involve any diminution of safety.

On close examination of the lay-out of the interlocking plant, Fig. 1, it will be seen that in principle there are no track circuits in the crossing of the track over Hägersten Road. Efforts have been made to avoid track circuits in the street because grooved rails are used there. It is usual to join two grooved rails in a track by track holders at intervals of about 2 metres. Naturally the track holders must be insulated if there are track circuits in the street and the Tramways Company has found by experience that the track holders constitute a troublesome source of fault. Another trouble with grooved rails is that the groove easily gets filled with gravel and sand, causing the risk that a single traction car which is raised and runs on the wheel flanges does not shunt the track circuit. The sand comes not only from sand knocked into the groove by automobiles but also from sand used by the tramdrivers when braking. Unfortun-

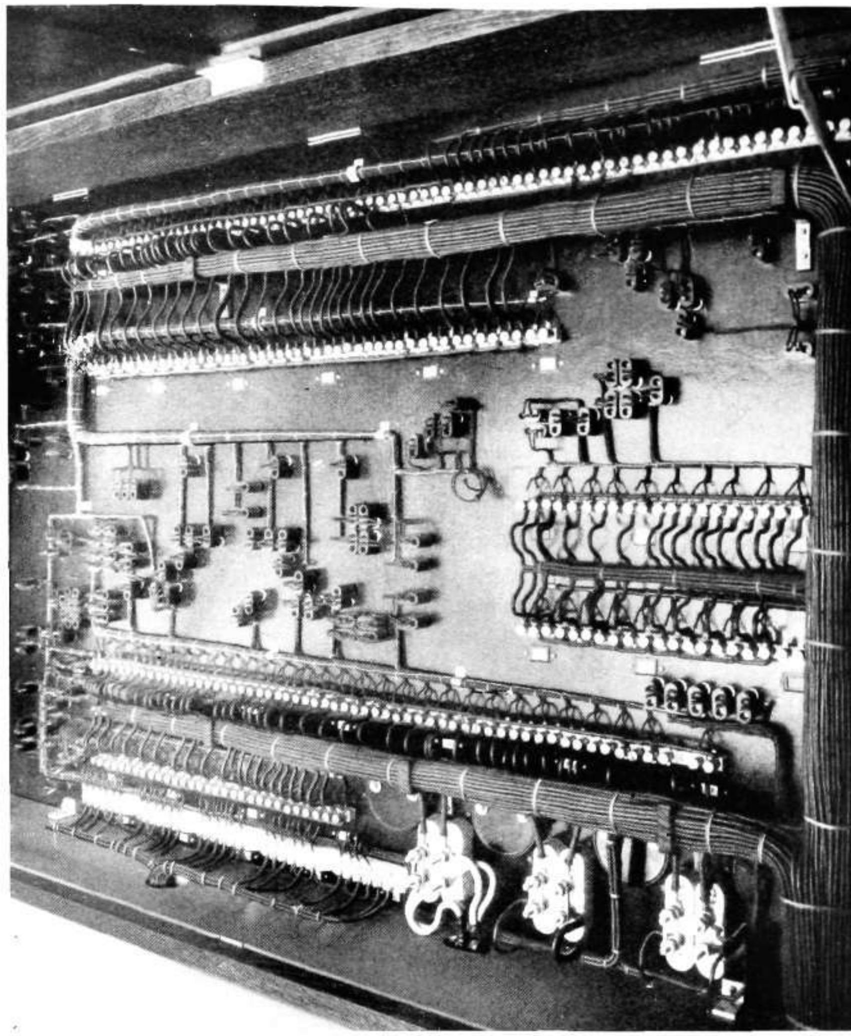


Fig. 8 X 6401

The rear of the track diagram is easily accessible

ately it has not been possible to avoid some of the track circuits lying partly in streets and trouble has not been absent. The greatest trouble has been that the routes *e* and *f* (from the car depot to Kilaberg and Stockholm respectively) on some occasions have not been released, so that the street signals did not return to clear light. It would seem therefore necessary to replace the grooved rails by Vignoles rails and to have four rails per track laid on sleepers, so that two of them may be used as support rails. This method has already begun to be used in the Tramway Company's system at other street crossings where there must be track circuits and the results have been satisfactory.

Other Equipment in the Interlocking Plant

The conclusion has been reached in the Tramways Company that the value of an interlocking plant is considerably lessened in heavy snowfalls, if the electrically operated points are not provided with heating arrangements. Consequently all the 10 electric points in the Brännkyrka area have been fitted with electrical heating arrangements. Connection and disconnection of the heating is done in the interlocking machine operating room.

As stated in the introduction the interlocking plant has been adopted chiefly as a means to ensure the safety of tram movements between the tracks for traffic and the area of the depot, which without the plant could only have been ensured with the aid of signalmen posted in the area.

The experience gained so far in operation shows that by means of the plant described the traffic can be handled rapidly and safely. In addition there is the saving in staff that has been made owing to replacement of the above-mentioned signalmen by a single interlocking machine attendant.

An Indicator for Checking the Insulation of Telephone Cables

G HAMMARLUND, ROYAL BOARDS OF TELEGRAPHS, STOCKHOLM

U.D.C. 621.317.333.4:621.315.2

Efficient cable maintenance demands a speedy and reliable warning method for indicating possible insulation faults.

A direct check of the cable insulation resistance to earth is considered to be the most suitable arrangement as well as being the most economical.

In order to obtain early warning of low or faulty insulation, it is necessary to have an accurate indication of relatively high resistance values *e.g.* 10 megohms.

The following article describes an indicator that fully meets such requirements as well as being unaffected by disturbances likely to cause a false alarm.

The circuit arrangement of the insulation indicator unit is shown in Fig. 1. A number of quads, preferably the whole outer layer this being the first to be affected by a fault, is connected to the indicator input.

The cable, when connected, is charged by the 24 V battery V_F and the separate 100 V supply V_H, the positive V_F being earthed.

Under normal conditions the grid of the valve E is biased to approx. — 20 V, the anode current being practically cut-off.

As soon as there is a change of insulation resistance the voltage distribution in the grid circuit of the valve changes, the bias voltage varying according to the expression

$$V_g = r_1 \cdot \frac{V_F + V_H}{r_a + r_1} - V_F$$

From this it is clear that the bias voltage passes through zero for an insulation resistance

$$r_{a0} = r_1 \cdot \frac{V_H}{V_F}$$

which is the highest value for which the indicator unit gives warning.

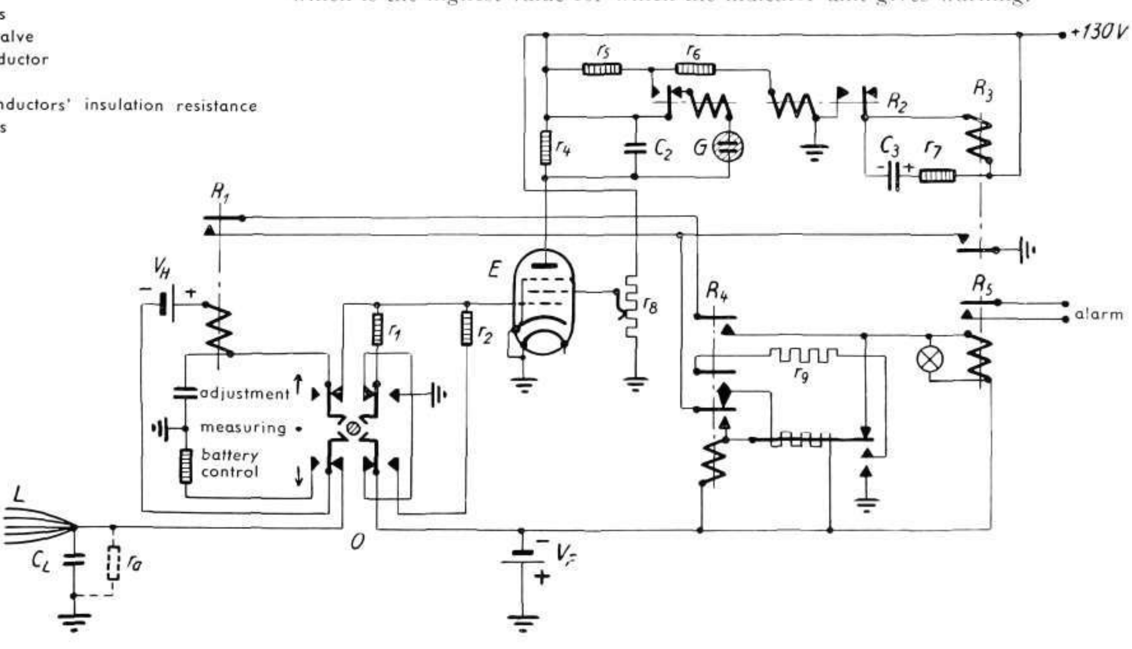


Fig. 1 X 7526

Circuit diagram for insulation indicator

C_L cable conductors' capacitance to earth
C_1—C_3 condensers
E electron valve
L cable conductor
O switch
r_a cable conductors' insulation resistance
r_1—r_9 resistances
R_1—R_5 relays

The anode current of the valve E is adjusted by the screen grid bias so that with zero grid volts, the voltage drop across the anode resistance r_4 is equal to the striking voltage of the neon or gas discharge valve G. As soon as this value of voltage is reached, the lamp G ignites and passes currents which discharges the condenser C_2 and causes the polarized relay R_2 to momentarily break the circuit through the lamp. C_2 is again charged to the striking voltage and the cycle is repeated at approx. 1 c/s for this value of voltage.

The relay R_3 is slow in releasing and connects and actuates in turn the heat relay R_4 and the alarm relay R_5, the alarm being given after approx. 2 minutes. This long delay of operation is obtained by utilizing the heat spring's heating and cooling times.

A small increase in negative grid voltage from zero causes the lamp G to stop passing current and the relays to return to their normal position.

The insulation of a connected cable is normally in the range 5—100 megohms depending upon the quality of the cable and the associated exchange equipment in the circuit.

Considerable leakage to earth in damp situations, is an additional factor.

A decrease in insulation resistance causes the grid bias to decrease. At zero grid volts the limit value r_{a0} is reached, lamp G ignites, the relays follow their sequence and after approx. 2 minutes the alarm is given.

If the insulation resistance decreases further, the grid is driven positive and grid current flows through the relay R_1. With an insulation resistance of about 100000 ohms the amount of grid current is sufficient to operate the relay, R_1. This relay is connected in such a way to the heat relay that only 25 seconds heating time is required before operating the alarm.

This arrangement has been designed to ensure the quickest possible indication of serious faults when time is short so as to localize the fault before the whole cable is affected.

Cable disturbances are mainly of two kinds, partly $16^2/_3$ and 50 c/s AC and partly, fluctuations of a DC character. Though the former may be considerable they do not effect the indicator to any extent because of the attenuation in the circuit R_1—C_1 and the long time constant in the circuit r_4—C_2. Fluctuations arising from earth currents, charging and temporary mechanical handling of the cable, may have an amplitude of 100 V, and these may cause the grid bias to change to a zero or positive value and operate the indicator. The cable is restored to its normal condition by charging via r_1 but as the capacity C_L to earth for a standard length of cable may amount to 200 μF, the time constant for the circuit r_1—C_L will be approx. 10 minutes. This, however, only applies when the grid bias is negative. If the grid is driven positive the time constant is reduced by the grid current and will have a value less than one second.

If, momentarily, the cable receives an earth potential, this will cause the grid bias to change from — 20 V to + 100 V. Consequently the lamp G quickly ignites and the relay R_1 operates.

The cable is charged via the grid cathode circuit but the current is restricted by the resistance of the relay winding. After about 5 seconds R_1 releases and after a further 25 seconds, or so the grid bias falls to zero and all the relays are restored to their normal positions before the heat relay can give alarm.

As was seen from the expression for maximum sensitivity, this is determined by the voltages V_F and V_H and the grid resistance r_1. If the voltage V_H is taken as 100 V, the sensitivity may be set anywhere between 2 and 10 megohm by changing the resistance r_1.

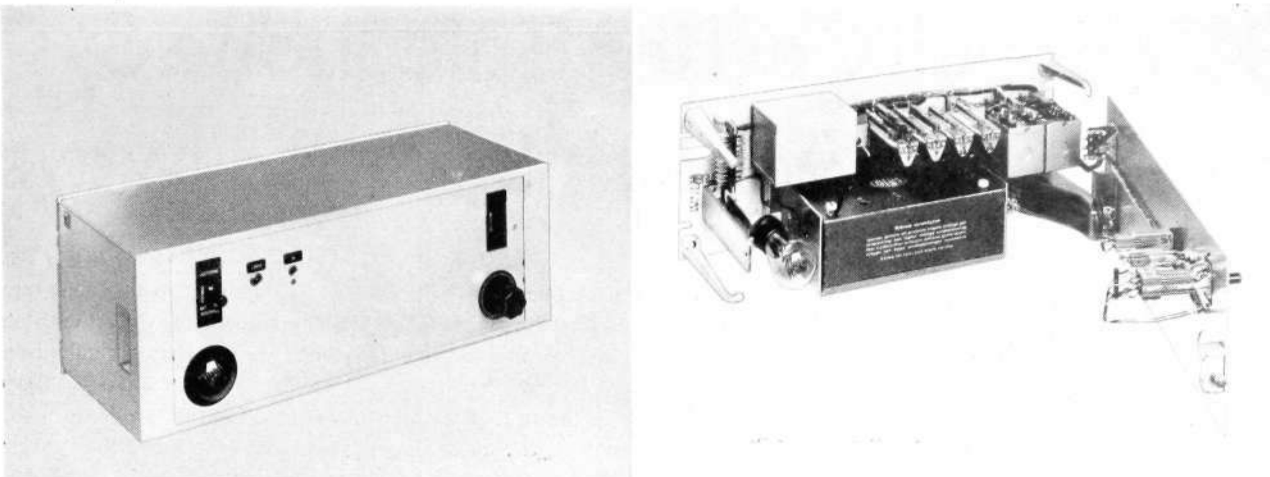


Fig. 2
Insulation indicator
right, with cover removed

X 7528

Calibration is carried out by switching *O* to the position »ADJUSTMENT«. *In this position the valve is operated with zero grid bias, the anode current* being adjusted by varying the screen volts until the lamp *G* ignites.

In the position »BATTERY CONTROL« a resistance r_3 is connected in the grid circuit to simulate a leakage or faulty insulation condition and thus operate the alarm circuit. An operation is an indication that the auxiliary battery needs replacing.

The valve used in the unit is an indirectly heated pentode type *RTR 4141* or *6J7G*. High tension and filament supplies are respectively 130 V and 24 V. Fig. 2 left shows the mechanical construction of the unit which is mounted on an iron panel 482.6 × 177 × 3 mm, the detachable cover being 180 mm high. In Fig. 2 right the unit is shown with the cover removed, revealing the hinged front panel which makes for easy access to all parts including the valve and battery.

An AC mains version is also available for operating on 20—60 c/s, 80 V, 90 V, 110 V, 127 V and 220 V supplies. In this the panel dimensiones are reduced to 482.6 × 132 × 3 mm.

8-Channel Carrier Telephone System for the Swedish State Railways

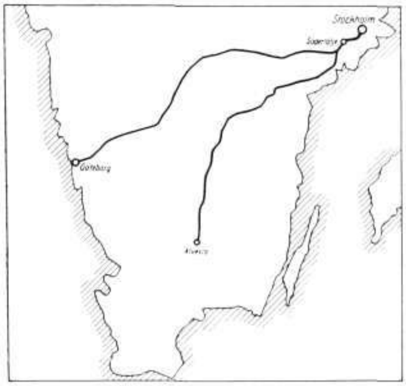


Fig. 1 X 4626

The extent of the 8-channel carrier frequency circuits on the railway system

U.D.C. 621.395.44:656.254.15(485)

The 8-channel system for telephony, which plays a large part in the Telegraph Administration's trunk network, has also found employment with the State Railways. The principle of this carrier frequency system has already been described in Ericsson Review No 1—2, 1945. The State Railways carrier frequency system has in the first place been introduced for the telephone cables Stockholm—Gothenburg and Stockholm—Alvesta. By the adoption of the 8-channel carrier frequency system it has been possible in simple manner to increase the number of circuits on the small number of pairs in these cables to meet the heavily increased demands for telephone communications.

The carrier frequency equipment between Stockholm and Gothenburg consists of a system in which an unloaded pair in the cable is utilized. The total length of the section is 456 km and it comprises 14 repeater stations 30—35 km apart.

The carrier frequency equipment between Stockholm and Alvesta consists of two systems, for which two unloaded coil pairs have been loaded. The total length is 417 km with 12 repeater stations. All repeater stations are housed in existing railway buildings.

Some of the repeater stations have permanent repair staff in attendance, who are responsible for the supervision of the system. These repeater stations with permanent staff have remote alarm receivers, taking fault indications from one to three unattended repeater stations' remote alarm transmitters. In this way the repair staff are able to localize any faults arising without delay.

Fig. 2 X 6408

Terminal station equipment for 8-channel carrier frequency circuit

U.D.C. 621.395.344.(485)(091)

VIGREN, S & BROBERG, W: *The Crossbar Switch and the Development of Crossbar Systems in Sweden.* Ericsson Rev. *26* (1949) No. 2 pp. 38—51.

Brief survey of different types of selector and a review on the development of the crossbar switch in Sweden.

U.D.C. 621.395.344

WIBERG, E A: *The Crossbar Switch — Its Design and Manufacture.* Ericsson Rev. *26* (1949) No. 2 pp. 52—61.

Description of the crossbar switch, model 1945, its design, manufacture and function.

The Crossbar Switch Components.—Crossbar Switch Operation.—Manufacture.—Types of Crossbar Switches.

U.D.C. 656.257: 656.4(487.1)

BOBERG, I: *Electric Interlocking Plant at the Car Depot of the Stockholm Tramways at Brännkyrka.* Ericsson Rev. *26* (1949) No. 2 pp. 62—68.

On 15th October, 1945, the Stockholm Tramways opened a new car depot, the Brännkyrka Depot. As it was estimated that traffic at certain times of the day to and from the car depot would be very heavy, it was considered that an interlocking plant at the approaches to the depot would be economically justified.

The new interlocking plant was installed in 1947—1948 by L M Ericssons Signalaktiebolag. Description of the build up and function of the new plant.

U.D.C. 621.317.333.4:621.315.2

HAMMARLUND, G: *An Indicator for Checking the Insulation of Telephone Cables.* Ericsson Rev. *26* (1949) No. 2 pp. 69—71.

Description of an indicator for checking the insulation of telephone cables. The indicator gives an accurate indication of relatively high resistance values and is unaffected by disturbances likely to cause a false alarm.

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CONTENTS

On cover: Master instrument for L M Ericsson's new loud-speaking intercom telephone

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New Telephone Installation in Bogotá

B ANDO, S FUNCKE & A STEIN, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.343(861)

On the 28th of December 1948 automatic exchanges for 20 000 subscribers were put into service in Bogotá, the capital of Colombia. This is the first instalment of a telephone installation contracted by Telefonaktiebolaget L M Ericsson covering automatic telephone exchanges for 40 000 subscribers along with telephone instruments and network material.

With exchanges according to the L M Ericsson automatic telephone system with 500-line selectors and network built on the L M Ericsson distribution system, this project is an interesting example of the telephone service in a large city.

Bogotá is the capital of the republic of Colombia, seat of government and other administrations. The population of the city is approximately 500 000 compared with 10 mill. for the whole of the country. Bogotá is the centre for the cultural life of the country, has many industries and is, in spite of transport difficulties to the coast, an important trading centre.

It is natural that a city of such importance should require a first class telephone service. Early in 1941 the city council and the executives of the new telephone administration, Empresa de Teléfonos de Bogotá, decided that the time had come for a complete overhaul and modernization of the telephone service in the city. Financial and exchange difficulties had prevented all extensions since 1935 and the existing manual CB-exchanges, of English make, had a total capacity of 13 000 subscribers only.

In their tender L M Ericsson proposed the automatic telephone system with 500-line selectors already well-known in Colombia. Automatic exchanges according to this system had been put into service at Honda and Ibagué as early as 1932 to be followed by exchanges at Armenia, Manizales and Medellín. In the latter town L M Ericsson had 1940 handed over an automatic exchange for 10 000 subscribers, a considerably extended and modernized network and a large quantity of telephone instruments. An extension of a further 15 000 numbers is in progress. (Particulars regarding this installation will be found in Ericsson Review, Special number 1945.)

The telephone administration of Bogotá was, therefore, able to study complete plants of the L M Ericsson system in service at close quarters. The favourable experiences from these plants no doubt contributed towards L M Ericsson securing the contract for the large telephone system in Bogotá in keen competition with several other world famous companies.

Following later redispositions the contract includes supply and erection of five automatic telephone exchanges covering a total of 40 500 numbers as well as telephone instruments and network material for 35 000 subscribers.

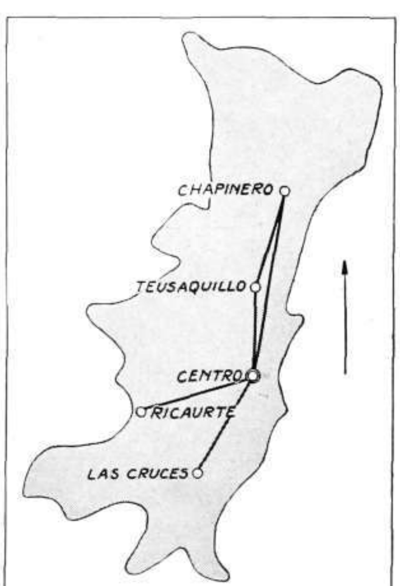


Fig. 1 X 4636
The positions of telephone exchanges in Bogotá

The Exchange System

The Schematic Lay-out of the Automatic System

Bogotá is situated on a high plateau bordered on one side by a mountain chain. The town is rather drawn out, 14 km in north—south direction and 4 km in east—west. The telephone system has, therefore, been provided with five exchanges, Fig. 1.

The centre of the network is the »Centro» exchange, situated in the middle of the administrative and business quarters, the other exchanges being grouped on either side. The 40 500 subscriber's lines are distributed with 22 000 lines in Centro, 6 000 in Chapinero, 5 000 each in Teusaquillo and Las Cruces and 2 500 lines in Ricaurte.

As mentioned above the exchanges are equipped with the L M Ericsson automatic telephone system with 500-line selectors of modern type, the traffic routes being shown in Fig. 2.

Separate cabling is running to second group selectors in Centro and the other exchanges (*II-GV* and *GIV*). All exchanges have direct junctions. Connection to special services is obtained over the second group selectors in Centro's first and third 10 000 groups.

Trunk calls are connected to local subscribers over trunk group selectors in Centro (*I-GT*) and separate second group selectors at the different exchanges (*II-GT* and *GIT* respectively). Final selectors used for trunk services are, however, also utilized for local traffic.

The numbering system has now five digits but registers may easily be changed to six digits. Fig. 3 shows the distribution of the number series at the central group and the multiple of the first group selector at Centro for six digit as well as five digit numbering. The series commencing with 8 is intended for automatic rural traffic and the registers for this series are made for decimal conversion, facilitating the future introduction of rural exchanges with decimal systems. For the special services two-digit numbers, *01—00*, are allocated.

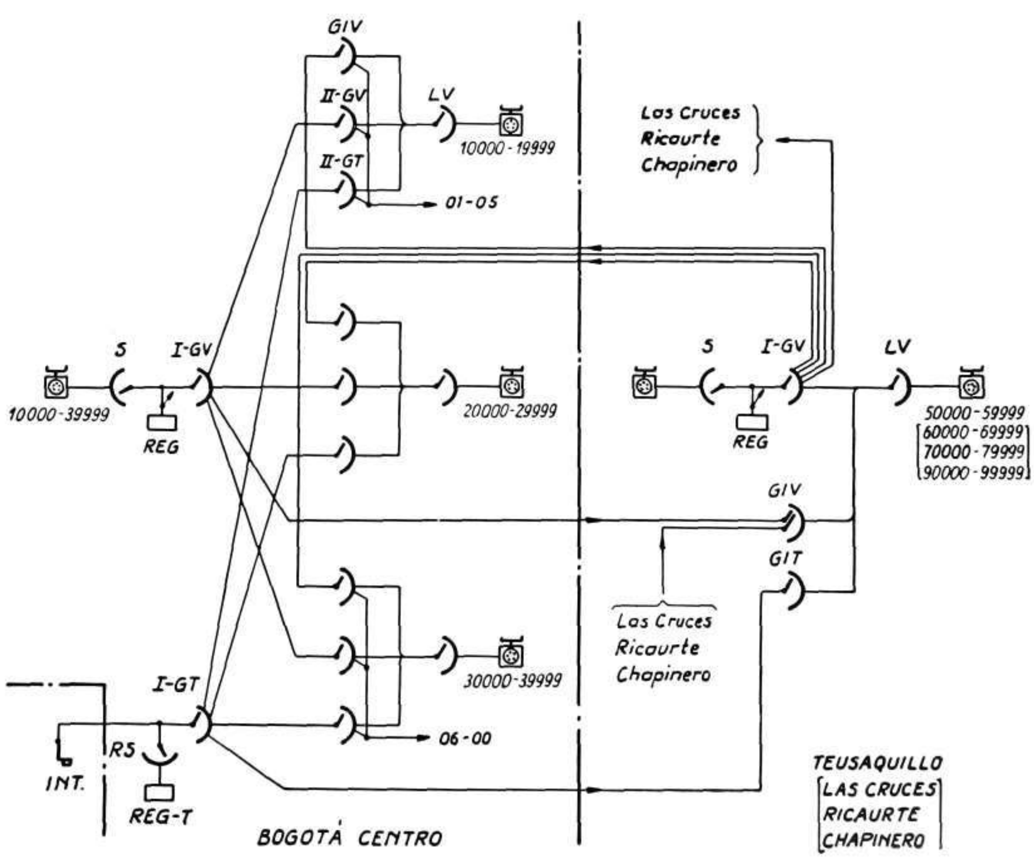
Special Technical Details

The operating voltage is 24 V and the transmission voltage 48 V. In this way the advantages of a low operating voltage are maintained, this being more economical with regard to power consumption and presenting easier spark

Fig. 2 X 7543

Traffic route diagram for the automatic exchanges in Bogotá

INT	trunk exchange
GIT	group selector for incoming trunk traffic
GIV	group selector for incoming local traffic
I-GT	first group selector for trunk traffic
II-GT	second group selector for trunk traffic
I-GV	first group selector for local traffic
II-GV	second group selector for local traffic
LV	final selector
REG	local register
REG-T	trunk register
RS	register finder
S	line finder



I	II	
810000 — 819999	[80000 — 89999]	
100000 — 109999		
110000–119999; 01–05	10000–19999; 01–05	Centro
120000 — 129999	20000 — 29999	Centro
130000–139999; 06–00	30000–39999; 06–00	Centro
140000 — 149999		
150000 — 159999		
160000 — 169999	60000 — 69999	Las Cruces
170000 — 179999	70000 — 79999	Ricaurte
180000 — 189999		
190000 — 199999		
200000 — 209999		
210000 — 219999		
220000 — 229999		
230000 — 239999		
240000 — 249999		
250000 — 259999	50000 — 59999	Teusaquillo
260000 — 269999		
270000 — 279999		
280000 — 289999		
290000 — 299999	90000 — 99999	Chapinero
300000 — 309999		
310000 — 319999		
320000 — 329999		
330000 — 339999		

Fig. 3 X 6438

Numbering diagram for the multiple of the first group selector at Bogotá Centro

I six digit numbering

II five digit numbering

quench problems. At the same time the high transmission voltage allows the use of smaller wire gauge, important for an extended local network as that in Bogotá. In non-operated condition the voltage on the subscriber's line is 24 V. Guaranteed operating limits are 22 and 26 V.

Release of a connection takes place from the calling subscriber only (A-subscriber). Should, however, the called subscriber (B-subscriber) omit to replace his receiver, the A-subscriber will be released but the connecting circuit remains. In this way possible malicious calls may be traced. Should the B-subscriber only replace his receiver both subscribers will remain connected and an alarm will be issued in the exchange after a certain time.

The trunk final selector tests on a local call in progress and the operator may break in on this call, disconnect the subscriber not required and establish the trunk call connection. The operator cannot, however, break in on a trunk call in progress.

The exchanges are equipped with traffic meters normally operated once for each completed call. For calls to one or more of the special services the metering may be suppressed as required by the administration. The system has provisions for introducing repeated counting during a call.

For cashing charges in coin box instruments the link circuit has been arranged with current reversal on the calling line, when the called subscriber is answering. The current reversal is omitted for calls to special services which are not to be charged.

A number of 500-groups in each exchange has been arranged for PBX-subscribers *i. e.* they have been provided with final selectors allowing free hunting over a number of consecutive lines. These lines may also be called individually for night service connections to the extensions in the private branch exchanges.

The traffic between the exchanges is carried on two-wire junctions. These are controlled by closed circuits and the release is effected by a 60 cycles A.C. impulse being received by a discharge tube circuit in the incoming group selector.

Distant rural lines are brought in to a switchboard with connection lines to the automatic exchange.

The Exchange Premises

Fig. 4 shows the rack lay-out at Centro. It is built in unit rows for 1 000 subscribers (rows 1—33) as is usual for the L M Ericsson automatic system with 500-line selectors. Each row consists of two panels for each line selector, first group selector, final selector and register. The relay sets for the connecting circuits are mounted on the rear side of the register rack. The corresponding line relay racks are mounted either at the end of the row or between two unit rows.

Second group selectors, trunk group selectors, junction equipment and intermediate distribution frames are brought together in rows 34—47.

The selector panels contain selectors, multiple frames, panel equipment, fuse strips, alarm relays, alarm lamps, test jacks and cut-off keys. The exchanges are equipped with 46 link circuits per 500 subscribers. In the normal 500-groups the racks are taking 50 connection devices, whereas final selector groups intended for PBX subscribers have a rack capacity of 60 connection devices. As it happens, however, the actual traffic does not require 46 link circuits. The exchanges, therefore, have large reserves of connection devices and as these always are jack connected to the rack cabling the reserves may be utilized for future extensions.

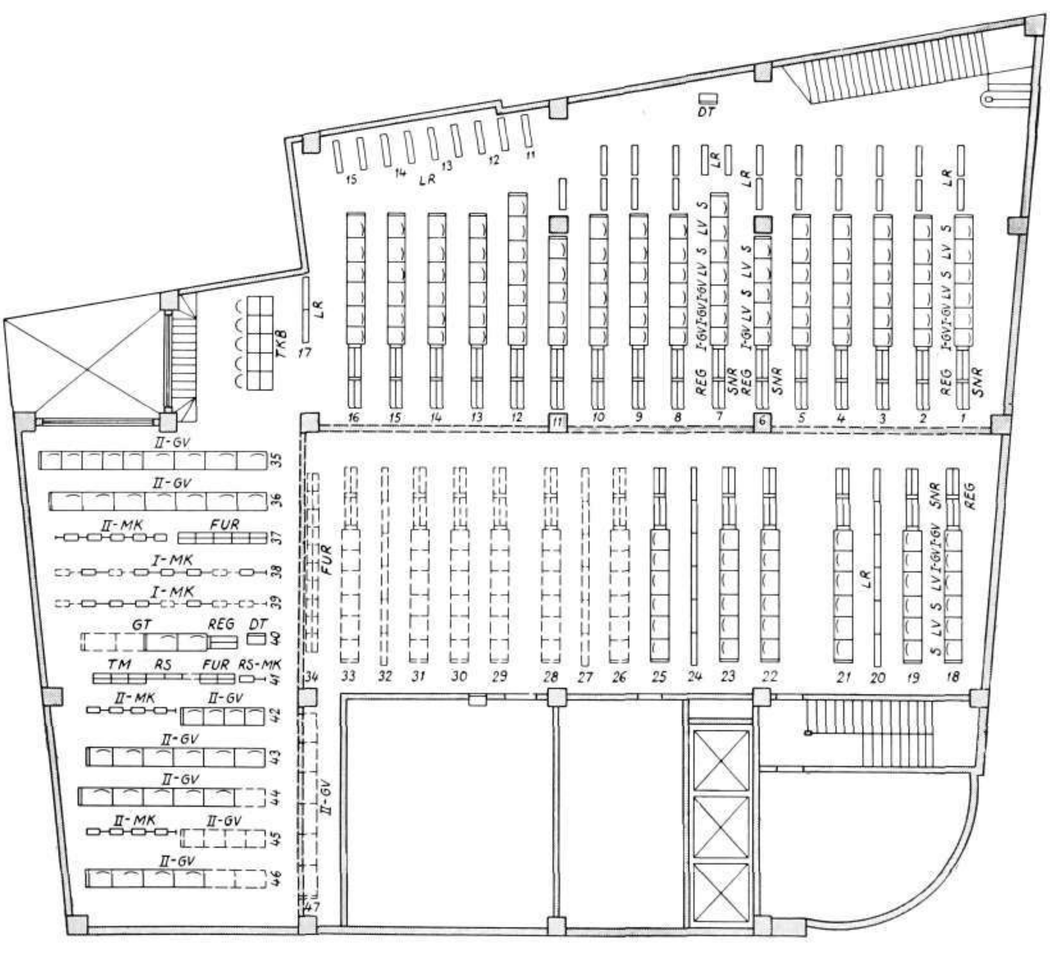


Fig. 4 X 7544

Floor plan showing lay-out of racks at Bogotá Centro

DT	distribution board
FUR	outgoing junctions
I-GV	first group selectors for local traffic
II-GV	second group selectors and group selector for incoming traffic
GT	first group selectors for trunk traffic
LR	line relays
LV	final selectors
I-MK	intermediate distribution frames for multiples of the first group selector
II-MK	intermediate distribution frames for the multiples of the second group selector
REG	registers
RS	register finders
RS-MK	intermediate distribution frames for register finders
S	line finders
SNR	connecting circuits
TKB	traffic observation desks
TM	traffic metering equipment

Fig. 5 X 6452

The exchange building for Bogotá Centro

The low building to the left is the manual exchange and that to the right the new extension. Behind the large glass wall rack row no. 1 is mounted.

Apart from the power plant the ground floor also contains the main distribution frames and the test desks. The traffic meters are installed in a separate room.

The original manual exchange was erected in a building, which on the floor plan Fig. 8 corresponds to the lower right hand part separated from the remainder of the exchange by a dotted wall indication. The administration had a new house built attached on two sides of the old one. In this way the new part of the building will contain rows 1—17 and 35—46. See also Fig. 5.

When the line cables have been reconnected on the new main distribution frame and the old building has been replaced by a new one, the exchange hall will obtain its final lay-out and be available for the remaining 6 000 lines. These are scheduled to be completed during 1951.

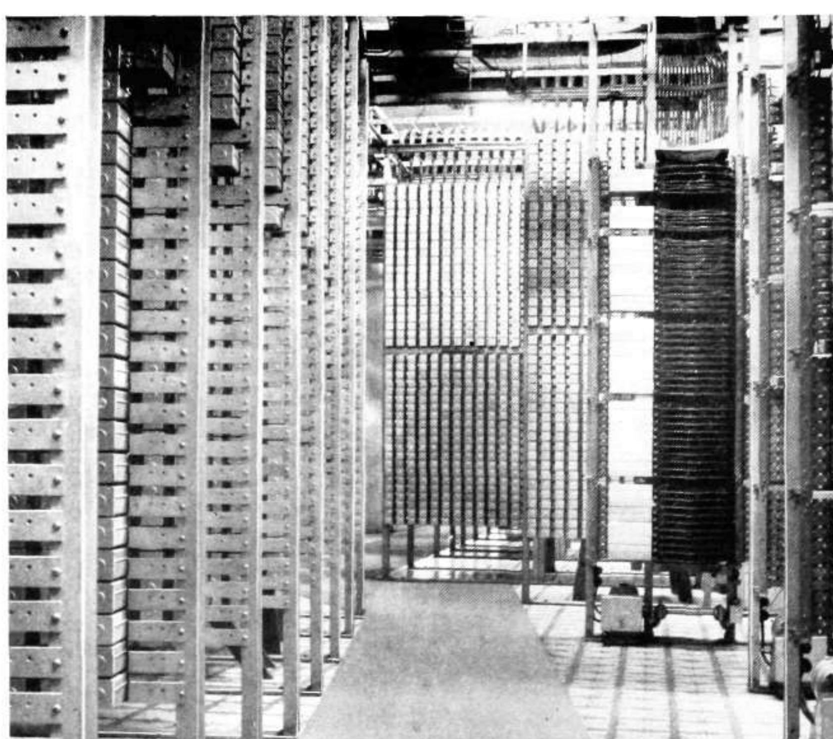


Fig. 6 X 6448

Interior of Centro showing rack rows nos. 16—12.

Fig. 7 X 6447
The automatic exchange in Chapinero

Fig. 8 is an example of the rack lay-out in one of the smaller exchanges. The space requirement for the automatic exchanges including junction equipment but excluding power plant, main distribution frame and subscribers' meters, is approximately 20—23 sq. m. per 1 000 subscribers.

Racks, relay sets and cable ladders are aluminium sprayed and the desks cellulose polished.

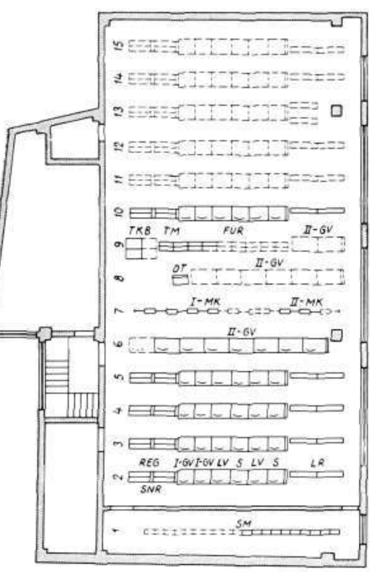


Fig. 8 X 4637
Floor plan of rack lay-out in one of the sub-exchanges

DT	distribution board
I-GV	first group selectors for local traffic
II-GV	second group selectors and group selectors for incoming traffic
FUR	outgoing junctions
I-MK	intermediate distribution frames for the multiples of the first group selectors
II-MK	intermediate distribution frames for the muliples of the second group selectors
LV	final selectors
LR	line relays
REG	registers
S	line finders
SNR	connection circuits
SM	subscribers' meters
TKB	traffic observation desks
TM	traffic metering equipment

Test, Supervision and Alarm Equipment

In order to facilitate supervision and maintenance the automatic exchanges are provided with various test and supervisory equipment.

The contract for Centro includes a test rack, which is an exchange in miniature and in which all possible connections in the exchanges may be reproduced, including calls over junctions, trunk calls and calls to special services. The rack is provided with one set of all occurring connection devices and a test position, in which the connection devices in the exchange may be tested, Fig. 9.

The test rack is primarily intended for more accurate adjustments and investigations. For routine tests, on the other hand, each exchange is equipped with an automatic exchange tester, Fig. 10. This is connected to one 500-group at the time, testing all connection devices and traffic routes in the group and checking all tones and signals during the connection operation. The tester operates against a test number in each 500-group in the home exchange as well as in the other exchanges. If a fault is revealed by the tester the appropriate connection is held and a signal is issued. For a more detailed description, reference is made to Ericsson Review No 2, 1945. Individual connection devices in the 500-group are tested by means of a portable manual exchange tester.

The performance of each register is indicated on pilot lamps in the traffic observation desks, Fig. 11. From these desks the supervisors may get telephone connection with a subscriber, while the latter is keeping the register engaged, and assist in effecting connection if so is required.

Lines and subscribers' instruments are checked from the test desks, which may be connected to the subscribers' lines over main distribution frame.

Each exchange is provided with traffic observation equipment giving all essential traffic data for the operating statistics. It is thus possible to read simultaneously engaged rate, holding time and lost calls for particular groups of connection devices and junctions as well as for larger units of traffic routes.

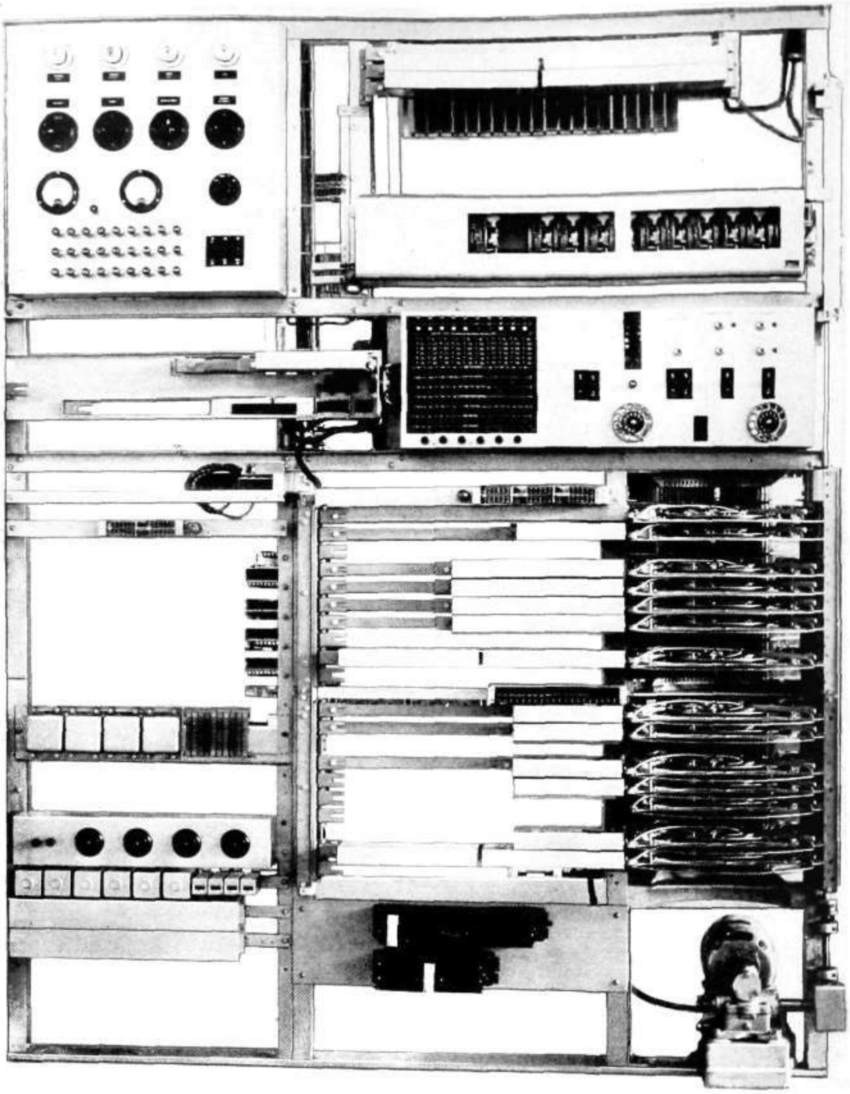


Fig. 9 X 7544

The test rack at Bogotá Centro

In addition to the above test and supervisory arrangements each exchange is supervised by alarm equipments with lamps for each panel and row indicating blown fuses, obstructed connection devices, motor faults and other faults. More serious alarms operate audible signals.

Power Supply

The power supply is arranged for direct operation with rotary converters, described in more detail in Ericsson Review No 4/1947. The converters consist of mains connected 3 phase A.C. motors driving D.C. shunt generators. Under normal conditions the generators supply power for the operation of the exchange and the charging of the batteries. The latter are only used in reserve in case of mains failure. The generators are automatically regulated by means of Brown Boveri regulators.

Fig. 10 X 4645

Automatic exchange tester

The equipment also includes petrol driven reserve sets for the battery charging. The batteries are lead acid accumulators. There are two large batteries for the operating voltage and two smaller ones for the transmission voltage. In Centro the large batteries each have a capacity of 5 184 Amp hrs and the smaller ones 576 Amp hrs each; for the other exchanges the corresponding figures are 936 Amp hrs and 144 Amp hrs respectively.

Fig. 11 X 6445
The traffic observation desks at Bogotá Centro

The power equipment is controlled from power boards containing circuit breakers, regulators, switch gear instruments, fuses, alarm lamps etc. The boards consist of rust proofed and aluminium sprayed mild steel panels 2.2 m in height, Fig. 12. Machinery, batteries and power boards are mounted on the ground floor. The power cable is drawn up to distribution boards in the exchange hall and distributed to the rows of racks.

Erection

Practically all material is manufactured at the L M Ericsson main factory in Stockholm. Colombian labour was used for the erection under direction of specialists from L M Ericsson.

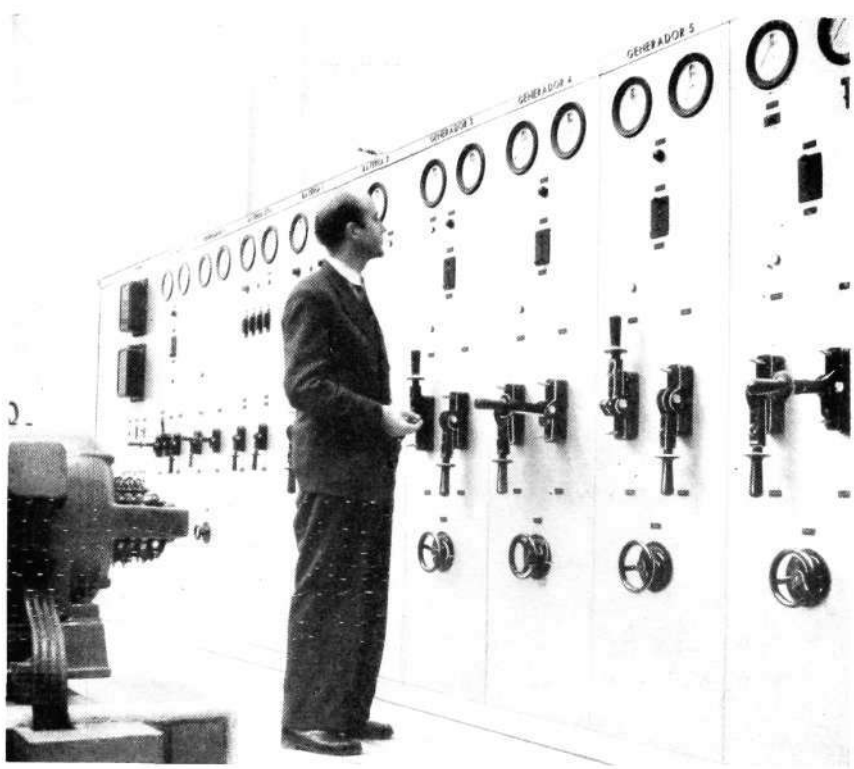


Fig. 12 X 6446
The power board at Bogotá Centro

*

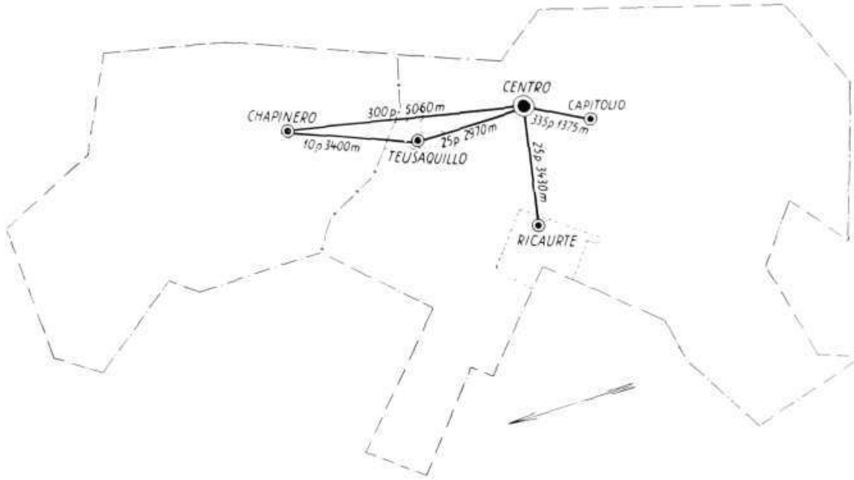


Fig. 13 X 6440

Sketch-map of the old installation

- manual exchanges
- junction cables
- boundaries for exchange areas
- boundary for urban area

It has, in the main, been possible to proceed with deliveries and erection according to schedule. Some delay has, however, been experienced owing to the port of Buenaventure at times being congested with goods, which was detaining the transhipment of the material to avoid delay on the first stage L M Ericsson found it necessary to ship the last important consignments to Cartagena and forward these by air to Bogotá.

The erection work covers consecutive extension of the exchanges. The program has from time to time been altered to line up with the actual distribution of the subscribers. The contract originally covered four exchanges, but this was later revised, one exchange being omitted and two new ones being added. In the course of the erection certain adjustments between the exchanges have also taken place, which has not caused any difficulties owing to the adaptability of the system.

The network

The Old Network

The following table shows the capacity of the network for the four manual exchanges in the old telephone installation and the automatic exchange in the government building Capitolia, as well as the number of subscribers immediately before the conversion to automatic system.

The positions of the exchanges and the boundaries for exchange areas are indicated on Fig. 13. These boundaries were, however, extremely diffuse. When moving from one area to another, subscribers were allowed to retain their

exchange	number of subscribers	outgoing network cables	
		numbers	total pairs
Centro	9 849	32	13 500
Teusaquillo	220	1	350
Chapinero	2 389	9	3 800
Ricaurte	133	1	175
Capitolio	450	3	450
Total	13 041	46	18 275

Fig. 14 X 4644

Distribution of subscribers' lines from a pole old numbers as far as connections could be arranged, often by means of long open-wire and insulated wire lines, the reason for this being lack of spare numbers in the exchanges.

The automatic exchange in Capitolio was used as a local exchange but had also a considerable number of extensions distributed over the whole of the city.

The old cables are mainly of an armoured type and vary in size from 50 to 900 pairs with a wire diameter from 0.51 to 0.91 mm. The cables are directly distributed to wall or pole boxes of 15—25 pairs. The American system of multipling is prevalent. As many as five boxes are connected in parallel. In addition direct connection to terminal strips will be found for indoor installations in large premises.

The number of outgoing pairs from the manual exchanges has not been increased for a long time. For necessary extensions, the existing cables have, therefore, been utilized to the very limit by means of consecutive parallel connections and re-jointing. This has resulted in a very intricate and confusing network.

The old subscribers' lines consist of twin insulated wires or open wires. The former will be found in large bundles supported on hooks in walls, but also on pole lines together with open wires. Fig. 14 shows a typical construction for the distribution of subscribers' lines from a pole.

The New Network

For the new automatic exchanges, according to Fig. 15, the old network at Centro and Chapinero could be utilized, the new exchange premises there having been built connecting on to the old ones. At Teusaquillo and Recaurte the automatic exchanges have been placed away from the old manual exchanges in addition to which the exchange areas were considerably extended. Completely new networks have, therefore, been planned for these two exchanges as for the new exchange at Las Cruces.

The new network has been projected according to the L M Ericsson distribution system with 35 000 new main cable pairs and 39450 in the secondary network. The total number of outgoing pairs from the exchanges are distributed as per table on next page.

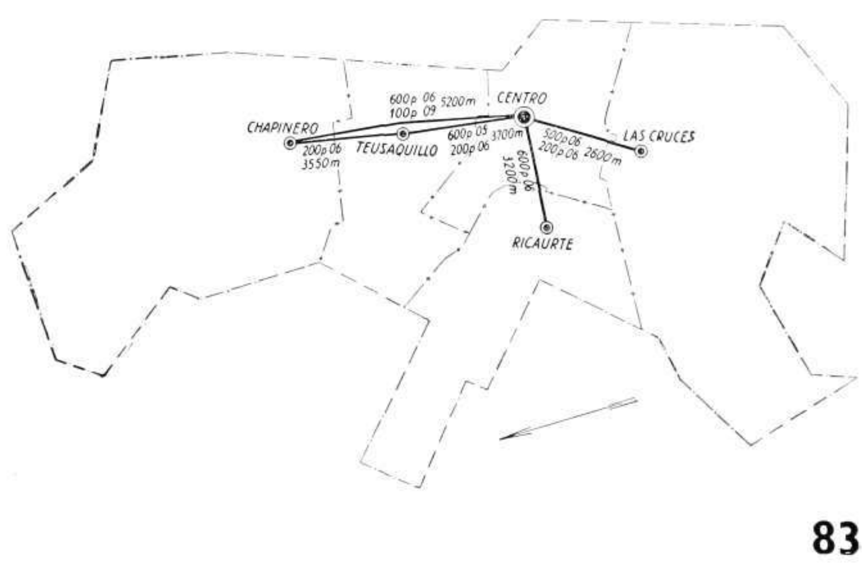


Fig. 15 X 6439

Sketch-map of the new installation

◉ new automatic exchanges
——— junction cables
— · + · — boundaries for exchange areas
—— · —— boundary for urban area

exchange	old network	new main network	total
Centro	13 200	16 700	29 900
Teusaquillo	—	6 800	6 800
Chapinero	3 800	4 300	8 100
Las Cruces	—	5 400	5 400
Ricaurte	—	1 800	1 800
Total	17 000	35 000	52 000

The contract covers delivery of all material required for this extension of the network. To give an idea of the quantities of material required, the following cable quantities may be quoted.

Total cable length to be drawn:

Main cable	100—600 pairs	119 200 m	45 090 km of pairs
Distribution cable	10—100 »	368 900 »	9 258 » » »
Junction cable	200—600 »	13 900 »	7 252 » » »
		Total 502 000 m	61 600 km of pairs

The quoted number of km of pairs, 61 600 means that the total length of double conductors in the telephone cables corresponds to one and half of the earth's circumference.

In the planning careful investigations have been made by means of detailed counts and prognostications of the number of subscribers in each block of houses. The rapid increase of population in the suburbs and the more and more prevalent tendency towards high building in the central parts have, however, caused a certain amount of difficulties when carrying out the projects, which have to be revised as the work is progressing in order to meet the actual requirements.

The old network has been utilized as far as possible. In certain cases the armoured cables have been brought in as main cables in new distribution boxes. The majority of cables have, however, been retained as a distribution system connected directly to the exchanges. In order to improve the standard of insulation and reduce the length of the subscribers' lines, which is often considerable, the old boxes of 15—25 pairs are divided up in suitable combination in new 10 pairs boxes.

The new main cables are almost exclusively run in duct work. For this purpose new concrete ducts of the L M Ericsson type have been constructed having a total of 207 outgoing duct pipes from the five new exchanges and a length of 395 500 duct pipe meters. The main cabling is run from the exchanges as lead covered 600-pairs cables and are terminated in a total of 192 cable distribution boxes. These boxes are mounted according to usual methods on the outside of house walls. To a certain extent, however, they have also been mounted indoors, especially when one large building constitutes a complete district, in which case boxes have been used specially designed to suit conditions from case to case. The secondary cabling runs from the cable distribution boxes, mainly as lead covered cables in ducts, mounted on house walls or as aerial cables on steel poles. Extensive application has been made of the erection method, specially developed for Latin-American conditions, with combined suspension strand for secondary cable and subscriber's single pair cable, described in Ericsson Review, Special number, 1945.

As far as is economically feasible the cabling has been carried out in ducts. In connection with alterations and adjustment of roads new concrete ducts are laid down for future requirements. When preparing new districts for building, ducts for main as well as secondary cabling is always arranged. This has become just as indispensible as running water mains and drain pipes.

Fig. 16 X 4643

Memorial tablet

The new telephone exchange was inaugurated on the 28th of December 1948 and to commemorate this the above tablet was placed in the new building.

The diameter of the conductor for main, secondary and junction cabling varies owing to the large geographical distances in the city. In Centro, where also the trunk exchange is situated, the entire network is run in 0.5 mm wire. The outer districts of Chapinero, Las Cruces and Ricaurte are on the other hand connected over 0.6 mm cables. The new junction cables have 0.5 and 0.6 mm wires depending on the distance to the Centro exchange. The trunk traffic, at present comparatively small, is in certain cases served over cables in the old network having 0.9 mm conductors.

The contract includes material estimated for 30 000 new subscriber's installations. The outdoor wiring for these installations is carried out with the L M Ericsson standard lead covered single pair cable, nailed on walls or mounted on suspenders, and free carrying single pair cables with special suspenders. Indoor wiring is made in the L M Ericsson PVC insulated conductors as described in Ericsson Review No 3/1948.

For larger premises the builder nowadays always provides concealed conduit for the telephone wiring. The cables are terminated in special boxes with arrangement for connection to the public telephone network. Also smaller buildings, sometimes even one-family houses, are often provided with telephone conduit. The wiring is in the latter case brought out to the front side of the house to be connected from the nearest cable box.

Prior to the conversion to automatic system all telephone instruments were replaced by the new L M Ericsson bakelite sets of latest design. See description in Ericsson Review No 3/1947. As the power supply for the old manual exchanges differed considerably from the new automatic exchanges, there was, however, some risk for excessive voltage. For that reason protective resistances were inserted in the main distribution frame for subscriber's lines having a resistance below a certain value.

The erection of the extensive network is carried out under management of the telephone administration with Colombian labour. Network experts from L M Ericsson are, however, responsible for the technical management. In spite of great difficulties due to irregular supply of material and lack of skilled labour, the erection work has progressed at such a rate that the network sections can be connected as the exchange equipments become completed.

Commencement of Service

On the 28th of December 1948 the telephone service in Bogotá was transferred to the automatic exchanges. This was an opportune moment, as town life is almost at standstill over the Christmas holidays and the telephone traffic consequently infinitesimal. On January 13th the formal inauguration was celebrated in the presence of delegates from the government, the city council and others. At the same time the first edition of the new telephone directory was presented, the first two annual editions being included in the contract. Since then several extensions have been carried out and been put into service, further extensions being continued until the contract is completed.

The great confidence enjoyed by the L M Ericsson automatic system with 500-line selectors, is illustrated by the fact that in Colombia alone exchanges are now installed and on order covering a total of 73 500 subscribers' lines.

New Loudspeaking Intercom Telephone

C G SÖDERBAUM, TELEFONAKTIEBOLAGET LM ERICSSON, TELESIGNAL WORKS, STOCKHOLM

U.D.C. 621.395.22.

«Talk instead of walk» is a modern proverb illustrating how telephoning nowadays has become a second nature. The ordinary telephone provides connection to a very large number of people — practically everybody — inside or outside an organisation. Apart from this, however, there is an increasing demand for interoffice communication equipment, independent of the ordinary telephone system and providing instant connection to a limited number of persons — the immediate associates.

For a long time back L M Ericsson have been able to supply equipment for this purpose such as intercommunication telephones, conference telephones and push button extension units for ordinary telephones. For their intended purpose all these are excellent solutions. The loudspeaking intercom telephone differs from the above equipment by the loud to loud property. In so far as loudspeaking communication offers advantages or is admissable, the loudspeaking intercom is a first class means of communication covering a combination of many valuable traffic qualifications.

The L M Ericsson new loudspeaking intercom, which is operating on direct lines, has push button calling, secret conversation, visual engaged signal and *right of way facilities.*

A loudspeaking intercom installation consists of master instruments and sub-instruments in different combinations, the more important ones being shown

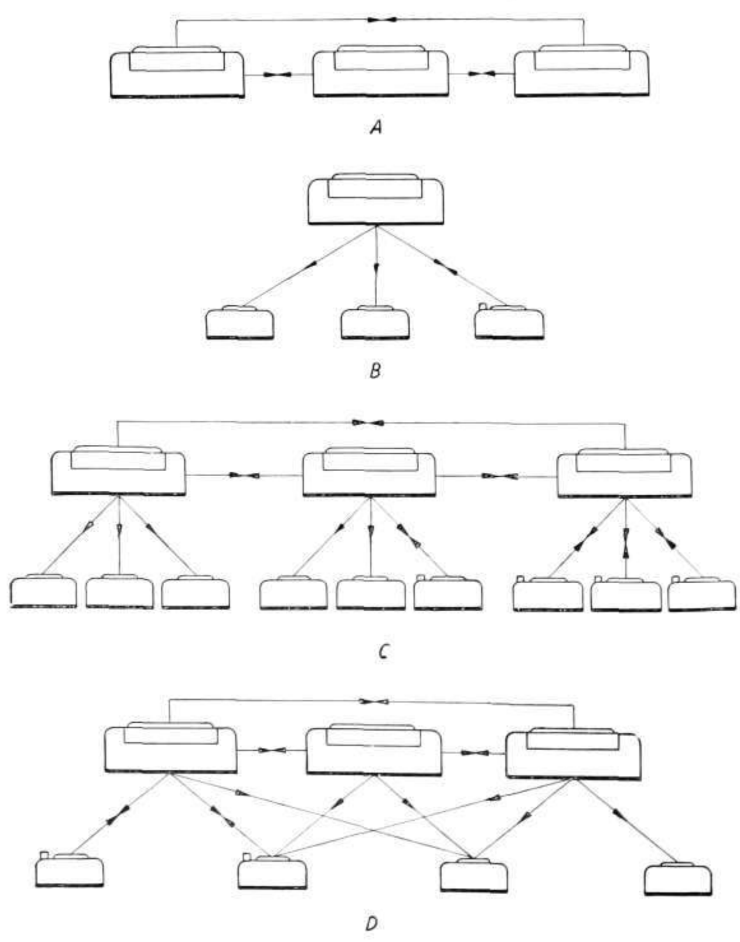


Fig. 1 X 6453

Schematic diagrams of loudspeaking intercom system with master instruments and sub-instruments in different combinations

- A system containing master instruments only, maximum 11 sets
- B system containing one master instrument and a maximum of 10 sub-instruments
- C system containing master instruments and sub-instruments, alocated to one certain master set; each master set may be connected to a maximum of 10 master and sub-instruments
- D system containing master instruments and sub-instruments, connected to one or several master sets; each master set may be connected to a maximum of 10 master and sub-instruments

Fig. 2 X 6457
Master instrument DEL 2301

in the schematic diagram, Fig. 1. In the diagram the lines between the units indicate possible connections whereas the arrows signify the directions of the calls. The diagrams illustrate the variety of combinations and the adaptability of the new intercom for different requirements. The properties listed in the first paragraph of this article refer in the first place to the master instrument, Fig. 2, but apply partly also to the sub-instruments, Fig. 3.

In addition to master and sub-instruments an installation includes a common amplifier connected to the A.C. mains over an ordinary wall plug. Through the mains connection no other power supply is required; no separate batteries are required for the microphone feed. The design of the wall terminal strip, which at the same time serves as junction box, makes it very easy to connect the instrument. The wiring is, furthermore, carried out in ordinary telephone lead covered cable without shielding. All this makes the L M Ericsson intercom easy to install, which is a very important qualification.

Function and Traffic Facilities

Call from a master instrument is made by momentarily pressing the white button corresponding to the wanted person. The red engaged signal is operated in the calling set and all other master instruments. The green button is then pressed down with the left hand thumb, the name of the wanted person is called, and the button released waiting reply. From then on the conversation is continued, the green speech button being pressed down for conversation from the master set and released for speech in the opposite direction. When

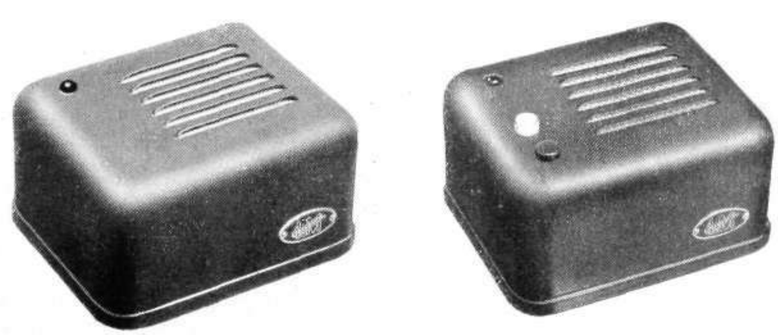


Fig. 3 X 6458
Sub-instruments
left DEL 1201, right DEL 1202

the conversation is finished the red release button is pressed, the engaged signal is extinguished and the circuit is restored to normal.

For calls to another *master instrument*, the engaged signal in this is operated, as mentioned above, together with a green call lamp. If the secrecy switch on the called set is in operated position a buzzer in the set is sounded. Before conversation can commence this switch must be restored to Off-position, the microphone loudspeaker then being connected and speech connection established. If the switch is in Off-position to start with, conversation may commence straight away and no manipulations are required by the called person. The latter can carry on conversation without being tied to the instrument; he has both his hands free and can move about in the room.

The microphone loudspeaker in the set is very sensitive and the reproduction is extremely good even for speech from a distance of 30 feet to the instrument. The excellent reproduction is partly due to the elimination of interference from the electric mains or from adjacent electrical machinery.

A call, on the other hand, to a *sub-instrument*, operates a green call lamp only in this set. There is no engaged lamp or secrecy switch on the sub-instruments. It follows that no set can be connected for eavesdropping from another set without the green pilot lamp being operated in the called set.

Call from a sub-instrument. As a rule sub-instruments are not provided with call button as generally no calls are wanted from these sets. There is, however, one type of sub-instrument which has a call button. A call from such a set is received by the master set without buzzer signal irrespective of the position of the secrecy switch. The caller cannot listen in to the master set before the speech button in the latter has been pressed. For conversation between master and sub-instrument the speech direction is always controlled from the master set.

Secret Calls, right of Way Connection

The equipment can only be operated by one master instrument at the time all other instruments being blocked during that time with exception of sets having right of way facility. Any master instrument may be provided with right of way facility by means of an easy reconnection in the wall terminal strip. A master set having right of way may disconnect any conversation in progress and then make a call to a required station. As the equipment is blocked during a call between two sets the conversations are secret and no other sets can be connected for eavesdropping. One master set may call several instruments simultaneously but this does not mean complete conference facility as a called person can only listen to the caller but not to the other connected persons.

Specification

Master instruments as well as sub-instruments are intended for desk mounting. All sets are provided with 7 feet connection flex and wall terminal strip. The instrument as well as the wall terminal strip are provided with mild steel covers finished moss-green.

Master instrument DEL 2301, Fig. 2. The front has a sloping push button set containing ten white call buttons, one green speech button, one red restore button, a green call lamp and a red engaged lamp. The call buttons not having mechanical lock-up are easy and comfortable to operate. The connection to the called instrument is maintained electrically. The restoring is also electrical and effected by momentarily pressing the restore button. Each row of buttons is provided with a designation frame strip, which can be pulled out when changing the designations. The instrument contains a microphone loud-speaker, secrecy switch, buzzer, connecting relay and call relay.

X 4650

Fig. 4
Loudspeaker RLE 70710

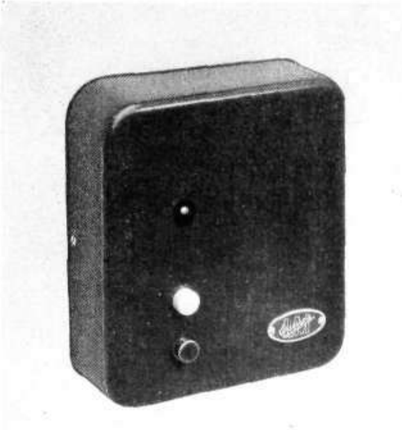


Fig. 5 X 4651
Control set 1042

There are two types of sub-instruments:

DEL 1201, Fig. 3 left, having call lamp and containing microphone loud-speaker; *DEL 1202*, Fig. 3 right, as the above but having in addition one call button and one restore button.

Large localities, for instance stores, sometimes require more powerful volume and wider range than obtained by the above sets. In such cases the sub-instrument may be replaced by a separate loudspeaker, *RLE 70710*, Fig. 4, mounted on a wall with relay set *KFB 1041* containing call relay and call lamp for incoming calls. If calling facility is required *from* the loudspeaker, which also serves as microphone the relay set is replaced by control set *KFB 1042*, Fig. 5, containing additional call button and restore button.

The amplifier ZGA 3011, Fig. 6, is made for wall mounting and is provided with a 32 inch cord with plug for mains connection. Apart from amplifying equipment the set contains relays for speech direction, blocking, rest condition and restoring. The mains transformer in the amplifier has tappings on the Up-side for 110, 125, 135, 150, 220 and 240 V A.C. mains. The different voltages are selected by means of a voltage switch in the set. The Down-side of the transformer has a separate winding for the operating voltage required for relays, lamps and buzzers in the installation. The amplifier contains ordinary standard wireless valves. Through the rest condition relay the power consumption is reduced and the life of the valves is increased. To eliminate humming the input transformer in the amplifier has been thoroughly screened. The small potentiometer balancing the two branches in the network relative to earth eliminates, with correct adjustment, interference, which may be caused by adjacent electrical machinery.

The amplifier components are mounted on an aluminium lacquered mild steel chassis provided with a terminal block at the bottom end for the incoming cable, Fig. 6 right, and is enclosed in an aluminium lacquered mild steel cover. The terminal block projects outside the main cover and is protected by a separate lid. The front of the cover has an aperture for volume control, switch and pilot lamp, which all are easily accessible and visible from the outside.

Fig. 6 X 4569
Amplifier ZGA 3011
right with cover and terminal lid removed

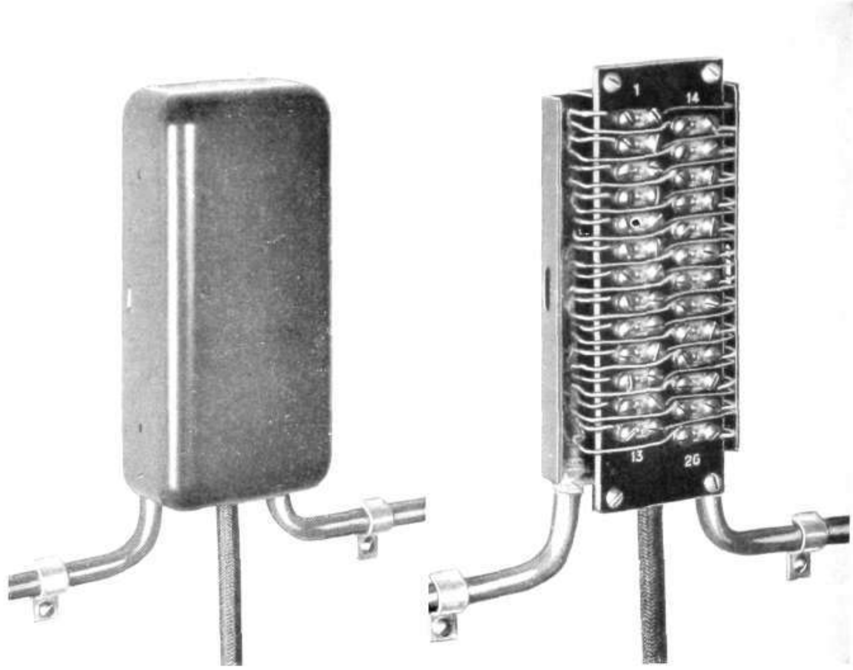


Fig. 7
Wall terminal strip 350989
right with cover removed

X 6456

The power consumption for the amplifier in operation is 50 watts and at rest 32 watts. The output at 1000 cycles is approximately 3 watts. The valve equipment comprises one first stage amplifier valve *6 SL 7*, an output valve *6V6 GT* and a rectifier valve *6X5*.

The Network

As indicated above the erection of the network is a very simple matter, as the wall terminal strips for the instruments, Fig. 7, also serve as junction boxes for the network. This is run in ordinary lead covered telephone cable from set to set through the whole installation.

Frame Work Design for Telephone Exchanges

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Top girders, tie bars and cable ladders for telephone exchanges have always presented tedious problems for the engineer as well as the frame shop and the erector. With the traditional nut and bolt method each plant must be engineered individually according to the varying shapes of the exchange premises. The following article gives an account of a method now practised by Telefonaktiebolaget L M Ericsson, the frame work being assembled by means of friction clamps. By this method a desirable standardization and simplification is obtained with regard to engineering lay out as well as production and erection.

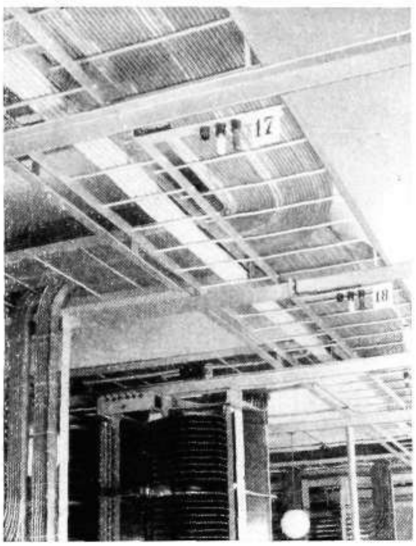


Fig. 1 X 6406

Racks and cable ladders in an automatic telephone exchange

old method with bolt and unit assembly

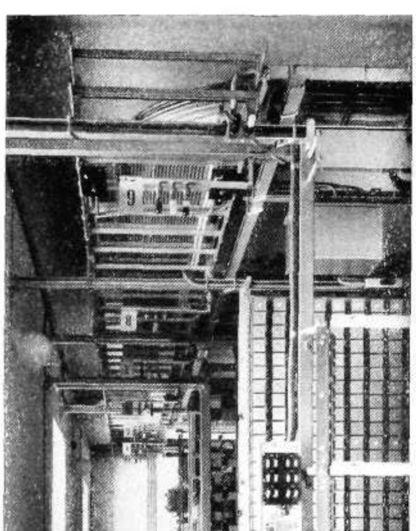


Fig. 2 X 6406

Racks and cable ladders in an automatic telephone exchange

new method with friction clamp assembly

The racks in a telephone exchange, containing selectors, relays etc., are as a rule arranged in rows and joined together by top and bottom girders. The various rows of racks are secured by means of tie bars traversing the top girders. The cable ladders required for the wiring between the racks are mounted on the top girders and the tie bars. The dimensions of the frame work components are, however, individual for practically every plant depending on the premises and the circuit conditions. The engineering of these components, simple enough in themselves, is complicated and often results in delay in deliveries.

The floor plans are seldom alike for two exchanges, as they depend on the shape of the exchange building. Top and bottom girders, tie bars and cable ladders vary, therefore, considerably for different exchanges. Individual drawings must be prepared for the drilling of holes required for bolt mounting, making standardization extremely difficult. Fig. 1 and Fig. 3 show an automatic telephone exchange where the frame work components are assembled with bolts. All bottom and top girders, tie bars and side bars for the cable ladders are provided with a large number of holes for the joining of the racks and the fitting of supports, angles, extension bars, fuse holders, rungs etc. Some of these components cannot be completed in the factory but have to be cut to size and provided with additional holes on site. Sometimes they have to be remade owing to the customer's building drawings being incomplete or even incorrect. Walls or doors may have been altered without notification, since the original drawings were made, or exact dimensions may be missing. The cable ladders often have to be altered or diverted — round a pillar, under beams, piping or ventilation shafts, past panels for the electric mains, radiators etc. The erection of racks and cable ladders will under such circumstances be very tedious and require excessive time and labour. Delays and dislocation in the installation work is often caused by these modifications and other difficulties resulting from individually engineered frame work constructions.

Frame Work Components with Friction Clamps

In order to overcome these unpredictable conditions in a rational manner, standard units have been designed for top girders, tie bars and cable ladders. These units are manufactured without holes for assembly and are joined by means of friction clamps of different kinds depending on the specific purpose. Fig. 2 is a main view showing the application of the new method. It will be seen that the top girders are fixed to the top of the racks by means

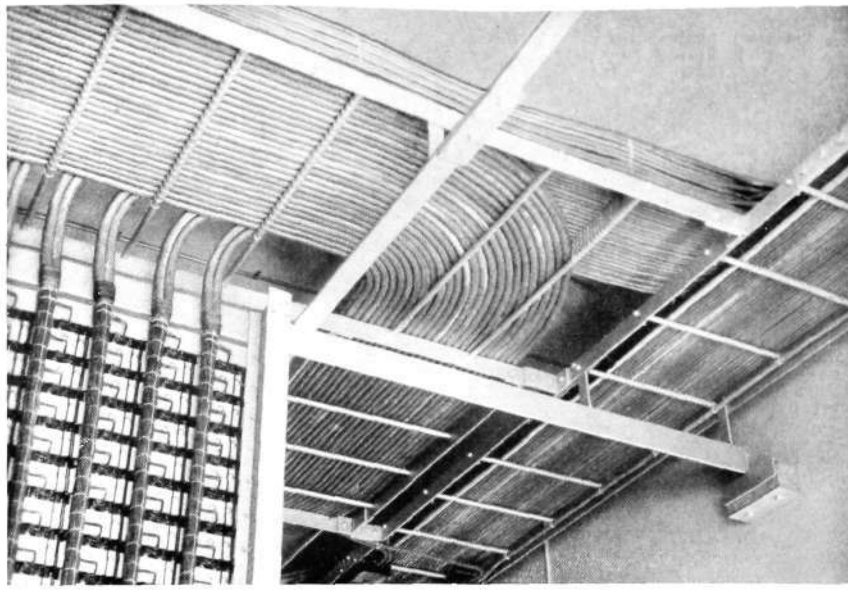


Fig. 3 X 6407

Joints and assembly according to the old method

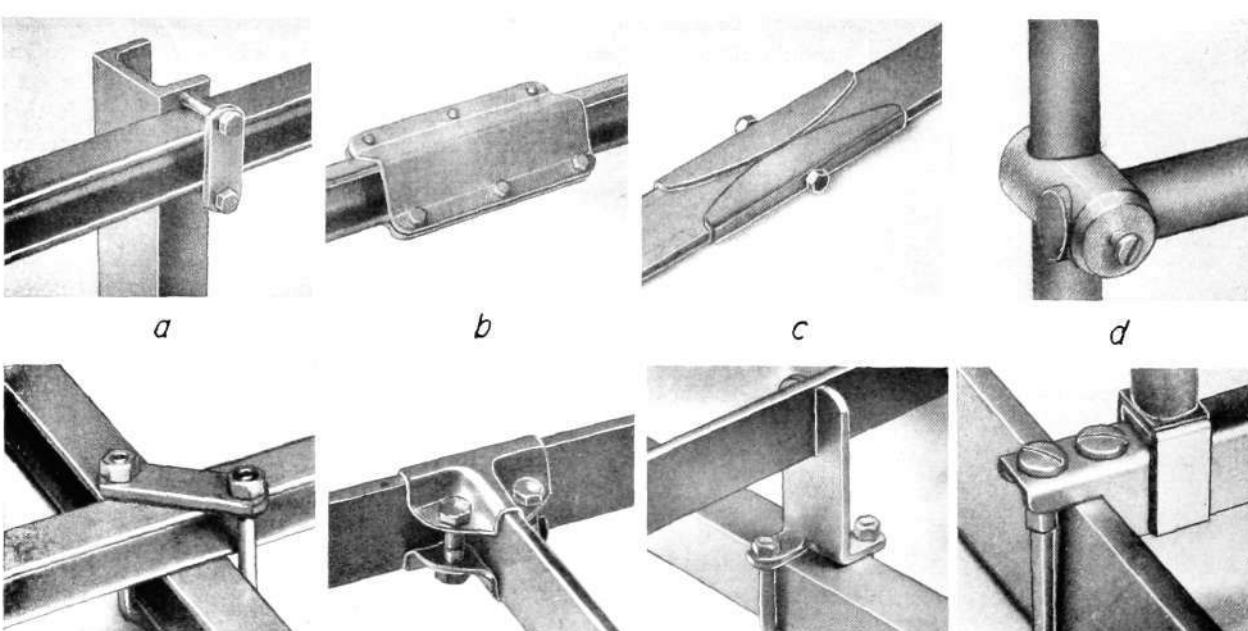
the cabling is laced to the cable ladders

of bolts and clamping plates or brackets. Top girders and traversing tie bars are joined by means of brackets and plates, Fig. 5, left.

The rungs in the cable ladders were previously made out of round rod with a tapped hole at each end. These are now replaced by mild steel strips bent lengthways to a U-section and clamped on to the side bars of the ladder. If the position of some rungs should be inconvenient or if they are obstructing the passage for the cables down to the racks, they can easily be moved along the ladder.

The supports carrying the cable ladders are fixed to the top girders and the tie bars by means of clamping brackets. The top ends of the supports are each provided with a slot which engages the side bar of the ladder. With a slight twist on the supports the cable ladder will be just as firmly secured as with bolt and nut.

Cable ladders are joined with two U-shaped channels embracing each side bar. The channels are clamped together by bolts and nuts and the friction is holding



a b c d

h g f e

Fig. 4 X 7549

The new type friction clamps

- a fixing top girder to frame column
- b joining top girder or tie bar
- c joining side bar on cable ladder
- d, e fixing rung on cable ladder and pillar for cable path (see also Fig. 7, centre), d shows the top part of a pillar
- f support for cable ladder
- g fixing row ladder to side ladder
- h fixing top girder to tie bar

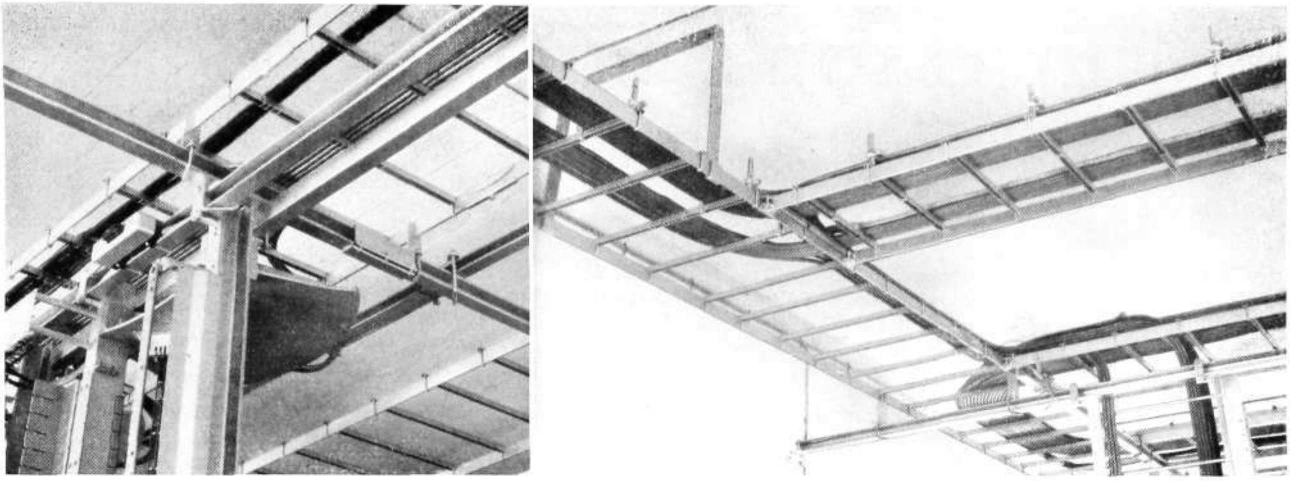


Fig. 5 X 7523

Joints and assembly according to the new method

the cable ladders have space for additional cabling required for extensions

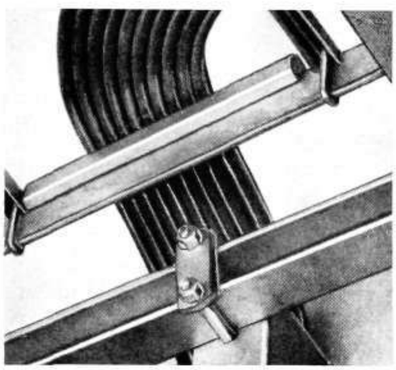


Fig. 6 X 4653

Detail view of cable run over side of ladder

The cable ladder is provided with a wooden strip protecting the cable from the sharp edge of the side bar.

Fig. 7 X 7524

Detail views

left, cabling running on separate levels: upper cabling running on supports to be lowered when final capacity has been reached in lower cabling, centre: cabling drawn according to the new method, right: joint on cable ladder rising from lower to higher level

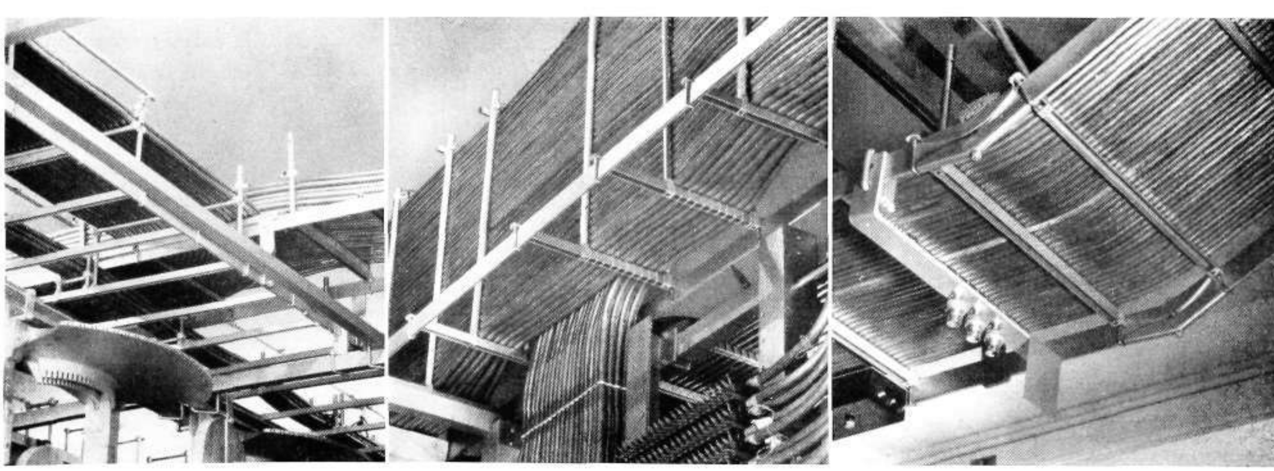
the bars firmly together. Joints on top girders or tie bars are made in a similar manner, the clamping pieces being somewhat different in shape.

Instead of lacing the cables, the new cable ladders are provided with vertical pillars which are clamped on the rungs in pairs. The cables are drawn in the path formed between these pillars. When the cabling is completed and adjusted, the pillars are joined in pairs by a traversing tube, which is pressed down over the cabling and clamped in position. In this way the tube, the pillars and the rung form rectangular frames conveniently spaced along the cable ladders and holding the cabling together. The vertical pillars are in places higher than the cabling, allowing space for additional cabling in case of extensions to the exchange.

In certain cases, however, the nature of the cabling may necessitate use of the older method of lacing the cables to the cable ladder.

Through the introduction of the clamping method of erection it is possible to manufacture a great number of required components for stock. By imagination and judgement a considerable number of ingenious combinations may be obtained, temporary as well as permanent. Fig. 7, left, shows an instance where the cables have to be drawn on separate levels. When the cabling on the lower level through extensions has reached its final capacity, the upper cabling may be lowered to bring it in its correct position.

With this new method the engineering time for frame work construction is considerably reduced. Frame shop production and erection has similarly been simplified, and it is fairly easy to make alterations, which for one reason or another may be required, without replacements or extensive modifications to the material already on site.



LM Ericsson's Factories

S EKLUND, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 061.5 L M Ericsson

Telefonaktiebolaget L M Ericsson has its seat in the Swedish head factory of the group at Midsommarkransen, Stockholm, which was taken into service in 1940.

The acquisition of this up-to-date plant provided considerably augmented facilities of manufacture compared with those available in an old factory plant situated in the central part of Stockholm. The rapid expansion of the undertaking, however, soon made it imperative still further to increase capacity, and this was done by finding accommodation for certain sections of manufacture in new factories, some in Stockholm and some in other towns of Sweden where facilities for rational manufacture were to be found, not least as regards supply of labour.

The present article gives a brief account of the head factory at Stockholm and the branch factories attached to it.

The factory erected by Telefonaktiebolaget L M Ericsson in the eighteen nineties at Thulegatan in Stockholm was at the time a pattern plant. The undertaking grew rapidly and reconstructions and additions had constantly to be made during the following decades. When around the nineteen thirties the limit of what was possible in this direction was reacted, operations must be moved to a new factory, which had already been planned and this was ready for occupation in 1940, at Midsommarkransen, Stockholm. The new premises not only provided a very appreciable gain of space — the floor space was 47 % more — but moreover benefits regarding light and pleasant conditions, such as it is impossible to express in figures, were obtained.

The establishment at Midsommarkransen has a floorspace of 78 000 m² and, in addition to the manufacturing workshops, offices and laboratories, it houses the central administration organs of the L M Ericsson group. It is arranged in one low block for heavy industry, the low block, and a more lofty block for lighter industry, the high block, these being separated from each other by a drive 9 metres wide, though they communicate with each other on an upper floor by three communication passages. Besides these two blocks, together covering an area of 130 × 230 metres, there is a separate office and laboratory building with the 72 m high wireless tower, designed for research as well as practical operation in the field of short wave wireless.

The high block is built around two large courtyards and on its two lower floors it provides space for assembly departments, test rooms and storerooms for components. The top floor houses the offices and a number of laboratories. The low block, consisting of a single storey construction, is mainly given up to a large machine hall with over 10 000 m² floorspace. Here all heavy processing and manufacture such as pressing, turning etc. is carried on.

Fig. 1 X 4652
The old factory at Thulegatan
gradually extended to comprise the whole block.

In this connection it may be mentioned that L M Ericsson's automatic lathe department is the largest in Scandinavia; the pressing and turning departments have a manufacturing capacity of some 5 700 000 components per week.

The factory at Midsommarkransen was probably at the time of erection the largest industrial building in Europe and it did seem that the space it made available would be adequate for a quite extensive expansion of the business. Nevertheless, when the second world war ended it was found that the demand for L M Ericsson's products was so great that it could not be anything like satisfied without very considerable extension of premises and machinery. Such extension, owing to the difficulty in obtaining a sufficient supply of labour, could only be partially arranged in Stockholm, where in 1947 a new telesignal factory was opened at Gröndal.

In many respects it would have been preferable for the undertaking if the new factory premises required could have been put up in the neighbourhood of the head factory. The shortage of labour in Stockholm together with the general tendency, directly encouraged by the authorities, to decentralize industry were more important considerations. The Company therefore looked round for facilities for founding branch factories in other parts of the country and gradually agreements were reached with the local authorities at Karlskrona, Söderhamn and Katrineholm and in these towns the larger branch factories of L M Ericsson have been located, each factory being devoted to a special side of manufacture.

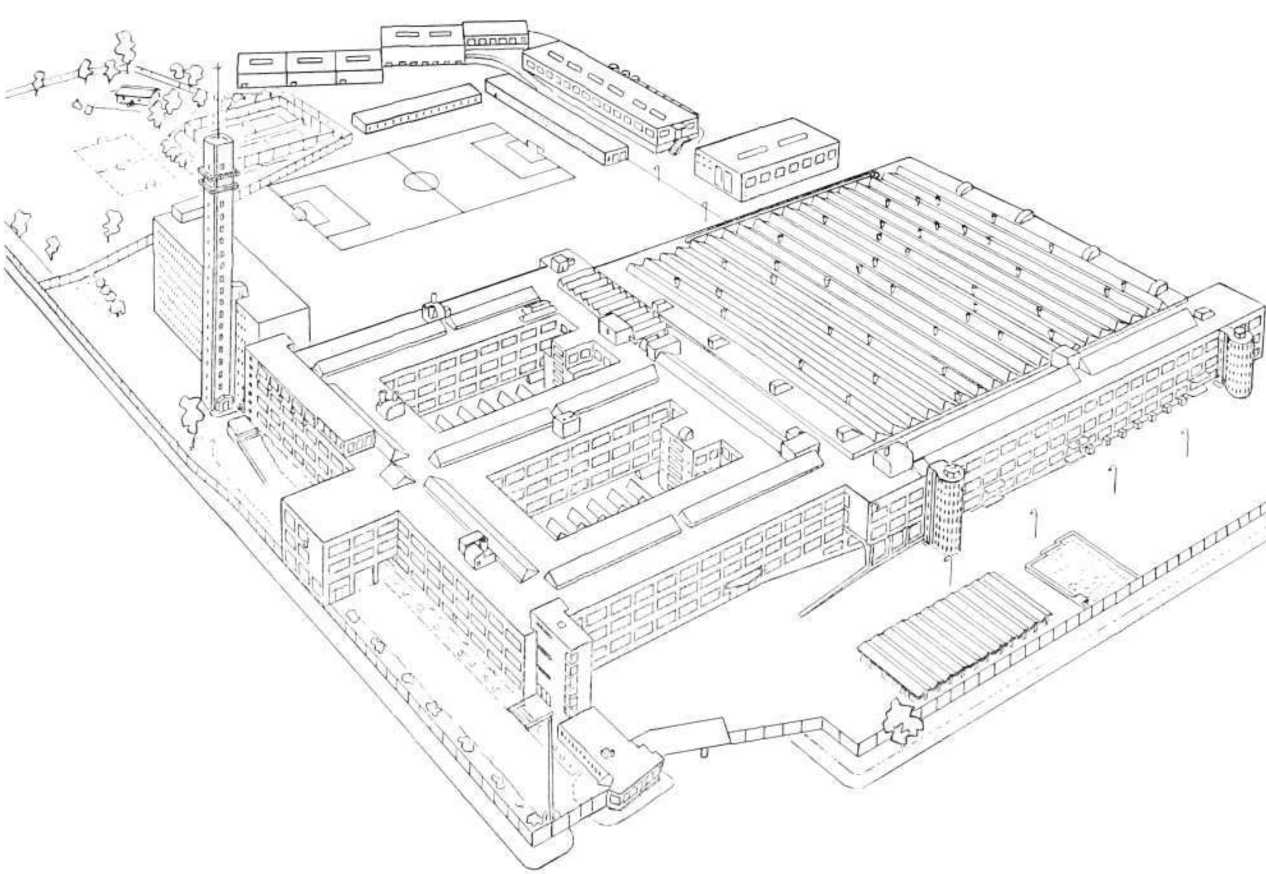
Complete particulars of L M Ericsson's comprehensive manufacturing programme covering most fields of teletechnics is outside the scope of this brief account. While the chief weight as regards manufacture lies of course in the sphere of telephony, in which the undertaking's contributions are widely known, not least in the field of automatic telephony, yet as suggested above many other branches of manufacture have been taken up in the course of time. Thus L M Ericsson manufactures in its own workshops, or in those of companies belonging to the group, all kinds of telesignalling material, electric measuring instruments, fire and burglar alarm installations, wireless receivers, machines for material testing, appliances for production control, time recorders, besides cable and wire for telephone purposes.

At the head factory it is mainly telephone switchboards, automatic and manual, that are produced, besides a certain amount of signalling material.

The manufacture of telephone instruments is done in the factory at Karlskrona, which with its 12 500 m² of floorspace is the largest of the branch factories. The ultramodern moulding compression department at the Karls-

Fig. 2 X 7548

The new plant at Midsommarkransen, Stockholm



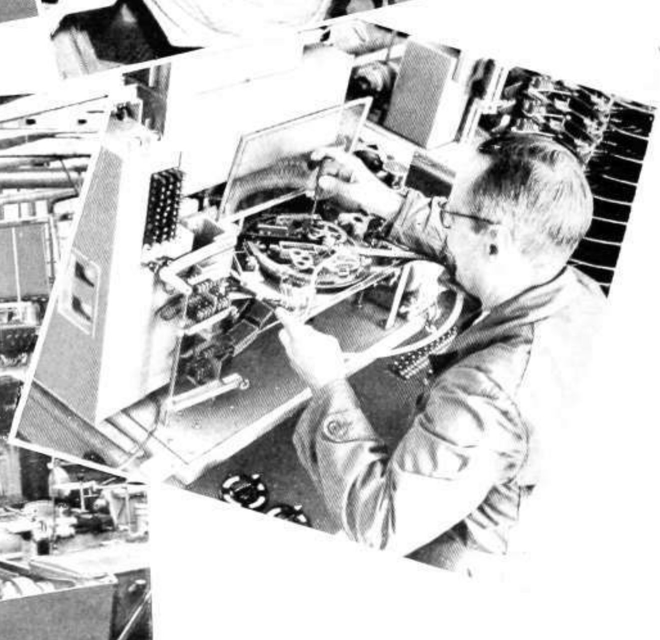
Some views of the L M Ericssons factories

Head factory

Left: View of the automatic lathe department, where 150 million components are manufactured annually; below, assembly of crossbar switches.

Below: The assembly and adjustment of telephone relays is done on light airy premises. The work calls for great experience and accuracy.

Left: Winding of coils for telephone instruments etc.; below: Before leaving the factory every 500-line selector is checked in this automatic testing set.

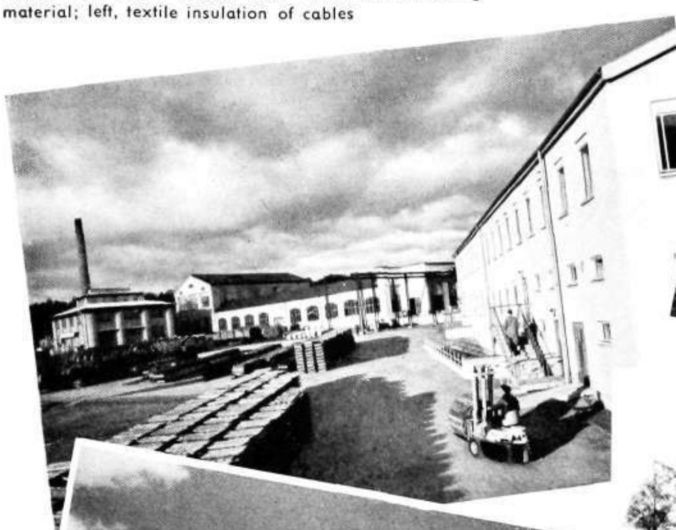


Left: Press tools, drill jiggers, lathe fixtures etc. are made in the tool department.

Branch factories

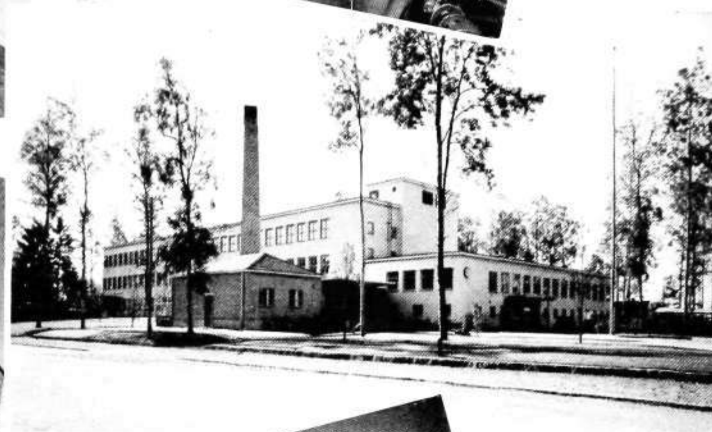
Cable works, Älvsjö

produces telephone and signal cables, telephone and switchboard flexes besides other weak current wiring material; left, textile insulation of cables



Below: Factory at Katrineholm

producing relays, coils, gear-wheels and stocks, dies and taps

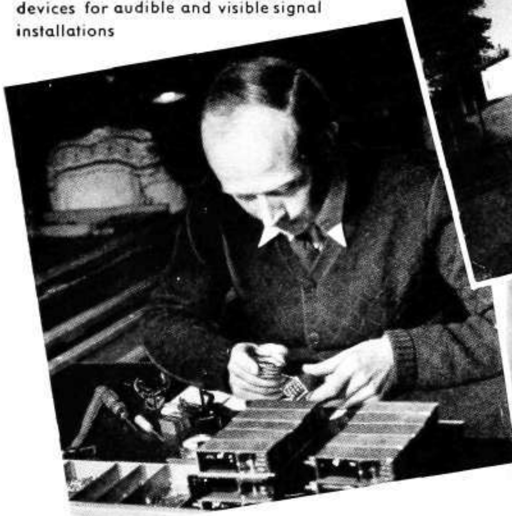


Above: Telesignal factory, Gröndal

producing telesignal material such as fire alarm telegraphs, fire alarms, centralographs, time recorders and devices for audible and visible signal installations

Left: Factory at Söderhamn

producing telephone dials, call meters etc.



Above: Adjusting call meters;

Right: Factory at Karlskrona

with a manufacturing programme including the assembly of telephone components

Fig. 3 X 6454

Section of the west front

showing the recently erected office and laboratory building and the 22 storey radio tower; in the foreground the well laid out sports ground

krona factory, dealing with the manufacture of the instrument cases for L M Ericsson telephones, constitutes one example of the excellent resources at the disposal of the factory. At these workshops, complete telephone instruments are manufactured, except for the dials which are made at the branch factory in Söderhamn. The Söderhamn factory also has on its manufacturing programme apparatus equipment for manual telephone switchboards and certain special relays. Finally the largest winding department of the undertaking is located at the factory in Katrineholm.

In the neighbourhood of the head factory are situated the L M Ericsson telesignal factory which has taken over the manufacture of telesignalling material, and also the company's cable works at Älvsjö, producing the cable and wire required by the undertaking.

Of the 13 000 or more persons employed by the Swedish undertakings alone of the Ericsson group, some 5 200 are at present engaged at the head factory in Midsommarkransen and about 2 600 at the branch factories working under the head factory. As a comparatively large part — approximately 30 % — of the labour is female, there have been established a number of children's day nurseries for the benefit of mothers working for the undertaking, where the children are looked after by trained children's nurses and are under constant medical supervision.

Fig. 4 X 4649

The sick clinic

at the head factory, Midsommarkransen, comprises, among other things, a complete X-ray installation

The founder of the undertaking, Lars Magnus Ericsson, was one of pioneers in Swedish industry in the social field and great efforts have always been made for the benefit of the employees. Proper sick care, thrift offices and athletic and club amenities supported by the firm may be mentioned in this connection. On the extensive site where the head factory is built there is a spacious, well laid out area for sports and games, comprising football ground, running tracks, jumping space, tennis courts etc. In the more cultural sphere there are facilities for an orchestra 45 men strong, two choirs, an amateur theatrical society, an art society and others.

The remaining 5 500 or more persons in the service of L M Ericsson in Sweden are employed by the undertakings belonging to the group and working under their own names. It is intended in future numbers of Ericsson Review to give brief accounts of these undertakings as well.

SRA Loud-speakers

E LINDSTRÖM, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.395.623

Nothing new of a revolutionary character has come to light in the loud-speaker field in the last few years. This does not mean that the loud-speaker designers have been idle. As a matter of fact, intensive work has been going on continuously in the laboratories in efforts to improve and simplify loud-speakers.

At Svenska Radioaktiebolaget, research has been proceeding for a couple of years on new and up-to-date premises which have been made available by the removal of manufacture to the factory at Hudiksvall.

The main object has been to raise the sound quality, reduce the percentage of rejects in manufacture by more adequate production methods and raise the reliability of the loud-speakers. Study of the latest discoveries in paper pulp research has enabled the designers to give the best form for sound reproduction to the diaphragm and the use of new apparatus has led to appreciable augmentation of production capacity.

A complete description of the design and method of manufacture for loud-speakers generally was given in an earlier article appearing in Ericsson Review No 1/1945, and it will therefore suffice now to furnish some explanatory text for certain new terms in the table below. This table shows the types of SRA loud-speaker systems, Fig. 2, now being made for sale by Svenska Radioaktiebolaget.

The second column of the table gives the overall size of the loud-speakers in both cm and inches. This has been done to allow of easier comparison of these loud-speakers with those of other countries.

Max. load, column 3, is given by two figures. The lower one refers to music reproduction with full register, the higher to reproduction of speech, i. e. without bass. It is the lower register, the bass, which imposes the greatest strain on the cone.

Technical data for SRA loud-speaker systems

type	size		max.[1] load	induction in air gap	total flux in air gap	voice coil impedance at 400 c/s	useful cone diameter	loud-speaker transformer matching impedance at 400 c/s	connection to loud-speaker output = 50 V
	cm	(inch)	watt	Gauss		ohm	mm	ohm	
HP 710/20	10	(4)	0.5— 1	7 000		20	86		
HPU 710	10	(4)	0.5— 1	7 000		20	86	(20) 1000 3000 7000	soldering
HP 713/4	12.5	(5)	1— 2	7 000	17 000	4	114		tag 3—4
HP 713/20	12.5	(5)	1— 2	7 000		20	114		
HPU 713	12.5	(5)	1— 2	7 000		20	114	(20) 1000 3000 7000	soldering
HP 918/4	18.5	(7.5)	5— 6	9 000	30 000	4	172		tag 1—2
HP 918/20	18.5	(7.5)	5— 6	9 000		20	172		
HPU 918	18.5	(7.5)	5— 6	9 000		20	172	(20) 100 500 1000 3000	soldering
HP 1021/4	21	(8.5)	7— 9	10 000	47 000	4	199	3500 4000 6500 7500	tag 4—5
HP 1021/20	21	(8.5)	7— 9	10 000		20	199	(20) 100 500 1000 2000	soldering
HPU 1021	21	(8.5)	7— 9	10 000		20	199	3500 4000 6500 7500	tag 1—3
HP 1230	30.5	(12)	15—20	12 000	120 000	8	275	(8) 125 165 250 500	soldering
HPU 1230			15—20	12 000		8	275	1250 2500	tag 2—3

1 The lower figure refers to reproduction with full register, the higher with smaller bass register.

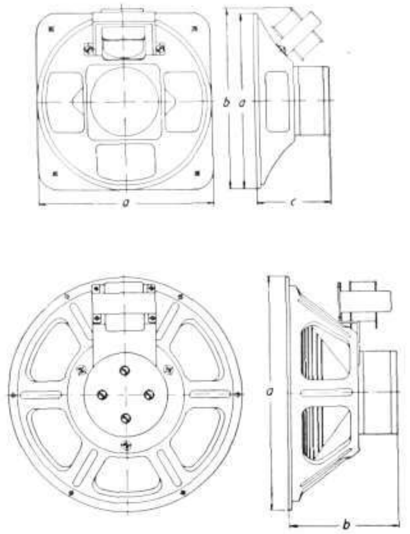


Fig. 1 X 4638

Dimensioned sketch of permanent dynamic loud-speaker HPU-2130

Exec.	a	b	c
1	97	—	55
1	97	108	55
1	125	—	60
1	125	—	60
1	125	145	60
1	186	—	82
1	186	—	82
1	186	190	82
1	213	—	108
1	213	—	108
2	305	—	160
2	305	—	160

Induction in the air gap, measured in Gauss, is an expression often misused by loud-speaker makers. A loud-speaker may have a high Gauss figure, without necessarily being a particularly good loud-speaker. The magnetic induction is measured by the number of lines of force traversing the air gap per unit area. By decreasing the length of the air gap and making the armature of thinner iron, it is possible to increase the induction up to a certain limit while using the same magnet. But the short air gap only allows limited movement of the cone, the voice coil then moving outside the air gap for the larger amplitudes.

A fairer measurement of a loud-speaker's quality is the expression of *the total flux of lines of force in the air gap* (column 5). This figure is arrived at by taking the product of the induction and the area. The area is then equal to the length of the air gap multiplied by the circumference of the hole. To raise the total flux it is always necessary to use a magnet of higher energy. The loud-speaker will then be more sensitive and will stand higher outputs. But, of course, the better magnet involves greater cost.

The *standard impedance* in the cone coils of the SRA loud-speakers has so far been 20 ohm. Many customers would like to buy this loud-speaker but would like also to connect them to any kind of receiver. Often these have an output impedance of 4 ohm and the SRA loud-speakers will in future also be made for this impedance.

Column 6 contains figures designating the *useful cone diameter*. Several booklets about loud-speakers talk of loud-speakers measuring so or so many inches in diameter. Generally no account is taken of how large a part of this diameter is required for glueing the cone to the chassis-edge, fixing devices etc. It is more correct therefore also to state how large the acting cone diameter is, that is the part of the cone which oscillates freely. SRA loudspeakers have large useful cone diameter in relation to the side of the chassis, as the glueing edge is only 4—6 mm wide.

Normalized Output Voltage

To simplify the installation and to obtain an upward limit for the output voltage, modern amplifier equipment is arranged for normalized voltage. This means that the output voltage will — within certain limits — be maintained constant even if the load is changed by varying the number of loud-speakers connected. This output voltage, according to »Swedish proposed standards for sound distribution equipment» is fixed at 50 V, when the amplifier is working with nominal output. The resulting load impedance must, of course, not fall below the amplifier's nominal output impedance, as otherwise distortion would arise at maximum output. (Nominal output impedance is defined by $\frac{50^2}{W}$ when W is the rated output of the amplifier.)

The normalized output voltage may be obtained in various ways. The most common way is to provide the amplifier with a feedback so that the open circuit voltage (i. e. at the load) does not exceed the double value of the voltage at full load, the input voltage to the amplifier in both cases being the same. The following example will serve to make this clear: If a 10 W amplifier delivers an output of, say, 4 W, equivalent to 30 V output voltage, and 8 loud-speakers are connected, that will represent 0.5 W per loud-speaker. If 7 of the loud-speakers were disconnected the remaining loud-speaker could not get higher voltage than $2 \cdot 30$ V $= 60$ V, equivalent to 1.8 W. Another way, rather more difficult to arrange, is the insertion with each loud-speaker's disconnection of an equivalent resistive load by means of a switch. The stabilization of output voltage may of course also be obtained by substitution of resistances for disconnected speakers.

Fig. 2 X 6449
SRA loud-speaker system

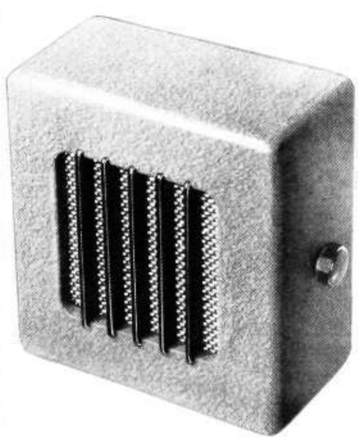


Fig. 3 X 4646
SRA loud-speaker

Matching

When planning a loud-speaker plant there is first computed the power utilized at the various outlets. The amplifier's output is arranged to correspond to the total power computed for the different loud-speakers.

The SRA loud-speakers for sound distribution systems with amplifiers from 10 W and more are always equipped with universal transformers giving several possibilities of choosing the value of the matching impedance. A label on the transformers gives directions how connections are to be made.

If the normalized voltage is fixed at V volts and if the loud-speaker is to handle W watts the matching impedance should be

$$Z = \frac{V^2}{W} \text{ ohms}$$

Z = the impedance at 400 c/s, V = the output voltage, W = the power.

Ex.: *HPU-918* should deliver normally 3 watts

$Z = \frac{50^2}{3}$; $Z = \frac{2500}{3}$; $Z = 833$ ohms. According to the table there are tappings on the transformer for the following impedances: 100, 500, 1000, 3000, 3500, 4000, 6500, 7500 ohm. The nearest value for which connection should be made is therefore 1000 ohm.

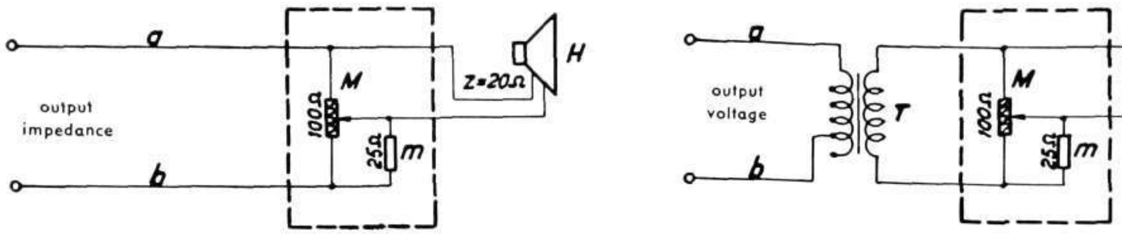


Fig. 4 X 6442 X 6443

Connection diagram for SRA volume control

Volume Control

At certain outlets loud-speakers with volume control are required and there must also be the facility of cutting out the loud-speaker. In private houses where one or more extra loud-speakers are connected to the wireless receiver, loud-speakers without transformers are used. The receivers have as a rule an extra loud-speaker terminal matched to 4 or 20 ohm. The SRA loud-speaker, Fig. 3, is suitable for use as such an extra loud-speaker. The system is an *HP 713* fitted in a wooden case of small dimensions and provided with SRA volume control. This volume control is coupled in to the loud-speaker system as per Fig. 4 to left. The resistance (*M*) for 100 ohm acts as potentiometer and the 25 ohm resistance (*m*) is fixed. When the volume control is in zero position this resistance replaces the loud-speaker. This means that there will always be an approximately constant load on the wireless receiver's output transformer; and the sound intensity is not altered on the receiver's own loud-speaker by variation of sound intensity in the extra loud-speaker.

The SRA resistance can also be employed with loud-speakers having universal transformers for connection to sound amplifying plants, the resistance being then inserted between the transformer and the loud-speaker, Fig. 4 at right.

For loud-speakers connected to amplifiers with normalized output voltage the volume regulation can be done over a choke coil (*D*) having 8—10 tappings. A switch is used to increase or decrease the voltage over the transformer.

When the loud-speaker plant is combined with an order giving plant, there must be facility of reaching the staff concerned with the orders, even if a volume control is in zero position, i. e. switched off for music. For this purpose there is employed a 3-wire system as per Fig. 5. The amplifier is connected by the circuit *a*—*b*. *c* is an auxiliary wire which runs to a switch. If *b* is connected to *c* the music circuit is in operation and the sound intensity of the loud-speaker can be regulated over the choke coil *D*, but if *a* is connected to *c* the order circuit is in operation and it is not then possible to shut off the loud-speaker.

The SRA loud-speaker systems may also be used as microphone. For manager's telephones, for instance, the microphone loud-speaker is convenient owing to its being unaffected by varying distance from the person speaking.

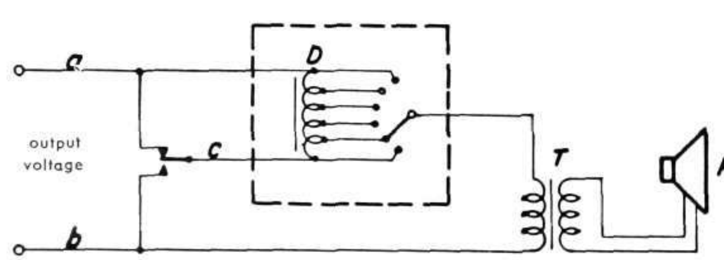


Fig. 5 X 6444

Skeleton diagram for combined music and order-giving plant

Sealing Ends of Rubber

O LÖTTIGER, SIEVERTS KABELVERK, SUNDBYBERG

U.D.C. 621.315.687.2

A new type of sealing end for paper-insulated cables has been put on the market by Sieverts Kabelverk. The sealing ends are manufactured of synthetic rubber. They are made in three types, GEI, GTI and GFI, and intended for indoor use.

There has often been need of a sealing end with smaller dimensions which is more adaptable than ordinary sealing ends with a body of cast-iron and insulators of porcelain. It is true that there exist sealing ends, where the paper insulation is surrounded by a cover of impregnated fabric tapes, but the applying of the tapes is time-consuming and requires considerable skill in order to secure a good result. The aim during the design of the new sealing ends has been to get small dimensions and a simple procedure of fitting. In the new sealing ends, an oil- and air-resistant synthetic rubber with good electrical properties has been used for the body as well as for the insulators.

To a limited extent, sealing ends of rubber were manufactured already before the last war. Due to the difficulties during the war of getting cast-iron details and porcelain for ordinary sealing-ends, the manufacture grew to a greater and greater extent.

The sealing ends of rubber are intended to be used in dry in-door premises. They are made for single-, three- or four-core cables and for up to 10 kV rated voltage.

Single-core Sealing End GEI

Sealing ends of rubber for single-core cables are shown in Fig. 1. The sealing end to the left is intended for small cable areas and the one to the right for greater areas. The sealing end consists mainly of a rubber tube and a top device. The tube is tightened to the cable sheath and to the top device by means of hose clips. The rubber tubes and the top devices are made with certain standard diameters. In order to neutralize great differences between the diameters of the tube on the one side and the sheath and the top device on the other side, cylindrical rubber packings are used between them.

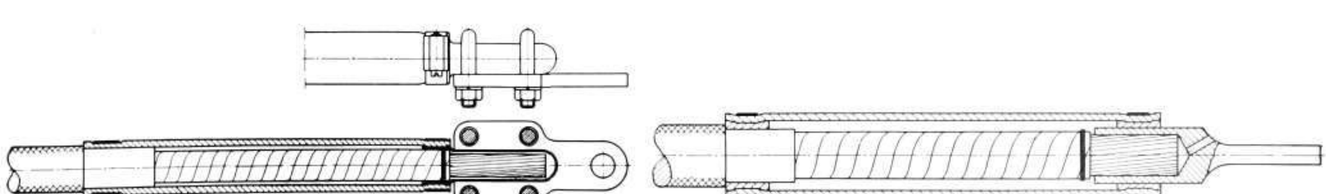
For the smaller areas the top device consists of a copper cap and a contact plate, the latter being shaped as a clamp with two straps. The desired contact between the conductor and the top device is secured by drawing the straps so hard that the copper cap is deformed. According to the special requirements, the contact plate may be fitted either parallel with or at right angles to the cable, as may be seen from Fig. 2. For greater areas the top device consists of a type of cable lug, which is soldered to the conductor. The lug is so shaped, that the rubber tube can be put in place after the soldering has been made.

Multi-core Sealing End GTI and GFI

A sealing end of rubber for multi-core cables is shown in Fig. 3. It consists of a number of single-core sealing ends, corresponding to the number of cable cores, completed by a common body and a branching device. The body is made

Fig. 1 X 7522

Sealing end of rubber for single-core cable
left, for cable of smaller area; right, of greater area



of rubber and the branching device of metal. The body is tightened to the cable sheath as well as to the branching device. If there is a great difference in diameter between the sheath and the body, a cylindrical rubber packing is used between them. The branching device has three or four openings, due to the number of cores of the cable. The rubber tubes, which surround each core, are slipped on the branches and fixed by means of hose clips.

The insulation of those parts of the insulation which pass the branching device is reinforced by means of oil-cloth tapes.

The sealing ends are pressure-tight and dimensioned for a rated pressure of 2 kg/cm². The rubber tubes are delivered in certain standard lengths. In some cases, it may be desirable to fit the sealing ends with cable cores of different lengths, see Fig. 3. For this purpose, the tubes may, on special request, be delivered with greater lengths than the standardized length.

The distances between phases and earth as well as between phases are fixed in an ordinary sealing end with rigid bushings. In a sealing end of rubber with its flexible cores this is, however, not the case. When fitting a multi-core sealing end, it is therefore necessary to make sure that the air distances between phase and earth and between phases are not smaller than the prescribed values for the rated voltage in question. Owing to the flexible cores it is also necessary to pay attention to the length of the cores and the fixing of the top device in order to avoid difficulties during short-circuits.

A special earthing device is used for the earthing of the cable sheath and the armouring. This device consists of a flat multi-conductor copper wire, the one end of which is connected to the sheath and the armouring by means of hose clips. The other end is connected to earth.

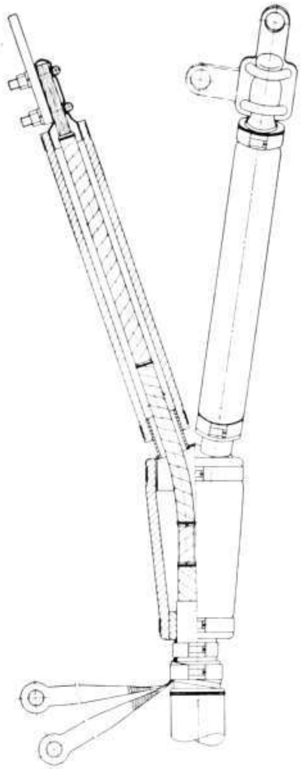


Fig. 2 X 4623

Sealing end of rubber for three-core cable

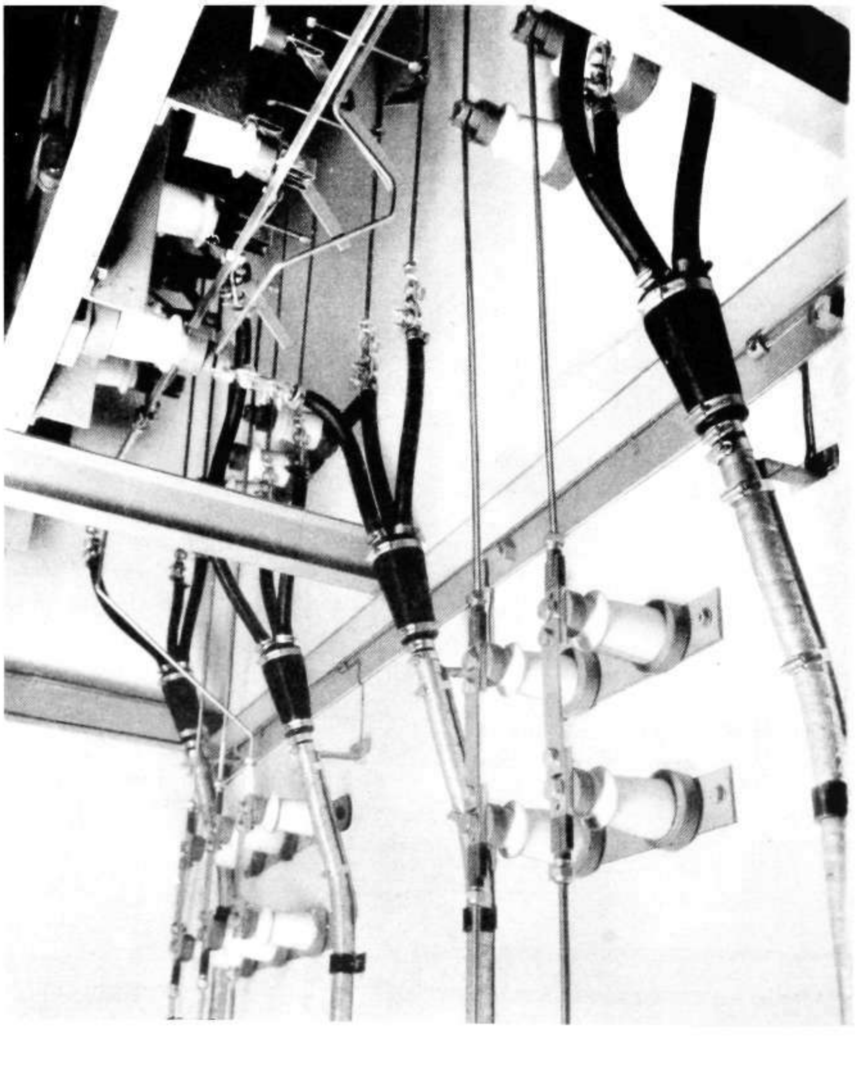


Fig. 3 X 6597

Sealing ends of rubber GTI

fitted in a switchgear plant

U.D.C. 621.395.343(861)

ANDO, B, FUNCKE, S & STEIN, A: *New Telephone Installation in Bogotá*. Ericsson Rev. *26* (1949) No. 3 pp. 74—85.

On the 28th of December 1948 automatic exchanges for 20 000 subscribers were put into service in Bogotá, the capital of Colombia. This is the first instalment of a telephone installation contracted by Telefonaktiebolaget L M Ericsson covering automatic telephone exchanges for 40 500 subscribers along with telephone instruments and network material.

The article gives a description of the new installation.

U.D.C. 621.395.22

SÖDERBAUM, C G: *New Loudspeaking Intercom Telephone*. Ericsson Rev. *26* (1949) No. 3 pp. 86—90.

Description of design, function and traffic facilities of the L M Ericsson new intercom telephone.

U.D.C. 621.395.722

ANDRÉ, N: *Frame Work Design for Telephone Exchanges*. Ericsson Rev. *26* (1949) No. 3 pp. 91—93.

An account of a method practised by Telefonaktiebolaget L M Ericsson, the frame work being assembled by means of friction clamps, a method giving a desirable standardization and simplification with regard to engineering lay out as well as production and erection.

U.D.C. 061.5 L M Ericsson

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CONTENTS

On cover: Row of racks with LM Ericsson's 500-line selectors in Storängen's automatic telephone exchange at Stockholm.

New Developments on the LM Ericsson Telephone System with 500-line Selectors

E LINDSTRÖM TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.343

During recent years the L M Ericsson system with 500-line selectors has been subject to considerable circuit revisions and additions.

The purpose of the following article is to give an account of some of the more important developments, referring in the first place to installations abroad. Relevant matter, which it has not been possible to include in this article, will be dealt with in a coming issue.

Development and improvement of a telephone system generally has two purposes. The first purpose is to make the system more reliable and economical in operation by means of improved design, changes to more suitable raw material and improved production methods. The second purpose is to add new traffic properties to the system by redesigning mechanisms as well as circuits, in order to meet the rapidly growing demands in this respect from the telephone administrations.

Instances of the first mentioned purpose are those steps, which have been taken in connection with the modernizing of the 500-line selector system, in order to increase operation margins for relays and selectors, making the system less dependent on voltage variations, wear on the material etc.

The following description will, however, in the main, be limited to changes relating to the traffic properties of the system.

Operating and Transmission Voltage

The operating voltage for the 500-line selector system is normally 24 V, and years of experience indicates that this voltage is extremely favourable from technical as well as economical point of view. The low voltage is causing a minimum of corrosion hazards in the network and is also of considerable advantage for exchange equipment, working with small power consumption for the operation of the selectors. The range of the system with regard to impulses and signals well covers the maximum requirements on line resistance and leakage, which may be permitted for other reasons in a network. It is, therefore, advantageous to retain the 24 V operating voltage.

The transmission voltage for the microphone supply is normally the same as the operating voltage.

For large exchange units with long subscriber's lines or for exchange groups with exchanges far apart, however, a higher transmission voltage is, in certain cases, economically more favourable with regard to the network. To meet these requirements the modernized 500-line selector system is supplied for 24 and 48 V transmission voltage alternatively. For the higher voltage a further battery of 24 V is included supplying additional positive voltage. This battery has a considerably smaller capacity than that for the operating voltage and is connected to the battery supply coils, which for 24 V are connected to earth. Remaining battery supply coils remain on the 24 V negative, making an aggregate transmission supply of 48 V. Provisions are made in all circuits for this modification and no alterations are necessary when the additional voltage has to be introduced.

This system consequently offers all the advantages of a low operating voltage and at the same time the possibilities of a higher transmission voltage when necessary.

The additional positive voltage is also used as signal voltage for certain complicated traffic conditions, a considerable simplification in the equipment then being attained.

Registers

Register control for establishing automatic telephone connections is nowadays generally used for telephone systems where maximum adaptability is required with regard to grouping and number distribution and where uniform numbering of subscribers has to be introduced.

The interconnected areas of automatic telephone traffic are gradually increasing in size. Towns and communities, which were previously separate automatic exchange units, are now united into larger traffic areas. For such areas there are generally certain minimum requirements with regard to numbering and grouping in order to simplify the telephone procedure for the general public.

For these problems register control of the connections offers a rational and easy solution.

The scope of the register being continuously increased, the requirements on the circuit adaptability is correspondingly increased. Some actual requirements may be indicated here. By means of minor reconnections the grouping in an area has to be adapted to changes in subscriber distribution; direct control of selectors or repeating of registered digits has to be arranged depending on the size and type of the units, which are otherwise engaged on establishing a connection; for traffic with other network groups and districts the register shall allow the use of numbers with considerably varying number of digits.

The 500-line selector system has, therefore, been provided with a new type of register, which will cover the exacting requirements on a register for modern and extensive telephone networks. This register includes a crossbar switch as storing device for the digits and relays for receiving impulses and controlling the connection procedure, see Fig. 1. The following advantages are obtained by this new method:

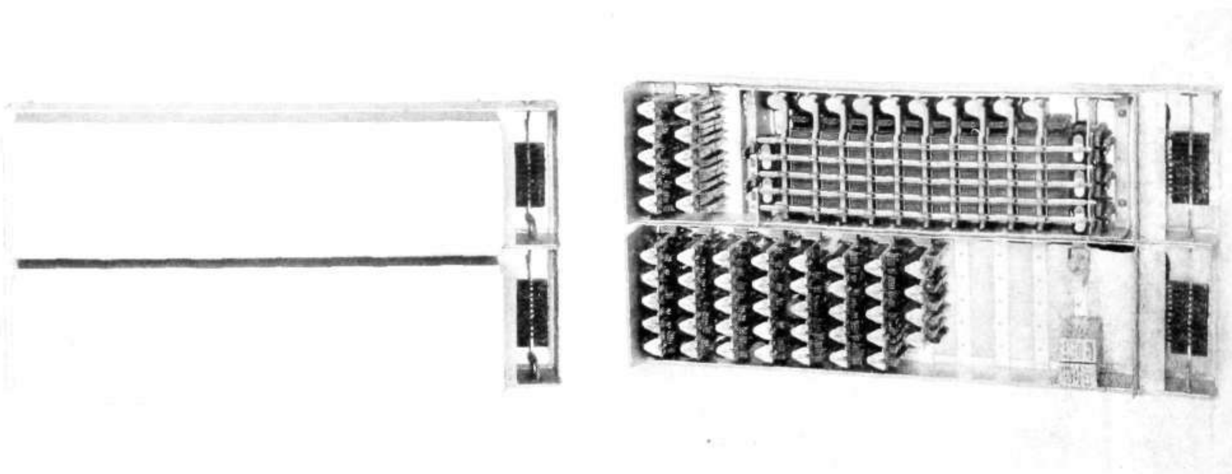


Fig. 1
Crossbar register
left exterior, right cover removed

X 7553

a) increased number capacity
b) considerable adaptability with regard to grouping
c) reduced holding time
d) more reliable reception of impulses
e) increased reliability in operation
f) reduced maintenance
g) increased facilities for supervision
h) silent working

The crossbar switch in the register is only used to store number combinations received from the subscriber's dial. In principle one vertical unit in the switch is used for each digit. For certain digits in the number, however, two vertical units are used, in order to obtain complete freedom in establishing the number of directions in the multiple of the first group selector in the most convenient way and to adapt the number capacity of these directions according to the actual requirement. As a rule it is sufficient to duplicate the vertical unit for the 10 000 group digit in order to enable arbitrary division of 10 000 group or to enable unification of 1 000-groups from different 10 000 groups to one exchange or group of exchanges. The number reserves will in this way be common for the whole of a number area and may be used on points in the network where they are most required without tedious replanning. This means that introduction of additional digits for subscriber's numbers will not be necessary unless all numbers in the reserve are exhausted.

The registers are built for a maximum of nine digits, which is quite sufficient for most national networks. These numbers include prefixes for network groups as well as subscriber's numbers within the network. With six digit internal numbers throughout the networks, 100 network groups may be contained in the same numbering system with three digit prefixes, and yet a common first digit be used for transfer to outside network groups. In the case of one network group having seven digit numbers, this is allocated to a two digit code number. Network groups having five digit subscriber's numbers may if so required be allocated four digit code numbers. The total number of digits in a number may be chosen indiscriminately from nine and downwards and may be different for calls to different network groups.

Disconnection of the register takes place by a signal from the junction, when the required number of digits has been transmitted to get connection with the called subscriber.

The register is provided with a relay chain for instantaneous registering of the impulses from the subscriber. The chain consists of quick operating relays with uniform operating times.

As soon as an impulse train is completed, the condition of the relay chain is transferred to the crossbar switch. The crossbar switch is a five bar selector having ten bar positions. Each digit in an impulse train corresponds to a bar position. When a digit is to be transferred from the relay chain, the bar corresponding to the registered digit is operated immediately followed by the vertical unit or units on which the digit is to be stored. The bar and the relay chain is released, the register being ready to receive the next digit. The transfer of the digits to the crossbar switch takes place very rapidly.

The selector bars could just as well be operated immediately from the impulse relay. It has, however, been considered important to allow wide limits on the speed and rate of the dial impulses and in view of this the intermediary relay chain has been introduced between the impulse relay and the crossbar switch.

In the same way a relay chain is used to register the impulses from the selectors, when these are operated. The digit positions on the vertical units of the crossbar switch are successively transferred to this relay chain, which has 25 different translating positions corresponding to the number of directions in the multiple of the 500-line selector. Only positions relevant to the pertaining selector are connected. In this way it has been possible to use the same relay chain for the control of the movements of all selectors taking part. This relay chain is also equipped with quick operating relays and the safety margins for the selector movements are consequently considerably increased.

A further relay chain will be found in the register governing the successive connection of the translator circuits to the revertive impulse chain at a rate as may be permitted by the registering of the impulses from the subscriber's set.

The digits registered on the vertical units may be used for immediate operation the 500-line selector, the digits being combined according the 500-grouping, or for direct reproduction in the form of decimal translation. Decimal translation is used for cooperation with exchanges having direct drive system (step by step systems) or with register controlled exchanges not having 500-grouping or when exchange junctions are such that direct operation of selectors would become uneconomical, for instance with voice frequency impulses or certain cases of low frequency A.C. impulses.

For the decimal translation the same system for start and impulsing is used as for the operation of the 500-line selectors. The junction repeaters are provided with equipment for direct impulses on the junction at the same rate as the revertive impulses transmitted to the register. Transmission of a digit cannot commence until the starting relay in the repeater equipment has been connected against the register. It is, therefore, possible to control the digit transmission rate from the junction, which means that cooperation may be arranged with exchanges having completely different systems of impulsing without causing complications of the registers.

The junction repeaters are adapted to the exchanges connected. For cooperation with step by step systems the minimum time between digits may be controlled in the outgoing repeaters. For register controlled systems or systems working with proceed-to-send signals, the start of impulse transmission may be controlled over the junction from the incoming line equipment.

Decimal translation is controlled by rigid connections in the register for a certain series of numbers, for instance a 10 000-group or directions, which refer to other network groups. For smaller series detached from 10 000-groups and otherwise in line with 500-line selector systems, transfer to decimal translation is signalled from the junction equipment. The group selector stages in the originating exchange generally work according to 500-grouping.

Registers intended for connection of trunk calls and operated from the trunk exchange in the same place are provided with key sending equipment. The relay chain for the dial impulses will then be replaced by a relay set adapted for reception of instantaneous D.C. markings from the key board. Transmission from the key board takes place over the line wires in the junction.

For small installations the same register is often utilized for both subscriber and operator traffic in order to increase employment of the small register groups. The usual rigid register connection is used for the local traffic, whereas trunk connection lines are equipped with register finders.

In such cases the registers are sometimes arranged to operate from dial impulses as well as from key boards. The relay chain is normally connected for dial impulses, but when the register is engaged from a trunk call junction, the key operated equipment is connected on a signal from the line equipment.

This type of combined registers are also used for automatic trunk traffic, operator controlled or fully automatic. Certain lines may then be equipped for normal dial impulses, for instance when low frequency signalling current is used whereas other lines are arranged for key transmission, as in certain cases of voice frequency signals.

In 500-line selector systems the traffic observation is carried out in connection with the registers. The introduction of the new register has simplified the observation equipment and increased the efficiency. Disturbances of different kinds may be differentiated immediately at the observation desks and the dialling from the subscriber may be supervised. Each observation position is for this purpose equipped with a simplified observation register and a corresponding lamp board. The register to be supervised is connected to the observation register by pressing a corresponding button, the registered number being indicated on the lamp board.

As in this way full information regarding the condition of an incomplete connection is obtained at the observation desk, the majority of reasons for traffic interruption may be verified without intervention of the service staff.

The register is provided with a time controlled alarm device signalling the observation desk, when the engaged time is excessive. This time device may be arranged in such a way that calls engaging the registers excessively are diverted to a separate alarm device connected to lines in the multiple of the first group selector disengaging the register. Such calls are generally caused by the subscriber omitting to replace the receiver but also by short circuits on the lines. Alarm from the latter alarm device is, therefore, issued after a comparatively long time. In this way most false calls are eliminated without intervention of the service staff.

Wrong dialling for instance to 10 000 groups not in service are similarly directed to a common alarm or supervision central.

All contacts in the register being twin contacts and all circuits being equipped with well balanced spark quenching, a very reliable register has been obtained requiring a limited maintenance comparable to that for a common well designed relay circuit. The restoring time for the register amounts to a few milli seconds reducing the holding time by approximately 15 % as compared with earlier registers with rotating selectors and motor driven homing.

As all switching is carried out by relay mechanisms, the register is silent in operation. The registers are mounted in double-sided racks. Each single panel takes 6 registers. The fuse strip for each panel carries, besides fuses and blocking buttons, also a multiple jack for connection of testing equipment.

Testing may be carried out with manual testing equipment or automatically by means of a routiner independently carrying through the testing of all circuits.

Loop Control of Selector Operation

The earth connection between exchanges in the same network is often not satisfactory or free from interference and cannot then be used favourably for the low voltages generally required for an automatic telephone system. The interferences are usually caused by stray currents from electric trams and railways. It has also happened that ground conditions are such that earth connection between the exchanges is altogether non-existent.

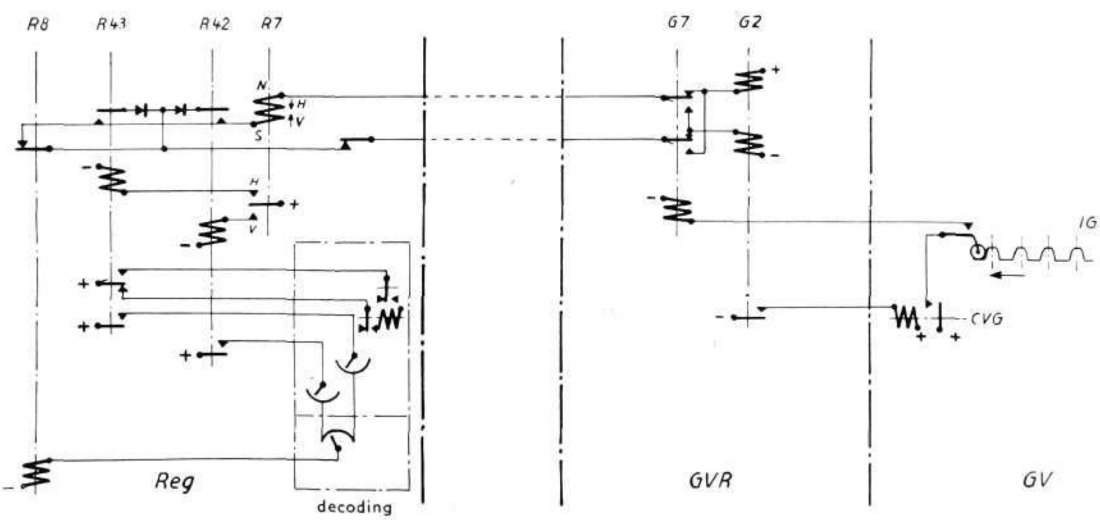
In such cases it is necessary to introduce loop operation of impulses and signals between the exchanges.

In order to meet these requirements without introducing repeaters on the junctions for impulses and signals a new method has been developed for direct control of the selector operation, see Fig. 2. This method is based on reversed impulses, giving a reliable and non-critical impulse transmission for extremely variable line conditions. The impulse relay in the register is a polarized relay in order to obtain rapid and accurate reproduction of the impulses.

Fig. 2 X 7550

Circuit diagram

showing loop control of selector operation
- CVG locking magnet for the rotating movement in the group selector
- G group selector relay
- GV group selector
- GVR group selector relays
- IGV impulse contact for the rotating movement of the group selector
- R register relay
- Reg register



The start relay $G2$ in the controlling relay set for the selector has two identical windings for the *a*- and *b*-wire. The start of the selector takes place, when the loop is closed in the register, the impulse relay $R7$ then being connected in the circuit.

Impulsing takes place by means of polarity reversal at the start relay for the selector. The selector giving a make for odd positions and a break for even position, the polarity will be reversed for odd and restored for even positions.

The displacement between a certain make or break on the impulse contacts in the selector and the corresponding multiple position is, as previously, exactly one multiple division, but the decoding in the register operates one more step in advance. If the selector is to be directed to the first multiple position the register is decoded on the first operation of the impulse relay *i. e.* when the starting loop is closed. This prepares the breaking of the starting circuit, whereas the start relay is held by a rectifier being connected in the circuit.

On the first reversal of polarity the starting circuit is blocked by the rectifier and the start relay for the selector is released. The opening of the starting circuit consequently requires no time wasting operations on the part of the register. Apart from the advantages mentioned above the new method of revertive impulsing consequently also results in a further improvement of the safety margins in the selector control, already ample with earlier methods. With 24 V operating voltage the system will operate with satisfactory safety margins for a loop resistance between 0 and 2 000 ohms. The number of junctions in series is immaterial as long as the loop resistance is limited to 2 000 ohms. Compensation of the impulse circuits for the resistance of the junctions is consequently not required.

The necessary changes in the system for the introduction of loop impulses are mainly of circuit nature, but a certain revision of the selector itself has been carried out in order to obtain better adaptability to the new circuits.

Alternative Routes

In a telephone network, for instance a city network, covering a comparatively limited area but containing several exchanges or exchange units of approximately the same size, the junctions between the exchanges are generally arranged in such a way that each exchange has direct junctions to all the other exchanges or exchange units. In the case of a system with 10 000-grouping direct junctions are employed to each 10 000-group. The reason for this is, of course, the endeavour to reduce capital cost of the exchange equipment as far as possible, although a certain simplification in the fault finding between the exchanges also is obtained.

When such a network is extended and new exchanges and exchange units are added, the traffic from a certain exchange will be distributed in an increasing number of directions resulting in a reduction in the traffic quantity in each separate direction. The number of lines per direction is diminished and when the line groups have reached a certain reduction, the traffic handling capacity of each separate line is diminished, resulting in a disproportionate increase in capital cost. Measures to increase the efficiency of small line groups are, therefore, in such cases extremely important from economical point of view.

L M Ericsson have, therefore, developed a method for so called alternative routes in connection with 500-line selectors. The bulk of the traffic in a certain direction is operating over direct junctions to the required exchange, whereas the remainder is directed over a tandem stage in one of the central exchanges and is mixed with the outgoing traffic from this exchange to the destination exchange.

By judiciously gauging the traffic on direct junctions in relation to the tandem directed traffic the direct junctions may be utilized with very high efficiency. The tandem route can generally be made common for the residue traffic for all outgoing directions from an exchange. In this way the route will be comparatively large increasing the traffic capacity of the individual lines. By this method the more fundamental disadvantages of small junctions are eliminated.

The circuits are comparatively simple, Fig. 3. A signal wire is arranged from each direct route, indicating at any instant if free lines are available in the junction or not. These signal wires are connected to control devices, termed markers, each being connected to a corresponding group of registers. The size of the register group is dependent on the amount of outgoing traffic, but even for very large networks a marker may clear the traffic from 30 to 40 registers.

When a register has received the number of digits in the called number required to establish the direction in the multiple of the first group selector, the marker is connected if this direction has alternative routes. The connection of the marker takes place through one relay operation, the number for the direction subsequently being instantaneously transferred from the register. The marker is always containing actual information regarding the traffic conditions on the various routes and is capable of giving immediate indication to the register as to suitable route. If a free line is available in the direct junction this is indicated by the operation of a relay in the register. If a tandem route is to be used the marker is disengaged from the register without issuing signal. By means of this method of signalling, a call will be directed over the tandem route, if the marker, being temporarily blocked, is unable to control the call.

The holding time for the marker is approximately 125 msecs per call. Load and permitted waiting time for the marker is gauged so as to make occurring congestion negligible.

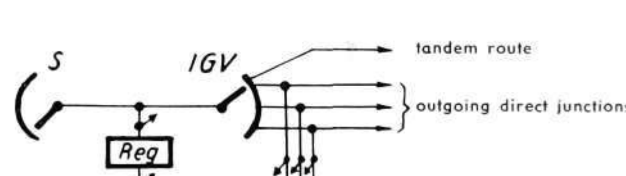
The method may be applied by comparatively simple means to existing installations of older type.

Fig. 3 X 4654

Routing diagram for group selector stage

showing marker equipment for alternative traffic routes

IGV first group selector
M marker
Reg register
S line finder



Two-wire Junctions

Three-wire junctions between telephone exchanges are generally not provided with separate repeater equipment for test and signals, the third wire being used for this purpose.

The three-wire method gives the simplest technical solution with regard to the exchange equipment, but suffers, for one thing, from the disadvantage that the comparatively sensitive test circuit easily may be disturbed by stray currents and possible differences in earth potential between the exchange.

These difficulties may be eliminated by the introduction of relay equipment on the junctions. With suitable design of this equipment and certain adaptive measures in the system it is, however, possible to dispens with the third conductor. The problem is, therefore, of considerable economical importance for the junction network. In town networks with limited distance between the exchanges, three-wire junctions are still extensively used, as reliable terminal equipment for two-wire junctions so far has proved comparatively expensive. For this reason they have not been profitable except for fairly long junctions.

The following properties should be covered by a two-wire system. All external disturbances in the test circuit must be eliminated. There should be adequate safeguards against parallel test and inadmissible seizing of other connections. The system should contain provisions for blocking the line both at the incoming and outgoing side and it should be sufficiently simple and inexpensive to make it economically justified even for comparatively short lines.

In connection with the modernization of the 500-line selector system L M Ericsson have developed terminal equipment for two-wire junctions meeting the above requirements, see Fig. 4. The test is arranged over an internal circuit in the outgoing line equipment, the control of the line and the equipment on the incoming side being carried out with a high resistance relay in the line circuit. When the line is available this relay is operated closing the test circuit.

The incoming line equipment and the group selector are engaged, when the numerical operation of the group selector is starting, and are then held by internal circuits.

The release of the connection is effected by an A.C. impulse transmitted from the outgoing repeater. The alternating current ignites a discharge tube, connected between the line wires in the incoming equipment. The release relay, being connected in series with the tube, operates and breaks the internal holding circuits restoring the selector.

As the ignition of the discharge tube is loop operated the connection is protected against release from atmospheric interference even if bare conductors are used. The line may be blocked from any end, but arrangements are made for the personnel on the outgoing side always being informed if a line is in traffic or not.

If the line is blocked on the incoming side by means of the blocking button or if the selector is removed or if the control circuit in any other way is inter-

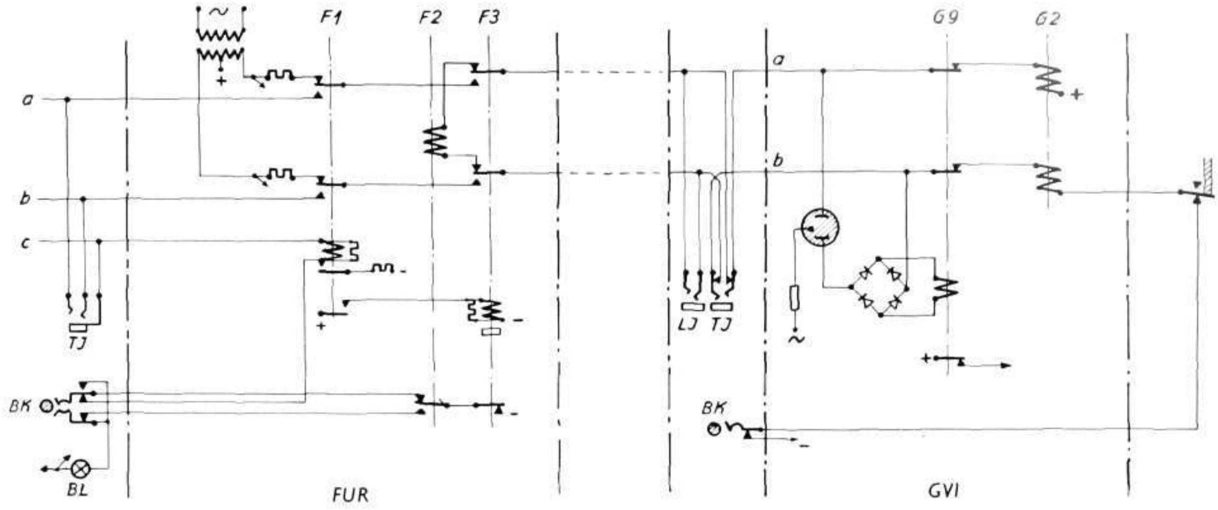


Fig. 4 X 7551

Circuit diagram of equipment for two-wire junctions

BK blocking button
BL blocking lamp
F_{1-3} relays for outgoing terminal equipment
FUR outgoing terminal equipment
G_2, G_9 relays for incoming terminal equipment
GVI incoming terminal equipment
LV listening jack
TJ test jack

rupted at the main distribution frame or through line fault, the line is blocked in the relay equipment through the high resistance control relay releasing and breaking the test circuit. A few seconds later a separate alarm is issued on the outgoing side, a lamp indicating to which line this refers. The blocking is thus brought to the attention of the personnel on the outgoing exchange and adequate steps may be taken. The alarm is released by operating the blocking button in the outgoing relay equipment. This will, however, reverse the alarm circuit returning the alarm signal when the line is clear and when the control relay operates.

In this way the personnel in an exchange are always informed regarding the condition of the junctions to other exchanges.

The group selector equipment for two-wire junction are so designed that for through traffic to another exchange all relay equipment on the line wires is disconnected as soon as the selector is operated. The discharge tube alone with the series connected release relay remains across the line wires for release of the connection.

The discharge tube does not increase the attenuation of the speech current and the use of this device is, therefore, very favourable for the purpose.

The introduction of the two-wire equipment has also resulted in an increased range for the system without increasing the capital cost of the exchange equipment.

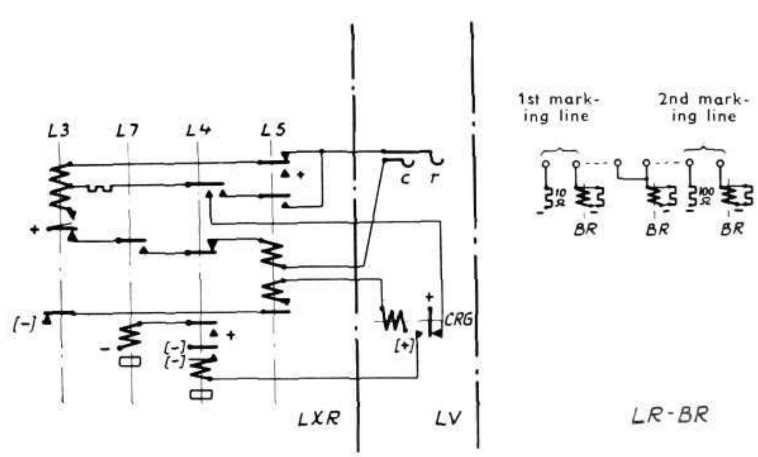


Fig. 5 X 6460

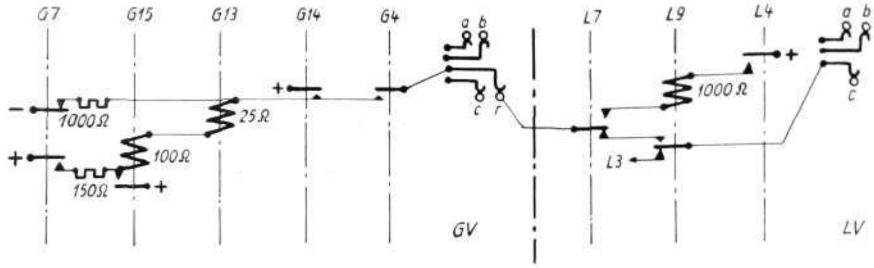
Circuit diagram of the test circuit in the P.B.X. final selector

BR break relay
CRG locking magnet for radial movement in the final selector
L_{3-7} final selector relays
LV final selector
LR—BR subscriber's line equipment
LXR P.B.X. final selector

Fig. 6 X 6463

Circuit diagram of test and signal circuit between trunk group selector and final selector

G group selector relays
GV group selector
L final selector relays
LV final selector



P.B.X. Numbers

By utilizing the new four-wire multiple for the P.B.X. final selector it has been possible to redesign and simplify the selector equipment for these groups. At the same time all idle positions in the multiple in the form of stops and marking positions have been eliminated, see Fig. 5. The redesigned arrangement, however, also implies a certain simplification of trunk traffic possibilities over the P.B.X. lines, the interruption of local calls in favour of trunk calls being possible only on one line in the P.B.X. group. This must, however, be considered quite satisfactory as in practice only groups covering few lines are effected. P.B.X. subscribers with many lines have, as a rule, separate numbers and lines for trunk traffic.

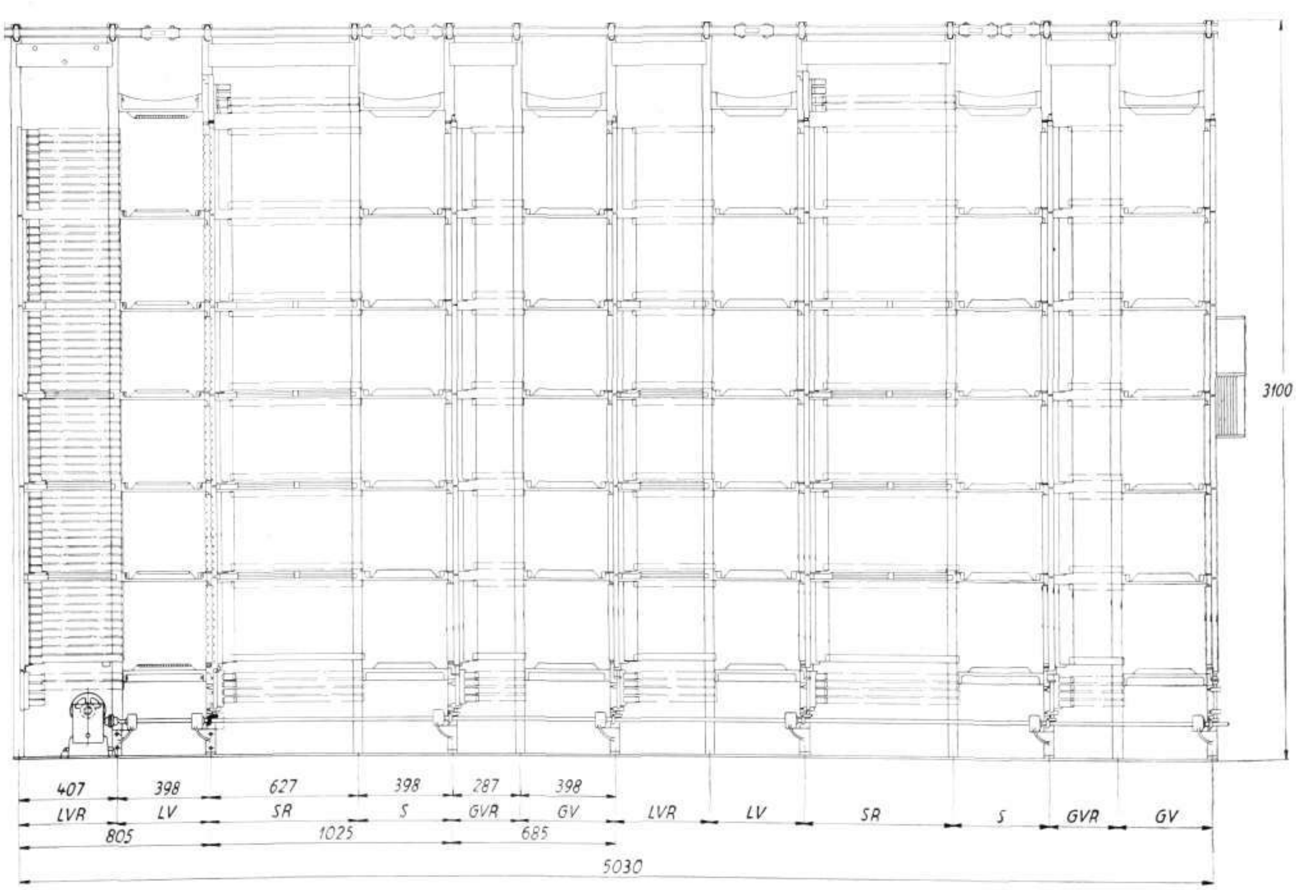
Fig. 7 X 7552

Row of racks

containing line finder and first group selector for 1000 subscribers

GV group selector
GVR group selector relays
LV final selector
LVR final selector relays
S line finder
SR line finder relays

The first line in the P.B.X. group decides the number allotted to the subscriber. When the P.B.X. number is dialled, the final selector stops on the first line and if this is free normal test takes place, whereas if it is engaged the hunting action of the P.B.X.-relay *L5* is started. When a free multiple position is found the P.B.X.-relay is released through a transient operation of the test relay *L3*. The selector stops on the free line and the test relay retests the position, this time with reversed polarity in order to make the test independent of the magnetizing from the test procedure a moment earlier.



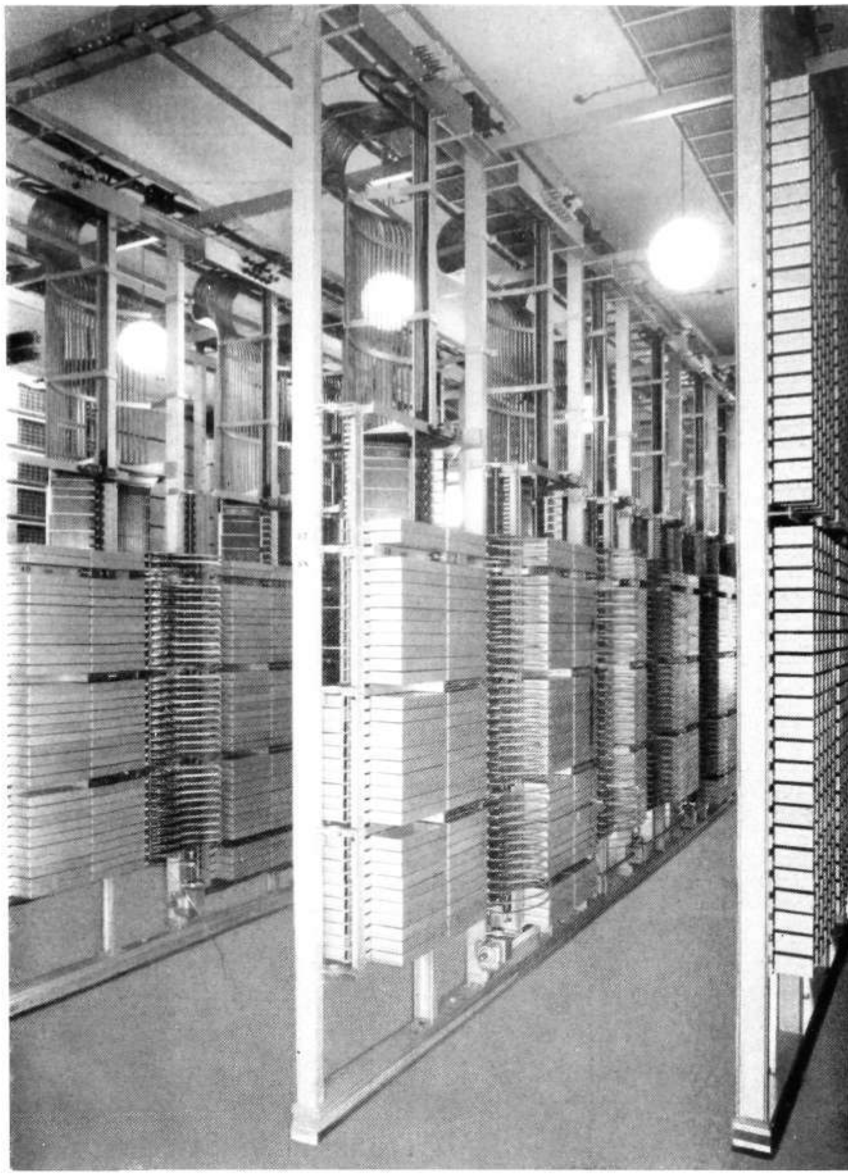


Fig. 8 X 6464

Selector row

built on the principles indicated on Fig. 7

If all previous lines in the group are engaged, the P.B.X.-relay is released on the last position and the hunting action is interrupted. This takes place, when the *r*-wiper is passing the *c*-wire in the last position, the test relay operating against the marking resistance on this wire and releasing the P.B.X.-relay. If the line is free, normal test takes place, whereas if it is engaged, busy tone is returned to the caller, the selector remaining in this position until the connection is released. The procedure is so far identical for local as well as trunk calls with exception of the busy tone, which is of different character for trunk calls, if the last line in the group is engaged on a local call. In this case the trunk operator may effect a parallel connection and announce the trunk call. Disconnection of the local call may be effected if the system otherwise is so arranged. This is, however, quite outside the scope of the P.B.X. selector design.

All lines within the group except the first line may be called individually and may consequently be used for so called night connections.

The purpose of the redesigned P.B.X. equipment is on the one hand to obtain maximum efficiency of the multiples and on the other hand to obtain a sufficiently simple final selector so as to allow P.B.X. numbers to be distributed over a larger number of rack groups in the exchange, without appreciable expense. P.B.X. lines generally carry a considerably larger amount of traffic than normal subscriber's lines and it is, therefore, of interest to intersperse these

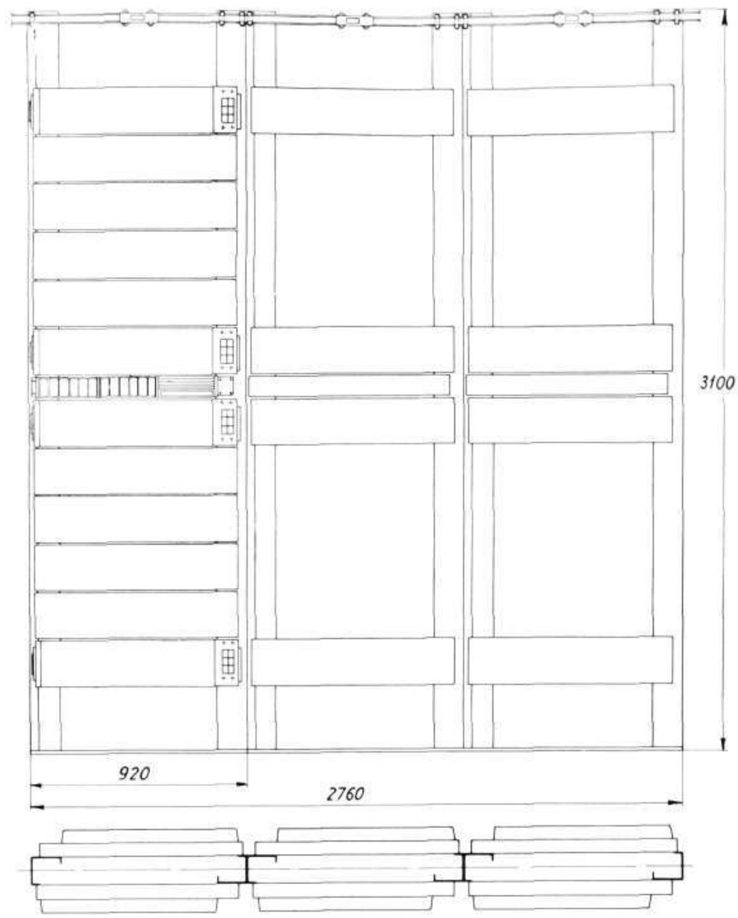


Fig. 9 X 6461

Register rack

containing three register panels each taking six register of crossbar type

among normal lines as much as possible in order to obtain most uniform distribution of traffic. Particular attention has to be paid to reserves for extension of lines in the P.B.X. groups, which is simplified the more the P.B.X. numbers are dispersed in the exchange.

Trunk Final Selectors

In the 500-line selector system type *OS 1029* the final selectors are generally made for use with both local and trunk calls. In certain cases only 20 selectors per 500-group are of this type.

These combined selectors are, therefore, provided with equipment for entering or disconnecting local calls, test relays differentiating lines engaged on local calls and on trunk calls or lines prepared for trunk calls and devices for trunk engaged signals on the subscriber's lines. These requirements involve a certain complication and increase in cost of the final selector equipment.

In the group selector stages, however, the different traffic categories are separated, partly because the different traffic groups here generally are sufficiently large to justify separate traffic routes, and partly because it is often necessary to use heavier gauge wire for the trunk junctions as compared with the local lines in order to keep attenuation within permissible limits.

The number of group selectors required for the trunk traffic in an exchange will, however, in all circumstances be insignificant compared with the number of final selectors. The special equipment required for the trunk traffic should, therefore, with advantage be confined to the group selector equipment in favour of the final selectors. By introducing a four-wire multiple in the trunk group selector stages it has been possible to carry out such a modification, Fig. 6.

The additional equipment for trunk call functions in the final selector has been reduced to one relay. This is operated from the trunk group selector over the r-wire, when the final selector has reached the required subscriber's line. On operation of the relay the final selector test relay is energized, independent of the condition on the subscriber's line, at the same time as the test wire on the final selector is connected over the group selector multiple to trunk call test relays in the group selector relay set. From then on all trunk traffic functions will be controlled from the group selector. In the P.B.X. final selectors the selection of a line within the group takes place before the test wire is connected to the trunk traffic group selector.

Apart from a considerable simplification of the final selector equipment the redesigned circuit also makes it easier to cover differences in trunk call conditions for different administrations, as only minor parts in the equipment will be effected by such modifications.

Mechanical Lay-out

The 500-line selector system, which previously actually required less space than most other systems, has been further concentrated in connection with the modernization. As only selector panels now require motor drive, more latitude has been possible with regard to the lay-out and the disposition of the rows of racks.

The relay sets for line finders, final selectors and incoming group selectors, which previously contained selector control relays only, have been augmented

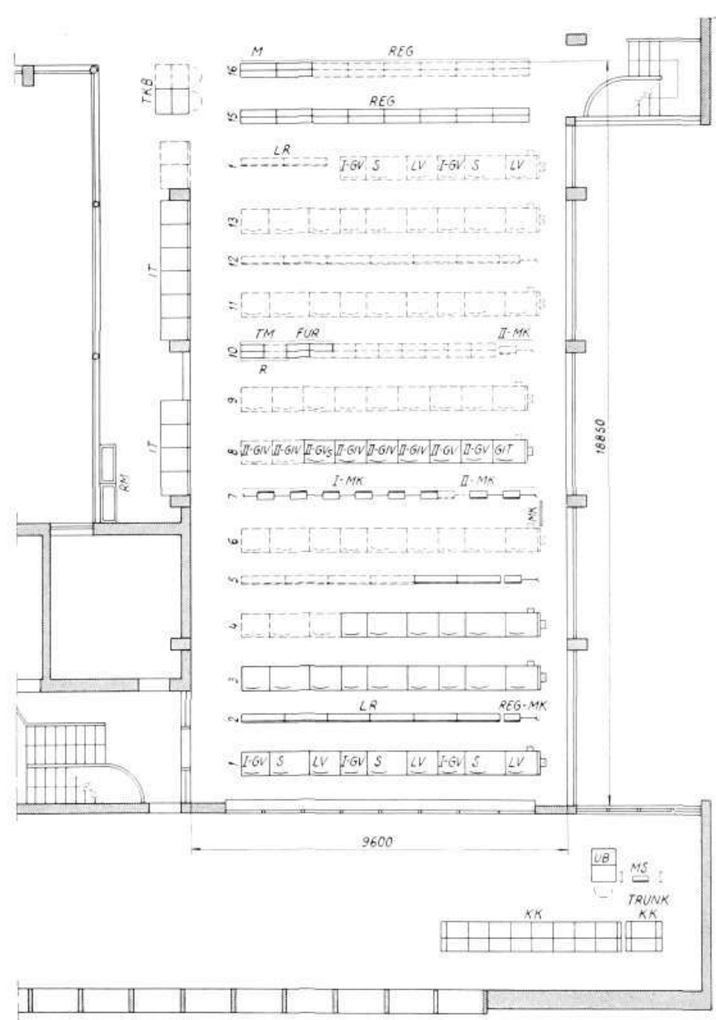


Fig. 10 X 6462

Lay-out

of automatic telephone exchange for 10 000 numbers

FUR	outgoing terminal equipment for junctions
I—GV	first group selectors
II—GV	internal second group selectors
II—GIV	incoming second group selectors
GIT	trunk group selectors
II—GV_s	special group selectors
IT	instrument boards and rectifiers for power supply
KK	M.D.F.
LV	final selectors
LR	line relays
M	markers for alternative traffic routes
MK	I.D.F.
I—MK, II—MK	I.D.F. for group selectors
MS	testing rack for junctions
R	various relay equipment
REG	registers
REG—MK	I.D.F. for registers
RM	ringing and signalling machines
S	line finders
TKB	traffic observation desk
TK	traffic metering equipment
TRUNK KK	junction distribution frame
UB	line testing desk

with the relays for the connecting circuits *i. e.* battery supply relays, ringing-trip relays, register connection relays and control relays for call metering. The number of relay sets have in this way been reduced, limiting the space requirements. The relay sets are, as previously, mounted between the selector panels in direct connection to corresponding selectors, the most favourable position from maintenance point of view.

Fig. 7 shows a row of racks containing line finders, final selectors and first group selectors for 1 000 subscribers. The selector panels take 60 selectors. The corresponding relay panels contain, apart from the relay sets directly connected to the selectors, also allotters, alarm relays, fuses, test jacks and blocking buttons required for the panels. The width of the relay panels is adapted to the extent of the relay equipment for the different selector stages.

The lay-out according to Fig. 10 indicates the space requirement for 10 000 subscribers. The illustrated exchange is included in a large network with very high traffic intensity and extensive space has, therefore, been allotted to incoming group selectors, rows 8 and 9, and for relay equipment for outgoing junctions, row 10. Remaining selector rows contain line finders, final selectors and first group selectors for 10 000 subscribers. The power equipment *IT* includes metal rectifiers and will have a final capacity for 20 000 subscribers.

Exchanges of this size are equipped with driving sets containing one mains operated and one battery operated motor. Ringing current and signal tones are generated from a signal set *RM* common to the entire installation.

For small installations battery driven single motor sets are used, which also supply signal currents for the corresponding row of racks.

A Level Meter for the Frequency Range 30 c/s to 5 Mc/s

B LUNDVALL, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.317.341

The development of the LM Ericsson carrier system for coaxial cables has resulted in an increased need for a new level meter with a wider frequency range than the type ZTE 15 used hitherto.

The new level meter, which bears the type number ZTE 16, covers the frequency range 30 c/s to 5 Mc/s, and its sensitivity is such that full deflection is obtained for a voltage level of — 4.5 N (zero level is 0.775 V). Satisfactory readings can be made down to — 5.5 N, and values can be estimated down to — 6.5 N. A switch permits changes of range in steps of 0.5 N so that full deflection can be obtained for values up to 2.0 N.

The instrument can also be supplied calibrated in decibels, with full deflection for an minimum input of — 40 db. The switch is then arranged to give steps of 5 db and the maximum input which can be measured is + 20 db. The accuracy is ± 0.03 N or ± 0.3 db over the whole frequency range for indicated voltages down to — 5.0 N or — 45 db.

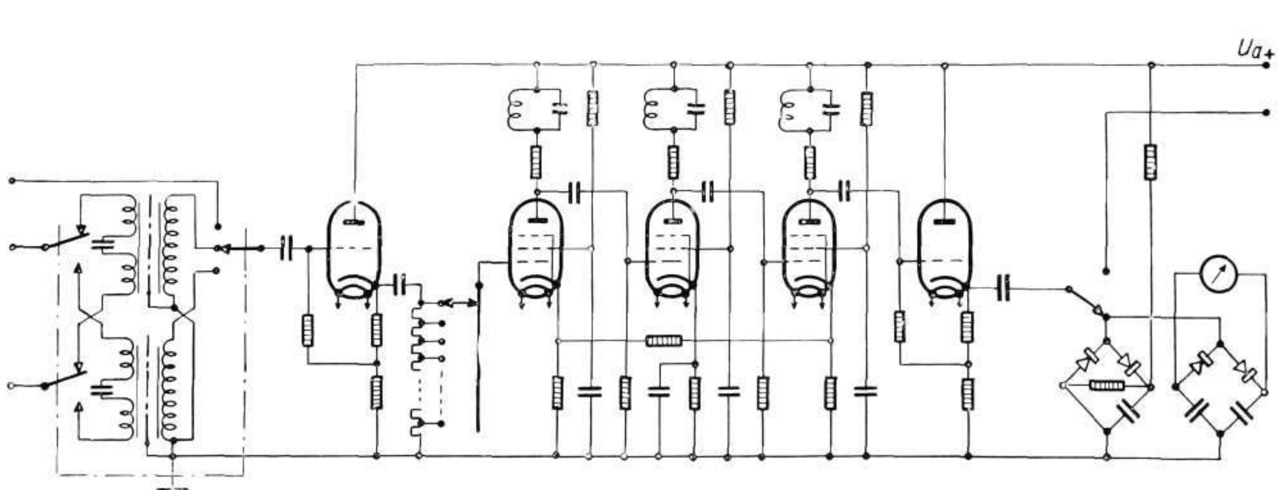
Design

The level meter, the simplified schematic of which is shown in Fig. 1, consists of an input section, amplifier, output stage and detector and power supply unit.

A key is provided in the input section to select either balanced or unbalanced input conditions. The balanced input is provided by means of two transformers, one for the frequency range 30 c/s to 50 kc/s and the other for the range 1 kc/s to 500 kc/s. Connection to the instrument in this condition is made either by means of a telephone jack or banana contacts.

In the unbalanced condition the signal is applied directly to the grid of the input stage through a blocking capacitor. The frequency range extends from 30 c/s to 5 Mc/s. Connection is made by means of the new type of L M Ericsson coaxial socket described in the Ericsson Review No 1, 1949.

Fig. 1 X 7529
Simplified schematic of level meter type ZTE 16



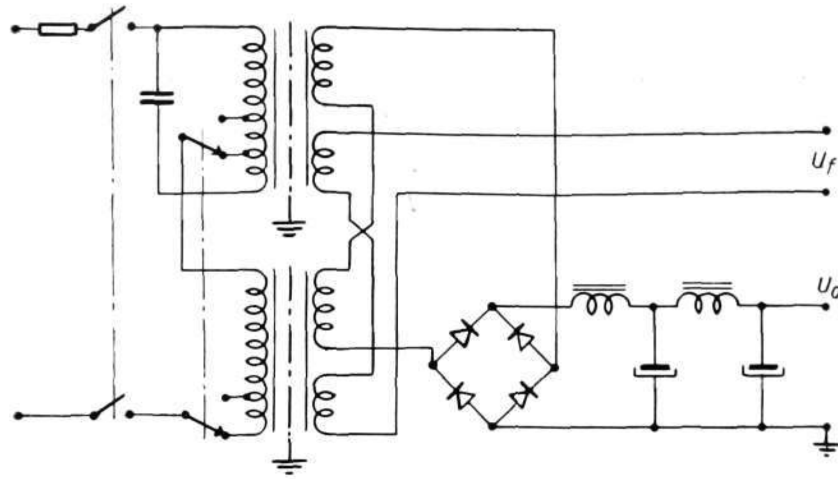


Fig. 2 X 6432

Simplified schematic of stabilized power unit

With both balanced and unbalanced inputs provision is made for terminating the circuit under test with a resistance included in the level meter. Values of 75, 125, 150, 300 or 600 ohms can be selected by means of a separate termination switch.

The input stage is a cathode follower having a voltage divider in the cathode load. The end section of this is built out into a constant impedance attenuator to simplify the construction of a frequency independent attenuation stage at the relatively high frequencies under consideration.

The sensitivity can be controlled by means of the voltage divider so that full deflection is obtained for values between —4.5 N and +2.0 N, in steps of 0.5 N.

The amplifier connected after the cathode follower consists of three stages with negative feedback. The feedback is arranged as current feedback between the cathodes of the first and third stages. Resistance-capacitance coupling is used, but the anode load impedances include inductance-capacitance circuits to provide a maximum uniform load up to 5 Mc/s.

The output stage is another cathode follower, with the detector in the cathode circuit. A key is provided for disconnecting the detector and transferring the output of the cathode follower to a coaxial socket. The level meter can thus be used as an amplifier over the frequency range for which it is designed.

The detector is a voltage-doubler circuit using germanium crystals. A limiter of normal type is included to protect the instrument against excessive overloads.

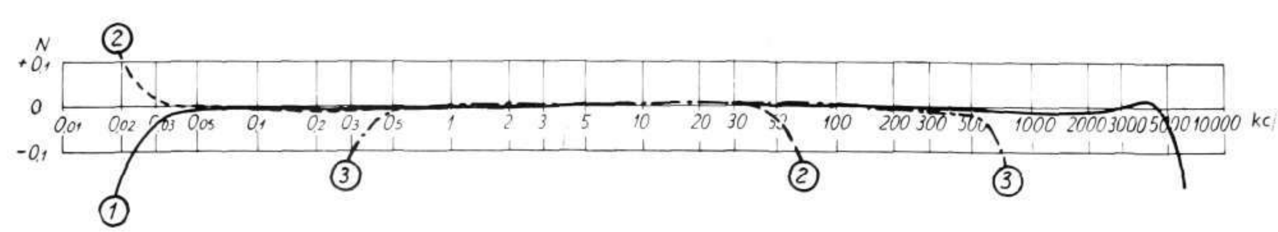
The indicator is a 50 microamp edge-wise instrument, calibrated in nepers or decibels and provided with two scales separated by 0.5 N or 5 db.

A reading accuracy of ±0.01 or ±0.1 is obtained between half-scale and full deflection. Below half-scale the reading accuracy falls off.

Fig. 3 X 7530

Meter reading as a function of frequency

Input level = 0. 00
1 unbalanced input 30 c/s—5 Mc/s
2 balanced input 30 c/s—50 kc/s
3 balanced input 1 kc/s—500 kc/s



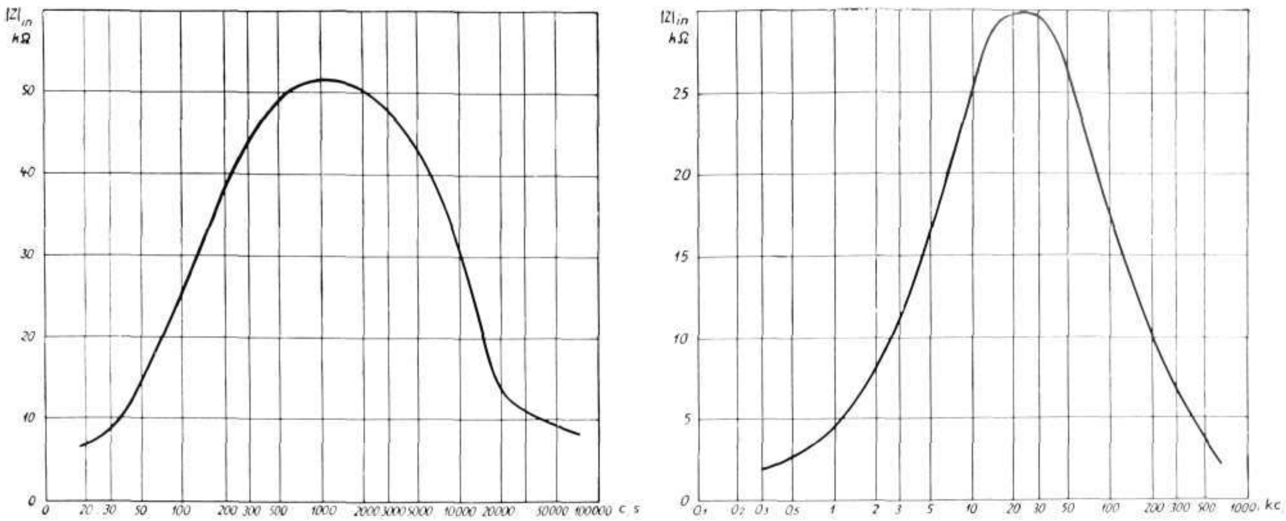


Fig. 4 X 7531

Input impedance as a function of frequency

left, for balanced input 30 c/s—50 kc/s; *right:* for balanced input 1 kc/s—500 kc/s.

The power supply unit is stabilized and the circuit is shown in Fig. 2. It can be supplied for either 50 c/s or 60 c/s operation and covers the voltage range from 100 to 270 V. This range is covered in two parts, 100 to 170 V and 160 to 270 V: the change is made by means of a switch which can be locked in position. Stabilization against changes of line voltage is effected by means of a saturated core transformer. The anode voltage, 200 V, is obtained from a selenium rectifier, adequate smoothing being provided by chokes and capacitors.

Technical Data

The frequency characteristics for the unbalanced and both unbalanced inputs are shown in Fig. 3.

The frequency dependence of the input impedance for both balanced inputs is shown in Fig. 4. It will be seen that for the low-frequency transformer the input impedance $|Z_{in}|$ is greater than 5 kilohms between 30 c/s and 50 c/s, and greater than 10 kilohms between 50 c/s and 20 kc/s. For the high-frequency transformers the input impedance is greater than 3 kilohms between 1 kc/s and 500 kc/s and greater than 5 kilohms between 2 kc/s and 300 kc/s. Both input impedances become reactive near the edges of the working bands.

For the unbalanced condition the input impedance is greater than 100 kilohms in parallel with 23 pF.

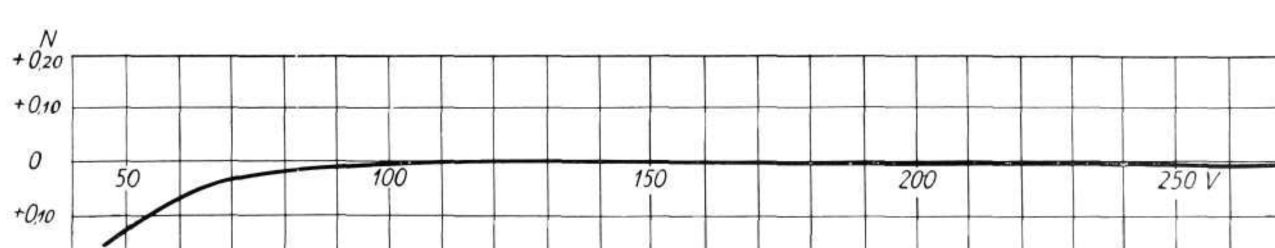
The dependence on supply voltage is shown in Fig. 5. This noteworthy independence of voltage variation is the result of the combination of a stabilized supply unit and an amplifier with a considerable amount of feedback.

Fig. 5 X 7532

Meter reading as a function of supply voltage

Constant input at frequency of 4 Mc/s. Supply unit connected for range 160—270 V, 50 c/s.

The level meter can be supplied either for rack-mounting, Fig. 6, or in a wooden box, Fig. 7.



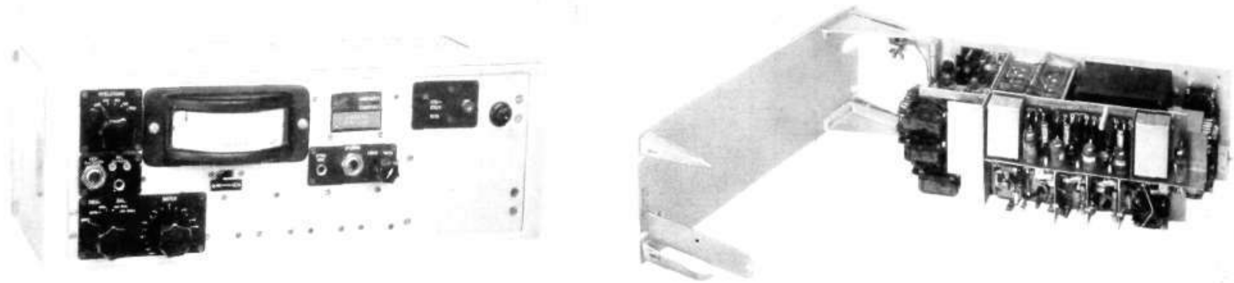


Fig. 6 X 7533

Level meter ZTE 1651 for rack mounting

left: with cover removed and front panel swung out

The right-hand photograph in Fig. 6 shows the main features of the mechanical design. On the right is the screened amplifier with its anode circuits, and on the left the power-supply unit.

The valves used are two *6J6* and three *403B* (*6AK5* equivalent). Four germanium crystals type *1N34* are incorporated.

The overall dimensions are, for the rack-mounting version, 483 × 177 × 179 mm; for the boxed version 474 × 186 × 270 mm.

The power consumption is about 40 W.

Table of available versions

type	mounting	calibration	supply frequency
ZTE 1601	wooden box	neper	50 c/s
ZTE 1602	wooden box	neper	60 c/s
ZTE 1611	wooden box	decibel	50 c/s
ZTE 1612	wooden box	decibel	60 c/s
ZTE 1651	rack	neper	50 c/s
ZTE 1652	rack	neper	60 c/s
ZTE 1661	rack	decibel	50 c/s
ZTE 1662	rack	decibel	60 c/s

Fig. 7 X 6433

Level meter ZTE 1601

in wooden box

Technical Potentiometers

S HOLMQVIST & B WANDIN, L M ERICSSONS MÄTINSTRUMENT AB, ULVSUNDA

U.D.C. 621.317.727

Direct-indicating electrical measuring instruments are convenient from the point of view of taking readings, but their accuracy is usually limited to about one percentage. For more exact calculations, therefore, it is preferable to employ measuring instruments constructed on the comparation principle, known as potentiometers. These may be employed both for the direct measurement of an electric quantity and for checking an indicating instrument.

The following article describes two potentiometers manufactured by L M Ericssons Mätinstrument AB, one of which is specially intended for measuring voltages in a thermocouple for temperature measurements, the other being used for checking direct current volt- and ammeters.

General Viewpoints

The term, technical potentiometer is applied to a potentiometer which permits the measurement of a quantity with an accuracy[1] which is fully adequate for technical requirements, that is to say, about 0.1 %. The arrangement must thus be capable of measuring with a corresponding degree of accuracy, but on the other hand, it is not required to improve on this. It lies in the nature of things that precision carried to excessive lengths will render the apparatus unnecessarily expensive and difficult to manipulate in many cases.

A comparation connection for measuring a voltage is carried out in principle as shown in Fig. 1. An auxiliary source of current B supplies a current i to a resistance R. The resistance R is provided with a sliding contact K. When the deflection of the galvanometer G is zero, the relationship $E = i \cdot r$ will exist. The voltage sought E can then be calculated since i and r are known. The accuracy of measurement will depend upon the exactitude with which i and r are known and upon the sensitivity of the galvanometer. From the manufacturing point of view the resistance can be adjusted to 0.05 % without difficulty. An indicating instrument is not sufficiently accurate for determining the current i, so that in this case also the zero method and a standard cell are usually resorted to. Fig. 2 shows the connection for determining and adjusting the auxiliary current i.

The current i flows through the resistance R_1 and the voltage drop is compared with that of the standard cell N with the zero galvanometer G_1. Where R_1 and N are known, the value of i can be determined. If $N = 1.019$ V and R_1 has a value of 10190 ohms, the auxiliary current $i = 0.100$ mA. By means of the rheostat R_2 the current is regulated so that G_1 indicates zero.

The sensitivity of the zero galvanometer must be so great that a clearly legible deflection is obtained if the deviation from the correct value exceeds the desired accuracy by 0.1 %. For the normal cell circuit this implies that with the assumed values, a clear galvano-deflection should be obtained for 1 mV. As the resistance of the circuit is about 10000 ohms, a current sensitivity of about $1 \cdot 10^{-7}$ A will thus be required. A simple high-ohmic reflecting galvanometer will therefore be found most suitable.

The voltages recorded in the measuring circuit may be quite small. A platinum-platinum rhodium couple has an e.m.f. of about 10 mV at 1000° C. If the

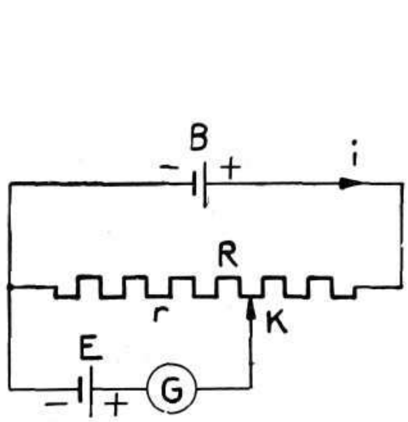


Fig. 1 X 4635
Schematic principle
for measuring a voltage E with a comparation connection

[1] Concerning comparation for highest precision measurements, see the Ericsson Review, Nos 1 and 4/1946.

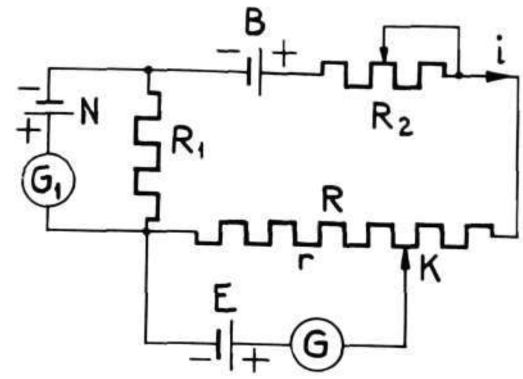


Fig. 2 X 6434
Method of regulating the auxiliary current

measurement has to be carried out with an accuracy of nearly 0.1 %, this corresponds to 0.01 mV. With an auxiliary current of 0.1 mA the resistance r in Fig. 2 will be 100 ohms. In this case the galvanometer should have a low resistance, such as 20 ohms for example, so that the resistance of the circuit will amount to about 100 ohms with the necessary sensitivity of $1 \cdot 10^{-7}$ A for the galvanometer. In the first case the galvanometer may have a high ohmic resistance, but in the second case the resistance should be low to obtain the most satisfactory adaptability. In addition, the damping of the galvanometer should be suitable balanced in each case to permit convenient working. A further requirement is that the galvanometer should be built into the apparatus itself. A lightspot galvanometer with scale distances of a few dm is the type for which space is available. From the foregoing it will be appreciated that the galvanometer problem is not so easy to solve, more particularly as the apparatus is required to be portable and have a built-in galvanometer of robust construction with a strong suspension strip.

The adjustment of the auxiliary current i is simple to carry out in principle if the rheostat R_2 in Fig. 2 is constructed with two series-connected resistances, one for coarse- and one for fine adjustment. It must be possible to read off the resistance r to three or four figures, for which purpose special connections must be employed which will be described at a later stage.

The auxiliary battery B should be built into the apparatus so that additional accessories are not necessary. The current should always flow in the circuit. The voltage of a newly connected battery drops somewhat rapidly causing the auxiliary current to change which is very disturbing when taking measurements. On this account the auxiliary current must be low in order to save the battery. At a few tenths of a milliampere the auxiliary battery will last much longer and will only need replacing once or twice a year.

Technical Potentiometer YBT 10

This potentiometer is primarily intended for the accurate measurement of voltages in electric pyrometers for temperature readings. The maximum measuring range for standard pyrometers is less than 50 mV. A chromelalumel thermocouple has an e.m.f. of about 40 mV at 1 000° C. As the cost of the potentiometer is not raised appreciably by increasing the measuring range to 100 mV it has been constructed for the range 0—100 mV. It is, of course, possible to graduate the readings on the scale in °C in place of mV, but this is accompanied by numerous drawbacks. In such a case the apparatus will only be suitable for a certain type of thermocouple such as copper-constantan. Furthermore, the cold junction of the couple must have a certain definite temperature or corrections must be made for varying temperatures. Consequently, it has been found preferable to take readings in mV and read off the corresponding temperature subsequently from the table for the thermocouple in question.

The potentiometer can, of course, be employed for many other purposes such as measuring the voltage drop across shunts, checking mV-meters and voltage measurements in general over the range 0—100 mV.

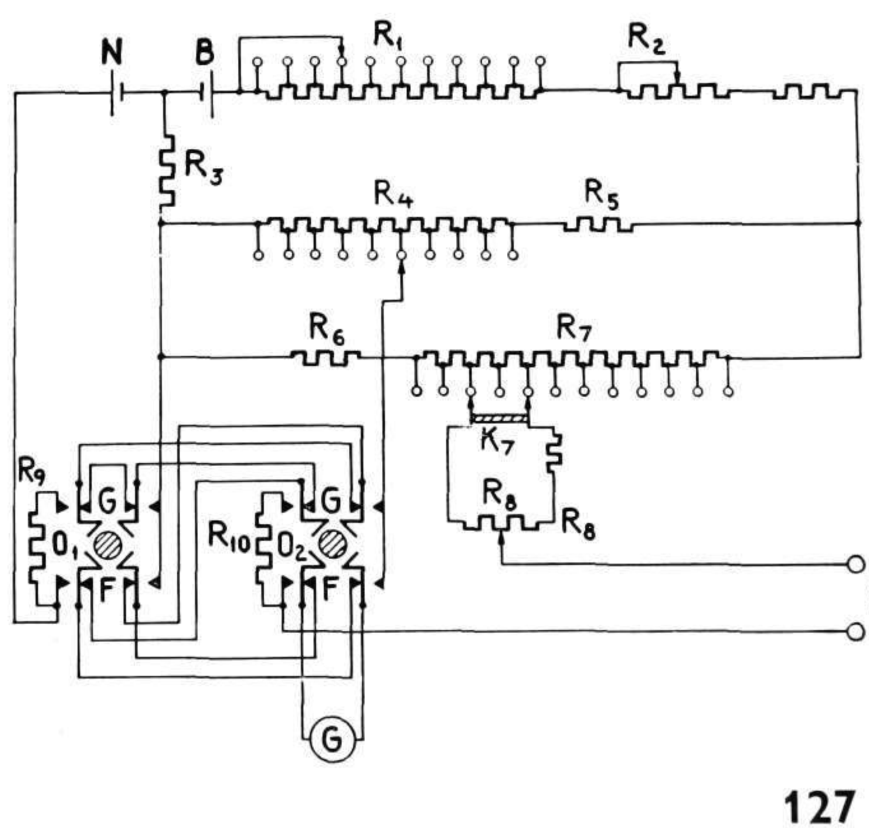
Diagram of Connections

The connection diagram for the potentiometer is shown in Fig. 3. The current from the built-in auxiliary battery B at 1.5 V is regulated in steps by means of the brush change-over switch R_1 and is finely adjusted by the rheostat R_2. A voltage drop of 1.019 V will take place in the resistance R_3 at a current of 0.4 mA, which corresponds to the e.m.f. of the built-in normal cell N. The current is distributed uniformly in the two branches R_4, R_5 and R_6, R_7. The resistance R_7 has double contacts between which the potentiometer R_8 is connected.

The switches O_1 and O_2 have three positions each, two resilient outer positions and a central position. When they are both in a position of rest corresponding to the central position, the galvanometer is short-circuited to protect it during transport. When the lever switch O_1 is moved to one outer position G, the galvanometer is connected in the auxiliary circuit in series with a resistance R_9. The auxiliary current is coarsely regulated by R_1. On moving the throw-over switch O_1 to the position F, fine regulation is effected with R_2. In this position the resistance R_9 is disconnected. Measurement is carried out by throwing over the switch O_2 to G and F respectively, whereupon coarse and fine adjustment take place through the resistances R_4, R_7 and R_8. Each step of the resistance R_4 corresponds to a voltage of 10 mV whilst R_7 gives 1 mV per step. The continuously displaceable contact on R_8 varies the voltage between 0—1 mV. The measuring voltage is applied to the terminal screws P. The galvanometer G consists of a light-spot galvanometer built into the apparatus casing.

Construction

The appearance of the potentiometer may be seen from Fig. 4. A direct- or alternating current of 6 V is applied to the terminal screws »6 V» for supplying the lamp for the galvanometer. The current here amounts to about 0.5 A. The object to be measured, such as a thermocouple, is connected to the terminal screws marked »0—100 mV». The auxiliary current is first checked by moving the throw-over switch KONTR (control) first to GROV (coarse) and then to FIN (fine). (The potentiometer shown in Fig. 4 has a press-button in place of the throw-over switch KONTR.) If the galvanometer gives a deflection, it is set to zero by the knobs JUSTERING (adjustment), GROV



X 6435

Fig. 3
Diagram of connections for the technical potentiometer YBT 10

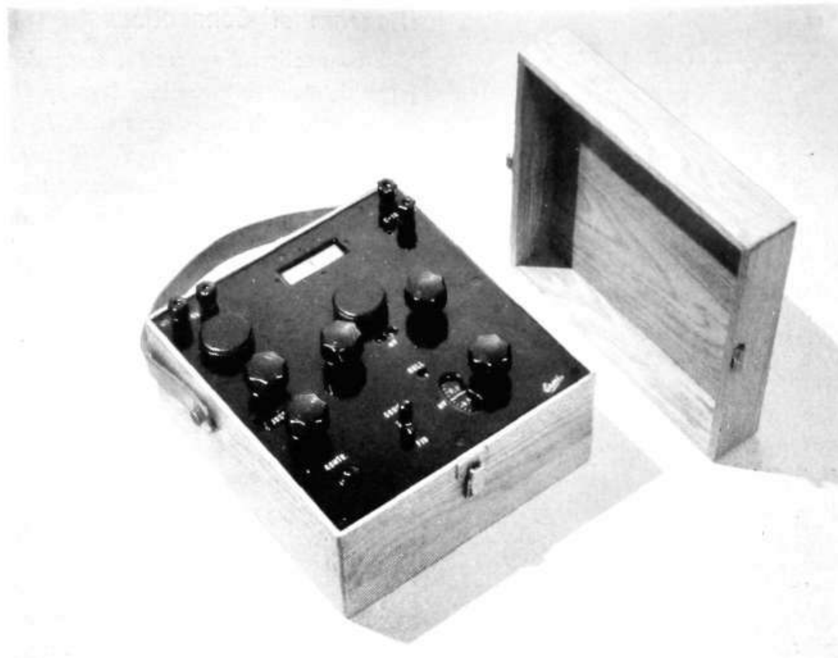


Fig. 4 X 6436
Technical potentiometer YBT 10

(coarse) and FIN (fine) respectively. Adjustment is then made for the measured value when the switch MÄTN (measuring) has been moved to the positions GROV (coarse) or FIN (fine) respectively in a corresponding manner. The numerical value of the voltage sought is read off directly in mV and fractions of a mV.

The built-in auxiliary battery can be exchanged conveniently on unscrewing the circular cover in the upper lefthand corner. The illuminating lamp is mounted below the other circular cover. The lampholder can be withdrawn by a simple manipulation and the incandescent lamp replaced. The mechanical zero setting of the galvanometer is accomplished by means of the screw, NOLL (zero).

The apparatus is mounted in a wooden case with a cover, the external dimensions are approximately 250 × 235 × 150 mm.

Calibrating Potentiometer YBK 10

Indicating instruments are normally employed for measuring currents and voltages. The accuracy of the measurements is dependent in a high degree upon the reliability of the instruments. It is necessary, therefore, to check from time to time whether an instrument is indicating correctly or to determine the corrections necessary for different deflections of the pointer. To enable this control to be carried out the apparatus should be convenient to manipulate and universally applicable. The potentiometer described below may be employed for determining the correction of the instrument directly in scale divisions on any scale whatsoever.

Diagram of Connection

Fig. 5 shows the connection diagram. The built-in auxiliary battery B feeds the branches R_3 and R_4 with the same current which is adjusted by the resistances R_1 and R_2. The correct current is checked in the usual manner by the voltage drop across a resistance R_9, a standard cell N and a galvanometer. The voltage obtained from the contacts K_3 and K_5 is determined by the positions of K_3, K_4 and K_5. This voltage is compared with a voltage taken from K_6 and K_7. The circuits R_6, R_7 and R_8 are supplied with a current which is proportional to the current connected to the instrument under examination.

The switch for R_3 has 16 positions, that for R_4 having 10 positions. These switches are marked PROVAT (tested) and are set at the figures cor-

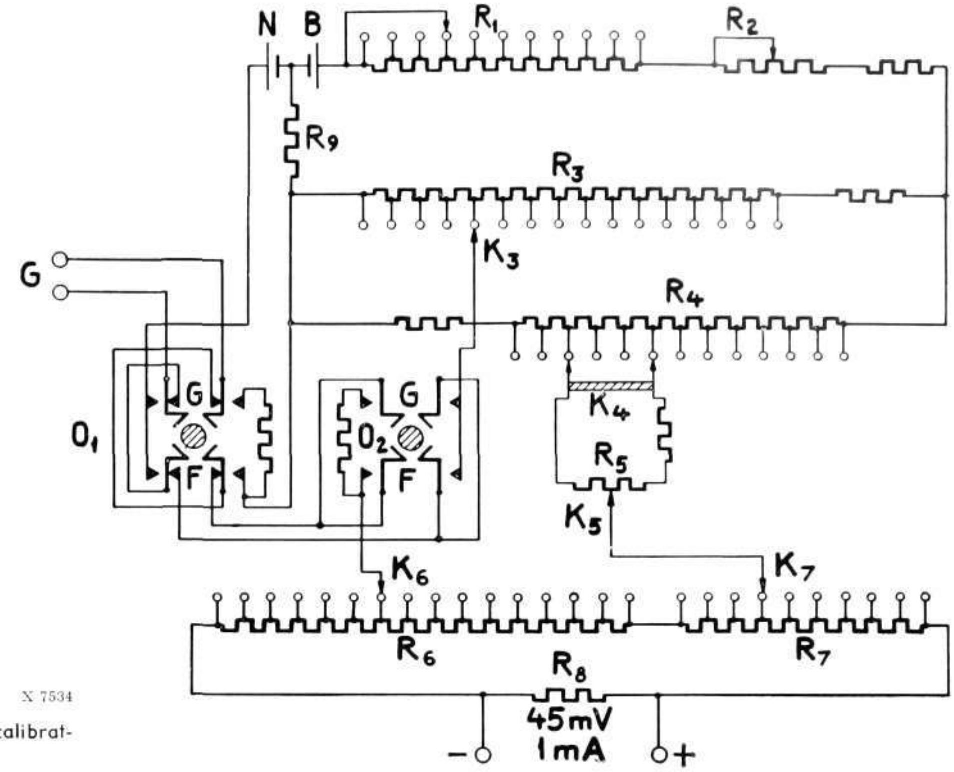


Fig. 5 X 7534

Diagram of connections for the calibrating potentiometer YBK 10

responding to the scale divisions to be tested. The switches for R_6 and R_7 also have 16 and 10 positions respectively and are marked TOTALT (totally). They are set for the total number of scale divisions with which the instrument scale is provided. The scale for the resistance R_5 which is marked KORR (correction) is graduated continuously from — 1 to + 1.

In this case a separate reflecting galvanometer must be used. It is connected to the terminal screws *G*. The connection of the galvanometer in the auxiliary circuit and the measuring circuit is carried out in the same manner as for the technical potentiometer described previously, with the help of two lever throw-over switches each having two resilient outer positions and a zero position at the centre.

The potentiometer is dimensioned for measuring a maximum of 1 mA. This current gives av voltage drop of 45 mV. For testing voltmeters the external resistance is connected in series with the terminal screws of the apparatus. For testing ammeters above 1 mA suitably dimensioned shunts are employed. In view of the construction of the apparatus, any voltmeter above 45 mV and any ammeter above 1 mA can be tested with direct current irrespective of the form of scale division adopted. When taking measurements, the correction is obtained directly in scale divisions for any desired scale range.

Construction

The appearance of the apparatus may be seen from Fig. 6. The galvanometer, which must be a relatively sensitive reflecting galvanometer, is connected to the terminals GALV, whilst the instrument to be tested is connected with suitable external shunts or series resistances, to the terminals on the righthand side marked »45 mV, 1 mA». By means of the two upper knobs marked TOTALT adjustment is made for the total number of scale divisions available on the instrument. The scale range to be tested is set by means of the knobs marked PROVAT. The correction is read off directly in scale divisions on the scale marked KORR. The built-in auxiliary battery is located below the detachable cover on the upper lefthand side.

The apparatus is mounted in the same type of wooden case as the technical potentiometer, the dimensions being 250 × 235 × 150 mm.

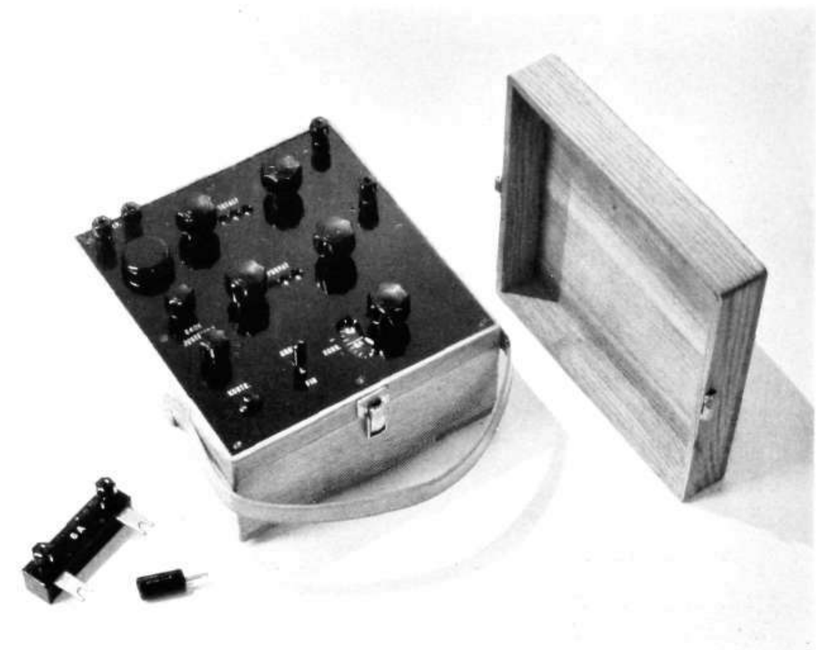


Fig. 6 X 6437

Calibrating potentiometer YBK 10

with shunt and series resistance

Application

The method of employing the apparatus may best be illustrated by means of examples. A voltmeter for 150 V is graduated 0—150. It is desired to draw out the correction curve for different scale divisions. A potentiometer is connected to the voltmeter in series with an external resistance marked 150 V. An adjustable source of supply is connected to the voltmeter. The knobs TOTALT are set at 150. If the scale range 10 is to be tested, for example, the knobs PROVAT are set at 10.

The deflection of the voltmeter is carefully set for the scale range 10. The auxiliary current is first checked and adjusted if necessary by means of the knobs JUSTERING, the throw-over switches KONTR being in the positions GROV and FIN respectively so that the galvanometer indicates zero. By means of the throw-over switch MÄTN (measurement) the galvanometer is connected in the measuring circuit and set for a zero deflection by the knob KORR. The value, such as —0.24, is read off on the scale. Thus, for the deflection 10 the voltmeter has a correction of —0.24 and consequently indicates 0.24 V too high. In the event of the instrument error exceeding 1 scale division, the righthand knob PROVAT is turned and the galvanometer is set at zero with the help of the former and the knob KORR. For example, with a voltmeter deflection of 100, the galvanometer is set at zero while the figures PROVAT indicate 102 and KORR +0.60. The correction for the deflection 100 will then be +2.60 scale divisions, and consequently the voltmeter indicates 2.60 V too low at this deflection.

An ammeter gives a full deflection for 6 A. The scale is graduated 0—30. A shunt marked 6 A is connected to the potentiometer and is series-connected to the ammeter and an adjustable current. If it is desired to test the deflection 20 the knobs TOTALT are set at the value 30 and the knobs PROVAT at the value 20. After the instrument has been adjusted the scale KORR indicates the value +0.30. Calculated in scale divisions, the correction is +0.30 and the current actually flowing through the instrument will be $(20 + 0.30) \cdot 0.2 = 4.06$ A.

New Types of Thermal Detectors for Automatic Fire Alarm Systems

H SZABÓ, TELEFONAKTIEBOLAGET LM ERICSSON, TELESIGNAL WORKS, STOCKHOLM

U.D.C. 654.924.53

Thermal detectors, commonly referred to as thermostats, have a certain reaction time, which is a most important factor for automatic fire a'arm systems. A short reaction time means an early alarm and more time to avert a fire incident. The new L M Ericsson detector combines short reaction time and reliability with simplicity in design and an attractive exterior.

The thermosensitive elements in the detectors consist of two springs soldered together by a fusible alloy. When the solder is fusing the two springs are forced apart breaking the circuits in which they are connected. The required spring tension for this action was in earlier designs obtained by pre-tensioning the springs or by adding separate tension springs. With either of these methods it was necessary to use comparatively heavy gauge springs particularly to compensate for deterioration due to ageing. With this followed the disadvantage of larger spring dimensions with higher heat capacity, which increased the reaction time of the detector.

Fig. 1 X 4642
Thermal detector KEA 1201
for fusing temperatures 70°, 100° and 130°C

On the L M Ericsson detectors of latest design the springs are made out of bimetal sheet, the break tension being obtained through stresses in the bimetal set up on temperature rise. A considerable reduction of the spring dimension can, therefore, be made, resulting in a more favourable reaction time. This method also ensures adequate break tension irrespective of age.

The new thermal detectors are manufactured in two types: one open type for dry premises and one enclosed type intended for damp premises or where explosion hazards exist. The open type is supplied black or white, whereas the enclosed type is only made in black.

Fig. 2 X 6441
Thermal detector KEA 1201
with protection frame removed

Fig. 3 X 7545

Enclosed thermal detector KEA 4601

for fusing temperatures 70 and 100 C

right: dismantled into connection box, base, protection frame (in order from the left).

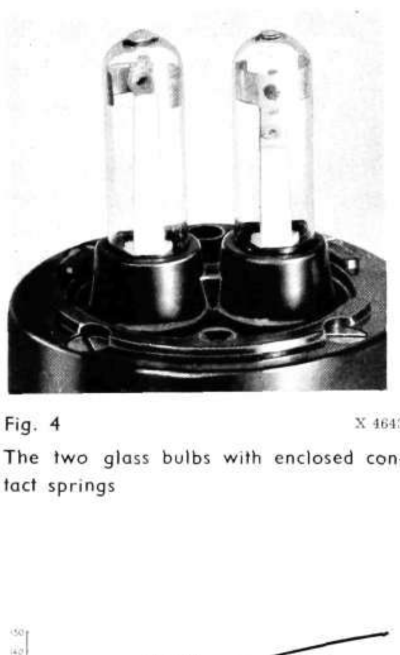


Fig. 4 X 4643

The two glass bulbs with enclosed contact springs

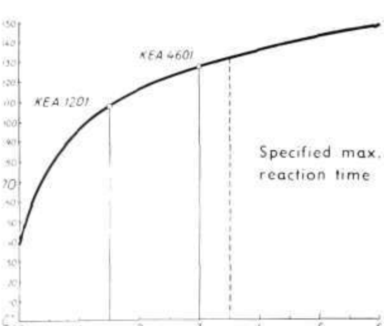


Fig. 5 X 4561

Diagram for the reaction times

of the new thermal detectors according to specification of National Bureau of Standards (U. S. A.)

The open detector, see Fig. 1, consists of two pairs of bimetal springs with four terminal screws mounted on a plastic base, Fig. 2. Each pair of springs is soldered together at the top end by a fusible alloy. The springs are shaped in such a way that they move apart on release, irrespective of possible distortion caused by external agencies. Such distortion does not appreciably effect the reaction time of the detector.

The above parts are covered by a protection frame in plastic material, which is fixed to the base by means of two screws.

Detectors in black plastic are supplied with fusing temperatures of 70°, 100° and 130° C and are coded *KEA 1201/70, KEA 1201/100* and *KEA 1201/130* respectively. Detectors in white plastic are only made for 70° C fusing temperature and are coded *KEA 1202/70.*

The enclosed type, Fig. 3, contains thermosensitive elements consisting of a bimetal spring and a supporting spring riveted on to a bakelite disc and fitted into a cylindrical glass bulb. The top portion of the supporting spring consists of a resiliant copper sleeve resting against the inside of the bulb. The bimetal spring is soldered by a fusible alloy to the copper sleeve in such a way that part of the solder rests against the glass bulb. In this way the heat transfer to the soldering point takes place on the one hand directly from the glass bulb and on the other over the copper sleeve, Fig. 4. Two such bulbs are mounted and sealed water-tight on a base of plastic material fixed by four screws to a connection box in the same material. The base is provided with four contact pins fitting into corresponding sockets in the connection box. Sealing between connection box and base as well as at the cable entry is effected by means of rubber packings. The glass bulbs are covered by a protection frame of the same type as that used for the open type of detector. The enclosed detectors are supplied with fusing temperatures of 70° and 100° C and are coded *KEA 4601/70* and *KEA 4601/100* respectively.

The reaction times for the new thermal detectors are shown in the diagram, Fig. 5, drawn in accordance with the specification of the American National Bureau of Standards. To comply with this specification the thermal detectors must fuse within $3^1/_2$ min. with a temperature rise according to the diagram. As will be seen from the diagram both types of the new thermal detectors meet these requirements.

New Svenskradio Receivers

C FREDIN, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.396.62

The autumn novelties on the radio receiver market include a large Svenskradio, model 1494, for AC and AC—DC operating and »the midget Svenskradio for AC», only types 502 V and 1502 V. Svenskradio 1494 is a medium-sized table-set with a comprehensive wave-length range, while the others are small convenient receivers with high sensitivity and good sound quality.

AC receiver Svenskradio 1494 V and AC—DC receiver Svenskradio 1494 LV

Svenskradio 1494 is produced in highly polished light elm and in the darker colours of walnut and mahogany, Fig. 1.

Equipment

The receiver is a 6-valve superheterodyne with 7 tuned circuits including oscillator and I. F. wave trap. It has automatically and physiologically correct volume control. Its special features include tuning indicator, bass and treble control, pick-up and speaker-connections.

Function

Several of the AC receiver's 6 valves serve double ends. The incoming signals are separated in the pre-circuits and are applied to the mixing valve *MECH 42*, where they form the intermediate frequency 452 kc/s along with the oscillator frequency. Two high gain powdered iron core tuned transformers and the high slope amplifier valve *6BA6* is used in the I. F. amplifier to keep a high degree of sensitivity compared with a good selectivity. From the diodes in *6AT6* there is taken an audio frequency part which is amplified and applied to the output valve *MEL 41* and the speaker. The DC voltage is returned to the control grids of the two first valves to maintain constant audio output. The rectifier valve *MAZ 41* feeds the receiver valves with anode voltage. The indicator valve *MEM 34* is double acting, i. e., it has a sensitive half for weak signals and a more insensitive part for strong signals.

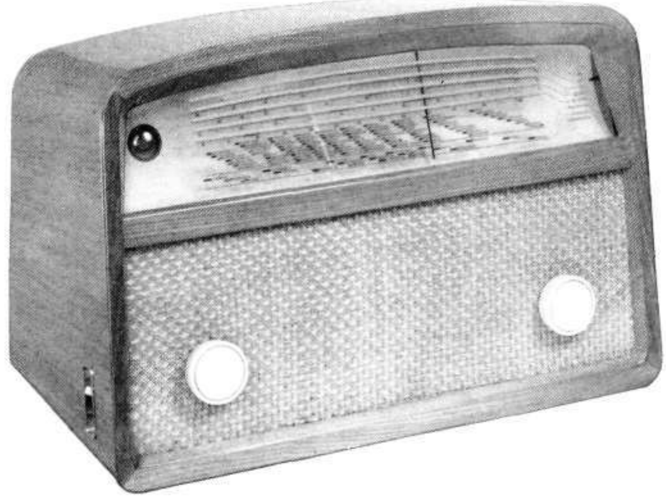


Fig. 1 X 6451

Svenskradio 1494

The controls are, from left: off-on-switch, volume control and band switch combined with tuning

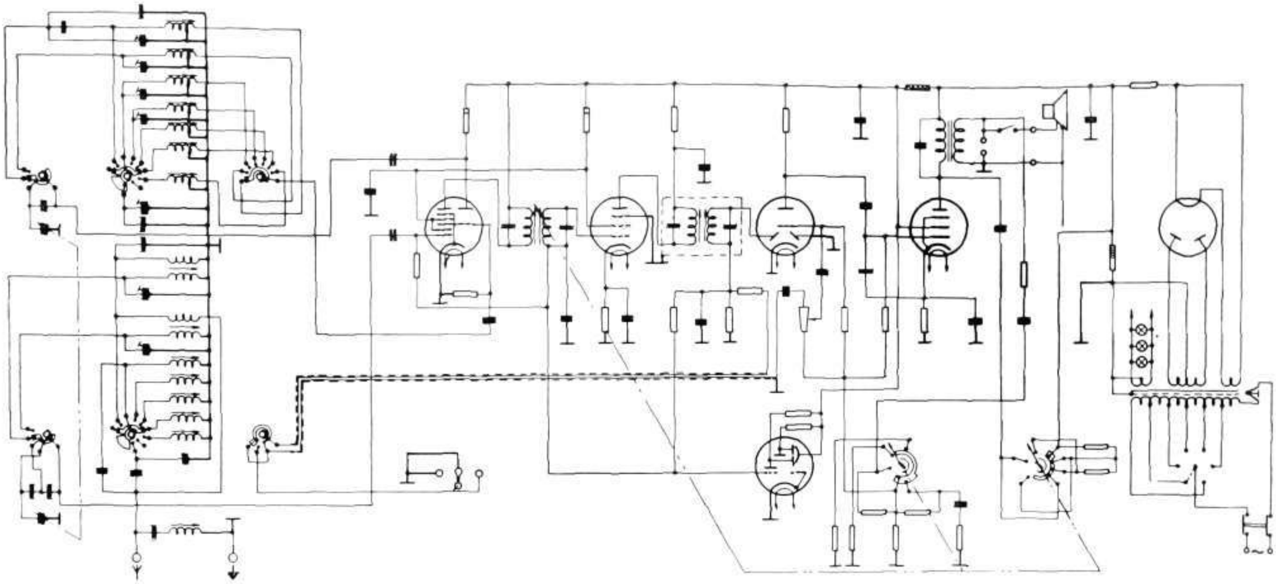


Fig. 2 X 7547
Circuit diagram for Svenskradio 1494

Svenskradio 1494 LV works in the same manner, but it is furnished with the valves *MUCH 42, MUF 41, MUBC 41, MUL 41, MUY 41* and *MUM 4*.

Tone Control

The tone control is located on the right-hand side of the receiver. In normal position the sound is the best possible, but on certain occasions it can be advisable to alter the character of the sound in some degree, according to the transmission, the acoustic conditions in the room, the disturbance or the listener's taste as regards sound quality. Therefore, it is impossible to state any general rule for the setting of the tone control. Broadly speaking, one turn to the left gives a good position for the reproduction of speech and one turn to the right is well suited to music.

Station Scale

In earlier Svenskradio types the short-wave range extended from 16 to 51 m, divided into 5 sections with band spread in each sections. To enable listeners also to hear stations in the 13 m band and in the range 50—180 m the total range has been increased to cover everything between 13 and 2 000 m, with one interruption only for the medium frequency between 580 and 690 m. The band spread is greatest on the 16, 19 and 25 m bands each having its own scale. The other scales have a fairly even wave length distribution. Over each short wave scale there is a special strip on which favourite stations may be marked in black or coloured pencil, so that these can easily be found.

On the medium and long wave the station names and calibration are executed in conformity with the »Copenhagen plan», which comes into force on the 15th of March 1950. In that plan the stations have been given a channel number between 1 and 121 on medium wave and 1—15 on long wave. These numbers are much more easy to keep in mind than the corresponding frequencies or wave lengths. For the same reason the division into wave lengths has been dropped and replaced by a channel number in the square before each name of station.

»Midget Svenskradio for AC»

The popularity of small receivers grows continually. They are inexpensive, easy to find place for and operate practically as well as the large ones. The disadvantage has been that they were only made for AC—DC operating. In districts where there is no direct current and where the mains voltage is often 110—130 volts the AC receiver operates better. By the employment of good

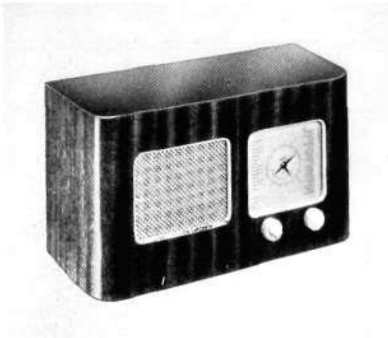


Fig. 3 X 4648
Svenskradio 502 V and 1502 V

components in miniature size Svenska Radioaktiebolaget has succeeded in producing a good AC receiver of small dimensions. Its type designation is Svenskradio 502 V, but it is popularly called »The Midget Svenskradio for AC», Fig. 3.

Advantages of 502 V over AC—DC receivers, whose strong point is that they can be connected to any electric mains, include the following features:

1) Better high frequency screening from the mains and therefore less disturbance.
2) Less sensitive to voltage variations. The filament currents of the valves alter only 5 % for 10 per cent variations of the mains voltage. The comparative figure for AC—DC receivers is 7.5 %.
3) Higher sensitivity and output on all mains with lower voltage than 220 V.
4) Less power consumption.

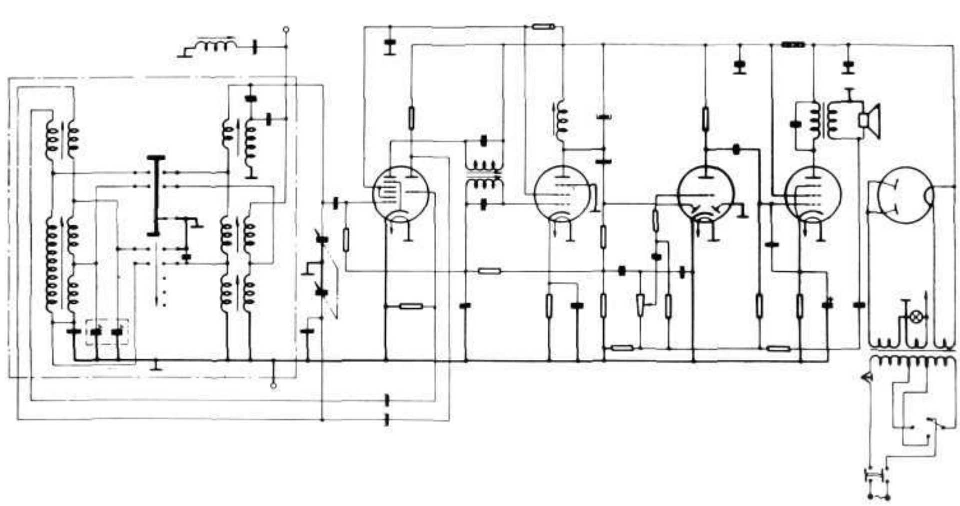
Ericsson Review 3/1948 contained a description of Svenskradio 492 LV, which resembles *Svenskradio 502 V* in appearance and size. This later receiver, however, has one more valve, making 5 in all, illuminated scale and wave-trap for the intermediate frequency. The mains transformer may be switched over for the voltages 110, 127 and 220.

Svenskradio 502 V is equipped with the valves *MECH 42*, *MEF 41*, *MEBC 41*, *MEL 41* and *MAZ 41*, which act as mixing, I. F. det. and A. F., output and rectifier valves respectively. In a later edition of 502 V — *Svenskradio 1502 V* — the second and third valves are replaced by SER valves *6BA6* and *6AT6*. *6AT6* has the same data as *EBC41*. *6BA6* has higher slope than *MEF41* but this has not been fully utilized.

»*Midget Svenskradio for AC*» has a case of fine highly polished wood, dark mahogany or walnut or light elm. The scale illumination is arranged in a convenient and pleasant manner. The whole impression given by the receiver is good, not least because of a soft sound free from resonance and with a large register. The receiver is so small (in size) that it can be put practically anywhere, in a bookcase, on a writing desk or like that. In most cases »the Midget Svenskradio for AC» operates perfectly well with only its built-in aerial.

As may be seen from the diagram of Fig. 4, the receiver is a fully equipped super heterodyne with automatic volume control. The net-work departs from the traditional in certain respects. Particularly noteworthy is the original way of arranging simultaneously feed-back coupling and physiologically correct sound regulation by the employment of a minimum number of components. The simple coupling gives a strong feed-back coupling for low sound intensity without any decreasing of weak signals. The raising of the bass is a very important factor for receivers of small size. In Svenskradio 502 V it amounts to the respectable figure of 20 dB for the exceptionally low frequency of 60 c/s.

Fig. 4 X 7546
Circuit diagram for Svenskradio 502 V_1



	1494 V	1494 LV	502 V	1502 V
List of valves				
Frequency changer	MECH 42	MUCH 42	MECH 42	MECH 42
I.F. amplifier	6BA6	MUF 41	MEF 41	6BA6
Det: and A.F. amplifier	6AT6	MUBC 41	MEBC 41	6AT6
Output valve	MEL 41	MUL 41	MEL 41	MEL 41
Indicator	MEM 31	MUM 4	—	—
Rectifier valve	MAZ 41	MUY 41	MAZ 41	MAZ 41
Number of valves	6	6	5	5
Number of valve functions	8	8	7	7
Dial lamps	BA9S 6.5V/0.2A	BA10S 6.5V/0.1A	BA9S 6.5V/0.2A	BA9S 6.5V/0.2A
Main features				
Sensitivity μV/50 mW	10	20	20	
Selectivity (band-width at 40 dB) kc/s	18	18	24	
Output at 220 V W	3.5	3.5	2.5	
» » 110 V W	3.5	0.6	2.5	
Power consumption at 220 V W	50	60	28	
» » » 110 V W	50	28	28	
Switchable for voltages	110, 127, 140, 155, 220, 245	110—120 130, 150, 220	110, 127 220	
Wave band ranges m	13—17		18.5—50	
	16—20			
	20—26			
	26—65			
	65—182			
	180—580		190—580	
	690—2000		690—2000	
Intermediate frequency kc/s	452		452	
Number of circuits including I.F. wavetrap	7		6	
Loud-speaker 5" P.M.	HK 918		HK 713	
Flux Gauss	9000		7000	
Cone area cm²	200		80	
Dimensions and weight				
Height mm	310		165	
Width mm	488		280	
Depth mm	240		135	
Weight kg	9.4	8	3.8	

Type designation: V = AC, LV = AC—DC.

U.D.C. 621.395.343

LINDSTRÖM, E: *New Developments on the LM Ericsson Telephone System with 500-line Selectors*. Ericsson Rev. *26* (1949) No. 4 pp. 106—120.

During recent years the LM Ericsson system with 500-line selectors has been subject to considerable circuit revisions and additions.

The purpose of the following article is to give an account of some of the more important developments, referring in the first place to installations abroad.

U.D.C. 621.317.341

LUNDVALL, B: *A Level Meter for the Frequency Range 30 c/s to 5 Mc/s*. Ericsson Rev. *26* (1949) No. 4 pp. 121—124.

Description of L M Ericsson's new level meter which bears the designation ZTE 16. The level meter covers the frequency range 30 c/s to 5 Mc/s, and its sensitivity is such that full deflections is obtained for a voltage level of -4.5 N (zero level is 0.775 V).

U.D.C. 621.317.727

HOLMQVIST, S & WANDIN, B: *Technical Potentiometers*. Ericsson Rev. *26* (1949) No. 4 pp. 125—130.

Description of two potentiometers, YBT 10 and YBK 10, manufactured by L M Ericssons Mätinstrument AB, one of which is specially intended for measuring voltages in a thermocouple for temperature measurements, the other being used for checking direct current volt- and ammeters.

U.D.C. 621.396.62

FREDIN, C: *New Svenskradio Receivers*. Ericsson Rev. *26* (1949) No. 4 pp. 133—136.

Description of three new radio receivers manufactured by Svenska Radioaktiebolaget, namely Svenskradio 1494 for AC and AC—DC operating and »the midget Svenskradio for AC», types 502 V and 1502 V. Svenskradio 1494 is a medium-sized table-set with a comprehensive wave-length range, while the others are small convenient receivers with high sensitivity and good sound quality.

U.D.C. 654.924.53

SZABÓ, H: *New Types of Thermal Detectors for Automatic Fire Alarm Systems*. Ericsson Rev. *26* (1949) No. 4 pp. 131—132.

Description of two new types of thermal detectors put on the market by Telefonaktiebolaget LM Ericsson. The new thermal detectors are manufactured in two types: one open type for dry premises and one enclosed type intended for damp premises or where explosion hazards exist.

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Thailand The Borneo Co., Ltd	*Bangkok*, Chartered Bank Lane
Syrie et Liban Swedish Levant Trading	*Beyrouth*, Place de l'Etoile, B.P. 931
Türkiey Genel Sanayi Techizati T.A.O.	*İstanbul*, Hezaren Caddesi. No. 77, Galata PK 1455

AFRICA

Egypt Swedish Industries	*Cairo*, 25 SH. Adly Pacha P.O.B. 1722
Moçambique J. Martins Marques	*Lourenço Marques*, P.O.B. 456
Tanger Elcor S.A.	*Tanger*, Calle de Fez No. 9
Union of South Africa and Rhodesia Reunert & Lenz, Ltd	*Johannesburg*, 86 Main Street P.O.B. 92

AMERICA

Bolivia Johansson & Cia, S.A.	*La Paz*, Avenida Montes 642, Casilla 678
Costa rica Tropical Commission Co.	*San José* Apartado 661
Curaçao NW.I. S.E.L. Maduro & Sons	*Curaçao*
Ecuador Ivan Bohman y Cia	*Guayaquil*, Almacen Nueve de Octubre 211, Casilla 1317
El Salvador Dada-Dada & Co.	*San Salvador*, Apartado 274
Guatemala Agencia de Fosforos Suecos, S.A.	*Guatemala*, C. A. Apartado 125
Surinam C. Kersten & Co. N.V.	*Paramaribo*, Steenbakkerijstraat 27, P.O.B. 216
Venezuela Electro-Industrial Halven O. L. Halvorssen C.A.	*Caracas*, Esquina de Monroy 28 Apartado 808

AUSTRALIA & OCEANIA

Australia Ericsson Telephone Manufacturing Co.	*Sydney*, Reliance House, 139 Clarence Street, G.P.O.B. 2554
New Zealand ASEA Electric (NZ) Ltd	*Wellington*, Huddart Parker Building P.O. Square