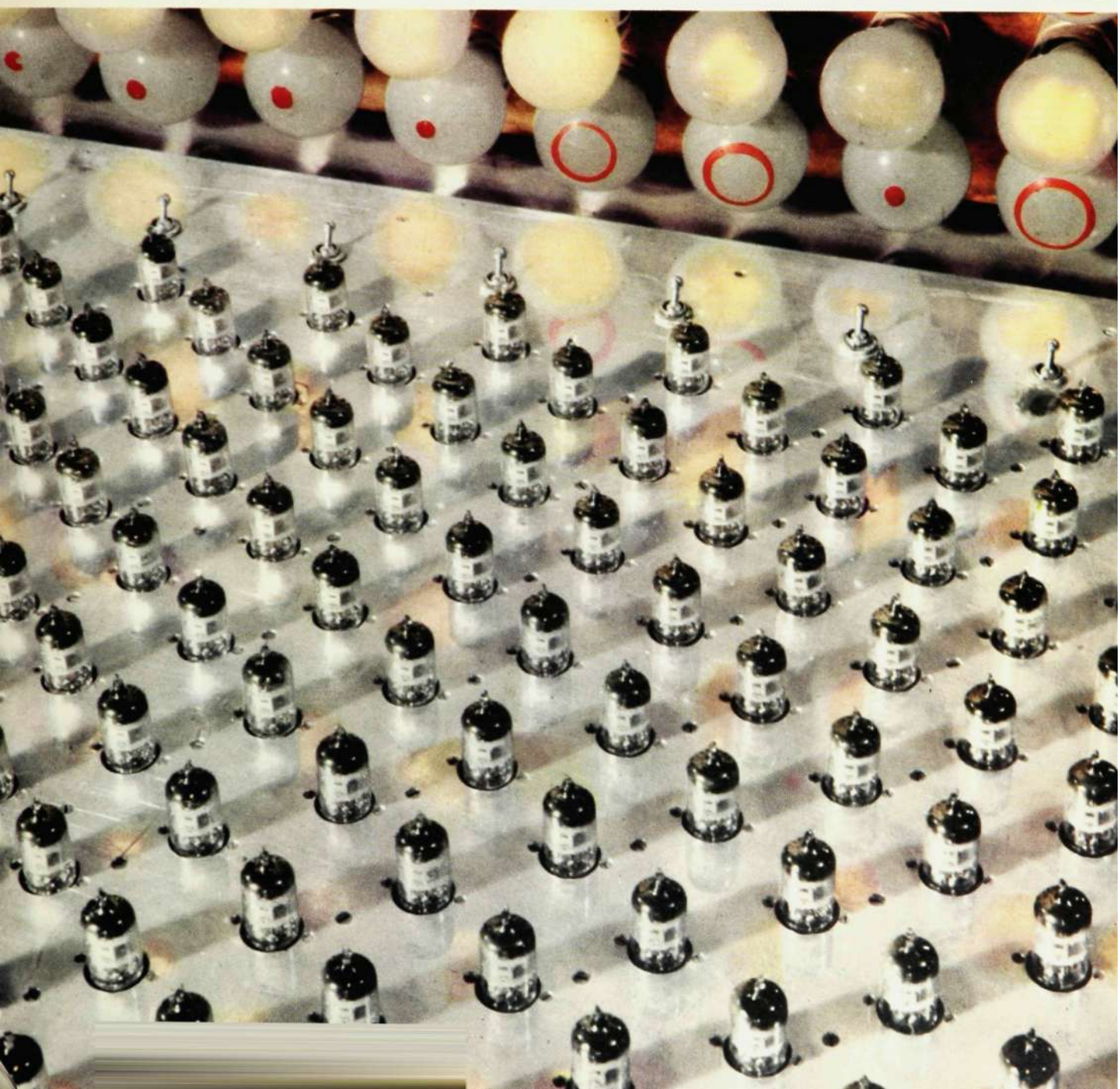


# ERICSSON

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1954

## *Review*





# ERICSSON REVIEW

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# Gas Control on Telephone Cables by Gas Flow Meters and Automatic Pressure Compensation

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U.D.C. 621.315.211.4

*In an article entitled »Gas Control on Telephone Cables» published in the Ericsson Review No. 4 1952 a new method was described by means of which, on the occurrence of a leak, gas is also fed into the cable automatically simultaneously with the gas control, whilst at the same time the drop of pressure in the gas is recorded. The following article describes this method in greater detail as well as the necessary apparatus and materials employed. The method itself and a part of the apparatus have been patented.*

## General

In the two systems employed hitherto for gas control on telephone cables the principle followed has consisted in dividing up the cable or cable network into a number of pressure-tight sections separated from one another, each such section being provided with a suitable number of pressure sentinels and valves. When a leak occurs an alarm is given, whereupon an approximate localization of the fault can be undertaken either by plotting a pressure curve for the faulty section, or by the bridge measurement of the resistance up to the pressure sentinels sending out an alarm, depending upon the type of pressure sentinel installed in the system. In the two systems mentioned above the pressure drops along the whole section on the occurrence of a leak. In the case of a large leak two days are usually available for repairing the fault after the alarm has been received. For smaller leaks it is permissible to wait for a longer period; when the leak is very small it may even be worth while in certain cases to allow the cable to remain untouched, and feed in gas instead from time to time from both end points of the section.

In L M Ericsson's new system the cable or cable network is provided with a suitable number of gas cylinders which, via reducing valves and pressure regulators, maintain the cables under a constant pressure continuously. When a leak occurs gas flows in from both sides and fresh gas is fed in automatically from the gas cylinders which maintain the cable section under pressure. In this system, therefore, the pressure at the ends of the section is always constant. As the gas leaves the gas cylinder, it passes a signal manometer which gives an alarm. Thus pressure sentinels are not required. At the same time that the signal manometer closes an alarm circuit it sends out an impulse to an indicating receiver, which then records the volume of the gas flowing out. When the gas flow becomes stationary, readings are taken from the counters on both sides of the fault; direct information concerning the position of the fault is then obtained (with the same accuracy as in the older system, that is to say, to within about 2 % of the section's length). It will be realized from what has been said above that the new system possesses many advantages over the older one:

1. The cables are more effectively protected against the penetration of moisture since the over-pressure cannot fall to 0 (as long as any gas remains in the cylinders) but assumes a certain value depending upon the size of the leak and the distance of the fault from the gas cylinders.
2. Gas refilling takes place automatically which is accompanied by the fact, amongst other things, that small leaks can be neglected entirely until it is desired to repair them, or they may be left alone altogether since the cost of the gas is very small, whereas the costs for repairs may be considerable in some cases (as for example, when it is necessary to break up the street paving).

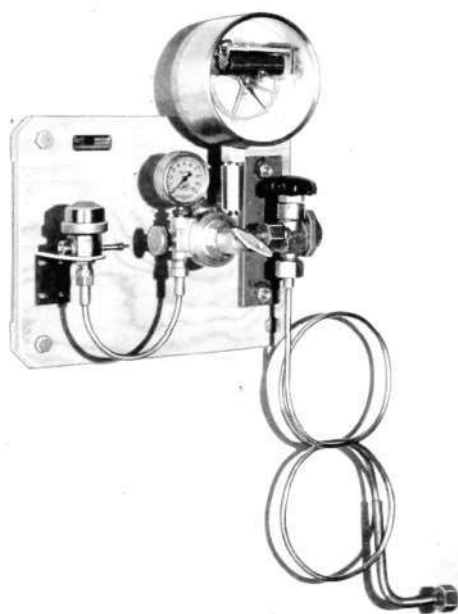


Fig. 1  
Pressure control unit NVB 3001

X 4952

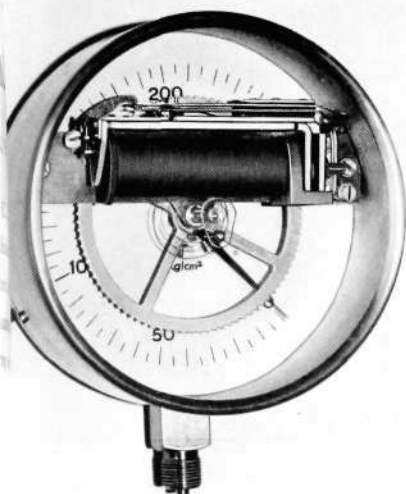


Fig. 2  
Signal manometer  
LTP 2061

X 4953

3. The supervisory equipment is conveniently accessible in amplifier stations or automatic stations or in similar premises. No pressure sentinels are required.
4. Fault localization is simplified and rendered cheaper. No pressure curves need be plotted along the cable and no bridge resistance measurements made.

## EQUIPMENT

### I. Stationary Installation

#### 1. PRESSURE CONTROL UNIT NVB 3001

The pressure control unit *NVB 3001* is mounted nearest to the gas cylinder, and consists of the constant regulator *LTP 2124* with signal manometer *LTP 2061*, fig. 2, pressure regulator *VAN 2301*, cut-off cock *NVB 1021*, high pressure pipe unit (for connection to the gas cylinder) *NVB 1351* and pipe units for the connections between the different parts. The whole equipment is mounted on a teakwood panel.

##### a. Signal Manometer *LTP 2061*

The signal manometer constitutes «the brain» of the system and sends out alarm impulses and impulses to a separate indicating receiver. It consists of an ordinary hydraulic pointer manometer graduated from 0 to 250 kgs/cm<sup>2</sup>\* and is provided with a signal mechanism which mainly consists of a pilot relay and a ratchet-wheel with a spiral spring, see fig. 2. The protective plate is provided with an opening at the centre through which the ratchet-wheel can be wound up by means of a screw driver.

A plate is placed on the pointer and makes contact with a pin on the ratchet-wheel, whereupon a circuit is closed. When the pressure in the gas cylinder to which the manometer is connected begins to fall, the pointer moves over the scale in a counter-clockwise direction. After the pointer has moved for a certain distance in this direction the contact between it and the ratchet-wheel is closed and the pilot relay then operates and feeds the ratchet-wheel forward a half-step in the same direction. At the same time an impulse is transmitted to the nearest attended station where an alarm is given simultaneously with the recording of the impulse. The impulse relay has now been deenergized which thus causes the ratchet-wheel to be moved forward a further half-step. After this first contact has been established, with the resulting forward movements of the ratchet-wheel totalling a whole step, the pressure must now fall further to a given value which has been selected as 3.75 kgs/cm<sup>2</sup> before a new contact can be set up between the pointer's plate and the ratchet-wheel pin, and also subsequently when the pressure falls further. A newly filled gas cylinder normally has a pressure of 150 kgs/cm<sup>2</sup> so that a pressure drop to 0 would correspond to 40 impulses.

Immediately above the text, "kg/cm<sup>2</sup>", on the scale dial a small contact strip is mounted which establishes contact with the pin on the ratchet-wheel when the pressure in the cylinder has fallen to about 30 kgs/cm<sup>2</sup>. The circuit of an observation lamp can thus close and an indication is given that it will soon be necessary to change the cylinder.

##### b. Pressure Regulator *VAN 2301*

If the signal manometer constitutes the «brain» of the system, the pressure regulator may be regarded as its «heart», since it pumps in gas when a leak occurs. The gas then flows from the gas cylinder through a constant regulator, the high pressure manometer for which is the previously described signal manometer *LTP 2061*, and passes on through the pressure regulator

\* According to the international agreement reached on the conclusion of the second world war, the pressure unit kg/cm<sup>2</sup> should be replaced by kp/cm<sup>2</sup> (kiloponds/cm<sup>2</sup>). Since 1 kg as a unit of power varies according to the gravitational acceleration of the latitude, by introducing a unit of 1 kp = 980,665 dynes/cm<sup>2</sup>, a standard value has been obtained for power irrespective of the latitude. In this respect the difference is insignificant, however, (the gravitational acceleration varies about 5  $\frac{0}{100}$  from the equator to the pole) and it is still most customary to indicate pressure in kg/cm<sup>2</sup> even when—as in this case—the manometer indicates a pressure which is independent of the latitude.

*VAN 2301* before it flows into the cable. The pressure regulator can be set with great accuracy for the over-pressure to be applied to the cable. As long as the cable is sound the pressure regulator remains in the stationary position, but as soon as the pressure in the cable begins to fall a valve is opened and allows the gas to flow into the cable. When the over-pressure in the cable has been restored, the valve cuts off the gas supply.

The pressure regulator is constructed in such a way that an eventual fault in it can not entail that the over-pressure in the cable exceeds the normal.

## 2. INDICATING RECEIVERS

For long distance cables and in branched cable networks the relay set *BCV 21001* is used as the indicating receiver, while for smaller networks the relay set type *BCV 212* is employed. Both relay sets can either be mounted on a wall or a framework. They can be pivoted out to permit convenient access to the relays' soldering tabs. The rectifier *BMA 1704* is employed for a 24 V operating voltage.

### a. Relay Set *BCV 21001*

This relay set which is constructed in the form of a counting mechanism, contains 6 relays and a maximum of 6 impulse counters, depending upon the number of pressure control units used. Simultaneously with the recording of an impulse a red control lamp lights up. An alarm bell may be connected to the relay set by means of special alarm wires. The alarm bell is disconnected and the control lamp switched out by a spring push-button. The operating voltages usually employed are 130 V and 24 V D. C. 130 V was chosen on account of the fact that this voltage is generally available in amplifier stations. The apparatus can also be constructed for other voltages than those mentioned above.

### b. Relay Set Type *BCV 212*

This relay set is constructed solely in the form of an indicating mechanism and therefore has no impulse counter. It contains 8 relays, two of which are cam-disc relays. Two control lamps are included in this set; a red one for indicating large leakages, that is to say, when the leak is so large that the signal manometer transmits more than one impulse within a certain time, for example per day, and a green lamp that lights up when the pressure in the gas cylinder has fallen to 30 kgs/cm<sup>2</sup>.

The relay set is also provided with two pairs of contacts for connecting the alarm conductors to the 220 V network.

The red lamps is switched out by a spring push-button. On pressing this push-button which is fitted with a locking device, the lamp or bell connected

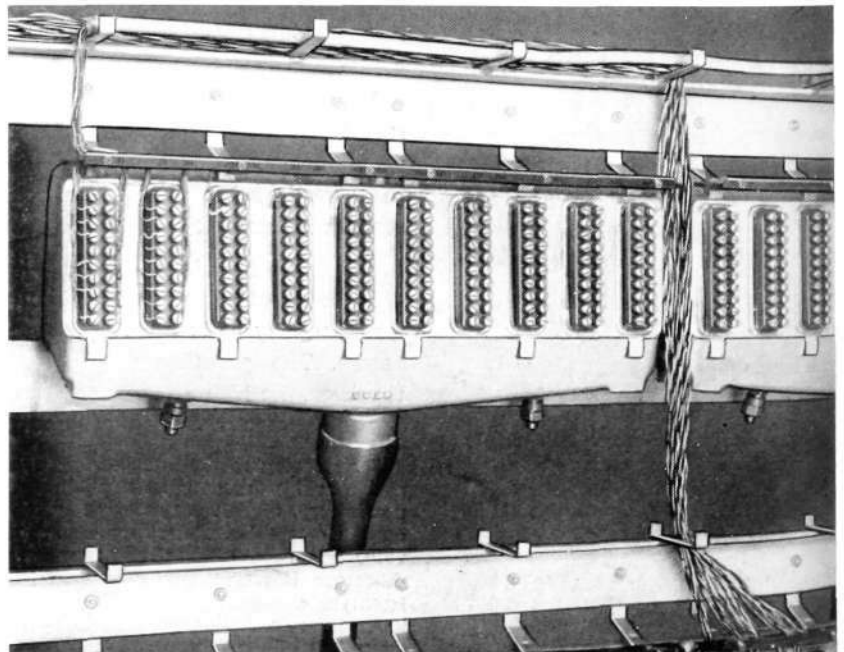
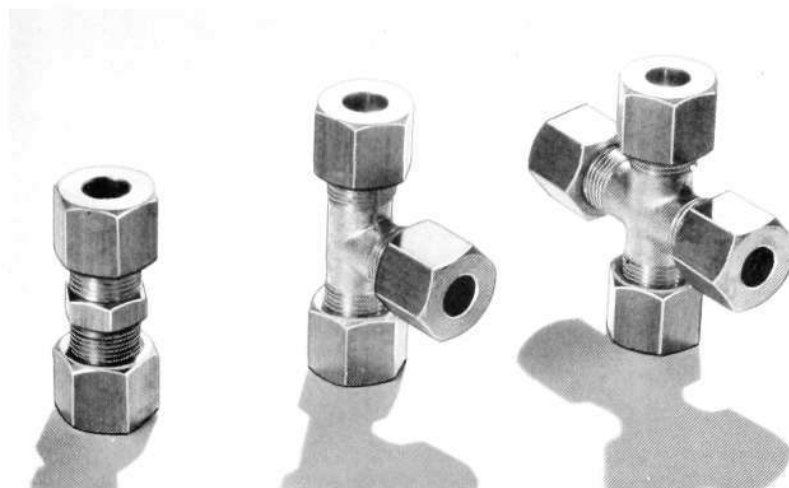


Fig. 3  
Cable terminal boxes mounted on a  
frame

X 6802

Fig. 4  
Pipe couplings, from the left,  
NVB 13001, NVB 13011, and NVB 13021

X 6803



to the extra alarm conductors is disconnected. The green lamp is not switched out, and this only takes place after a new gas cylinder has been inserted.

Only 24 V D. C. is required for this relay set.

#### c. Rectifier BMA 1704

The operating voltage is 24 V and the rectifier can be reconnected for single-phase alternating current, 110, 127, and 220 V, 40—60 c/s. The rectifier is mounted on a wall.

### 3. BOXES

If the cables are fitted with, or are intended to be fitted with gas-tight plugs, they can terminate in L M Ericsson's standard connection boxes. If this is not the case one of the following pressure-tight boxes may be selected:

<i>NCL 4513</i> (30-pairs)	<i>NCL 4515</i> (50-pairs)
<i>NCL 4514</i> (40-pairs)	<i>NCL 4516</i> (60-pairs)
<i>NCL 4520</i> (100-pairs)	

The boxes are provided at the bottom with two threaded holes, in one of which the nipple *NVB 1171* can be inserted and the control valve *NVB 1181* in the other (see further on). The boxes may either be mounted on a wall or on a framework, see fig. 3.

For coaxial cables so-called coaxial boxes are used, these now being of the cylindrical type. The operating conductors are connected to protector terminal boxes, usually *NCN 2501* or *NCN 2502*.

### 4. PIPING MATERIAL

The piping consists of 8 mm tombac or copper pipes having an internal diameter of 4 mm. All the other material is adapted for use with pipes of these dimensions.

For jointing and branching the piping the pipe couplings *NVB 13001*, *NVB 13011*, and *NVB 13021* are used, see fig. 4. No brazing is necessary at the site when installing the couplings. When drawing the nut tight it is forced by means of a tightening ring provided with a cutting edge into the cone of the nipple, whereupon the front part of the tightening ring is crushed together and cuts into the pipe. The material which is thus pressed up round the pipe forms a shoulder which holds the pipe in position.

The connection produced in this way fulfils the highest demands with regard to pressure, fatigue stresses and tightness provided that installation is carried out correctly.

For disconnecting the individual cables separately, cut-off cocks *NVB 1011* are employed, and these are fitted with the same tightening system as the pipe couplings described above. For connecting the pipes directly to the cables connecting washer type *NVB 112* (with a radius of curvature corresponding to that of the cable or jointing sleeve) is soldered to the cable, the nipple *NVB 1171* being screw-threaded into the washer after a hole has been drilled in the cable sheath with a cable sheath borer *LTP 2161*. A packing *SCG 20001* is used

Fig. 5

X 6804

Material for gas pressure-protected cables from the left, connecting washer NVB 1121, plug NVB 1151, nipple NVB 1171, control valve NVB 1181, and packing SCG 20001.



for tightening. In certain cases connecting washers only are soldered to the jointing sleeves along the cable section and terminate in a plug *NVB 1151*. A control valve *NVB 1181* can subsequently be screwed into the washer when desired for purposes of control. The nipple *NVB 1171* and control valve *NVB 1181* are also used for the pressure-tight boxes. The above-mentioned parts are illustrated in fig. 5.

At the transition points between the pressure control unit and piping system and between the latter and the connections to the cables or boxes the piping must terminate in a sealing extension which is brazed to the pipe. In order to avoid brazing at the installation site as mentioned above, special pipe units are available, *NVB 1331* (15 cm long) and *NVB 1332* (25 cm long) which are previously fitted at one end with a brazed sealing extension of this kind and a box nut, see fig. 7. These pipe units are jointed to the other piping by means of the pipe coupling *NVB 13001*.

The separate piping for each cable should be provided, via a pipe coupling *NVB 13011*, with an attachment which in turn is fitted either with a cut-off cock *NVB 1011* (as shown in fig. 13) and a pipe with a hose socket *NVB 1341* (fig. 7) suitable for a plastic hose having the external and internal diameters of 14 and 8 mm respectively, such as Polva SSY 84, or with a pipe coupling *NVB 13031* and valve 1/*NVB 1101*, fig. 6. The valve 1/*NVB 1101* forms part of a bayonet coupling the other part of which consists of a nozzle 2/*NVB 1101* which is screwed to the apparatus to be inserted in the attachment. When the nozzle is pressed into the valve the passage is open for the flow of gas, but as soon as it is withdrawn from the valve, the latter cuts off the gas.

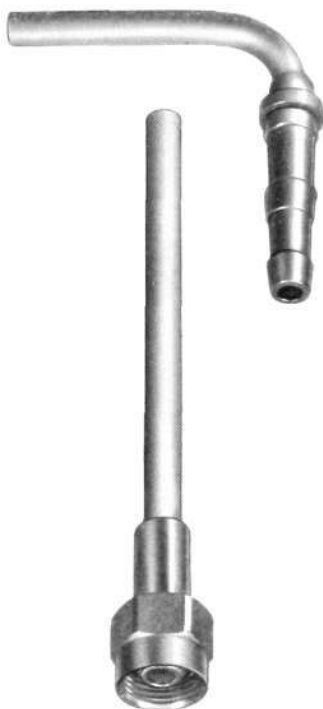
The clamps *NSV 2829* are employed for fixing the piping to a wall.

Fig. 6

X 4978

Bayonet coupling *NVB 1101*

from the left, valve 1/*NVB 1101* and nozzle 2/*NVB 1101*



## II. Apparatus for Fault Localization

### 1. PRESSURE TESTING UNIT LTP 2001

This unit is designed for portable use, see fig. 8, and consists of a box containing the same parts as those included in the pressure controlling unit *NVB 3001* with the exception of the 8-shaped high pressure pipe unit which here bears the designation *NVB 1352* and the signal manometer *LTP 2061* which is here replaced by a high pressure manometer *LTP 1501*. In the cover, which can be completely removed, a hose pipe *NVB 2221* for connection to the cable and the high pressure pipe unit for connection to the gas cylinder are fixed. The hose pipe *NVB 2221* consists of a plastic hose 2 metres in length with a sealing extension at each end.

### 2. RADIATION INTENSITY METER LMK 3001

For accurate fault localization (see page 45) radon is used and is traced with the help of a radiation intensity meter *LMK 3001*. The latter consists of a radiation detector 1/*LMK 3001* and a radiation indicator 2/*LMK 3001*, see fig. 9.

The detector is housed in a rainproof metal casing equipped with a change-over switch for three different sensitivity ranges and for controlling the battery voltage. It has non-loosable screws and can be easily opened for changing the batteries or tubes. The detector is very small and light, having dimensions of 21 cm × 8.5 cm × 8 cm and a weight of 1.75 kgs.

The radiation indicator is a pointer instrument calibrated in radiated impulses per minute. The instrument is built into a small and robust leather case fitted with a strap. The connecting cord is also placed in the case.

Fig. 7

X 4981

Pipe units *NVB 1341* (above) and *NVB 1331*



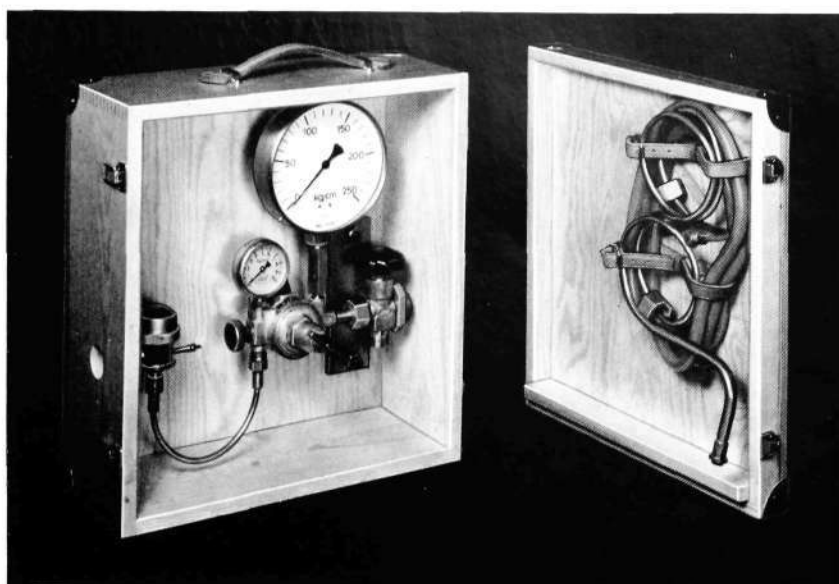


Fig. 8  
Pressure testing unit LTP 2001

X 6805

### 3. INJECTION EQUIPMENT

For the injection of radon (see section on Accurate Fault Localization further on) the following are employed: gas cylinder LTP 2043 (1 litre nitrogen cylinder) a constant regulator LTP 2123, a hose pipe LTP 2221, a connecting washer of the type NVB 112, a plug NVB 1151, nipples NVB 1171 and NVB 1172, a valve 1/NVB 1101 with a nozzle 2/NVB 1101, together with hose clamps LTD 2401, a copper cloth No. 50, protective gloves (preferably of thin rubber), pliers LSD 32402 or LSD 32404, pincers with milled ends LSH 2003 and radon ampoules.

The above parts are placed in an injection toolbox type *LTT 206* which also contains general tools and jointing material. The dimensions of the toolbox are 55 cm × 32 cm × 17 cm.

A connecting washer and plug remain at each injecting point after injection. In addition, two hose clamps, a radon ampoule and a pair of protective gloves are required for every injection. Furthermore, a part of the copper cloth and a part of the hose are used. When the latter has been used up, the sealing extensions are moved over to a new two-metre plastic hose, such as Polva SSY 84. Care must be taken to see that the hose fits tightly over the sealing extensions. For this purpose the ends of the hose may be heated up carefully when they are being fitted on, for example.

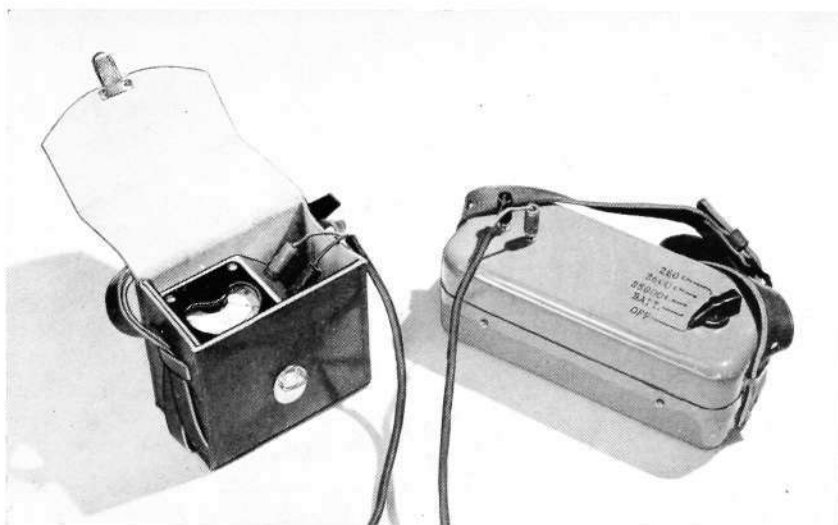


Fig. 9  
Radiation intensity meter LMK 3001  
right, radiation detector 1/LMK 3001, left,  
radiation indicator 2/LMK 3001

X 6806

# INSTALLATIONS IN SERVICE

## General

In order to ensure that a gas entirely free from moisture is available, nitrogen is always employed nowadays. This gas is supplied in gas cylinders and is sold in most countries by AGA, for example. The purity never falls below 995 ‰ and is generally as high as 999 ‰.

The gas pressure should be chosen with regard to the construction and size of the cables; thus, for example, the following values of overpressure may be found suitable:

0.7 kg/cm<sup>2</sup> for coaxial cables and large cables (external diam.  $d > 5.5$  cm)

0.6 kg/cm<sup>2</sup> for medium-size cables ( $3 \text{ cm} < d < 5.5 \text{ cm}$ )

0.5 kg/cm<sup>2</sup> for small cables ( $2 \text{ cm} < d < 3 \text{ cm}$ )

0.4 kg/cm<sup>2</sup> for the smallest cables ( $d < 2 \text{ cm}$ )

These values hold good for a temperature equal to the mean annual temperature of the soil.

The requirements will not be met, however, if the cables are leak-proof but the ends are not sealed. The simplest method of sealing the cable ends consists in leading them into pressure-tight boxes. Nevertheless, it may be found desirable in many instances to retain the cable boxes already available, or to employ »standard» boxes, i.e. boxes that are not pressure-tight, for some reason or other. In such cases a gas-tight plug must be inserted in the cable a short distance from the box. A description of these gas-tight plugs will be found in the Ericsson Review No. 4/1952 in the article »Gas Control on Telephone Cables». Detailed instructions for producing gas-tight plugs are given in special directions for installation.

In the following description of cable installations under gas control in accordance with L M Ericsson's new method particulars are given of three types of installations, namely, for long distance cables, for small cable networks and for large, branched networks, since both the equipment and its method of functioning vary somewhat in the different cases.

## 1. Gas Control Installation for Long-distance Cables

The term, long-distance cable, here implies a cable that is at least ten kilometres in length. The construction of a gas control installation according to the new method for a coaxial cable with two manned terminal stations  $S_1$  and  $S_{12}$  and ten unattended amplifier stations  $S_2$ — $S_{11}$  is described below. The distance between the stations is usually about 10 kms. Each station is equipped with a gas cylinder and a pressure control unit NVB 3001, see fig. 10, while the terminal stations alone are provided with indicating receivers, in this case counting mechanisms (relay set BCV 21001).

The electrical circuit diagram may be seen from fig. 11. The nearest half of the number of unattended stations is supervised from each of the two manned terminal stations. The pilot relays are distributed over 4 operating wires which may, however, be used at the same time as service conductors. The diagram in fig. 11 may best be explained by means of the following example. At station No. 6 the pressure in the gas cylinder has fallen to such an extent that the pointer on the signal manometer makes contact with the pin on the ratchet-wheel. A circuit is then closed from the plus pole through  $R_1$ , the pilot relay at station No. 6 and  $R_4$  to the minus pole. All three relays operate. The pilot relay moves the ratchet-wheel forward a half-step and is at the same time held in position. By the operation of  $R_1$  and  $R_4$  positive passes through make contacts to  $IR_6$  which operates.  $R_5$  is thereby energized and breaks the circuit of the pilot relay at station No. 6. The pilot relay will thereupon drop out and move the ratchet-wheel a further half-step. The plus side is simultaneously connected to  $R_6$  which closes different alarm circuits. The relays  $R_1$  and  $R_4$  released when  $R_5$  was energized whereupon  $IR_6$  released and the counter mechanism recorded an impulse.  $R_5$  is deenergized at the end of the delayed action period while  $R_6$  must be reset manually.

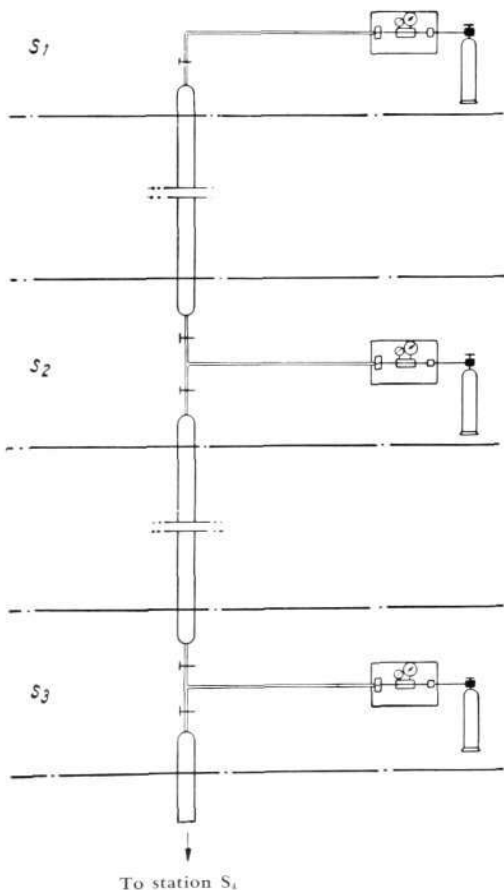
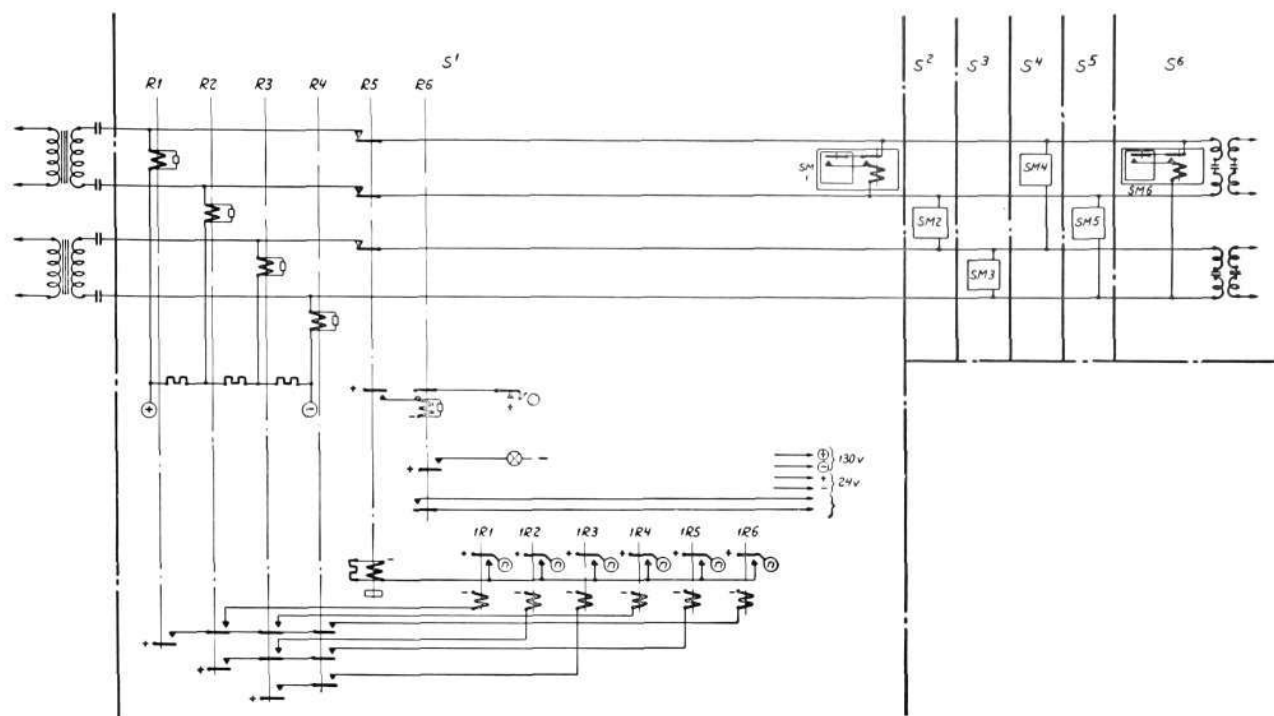


Fig. 10

Schematic diagram of gas controlled cables in coaxial cable installations



**Fig. 11**  
Schematic diagram of the relay equipment for long distance cables

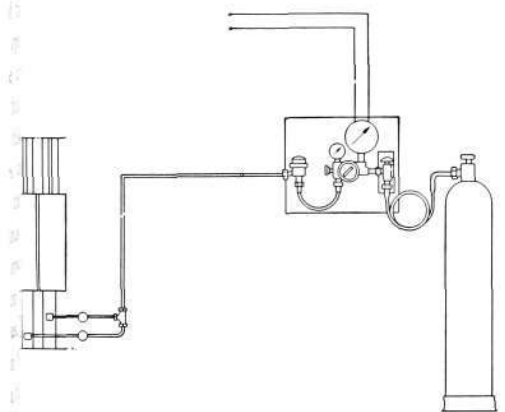
In the above example the cable connects two manned terminal stations between which there are ten unattended stations. If the length of the cable exceeds 110 km it is customary to have a larger number of manned stations; usually there is a maximum of 12 unattended stations between two manned ones. A terminal station need not, of course, always be manned, but in such a case one of the intermediate stations is provided with a staff. In this event it is usual to place a maximum of 6 unattended stations beyond this intermediate station.

As is shown in fig. 11 four operating wires are required in the cable, which, however, need not be used in a manned station as the gas cylinder and pressure unit are located in the same building as the relay- and alarm equipment. Thus, by means of the 4 operating wires in the cable, 6 unattended stations can be supervised in each direction. In the event of there being more than 12 unattended stations in sequence, it is possible with the help of 2 additional operating wires to supervise up to 30 unattended stations in sequence (i.e. 15 stations in each direction).

## II. Gas Control Installation for Small Branched Cable Networks

In a city an administrative body such as an electric supply company frequently has a private external telephone network between its head office and branches or substations. The telephone cables between these offices or stations are usually of relatively small dimensions and are not very long. In order to place a telephone network of this description under gas control it is only necessary to employ one pressure control unit with gas cylinder and one indicating mechanism, in this case of the type BCV 212. This apparatus should preferably be installed in the main station. All distribution of the gas to the cables will then take place from the main station. The pressure control unit is connected through a pipe distribution system either directly to the cables as illustrated in fig. 12, or to the connections at the pressure-tight boxes. Fig. 13 shows an example in which connection is made to twelve terminal boxes.

In a gas control system of the type discussed under I a daily record must be kept of the readings from the impulse counters. In a smaller system, on the other hand, which is only equipped with one gas cylinder, it is desirable to be able to dispense with this routine control, on which account the relay- and alarm equipment is so designed that no alarm is given on the occurrence



**Fig. 12**  
Gas control equipment in an amplifier station for a coaxial cable installation

- 1 gas cylinder LTP 2042
- 2 high pressure pipe unit NVB 1351
- 3 pressure control unit NVB 3001
- 4 pipe coupling NVB 13021
- 5 " " NVB 13011
- 6 " " NVB 13001
- 7 cut-off cock NVB 1011
- 8 nipple NVB 1171
- 9 packing SCG 20001
- 10 tombac or copper pipe, 8 mm external, 4 mm internal diameter
- 11 pipe unit NVB 1332
- 12 pressure-tight box, type NCL 45
- 13 pipe unit NVB 1341
- 14 clamp NSV 2829
- 15 pipe unit NVB 1331

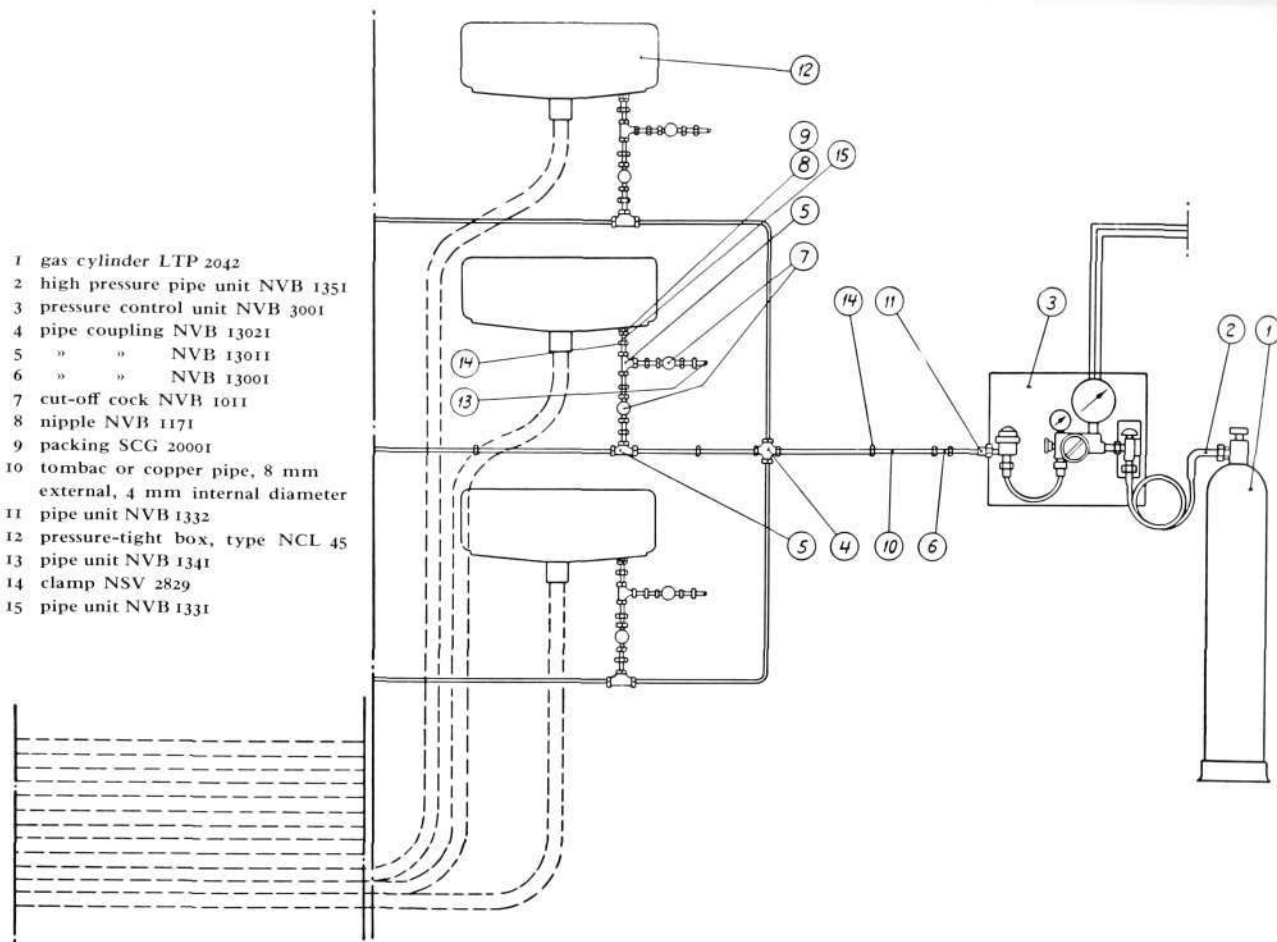


Fig. 13  
Central station in a branched cable network

X 7666

of leaks which are regarded as so insignificant that a continuous supply of the gas is found preferable to the repairing of the damaged cable sheath. In this case, therefore, it is unnecessary to control the fall of pressure in the gas cylinder continuously since a separate alarm is given when the gas in the cylinder is nearly exhausted. For the same reason an impulse counter is not needed.

The electrical circuit diagram for the alarm system is shown in fig. 14. As may be seen, the system includes a thermal springset and two cam-disc relays the purpose of which is to transmit an alarm signal when more than one impulse is received within a given time, such as 24 hours. The requirements regarding the limits which should be set between an insignificant leak and one which should transmit an alarm may naturally vary from case to case. In the example described here a limit of 1 impulse per 24 hours has been selected.

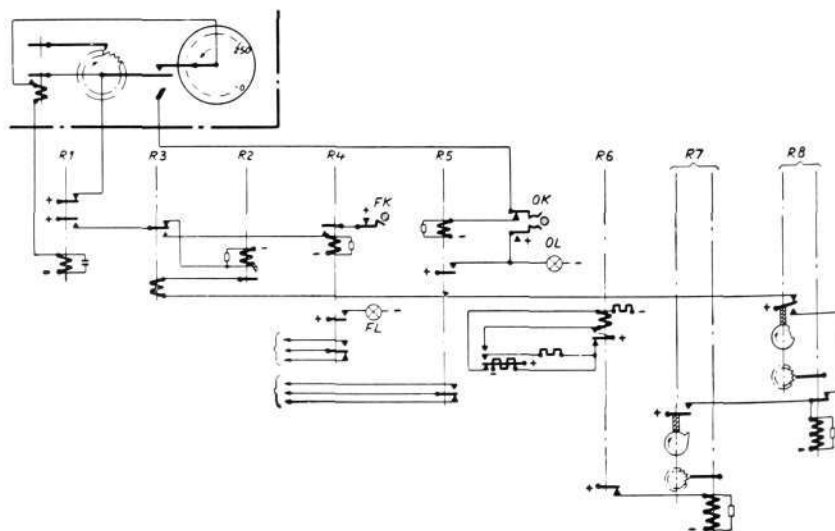


Fig. 14  
Schematic diagram of the relay equipment for a small cable network

X 6808



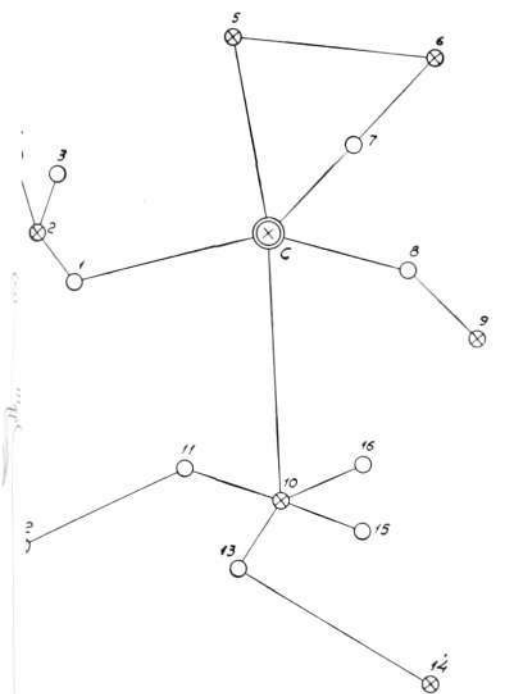


Fig. 15  
Large branched cable network

When the pointer on the signal manometer establishes contact with the ratchet-wheel a circuit is closed from the plus pole at the breaking contact  $R_1$ , through the pilot relay and  $R_1$  to the minus pole. Both relays then operate whereupon  $R_2$  also operates. On the release of  $R_1$  at the end of the delayed action period,  $R_3$  operates in series with  $R_2$ . If the next impulse is received within 24 hours,  $R_4$  is energized, whereupon the fault lamp  $FL$  lights up and the alarm circuit is closed to a bell, lamp panel, etc. If on the other hand, the impulse is first received after, say, 30 hours the upper cam disc will have passed the position at which the roller drops down into the notch in the cam disc and the plus pole is then disconnected from  $R_3$  and  $R_2$  so that these relays are reset. The relay  $R_4$  cannot then operate again, that is to say, no alarm signal is given.

When the pointer on the manometer has fallen to the value 30 kgs/cm<sup>2</sup> the ratchet-wheel makes contact with the contact strip on the scale dial. The plus pole is then connected to  $R_5$  which operates and thereby closes the circuit for the observation lamp  $OL$  and the alarm circuit. The lamp  $OL$  remains alight even when the push-button  $OK$  is pressed. After changing the gas cylinder the ratchet-wheel on the manometer must be wound up until the pin reaches the pointer; otherwise the observation lamp will remain lighted up.

### III. Gas Control Installation for Large Branched Cable Networks

Where a larger network is in question a combination of both the previously described types may be employed. Fig. 15 shows an example of a network of this kind. Gas cylinders and pressure control units are also installed in the stations 2, 5, 6, 9, 10, 12, and 14 in addition to those in the main station.

An impulse counter forms part of each pressure control unit, and all the counters are installed in the main station. If a leak occurs between the stations 10 and 13, for example, the fault is recorded by the impulse counters at the stations 10 and 14. With a fault between the stations 10 and 16, however, only the impulse counter for station 10 will be affected.

With regard to the current supply for the three different forms of installations, the electrical equipment is designed for a working current and not for a closed-circuit current; this has been considered most suitable both from a technical and economic point of view. Thus there is no risk of the system ceasing to function if the cable is cut through, for example. It is true that in such a case the operating wires would also be cut off, but this will not prevent the functioning of the signal manometer lying closest to the fault location, reckoned from the main station. On the contrary, the signal manometer will operate very rapidly and will thus transmit a major alarm signal. (A system with impulse counters will record the maximum number of impulses per unit of time, and a system without impulse counters will transmit an alarm which always indicates that a large leak has occurred.)

## FAULT LOCALIZATION

### I. Approximate Localization

#### 1. LONG-DISTANCE CABLES

When a leak occurs between the stations A and B such as at  $S_2$  and  $S_3$ , see fig. 10, the fault lamp lights up at the supervisory terminal station  $S_1$ . If an alarm bell is connected in circuit it will begin to ring at the same time. One of the counters  $IR_2$  or  $IR_3$  will have recorded an impulse. All the counters are read off and the time noted. The fault lamp is switched off by pressing the push-button, whereupon the alarm bell will cease to ring. After a certain time has elapsed a new alarm will be received while a new impulse will be recorded at the same time on one of the two impulse counters mentioned. Each time an impulse is recorded and read off, it should be plotted on a time-impulse chart. A chart is plotted for each counter, see fig. 16.

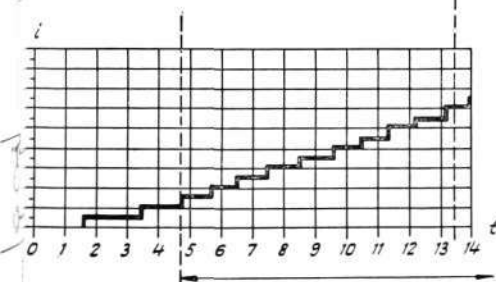
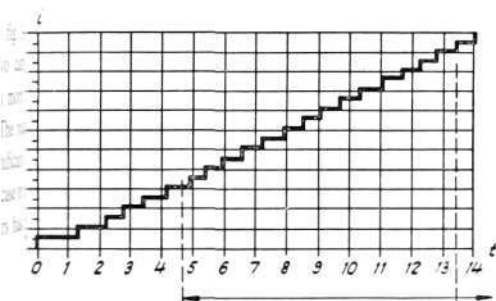


Fig. 16  
Time-impulse chart

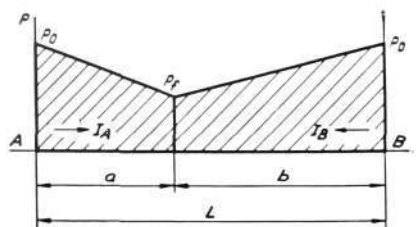


Fig. 17  
Pressure distribution curve

X 4959

It is assumed that the upper chart relates to the counter  $IR_2$  and the lower one to  $IR_3$ . The point of time for recording the first impulse by either of the counters,  $IR_2$  for example, is taken as 0 in both charts. The second impulse to  $IR_2$  was received at the time  $t = 1.3$  and the first impulse to  $IR_3$  at the time  $t = 1.5$ , and so on. When the gas flow in the cable becomes stationary, which is indicated by the »steps» in both charts assuming a constant length, it is possible to read off the number of impulses per unit of time from the charts.

If the number of impulses are denoted by  $n_A$  and  $n_B$  respectively, the location of the fault can be determined with an accuracy of about 2 % of  $L$  from the formulas:

$$a = \frac{n_B}{n_A + n_B} \cdot L$$

and

$$b = \frac{n_A}{n_A + n_B} \cdot L$$

where  $a$  is the distance from station A (in this case  $S_2$ ) to the fault,  $b$  is the distance from station B (here  $S_3$ ) to the fault and  $L = a + b$ , the distance between these stations, see fig. 17.

From the chart, fig. 16, we obtain the number of impulses  $n_A = 14.3$  and  $n_B = 9.3$ . These values have been obtained by calculating the impulses from the stationary condition of flow (the broken line between  $t = 4$  and  $t = 5$ ) up to the point of time between  $t = 13$  and  $t = 14$  (the righthand broken line). On inserting these values in one of the formulas, it is found that

$$a = \frac{9.3}{9.3 + 14.3} \cdot L = 0.395 \cdot L$$

that is to say, the distance from station  $S_2$  to the fault is 39.5 % of the cable section's length.

The derivation of the above formulas may be found in the appendix, page 47.

## 2. SMALL CABLE NETWORKS

On the occurrence of a large leak in the cable network the fault lamp at the main station lights up with the simultaneous ringing of an alarm bell when such a bell is connected in the circuit. It is first necessary to determine in which of the cables that pass out in different directions the fault has occurred either, 1) by cutting off the gas supply to one cable at a time until the faulty cable is located, or, 2) by employing the halving method in order to save time when several cables are fed from the same gas cylinder. According to the latter method the cables are divided into two groups of equal size and the supply to all cables cut off at one time until the faulty group is located. The latter is then divided up again into two equal groups, etc., until the faulty cable is found.

The reference here to the cutting off of certain cables, implies that they are disconnected from the stationary gas cylinder and the pressure control unit. The cables disconnected from the latter should be placed under pressure from another gas cylinder via a constant regulator so that the full protective effect of the system is maintained.

This cable is then connected at the main station to a gas cylinder and pressure testing unit LTP 2001 via the hose socket 13 and the cock 7 in the attachment for the piping shown in fig. 13.

Another gas cylinder, 1 litre size for example, and another pressure testing unit LTP 2001 are then transported to the other end of the faulty cable and connected up at that point. The pressure drop indicated by both manometers is then checked at both gas cylinders and when conditions of stationary flow (see previous section) have set in, a chart for the fall in pressure is plotted as a function of the time for both manometers. Let it be assumed, for example, that the upper chart in fig. 18 represents the fall in pressure for the gas

cylinder at the main station, and the lower one the fall in pressure for the gas cylinder at the other end of the cable. From the chart we read off:

$$\Delta P_A = 52 \text{ kgs/cm}^2$$

$$\Delta P_B = 28 \text{ kgs/cm}^2$$

On inserting these figures in the formula:

$$a = \frac{V_B \cdot \Delta P_B}{V_A \cdot \Delta P_A + V_B \cdot \Delta P_B} \cdot L$$

where  $V_A$  and  $V_B$  are the volume of the gas cylinders at  $A$  and  $B$  respectively, and assuming that a  $2\frac{1}{2}$  litre gas cylinder has been employed at the main station and a 1 litre cylinder at the other end of the cable, it is found that:

$$a = \frac{1 \cdot 28}{2.5 \cdot 52 + 1 \cdot 28} \cdot L \approx 0.18 \cdot L$$

that is to say, the distance from the main station to the fault is 18 % of the cable's length. In practice the chart should, of course, be plotted to a larger scale so that  $\Delta P_A$  and  $\Delta P_B$  can be read off with greater accuracy. For the derivation of the formula reference should be made to the appendix.

### 3. LARGE CABLE NETWORK

When a leak occurs at some point in the cable network, see fig. 15, an alarm is transmitted to the main station in the same way as set out under point 1. If the leak occurs in a cable section between two stations with gas cylinders or in a cable section that is only fed with gas from one end, two and one impulse counters will be started respectively and will record the impulses. *In the first case the method of procedure for fault localization is the same as that under point 1 (long-distance cable) and in the second substantially as under point 2 (small cable network).*

## II. Accurate Localization

The accurate localization of the fault is effected with the help of the tracer gas method which consists in introducing a gas into the cable the gas being traced to the point of the fault. The tracer gas used is radium-emanation or radon as it is also called.

### I. RADON

Radon, Rn, or radium-emanation is the next transmutation product after radium in the uranium-radium chain. Contrary to the other radioactive transmutation products, it is gaseous. The table below shows the periods and forms of radiation for the radioactive products obtained.

Substance	Form of radiation	Period
Uranium I	$\alpha$	5 000 million years
Uranium X <sub>1</sub>	$\beta, \gamma$	25 days
Uranium X <sub>2</sub>	$\beta, \gamma$	1 minute
Uranium II	$\alpha$	2 million years
Ionium	$\alpha$	100 000 years
Radium	$\alpha, \gamma$	1 700 years
Emanation (Radon)	$\alpha$	4 days
Ra A	$\alpha$	3 minutes
Ra B	$\beta, \gamma$	27 minutes
Ra C <sub>1</sub>	$\beta, \gamma$	20 minutes
Ra C <sub>2</sub>	$\alpha$	$1.5 \cdot 10^{-8}$ seconds
Ra D	$\beta, \gamma$	20 years
Ra E	$\beta, \gamma$	5 days
Ra F	$\alpha$	5 months
Ra G (Lead)	none	

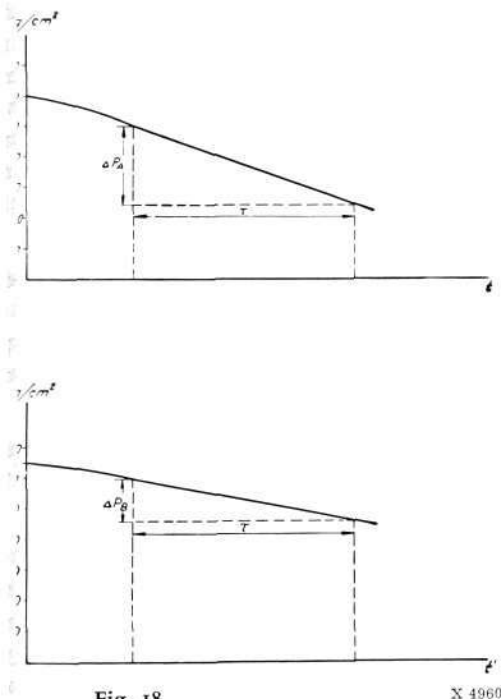


Fig. 18

Time-pressure chart

X 4960



Fig. 19  
Radiation intensity meter LMK 3001  
in use

Only the  $\gamma$ -rays are of significance for the accurate localization. At the point of the fault where the radon gas penetrates into the ground or into the air surrounding the cable the direct  $\beta$ -rays may be indicated in certain cases. On the other hand, the range of the  $\alpha$ -particles is too short to allow them to produce a deflection on a radiation intensity meter.

Radon can be purchased from large hospitals in ampoules 1 to 2 cm in length and about 1 mm in diameter. The ampoules sold have already been used for medical purposes and are therefore relatively cheap.

## 2. INJECTION

Injection is carried out with the help of a gas cylinder and a pressure unit (NVB 3001 or LTP 2001). One end of the cable or a joint in the latter is selected as the point for the injection.

In order to inject the gas into the cable the ampoule is crushed and the radon is passed into the cable with the gas stream; it then moves in the form of a plug towards the leak. This plug becomes very attenuated during its passage through the cable, but its front end is always clearly marked.

On long distance cables the injection should preferably be made at the joint nearest to the calculated point of the fault. Where shorter cables are in question or in cases in which it is undesirable to excavate round the joint (as in streets with a heavy traffic) injection can take place from one end of the cable. In installations of the type illustrated in fig. 13 it is unnecessary to braze on a connecting washer and drill a hole in the cable prior to the injection, since a pipe attachment is already available for injection amongst other purposes.

## 3. LOCALIZATION

A beginning may be made in localizing the fault approximately half an hour after making the injection. For this purpose a radiation detector is moved along the ground over the cable, fig. 19. The radiation intensity meter LMK 3001 is employed for this work. The indicator is supported by a strap suspended round the observer's neck to enable the deflection of the pointer to be conveniently followed. Owing to the cosmic radiation the pointer will always give a certain deflection over the scale. The radiation from the radon in the cable will always be clearly visible, however, and a strongly marked maximum emission will be indicated at the leak. It will sometimes be found of considerable help to dig a number of control pits down to the cable from which the emission is particularly strong.

The above method has been applied both to long distance cables and to armoured lead-covered cables in urban networks. On the other hand, it is not suitable for cables laid in ducts. In the latter case, however, by means of approximate localization and with the help of gas flow direction indicator LTP 2111 the position of the leak can be determined to within a cable section between two cable pits. After drawing out the cable, the fault can be localized in the ordinary manner by using soapy water.

## 4. THE METHOD FROM THE POINT OF VIEW OF HEALTH

On the conclusion of the injection, the piece of hose cut off should be buried together with the crushed gas ampoule and the gloves. Although no risk is involved for persons carrying out this form of fault localization according to the directions it should be borne in mind that radioactive substances must be handled with a certain caution.

The intensity of a radioactive substance is usually measured in millicuries (mC). 1 curie corresponds to  $3.7 \times 10^{10}$  disintegrations (nuclear transmutations) per second. The shorter the period is, the greater will the intensity be. The radiation dosage, that is to say, the quantity of emitted gamma-rays absorbed by the body, is measured in röntgen (r) or mr (1 r = the amount of radiation that produces and ionizing effect in 1 cm<sup>3</sup> of air which is so great that the total charge of the ions produced is 1 E. S. U. of each sign).

The maximum permissible dosage for the vital parts of the body is 100 mr, whereas the hands can withstand up to 1,000 mr per week without risk. The ampoules used for localization usually have an intensity of 10—15 mC. Since



1 C gives an emission of 2 r/h/m, the emission obtained in this case will be 20—30 mr/h/m. Thus at a distance of 1 metre from the preparation 100 mr per 3½ hours is obtained, and at a distance of ½ metre the same emission in a quarter of this time. (The intensity is inversely proportional to the square of the distance.)

It will be realized from the foregoing that as great a distance from the ampoules as possible should be maintained during transport and that the ampoules should not be handled prior to their use. Nor should they be handled by unskilled persons, but otherwise there is no reason to fear the employment of the method described in the article, which has been adopted with success by the Swedish Board of Telecommunications amongst others.

## APPENDIX

Derivation of the formulas  $a = \frac{V_B \cdot \Delta P_B}{V_A \cdot \Delta P_A + V_B \cdot \Delta P_B} \cdot L$  and analogously for  $b$ , and  $a = \frac{n_B}{n_A + n_B} \cdot L$  and analogously for  $b$ .

Let us consider a faulty cable section  $AB$  fed with gas from both ends,  $A$  and  $B$  respectively. The flow conditions are assumed to be stationary. The gas cylinder at  $A$  has a volume of  $V_A$ . During the time  $t_A$  the pressure in the cylinder has fallen from  $P_A$  to  $P_A - \Delta P_A$ . Denoting the gas flow by  $I_A$ , we obtain:

$$I_A \cdot t_A = V_A \cdot \Delta P_A \quad (1)$$

Analogously for the gas container at  $B$ :

$$I_B \cdot t_B = V_B \cdot \Delta P_B \quad (2)$$

The distance of the fault from  $A$  and  $B$  is denoted as  $a$  and  $b$  respectively. We then obtain:

$$a = \frac{I_B}{I_A + I_B} \cdot L \quad (3)$$

$$b = \frac{I_A}{I_A + I_B} \cdot L \quad (4)$$

On reading the fall of pressure  $\Delta P_A$  and  $\Delta P_B$  during the same time  $t = t_A = t_B$ , we then obtain from (1) — (4):

$$a = \frac{V_B \cdot \Delta P_B}{V_A \cdot \Delta P_A + V_B \cdot \Delta P_B} \cdot L \quad (5)$$

$$b = \frac{V_A \cdot \Delta P_A}{V_A \cdot \Delta P_A + V_B \cdot \Delta P_B} \cdot L \quad (6)$$

The formulas (5) and (6) may suitably be employed where the reading has to take place directly from the manometers. In a system with impulse counters the arrangement is such that each impulse corresponds to a certain fall of pressure. We can then write:

$$\Delta P_A = n_A \cdot p_A \quad (7)$$

and

$$\Delta P_B = n_B \cdot p_B \quad (8)$$

where  $n_A$  and  $n_B$  indicate the number of impulses indicated in the time  $t$  by the impulse counters for  $A$  and  $B$  respectively. Since in this system a gas cylinder of the same size is used at both ends,  $V_A = V_B$  and since  $p_A = p_B$ , then:

$$a = \frac{n_B}{n_A + n_B} \cdot L \quad (9)$$

and

$$b = \frac{n_A}{n_A + n_B} \cdot L \quad (10)$$

In the derivation of the formulas (1) — (10) the temperature and air pressure have not been taken into consideration. If these differ at  $A$  and  $B$ , the formulas will not be entirely correct, which is of no significance, however, where approximate localization is concerned.

# New Type of Cordless C.B. Private Branch Exchanges

W A D E N S T E D T, T E L E F O N A K T I E B O L A G E T L M E R I C S S O N, S T O C K H O L M

U.D.C. 621.395.26  
621.395.655

*A new line in the range of L M Ericsson's modern manual telephone switchboards has been brought out in the form of cordless C.B. private branch exchanges. These switchboards possess a number of advantageous features which make them simple to handle: they are easy to install and maintain, can be placed independently on a table and are of attractive appearance.*

LM Ericsson's new cordless switchboards, type *ADD 13*, can operate in conjunction with all automatic or manual C. B. exchanges of any system.

Automatic holding of the public exchange line permits the operator to leave the connection before the call is answered by extension.

The ringing current required for calling extensions is generated by a pole changer controlled by the dial. The ringing signal is automatically interrupted if the call is answered while the signal is being sent.

The larger switchboards are equipped for individual through-connection on every external line, which permits an executive to have a direct external line on which calls can be answered by the operator in his absence.

## Types

L M Ericsson's cordless switchboards, type *ADD 13*, are made in the following standard sizes:

*ADD 1311* for 3 extensions and 1 public exchange line with 1 external and 1 internal call facility.

*ADD 1321* for 6 extensions and 2 public exchange lines with 2 external and 1 internal call facility.

*ADD 1331* for 9 extensions and 3 public exchange lines with 3 external and 2 internal call facilities.



Fig. 1 X 4962  
Cordless switchboard ADD 1311  
for 3 extensions and 1 public exchange line

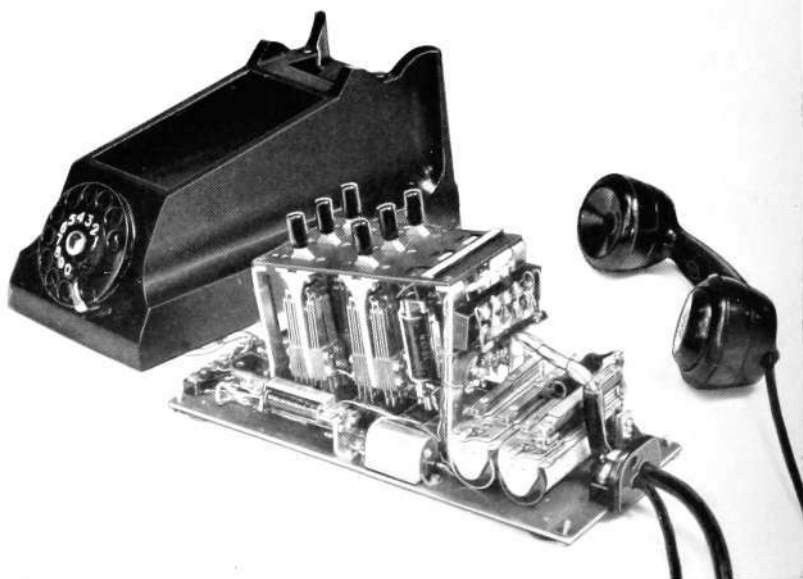


Fig. 2 X 6811  
ADD 1311 with case removed

## ADD 1311

As is seen in fig. 1, *ADD 1311* is designed in the form of a telephone instrument with extended front. The black phenolic case is secured to the base plate by four screws. With the exception of the dial all components are mounted on the base plate, as shown in fig. 2. The keys and indicators are mounted on the front panel, which is easily removed from the base to permit full accessibility of all units for inspection and adjustment.

The positions of the keys on the front panel, and their functions, are shown in fig. 3.

## ADD 1321 and ADD 1331

Figs. 4 and 5 show the two cordless switchboards *ADD 1321* and *ADD 1331*. The components of each switchboard are assembled on an oak base and a green-enamelled aluminium front panel. The front panel is hinged and can be folded forwards (see fig. 6), whereby all parts become readily accessible for checking and adjustment. The equipment is enclosed in a light oak case which is secured to the base by two screws. The switchboard handset hangs on the left wall.

The placing of the keys on the front panel, and their functions, are shown in figs. 7 and 8.

## Components

The components used in the new series of switchboards are all well-known and tested in different kinds of equipment under operating conditions. The following facts alone are of interest in this connection.

The *signalling devices* consist of visual indicators for the extension lines and drop indicators for the public exchange lines. (The smallest switchboard *ADD 1311* has only one audible signalling device—a buzzer—on the public exchange line). The visual and drop indicators are fairly similar, being incorporated in the same electromagnetic circuit and having recessed shutters. The public exchange line drop indicators are automatically restored when the operator answers the call. Both visual and drop indicators have alarm contacts for audible signal circuits.

The *keys*, which have twin contacts, are of the previously known type *RMA 11*.

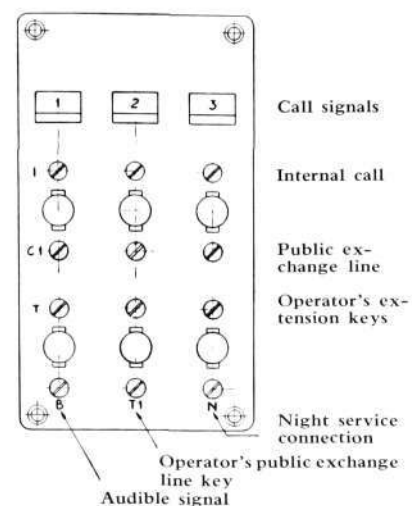


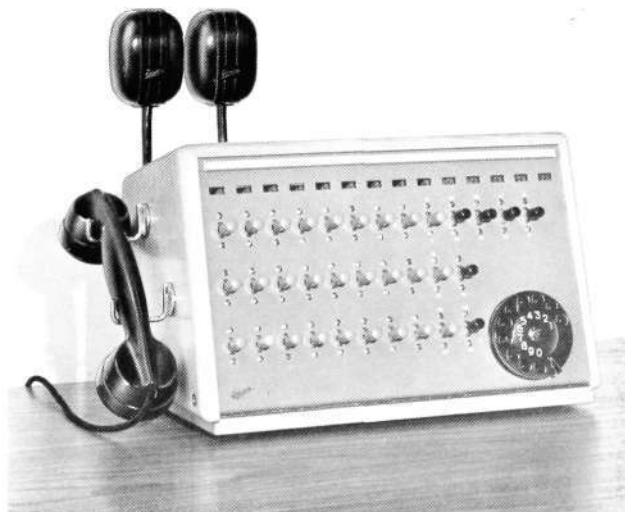
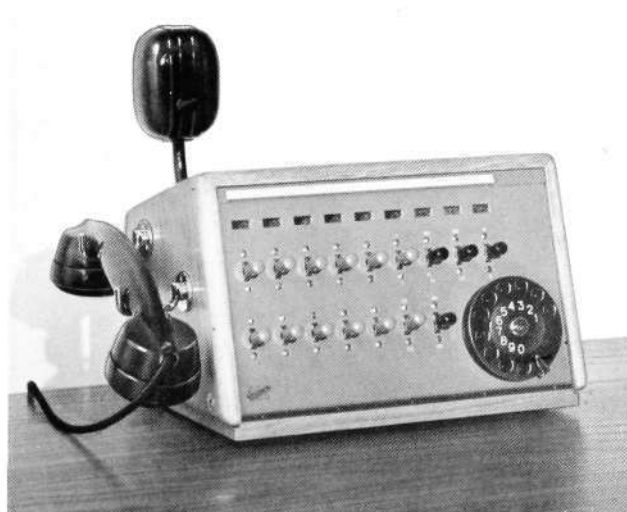
Fig. 3  
Front panel of ADD 1311

X 4965

Fig. 4  
Cordless switchboards ADD 1321 and  
(right) ADD 1331

X 6809  
X 6810

for 6 extensions and 2 public exchange lines  
(ADD 1321) and 9 extensions and 3 public ex-  
change lines (ADD 1331)



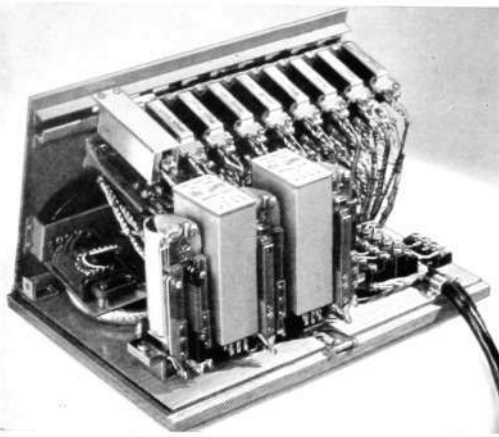


Fig. 5  
ADD 1321, case removed

X 4963

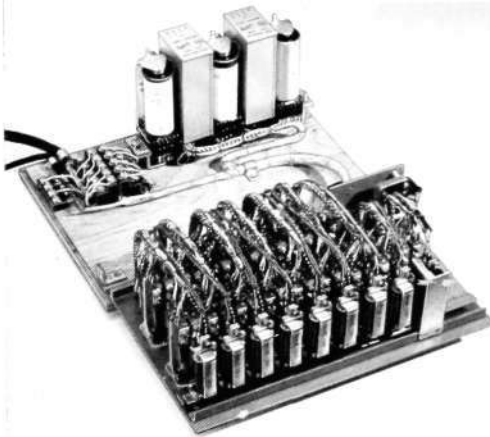


Fig. 6  
ADD 1321, case removed  
and front panel down

X 4964

Fig. 7  
Front panel of ADD 1321

- H 1 Holding of external line 1
- H 2 " " " " 2
- N Night service
- N 1 Individual through connection of external line 1
- N 2 Individual through connection of external line 2
- B Audible signal

X 6812

Relays and capacitors are of normal telephone type. All relays have twin contacts.

Of particular interest is the pole changer relay. Apart from its function of generating ringing current, it has three other functions, viz. as ringing trip relay, operator's transmitter feed relay and audible signalling device (buzzer).

## Operation

### Internal Call

The switchboard is called by lifting the handset, which operates a visual indicator. The operator answers by throwing the corresponding key to *T*, so restoring the indicator. If an internal call is required, the operator throws the caller's key to *I* and thereafter the called party's key to *T*. The operator rings the called party by dialling one digit, a ringing signal being transmitted until the dial has returned to rest. The called party's key is then thrown to *I* and the connection is established.

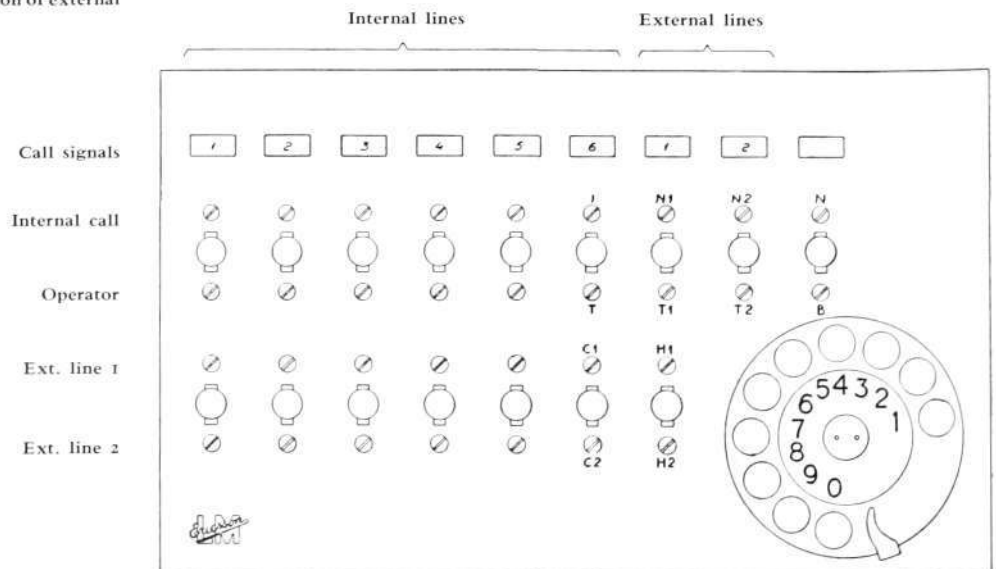
If the extension replies during the ringing signal, the signal immediately ceases. Thus the extension can never be irritated by a ringing signal when the handset is raised.

The replacing of both handsets on completion of a call is signalled on the respective visual indicators, whereupon the operator restores both keys.

### Incoming Calls from Public Exchange

An incoming call on, for example, external line 1 is answered by the operator throwing the key to *T1*. After receiving the order, she throws the external line key of the wanted extension to *C1*, which actuates the visual indicator of that extension. The upper key of the extension is then thrown to *T* and the external line key is restored from *T1*. The operator next rings the extension as described above. After ringing she restores the upper key and, when the extension replies, the indicator returns to rest. The connection is now through.

From the time the lower key is thrown to *C1* until the called extension answers, the external line is held over a holding circuit in the switchboard.





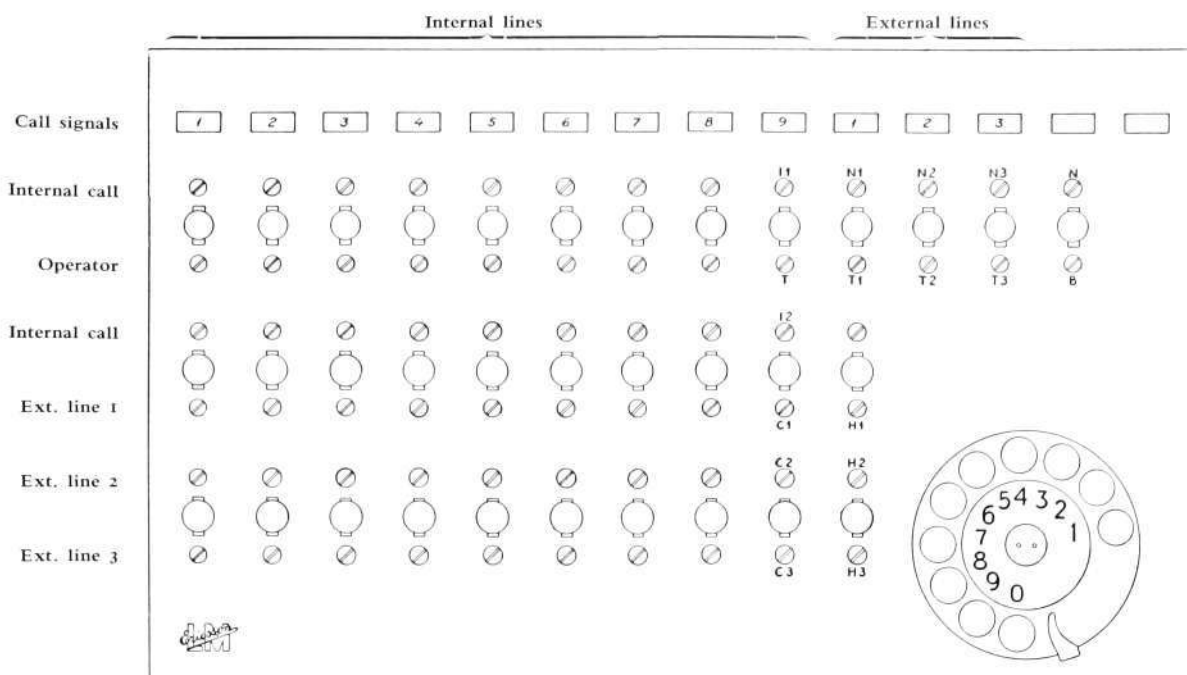


Fig. 8  
Front panel of ADD 1331

X 6826

- H 1 Holding of external line 1
- H 2 " " " " 2
- H 3 " " " " 3
- N Night service
- N 1 Individual through connection of external line 1
- N 2 Individual through connection of external line 2
- N 3 Individual through connection of external line 3
- B Audible signal

The replacing of the extension's handset is signalled on the visual indicator and the external line is released. The operator restores the external line key from *C1* and the indicator signal disappears. If a new call comes in on the external line before the operator has restored the above-mentioned key, the calling device of the external line is actuated nevertheless.

### Outgoing Calls to Public Exchange

The extension calls the switchboard and the operator answers as described above. The connection is extended to the public exchange by the operator throwing a free public exchange line key to *C*, after which the extension's upper key is restored. The extension can then dial the required number.

The end of a call is signalled on the extension's visual indicator, and the operator disconnects the call by restoring the key from *C*.

The operator can also establish an outgoing call by means of her dial.

### Audible Signal

If the operator is unable to keep the visual signals under observation, she throws an audible alarm key to *B*, whereupon a subdued tone is heard both on call and clearing signals.

### Night Service

Night service connection is obtained by throwing the night service key to *N* and the public exchange line keys to *C1*, *C2* and *C3* respectively for the extensions who wish the night service connection. When key *N* is thrown, the current supply to the switchboard is cut off.

The public exchange lines in ADD 1321 and 1331 have been supplied with individual through connection facility, allowing direct connection of the respective public exchange line to the desired extension. This means that an

executive can have a directly connected exchange line on which calls can be answered by the operator in the executive's absence. The individual through connection can also be utilized when an extension desires a number of outgoing calls in succession. Thus the operator is not troubled by any signals.

## Current Supply

When the operator or an extension is speaking on an external line, the current to the transmitter is obtained from the public exchange. Only on internal calls between extensions or between an extension and the operator is a local current supply required. The switchboard is designed for 24 V, but variations between 15 and 30 V may be tolerated. The current consumption at 24 V is

for external calls: 0 mA

for internal calls: abt 40 mA

for calls between operator and extension and ringing to extension: abt 170 mA.

Dry cells, storage batteries or battery eliminators may be used for the power requirements of the switchboards.

## Dimensions and Weights

The dimensions and weights of the switchboards are tabulated below. The width measurements of ADD 1321 and ADD 1331 do not include the handset hooks which project about 50 mm.

Designation	Length mm	Height mm	Depth mm	Net weight kg
ADD 1311	126	154	293	3.9
ADD 1321	303	200	216	8.2
ADD 1331	388	249	226	12.2

# Review of SER Electron Tubes: Standard and Long Life Types

S E D S M A N & G L A G E R H O L M, A B S V E N S K A E L E K T R O N R Ö R, S T O C K H O L M

U.D.C. 621.385.1

*This article presents a summary description of the range of standard and long life electron tubes at present being manufactured by AB Svenska Elektronrör.*

*In a following series of articles some of the more recent types of tubes will be discussed, as also new types to be incorporated in SER's manufacturing programme at a later date.*

The developments in the manufacture of electron tubes in latter years have tended towards smaller sizes, and the majority of modern designs of tube are of all-glass miniature type. In addition to the obvious saving of space and the opportunity afforded for more compact apparatus, the miniature design has other advantages over the older types of tubes. The most important of these are the improved mechanical stability of the tube structure, the possibility of using the tubes within a higher frequency range and the lower cost of manufacture.

SER's manufacture of tubes has been adapted to these trends and for some years has been concentrated to miniature types. Apart from special purpose tubes, the programme comprises two categories: standard tubes and long life tubes.

## Standard Types

The standard types are designed for purposes for which normal demands are placed on the life and reliability of the tubes and a low price is essential. In view of the moderate productive capacity and the low price of the tubes the number of types has necessarily had to be comparatively limited. Among

**Fig. 1**  
**Design of an electron tube**  
From left: Individual parts, assembled tube system, final electron tube



the types at present being manufactured complete series are available for radio receivers, both for a.c. and a.c./d.c. operation. Some of the types are designed especially for amplifiers and radio communication equipment. All types listed below are equivalent to the corresponding American tubes.

### Pentodes

*6AK5* is a high-frequency pentode, especially suited for wide band amplifiers. The input conductance is only 125  $\mu$ mhos at 100 megacycles and the transconductance is 5,000  $\mu$ mhos. Owing to the fact that the cathode has two separate terminals, the tube, by means of appropriate circuits, can be used at frequencies up to 400 megacycles.

*6BA6*, *12BA6* are high-frequency remote-cutoff pentodes. Due to the high transconductance and low grid to plate capacitance, the amplification obtainable with these types of tubes is as high as conventional circuits can provide.

*6AU6*, *12AU6* are high-frequency and low-frequency, sharp-cutoff pentodes, but otherwise of the same design as *6BA6*. Used as low-frequency amplifiers, the tubes have excellent properties as regards microphonics and noise.

### Converters

*6BE6*, *12BE6* are converters of pentagrid type. The inner grids are used for the oscillator function, and feed-back is obtained through the cathode current. The tubes have a conversion transconductance of about 500  $\mu$ mhos and comparatively small frequency drift.

### Twin Triodes

*6J6*, *19J6* are double triodes with common cathode. These types of tube were originally designed for oscillator circuits for very high frequencies and will operate at frequencies up to 800 megacycles. They are used to a great extent as converters, a conversion transconductance of about 2,000  $\mu$ mhos being attainable.

*12AT7* is a double triode with separate triode systems. The data of the tube are much the same as those of *6J6*, but wider applicability is obtained as a result of the separate triode systems. Type *6J6*, however, is generally better adapted for use at extremely high frequencies.

### Double Diode Triodes

*6AT6*, *12AT6* have a common cathode for the triode and diode systems. The amplification factor of the triode is 70, which affords good low-frequency amplification. The diodes may be utilized for detection and for automatic volume control.

*6AV6*, *12AV6* are of the same design as *6AT6*, but the amplification factor of the triode is 100, which permits higher low-frequency amplification.

### Power Amplifiers

*6AQ5* is a beam power amplifier. The tube is capable of providing a power output of 4.5 W and is chiefly used in the output stages of radio receivers and amplifiers, but can be employed to advantage as oscillator and power amplifier within the high-frequency range.

*6AS5* is designed on the same principle as *6AQ5*. The tube is, however, adapted to lower plate and screen grid voltages, thereby handling a power output of 2.2 W, and being used particularly in car radio receivers.

*35C5*, except for heater ratings, is equivalent in most characteristics to *6AS5* and is used in output stages of a.c./d.c. receivers.

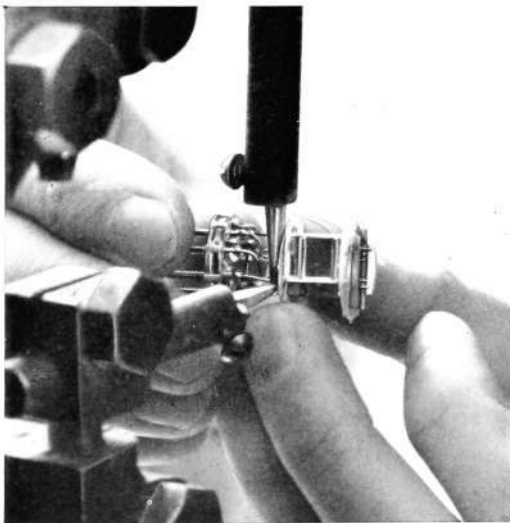


Fig. 2  
Assembling an electron tube  
The parts are joined together by spot welding

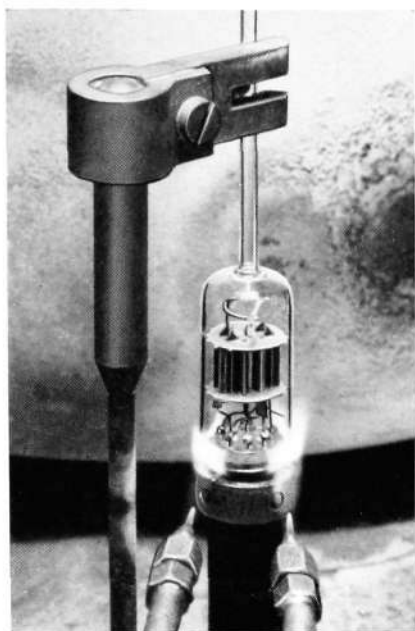


Fig. 3  
Sealing the bulb to the base of the tube structure

X 4949

## Rectifiers

*6X4* is a full-wave rectifier tube with indirectly heated cathode. The tube is suited for a rectified current of max. 70 mA and has a low voltage drop. The insulation between the heater and cathode permits a maximum voltage of 450 V, and the tube does not therefore normally require separate heater circuits.

*35W4* is a half-wave rectifier with indirectly heated cathode. The tube is suited for a rectified current of max. 100 mA and is primarily used in a.c./d.c. radio sets. The heater has a tap for operation of a panel lamp.

## Long Life Tubes

The reliability of equipment and plant is highly dependent on the durability of the electron tubes. The inconvenience and cost of breakdown can be avoided by employing tubes especially designed for long life service and, though considerably more expensive than standard tubes, they generally prove to be more economical in the long run.

SER manufactures a number of types of long life tubes with a guaranteed mean life of minimum 10,000 hours. Such tubes are primarily intended for telephone transmission systems and their development has been determined by the latter requirements.

The long life types developed during recent years, however, are well suited to other applications as well. It may be mentioned that, apart from the normal 18 V heaters employed for carrier systems, these types are also designed with heaters operating on 6.3 V.

The types at present being manufactured comprise:

*403B, 18AK5*, high-frequency pentodes particularly suited to wide band amplifiers. The data are identical to those of the standard 6AK5 apart from the heater data and maximum ratings. 403B is used in line amplifiers for coaxial and twisted-pair cables for carrier systems, 18AK5 in terminal equipment amplifiers and oscillators and in two-wire and four-wire amplifiers and certain voice frequency signal receivers.

*6J6L, 18J6*, twin triodes with common cathode. Apart from heater data and maximum ratings, the tubes are practically equivalent in characteristics to the standard 6J6. 18J6 is used in carrier terminal equipments as audio frequency amplifier.

*6AQ5L, 18AQ5*, beam power amplifiers. Apart from heater data and maximum ratings, these types are identical to the standard 6AQ5. 18AQ5 is used in various kinds of amplifier, such as line amplifiers and auxiliary amplifiers in carrier systems.

*2C51L, 18C51*, twin triodes with separate triode systems and intermediate shield. Nominally the transconductance is 5,500  $\mu$ mhos and the amplification factor 35. The tubes are suited for amplifiers, particularly in cascode connection, oscillators, converters etc. 18C51 is used in carrier terminal equipment and has replaced type 18J6 in recent designs.

*404A*, high-frequency pentode particularly adapted for wide band amplifiers. Nominally the transconductance is 12,500  $\mu$ mhos and the combined output and input capacitance 9.5 pF. As a pentode the equivalent noise resistance is only about 500  $\Omega$ . 404A is used in carrier systems for, among other purposes, line amplifiers on coaxial cable circuits, for which it has replaced type 403B.



# Plastic Film Capacitors

P O H A R R I S, A B R I F A, U L V S U N D A, S T O C K H O L M

U.D.C. 621.319.416.3

*AB Rifa has for several years been manufacturing capacitors of polystyrene—a plastic material obtainable in thin sheets. Due to their unusual properties these capacitors are now being used for a number of special purposes. The present article describes the capacitors and their properties in the form in which they are manufactured by Rifa.*

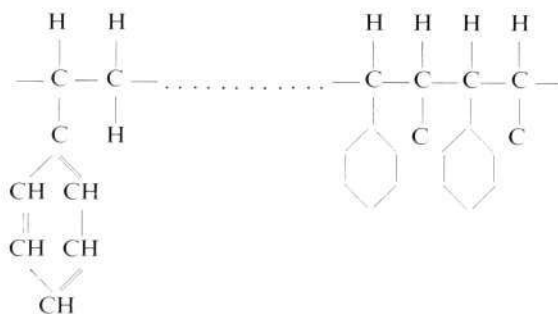
Insulating materials are mainly used in the general electrotechnical field as auxiliary materials for the purpose of separating circuits or parts of circuits from each other electrically. For such purposes the primary requirements are high dielectric strength, high insulation resistance, and dimensional stability in respect both to mechanical and thermal stresses.

In the particular electrotechnical component that is called a capacitor, on the other hand, the insulation material is not auxiliary to, but constitutes the actual material on which the function of the entire component is based. The foremost requirement in an insulation material to be used for this purpose is that it shall have a high dielectric constant and a low loss angle, and good constancy of these two quantities in respect to time, temperature, and frequency. In addition, the material should meet at least some of the requirements normally placed on insulation materials for general purposes. There is therefore a fairly narrow choice of dielectrics that are suitable for capacitors, and in the past only impregnated paper, glass, and mica have been employed to any considerable extent for the purpose.

During the last twenty-five years, however, a veritably fantastic development in the chemistry of plastics has resulted in the discovery of a number of new materials with properties suited for use in capacitors. The material that has been used longest is polystyrene; polystyrene capacitors have been marketed for some 15 years. More recently capacitors have been made of cellulose triacetate, cellulose acetate butyrate, polytetrafluorethylene, and polyethylene terephthalate.

## Manufacture of Polystyrene Film

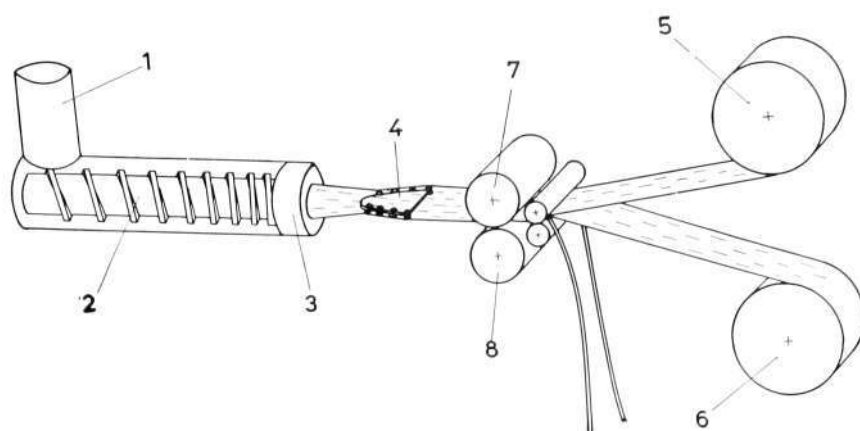
Polystyrene is a plastic made by the polymerization of styrene with the following structure:



In the process of polymerization a transparent material is formed with a molecular weight of the order of 50,000—100,000. Its dielectric constant is about 2.55, which remains unchanged up to very high frequencies. The insulation resistance is almost immeasurably high, of the order of  $10^{18}$  ohm cm. The power factor is of the order of  $1 \cdot 10^{-4}$  and is constant over a very great range of frequencies.

Fig. 1  
Machine for production of thin  
polystyrene film schematic

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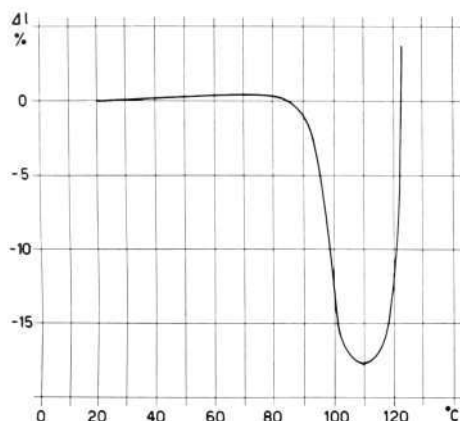


Polystyrene has been known since the middle of the 19th century, and electrical engineers have long been attracted by its excellent properties. Due to its brittleness, however, it cannot readily be produced in the form of film and was, therefore, found unsuitable as dielectric in capacitors. Not until the 1930s was a method discovered of stretching the material during solidification, which enabled foil to be produced with good strength characteristics.

The manufacture of thin polystyrene foil is done by extrusion moulding on the principle illustrated in fig. 1. The finely pulverized material is heated in chamber 1 to about  $150^{\circ}\text{C}$  and is compressed by screw 2, being extruded through nozzle 3 in a melted condition, so forming a tube. While the tube is still hot, it is passed over the parabolic spreader 4 the periphery of which is fitted with a series of small wheels. This stretches the tube laterally. The resulting flattened tube is slit into two sheets which are wound up on rolls 5 and 6. The sheets, now cold, have previously passed the two draw-in rolls 7 and 8, which give the foil an orientation strain longitudinally as well. By this process a foil that is flexible in all directions is obtained which is extremely well adapted for the production of capacitors. This foil maintains its elastical properties up to about  $70^{\circ}\text{C}$ , but above this temperature it softens and returns to its original unstretched condition. Fig. 2 shows the change in length of a foil that is slowly heated to  $100^{\circ}\text{C}$  under a load of about  $0.01\text{ g/cm}^2$ .

Fig. 2  
Change in length of polystyrene film  
when heated above softening point

X 4972



The material is now manufactured by a number of firms and is sold under the name of Styroflex, Styrafoil, etc.

Fig. 3  
Winding machine for polystyrene  
capacitors

X 6827

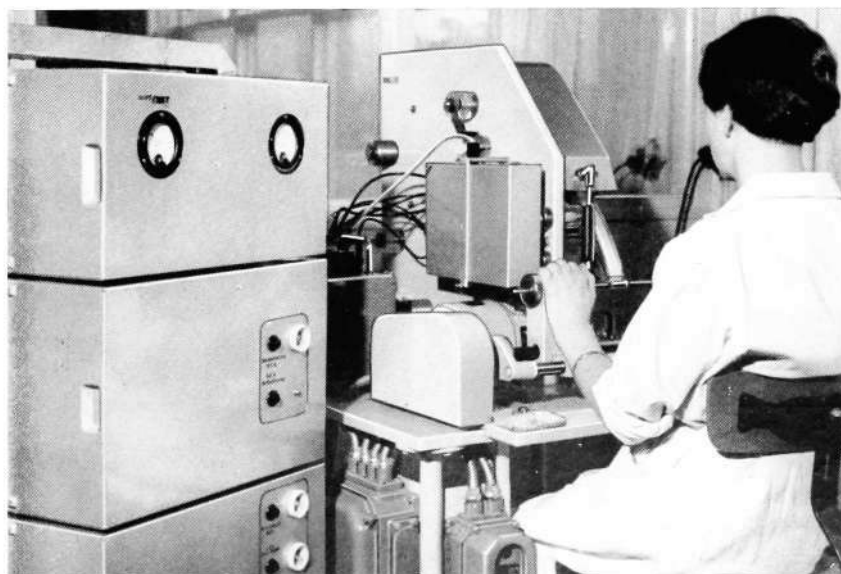




Fig. 4

#### Polystyrene capacitor roll

- a) before heat treatment
- b) after heat treatment

X 4975

## Production of Polystyrene Capacitors

A roll is wound consisting of two metal foil electrodes interleaved with one or more polystyrene foils. The foil is subject to comparatively great variations in thickness—up to  $\pm 10$  per cent in the same roll—and the normal method adopted for paper capacitors of winding a given length of foil has therefore proved unsuitable. This is because, in view of the good properties of the dielectric, the capacitors are intended for purposes in which high stability is required, and with this follows a need of close capacitance tolerances. The most appropriate winding method has proved to be to carry out capacitance measurements in a bridge during the winding. The winding is stopped as soon as the correct capacitance is obtained, the foils are cut off and the foil ends are glued together. Fig. 3 shows a winding machine with measuring equipment on the left.

The roll obtained in the manner described above does not at this stage possess the good properties that are desirable. Due to the variations in thickness small air inclusions exist between the metal and plastic foils. The roll is also comparatively soft and changes capacitance when it is pressed. By means of heat processing at  $90$ – $95^{\circ}\text{C}$ , however, it is possible to release the tension stored in the foil during its manufacture so that it is tightened and the roll shrinks at the ends and becomes hard and stable. The air is thereby pressed out of the roll and at the same time good contact is obtained between dielectric and metal foil, so that no cavities are left in which ionisation might arise. Fig. 4 shows a roll before and after heat treatment.

During the heating process the capacitance increases, which necessitates the winding of a lower capacitance than that finally required.

A check measurement is made of the capacitor rolls when they have cooled to room temperature. A voltage test is first carried out, and rolls not possessing the required dielectric strength are rejected. Next the capacitance is checked by accurate bridge measurement. Unfortunately the demands of customers for narrow capacity tolerances have proved impossible to meet fully by controlling the capacitance of the rolls through capacitance measurements during winding. A special method of assortment has been developed by which capacitance tolerances of  $\pm 0.5\%$  or better are attainable. The rolls are first sorted into capacitance groups with close tolerances. After that two groups are selected, the combined mean values of which give the desired capacitance, and a roll from one group is connected to a roll from the other group. In this way it is possible to produce capacitors down to an accuracy of about one-tenth per cent.

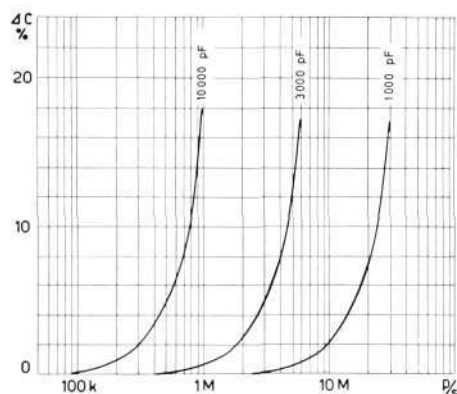


Fig. 5

Apparent capacitance as function of frequency for polystyrene capacitors, type PFD 1012

X 4973

## Properties of Polystyrene Capacitors

The normal polystyrene capacitors can be used at temperatures up to  $+70^{\circ}\text{C}$ . Recently new kinds of polystyrene with higher temperature stability have been produced. This has been achieved by the introduction of cross-linking between the rod-shaped styrene molecules. The electrical properties of this modified material do not differ noticeably from those of the normal material. Capacitors which withstand ambient temperatures up to  $+85^{\circ}\text{C}$  can be produced from the new materials.

Polystyrene is a non-polar material, and its capacitance is therefore independent of frequency. At high frequencies, however, an apparent rise in capacity is noticeable, due to resonance with the inductance in connecting wires and metal foils. In fig. 5 are shown curves of the capacitance as function of frequency for an unprotected polystyrene capacitor.

The capacitance stability of polystyrene capacitors on ageing is very good and is comparable to that of the best mica capacitors. As a test of stability the capacitors are subjected to an ageing test by passing them through a number of temperature cycles. The capacitance after a series of cycles

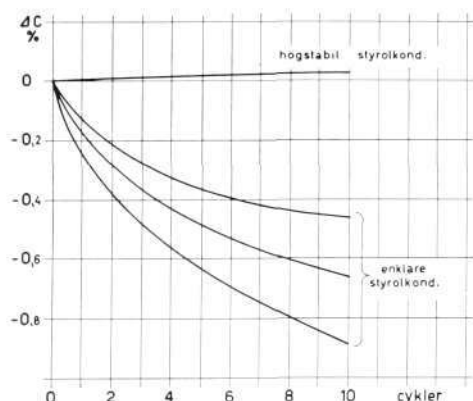


Fig. 6

Capacitance stability of polystyrene capacitors on ageing in temperature cycles  $+20 \rightarrow +70 \rightarrow +20^{\circ}\text{C}$

X 4974

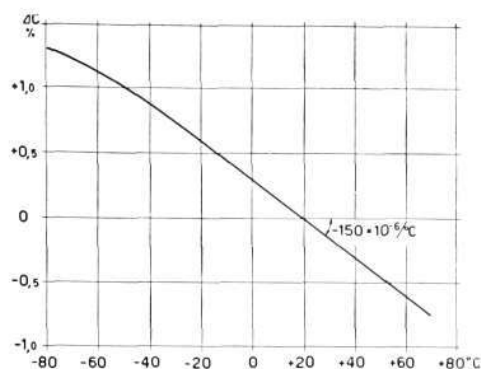


Fig. 7  
Change in capacitance of polystyrene capacitors as function of temperature

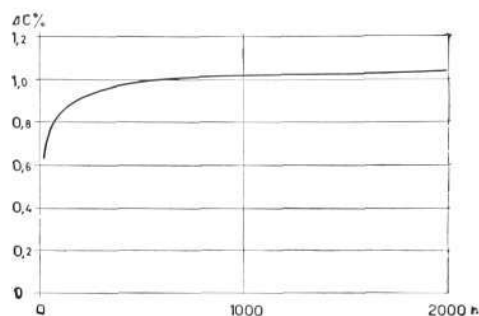


Fig. 8  
Rise in capacitance of unprotected polystyrene capacitors as function of storage time at +40°C and 100% relative humidity

+20 → +70 → +20°C is shown in fig. 6. The same figure contains some curves illustrating the stability of some capacitors of other makes.

The change in capacitance of polystyrene capacitors with temperature is illustrated in fig. 7. The temperature coefficient is negative and practically constant, being equal to  $150 \cdot 10^{-6}$  per °C over the whole range of working temperatures.

The capacitance is affected, though only slightly, by moisture absorption. Fig. 8 shows the rise in capacitance of an unprotected polystyrene capacitor after storing at +40°C and 100% relative humidity. On storage in a dry atmosphere they dry out fairly quickly, and therefore, when the demand for capacitance stability is not too high, capacitors can be used unprotected.

As already stated, the power factor in the polystyrene foil is about  $1 \cdot 10^{-4}$ . This low value can only be utilized over a large range of frequencies with capacitors possessing extended metal foils. In normally wound capacitors, i. e. when the connection to the metal foils is by tags inserted between the foils, an increase in the power factor takes place at higher frequencies due to the resistance in the metal foils. When only one tag is used per metal foil, the lowest power factor will be obtained if the tag is inserted at the centre of the foil. Figs 9 and 10 show the power factor as function of temperature and frequency respectively for a number of different capacitances.

The next property of polystyrene capacitors which makes them superior to earlier used types is their high insulation resistance. The insulation resistance is determined almost exclusively by the moisture absorbed by the material. Therefore, if polystyrene capacitors are required with exceptionally low leakage, it is essential that the capacitor rolls are dried with extreme care

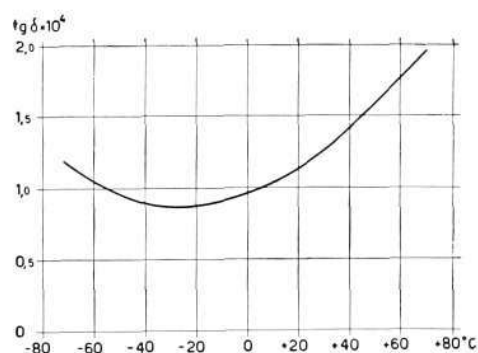


Fig. 9  
Power factor of polystyrene capacitors with extended foils as function of temperature

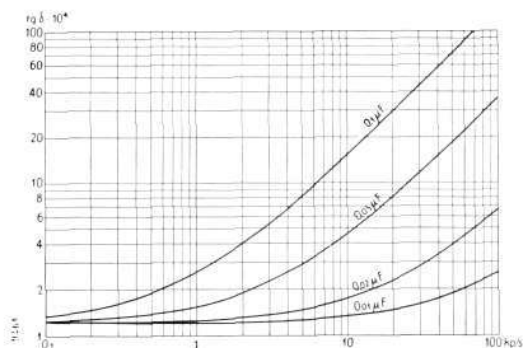


Fig. 10  
Power factor of polystyrene capacitors with tags (normal winding) as function of frequency

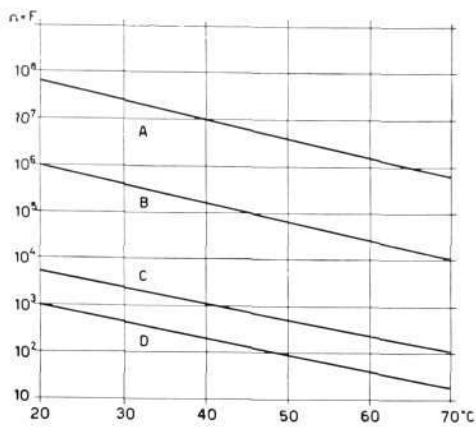


Fig. 11

X 4969

Insulation time constant of polystyrene capacitors as function of temperature

- A Maximum value for polystyrene capacitors
- B Normal value for polystyrene capacitors
- C Normal value for paper capacitors
- D Guaranteed value for paper capacitors

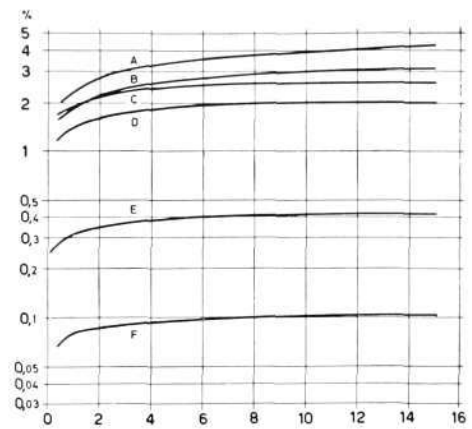


Fig. 12

X 4970

Retained charge in capacitors containing different dielectrics

- A Chlorinated wax impregnated paper
- B Vaseline impregnated paper
- C Cellulose acetate butyrate
- D Mica
- E Polyethylene terephthalate (Mylar)
- F Polystyrene

and that they are then enclosed in hermetically sealed cans. Especial care must also be devoted to the bushings, the surfaces of which must be protected to prevent the insulation resistance from falling, possibly even below that of the capacitor rolls. The manufacturer does not therefore guarantee high insulation resistance, but prefers to state that the insulation time constant (the product of insulation resistance and capacitance) exceeds 5,000 or 10,000 seconds at  $+20^{\circ}\text{C}$ . In the majority of cases, moreover, the customer's desire is not so much high insulation resistance as good capacitance stability and low power factor. It is, however, fully possible to produce polystyrene capacitors by factory methods with time constants up to  $10^6$  seconds at  $+20^{\circ}\text{C}$ . In the case of well dried specimens, insulation time constants of even up to  $10^8$  seconds may be measured. The latter time constant implies that a capacitor, which is charged up to 100 V and then left to self-decay, still retains a charge of 37 V after 3 years. Fig. 11 shows the insulation time constant of polystyrene capacitors as function of temperature compared with the insulation time constant of paper capacitors.

If a capacitor, after being charged, is short-circuited a moment and then left with open poles, it is found that part of the charge returns within a few seconds or minutes. Latterly there has been a certain demand for capacitors with an especially low residual charge of this kind. Polystyrene capacitors are particularly well adapted for such purposes, and fig. 12 shows the retained

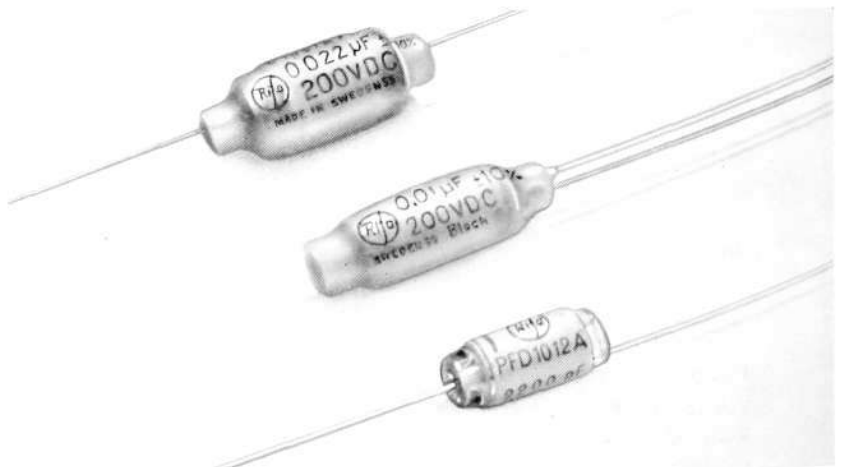


Fig. 13

X 6829

Various designs of polystyrene capacitors



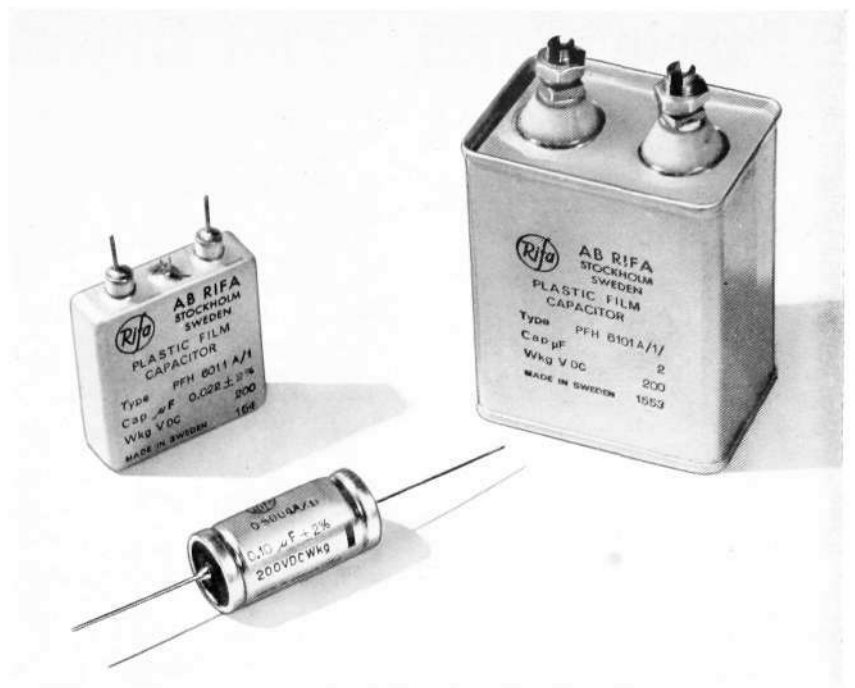


Fig. 14 X 6828  
Various designs of polystyrene capacitors

charge of polystyrene capacitors compared with various other types. For purposes of measurement the capacitors were connected to a 100 V supply for 10 minutes, after which they were disconnected and short-circuited across a 2-ohm resistance for 20 milliseconds. The charge recovered was measured with a very high-ohm valve voltmeter. As is seen, the residual voltage in the case of polystyrene capacitors is only about one thousandth of the applied voltage, and five times as low as the best of the earlier types, the mica capacitors.

## Applications and Designs

Polystyrene capacitors have hitherto been mainly used for electric filters in transmission systems in place of mica capacitors. Polystyrene capacitors are very much simpler to manufacture than mica capacitors, and their use involves a great saving in cost. The fact that the temperature coefficient of the capacitance of polystyrene capacitors is negative means that a certain compensation of the positive temperature coefficient in the filter inductances is obtainable.

With the advance of electronics the number of applications open to polystyrene capacitors has increased. Their excellent capacitance stability enables them to be used as capacitance standards in bridges, and their high insulation makes them suited to electronic computing circuits, timing meters, and indicators, for the measurement of small currents or charges, as filter capacitors in rectifiers for high voltages at low current outputs etc. Due to their low moisture absorption they have become popular as cheap and highly insulated tuning and coupling capacitors in radio sets, amplifiers, and oscillators.

Figs 13 and 14 show some different forms of design. The simplest unprotected type which is mounted suspended on its tags is seen at the bottom right of fig. 13. Behind it and to the left are seen some capacitors enclosed in a polyvinyl tube and dipped in a moisture-protecting wax with high melting point according to a process for which patent has been claimed. In the background of fig. 14 are two capacitors in soldered metal cases with ceramic bushings and, in front, an aluminium tube type that is seated with a rubber-bakelite laminate.

# Balancing Machine for Objects Rotating at High Speeds

H TÖRNROS, L M ERICSSONS MÄTINSTRUMENT AB, STOCKHOLM

U.D.C. 621—755

*L M Ericssons Mätinstrument AB has included a new type of balancing machine, YRB 30, in its production schedule, which is specially designed for balancing the rotors of reamotors. It differs from Ericsson's other types of balancing machines with respect to the transmission of the torque and ensures a high degree of precision when balancing rapidly rotating objects. The machine may also be used for rotors that do not require extremely accurate balancing, such as pump rotors, fans and rotors for electric motors*

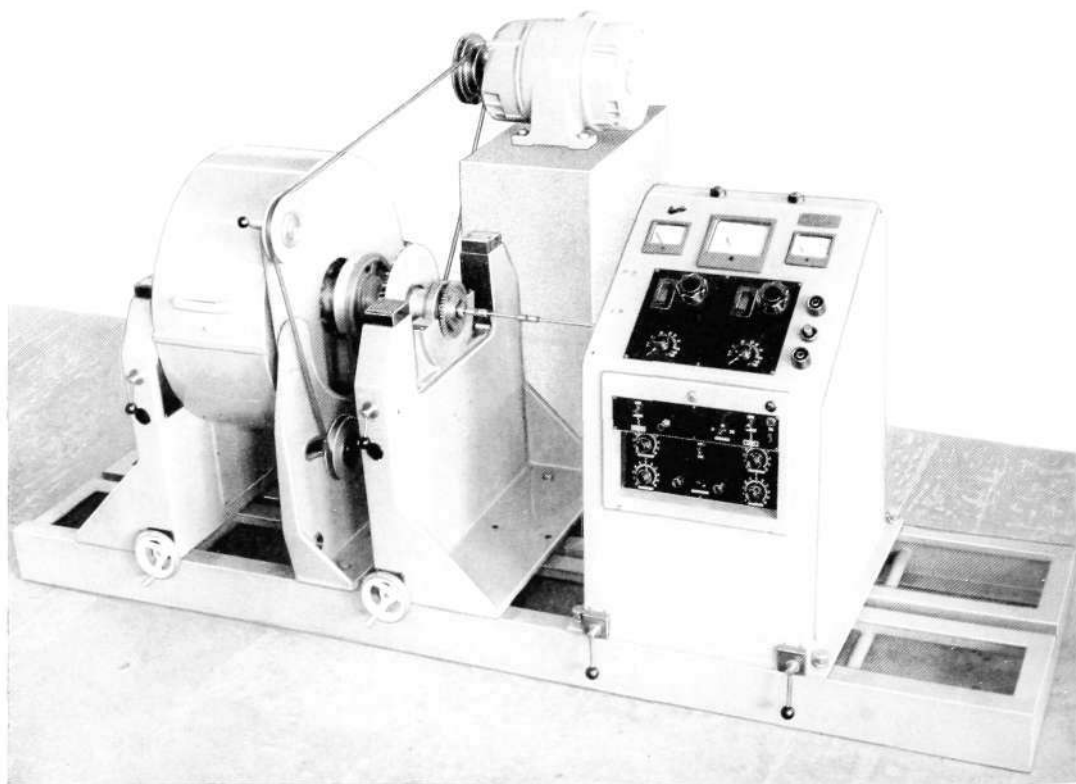
L M Ericsson has designed a balancing machine, type YRB 30, for balancing the rotors of reamotors, which differs in many respects from the balancing machines hitherto manufactured by this concern, fig. 1.

Objects rotating at high speeds require very accurate dynamic balancing. For example, one manufacturer of reamotors specifies that the residual unbalance in turbine and compressor rotors must not exceed 0.01 oz. inch. (7 gcm), which in a rotor of this size corresponds to a displacement of the centre of gravity of approximately 0.00004" (1  $\mu$ ). As the manufacturing tolerances for roller and ball bearings are of the same order of magnitude, this implies that the balancing accuracy represents the limit of what can be actually obtained under practical conditions.

Fig. 1

X 6776

Balancing machine, type YRB 30



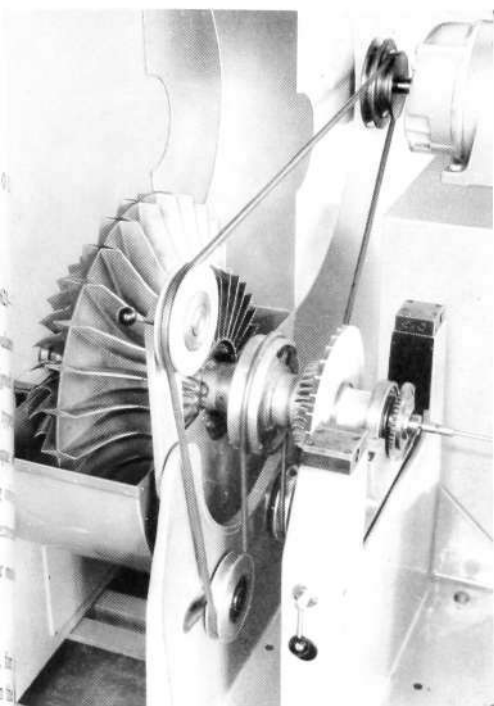


Fig. 2  
Belt-tightening device

In L M Ericsson's other types of balancing machines the torque is transmitted to one shaft-end of the object through a link coupling which is attached to a driving sleeve mounted on the shaft-end. This form of drive is unsuitable for the high degree of sensitivity necessary for cases of the kind mentioned above. In this instance it is difficult to produce the driving sleeve with the requisite concentricity to obviate disturbances from the coupling. In this machine, therefore, the torque is transmitted directly from the driving motor through a belt of plastic material to the shaft of the object as close to the centre of gravity as possible. When vibrations in a horizontal direction are measured by the machine, the belt must be led over the shaft vertically in order to eliminate disturbances in the horizontal plane. Furthermore, the belt must be mounted in such a way that it can be easily released when changing the object to be balanced. The belt-tightening device designed for this purpose is shown in detail in fig. 2.

The principle of measurement is the same as that adopted in L M Ericsson's other balancing machines. The rotor is suspended in two resilient bearings which can execute substantially undamped oscillations in the horizontal plane. Each bearing is connected to a vibration indicator which consists of a coil inserted in the air-gap of a permanent magnet. When an unbalanced object rotates in the bearings at a constant speed, the latter will vibrate, whereupon sine-wave alternating voltages proportional to the vibrations are set up in the vibration indicators. These voltages are amplified and applied, one at a time, to the one coil of an electrodynamic instrument. The other coil is fed at the same time with a reference voltage obtained from one of two synchronous generators—one for each balancing plane—mounted on a shaft in a stand which contains the measuring equipment. This shaft is driven from a sleeve mounted on the shaft-end of the object, via a link-coupling which can be constructed very light since the necessary torque is small. The disturbance due to the link coupling will thus be negligible.

The electrodynamic instrument will give a deflection under the influence of the vibration voltage and the reference voltage, which is dependent upon the product of these voltages and the cosine of the phase angle between them. The phase position of the reference voltage can be changed by turning the stator of the reference generator by means of a handwheel. If the phase position for the two voltages is the same, that is to say, the cosine of the phase angle between them = 1, the instrument will give a maximum deflection. By this means the angular position of the unbalance can be determined. Thus, the magnitude of the deflection is solely dependent upon the product of the two voltages, and since the reference voltage is directly proportional to the balancing speed of rotation which is always fixed for a given type of rotor, the instrument's maximum deflection represents a measure for the magnitude of the unbalance.

The angular position of the unbalance can be read off directly on a scale placed on the handwheel employed for turning the stator of the reference generator. After the machine has been stopped the object is turned by hand until the corresponding angular position can be read off on a scale placed at the ingoing shaft-end of the measuring equipment. The point to be machined will then be in the required position, vertically upwards for example. It is also possible to locate the position by means of an optical position-marking device. This consists of two lamps—one for each balancing plane—which light up through a commutator mounted on each generator when the point to be machined in the plane concerned is facing vertically upwards.

In addition to the above-mentioned electrodynamic instrument the instrument panel includes an instrument for reading the number of revolutions and an instrument on which the residual vibration voltages, after correction has been effected, can be read off for the respective planes. In this way it is possible to check the condition of the bearings which is of interest in cases where the rotor is fixed in the machine with the help of the ordinary ball-

or roller bearings. Furthermore, a change-over switch is provided for connecting up the measuring equipment to the left or right balancing plane, a change-over switch for measuring the "heavy" or "light" points, depending upon whether material is to be removed or added, handwheels for regulating the amount of amplification and adjusting the correction network, with the help of which one is rendered independent of the effect exercised by unbalance in the one balancing plane on the measurements in the other one. Pushbuttons are also mounted on the stand for operating the driving motor.

## Mechanical Construction

The machine consists of a base on which the pedestal bearings, the belt-tightening device and the measuring panel are mounted. The base is intended to be cast into a concrete foundation and is constructed of welded and planed iron girders. The driving motor is installed on a separate concrete foundation and the belt-tightening device is located on the base immediately in front of the driving motor. On account of the driving system adopted, the position of the belt-tightening device is fixed. Thus, in order to enable the machine to be adapted to different types of rotors the pedestal bearings and measuring panel framework have been arranged to move along the base.

The pedestal bearings are constructed of cast iron and are fitted with bearing cradles suspended by leaf springs. Adjustable roller bearings or holders for fixing the object's own bearings can be mounted in the bearing cradles. In order to eliminate aerodynamic disturbances and limit the driving motor output required, the machine is provided with air casings for turbine and compressor rotors.

The framework for the measuring panel is constructed of welded sheet iron. The amplifier and operating device, the adjusting gear and change-over switches are mounted on a hinged shutter so that they are conveniently accessible for inspection. The vital parts of the measuring equipment can be readily changed, so that any servicing at the point of use can be restricted to the replacement of complete units, such as a complete amplifier or reference generator equipment.

## Other Forms of Application

The machine can, of course, also be employed for rotors which do not require such extremely accurate balancing, such as pump rotors, fans and the rotors of electric motors. A necessary assumption is, however, that a smooth surface must be available for the driving belt or can be applied without difficulty. The machine is particularly suitable for use where objects of varying types have to be balanced. The sleeves required for driving the measuring equipment can be made in a very simple form and do not call for a specially high degree of concentricity so that their cost is insignificant compared with that of driving sleeves for driving the object through a link-coupling.

## Technical Data

Rotor weight: 6—2,000 lbs. (3—1,000 kgs).

Max. rotor diameter: 40" (1,000 mm).

Max. distance between bearings: 80" (2,000 mm) (can be increased if necessary).

Balancing speed: 490—900 r.p.m.

Sensitivity: Vibrations with amplitudes of 0.00001" (0.2  $\mu$ ) can be measured at slide bearings.

Total length: 120" (3,100 mm) with a distance between bearings of 80" (2,000 mm).

Max. width: 53" (1,350 mm) incl. motor foundation.



# NEWS from *All Quarters of the World*

## Water Level Indicator System for Flood Prevention in New Zealand

A water level indicator system was recently supplied by L M Ericsson for the Rangitikei River on the North Island of New Zealand. It is anticipated that this system will have a great effect in the prevention of the serious annual flooding of this river. The Rangitikei River drains the western slopes of the Ruahine Mountains in the southern part of the island. The spring flood is very heavy and the water level varies greatly at different seasons.

The transmitter of the water level indicator system, which is of L M Ericsson's normal design, is placed at Mangaweka Bridge. The photograph below was taken when the water level was 7 ft. In May this year the depth at the same point was 15 ft.

The transmitter impulses are received and recorded on the receiver equipment located in a telephone exchange about 3 kilometres from the bridge. On the sounding of a high



Rangitikei River where the road crosses Mangaweka Bridge. The transmitter equipment of the water level indicator system is located at this bridge. The photograph was taken in summer at low water.

water alarm signal, the telephone operator immediately informs the staff of the dam at Marton, a town some 50 kilometres down river. Measures are there taken to prevent flooding and the damage caused by it, particularly in the agricultural areas through which the Rangitikei flows in its lower stretches.

The telephone connection with Marton is a reminder of the automatic exchange L M Ericsson supplied to that town as long ago as 1931. The exchange is equipped with 500-line selectors for 990 extensions and is the most southerly of L M Ericsson's automatic exchanges. Marton lies on a latitude of 40°.

## New Edition of »Table of the Erlang Loss Formula«

The first of a projected series of formulae tables for use in the designing of telephone plants, »Table of the Erlang Loss Formula«, was published by Conny Palm in 1947. The table comprises congestion figures for different traffic values and numbers of switching devices according to Erlang's formula for busy-signal systems (Erlang's B formula). The table is computed for traffic values with the following intervals:

interval 0.05 within the range 0.05— 1.00				
» 0.1	» »	» 1.0	— 20.0	
» 0.5	» »	» 20.0	— 30.0	
» 1.0	» »	» 30.0	— 50.0	
» 4.0	» »	» 50.0	— 100.0	

The table has proved its value to telephone administrations and companies. The first edition ran out some time ago. In the new edition the range has been extended to comprise traffic values up to 200 Erlang with a 5.0 Erlang interval for the added section. The calculations have been carried out on the Swedish electronic computer BESK.

The new edition, like the former one, is the product of cooperation between the Swedish Board of Telecommunications and Telefonaktiebolaget L M Ericsson, from either of which the table may be ordered.

C PALM: Table of the Erlang Loss Formula, 2nd edition, Stockholm 1954.





## Frederiksberg's New Town Hall Equipped by L M Ericsson

A new town hall was recently built in Frederiksberg, a suburb of Copenhagen with about 120,000 inhabitants, and some of its equipment was supplied by L M Ericsson, viz. a P.A.B.X. with 500-line selectors at present equipped for 400 extensions, 44 link circuits and 50 public lines; an electric clock installation to which the large clock in the tower of the town hall is connected; and finally a fire alarm system comprising 30 alarm sections. The latter includes both thermocontacts for automatic alarm and alarm press buttons.



The head of the Ericsson Company in Essen is Herr Gerhard Dillenberg.

Similar types of P.A.B.X. to that in the Frederiksberg Town Hall are installed in other parts of Denmark, serving at present about 2,900 extensions. A further plant will soon be operating in the Town Hall of Lyngby, with a capacity of 200 lines.

## Ericsson Verkaufsgesellschaft m. b. H. to Essen

Ericsson Verkaufsgesellschaft m.b. H., the offices of which were previously in Frankfurt-am-Main, moved on May 1, 1954, to its new address, Daimlerstrasse 2, Essen-Bredeney. The head of the company is Herr Gerhard Dillenberg, while Herr Walter Schöneck is in charge of the technical service. Sales comprise telephone and telesignal material. The Essen office furthermore acts as L M Ericsson's purchasing agent in Germany.

Its situation in the heart of the Ruhr affords the firm excellent contact with the large industries of the area. Among the groups of material which are of most interest may be mentioned time control systems and *Centralograph*, for which an ample spare parts stock is held. Ericsson Verkaufsgesellschaft is thus in a position to render rapid and efficient service to all new West-German customers as well as to those who have had Ericsson plants operating since before 1939.

## Grants for Research and Travel Scholarships

The Telefonaktiebolaget L M Ericsson Foundation for the Promotion of Electrotechnical Research has granted scholarships this year amounting to 21,000 kronor. Among the recipients is Folke Bolinder, Doctor of Technology who received 4,000 kronor for research studies in Mexico City at the laboratory of Dr. Manuel Cerrillo, one of the world's foremost experts in the theory of modern circuits.

The Foundation for Travel and Study Scholarships has allotted 27,800 kronor to 18 employees at L M Ericsson companies and to 6 members of the Swedish Telecommunication Administration.



## New Sections of French Catalogue

L M Ericsson's new export catalogue of telephone material is divided into sections, each comprising one group of materials. The English catalogue is already complete, as announced earlier, and the Spanish edition is expected to be ready very soon. The sections covering telephone instruments, private automatic exchanges and selective calling telephone systems have now been printed in French as well under Catalogue No. 685 to fulfil the requirements of catalogues in the French language for some of L M Ericsson's markets.

## From the Visitors' Book



Dr. Vladimir H Zworykin, Vice President and Technical Consultant of the RCA Radio Corporation of America is seen in the photograph above between Dr. Christian Jacobæus (left) and Dr. C-G Aurell during a visit to one of the Transmission Dept. laboratories. At the far left is Mr. K V Fredriksson of Elektronikbolaget.

The members of the British Iron and Steel Institute held a congress in Stockholm in June. The photograph below shows a group studying the work in one of L M Ericsson's workshops.



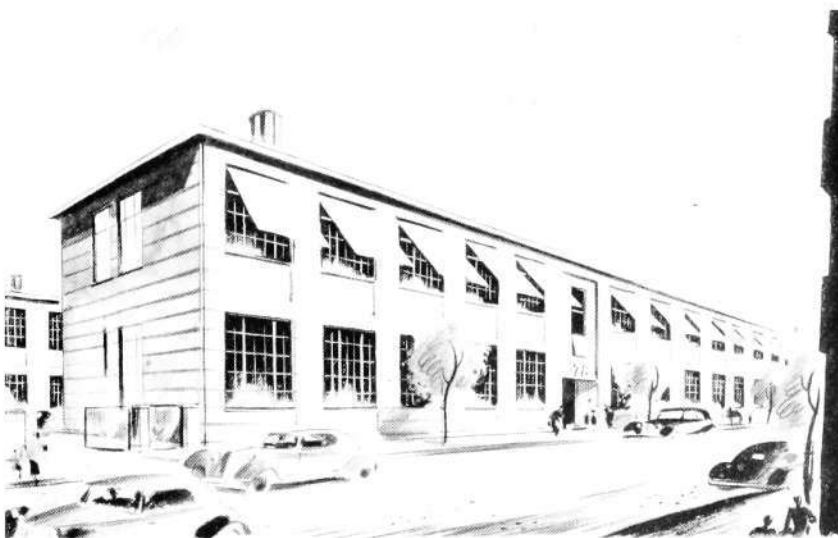
## LM Ericsson A/S, Copenhagen

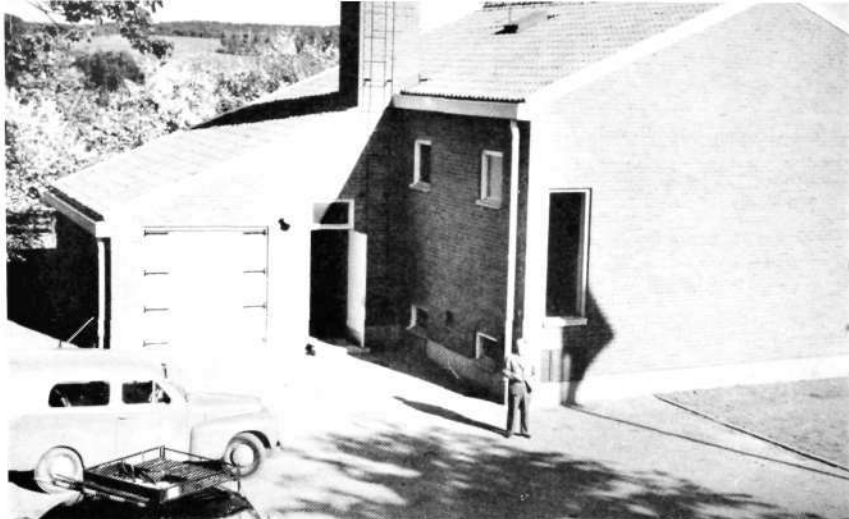
The Danish sales company, L M Ericsson A/S, has moved into premises of its own at Finsens Vej 78, Copenhagen F. In the same building are offices and workshops of the associated firm of Dansk Signal Industri A/S.



The above photograph shows the Mexican Minister to Sweden, Mme Amalia de Castillo Ledon, on a visit to Midsommarkransen. On her left is the President of L M Ericsson, Mr. Sven T Åberg, and on her right the head of the Mexican Telefonaktiebolaget Ericsson, Mr. Bernhard Wahlqvist.

Dr. Azikiwe, Prime Minister of Eastern Nigeria (right in photograph below), paid a visit to L M Ericsson at the end of June, accompanied by Dr. Ojukwu, a leader of industry. Before being shown over the factory, some of the main features were pointed out to them on the Show Room model by their guide, Captain Hagstedt.





The photograph (left) shows a corner of the Sjöbo telephone exchange.

## Advance of Automatization in Southern Sweden

Among the automatic telephone exchanges in the south of Skåne being installed by L M Ericsson, the 900-line exchange at Sjöbo has now been delivered and was cut into service in May. All of the exchanges on order are being built to the Telecommunication Administration marker system with crossbar switches.

Sjöbo is a group centre with nine terminal exchanges. The Sjöbo group will in the first place have fully automatic traffic with Malmö and Lund. Of the four south-Skåne exchanges on order, totalling 7,900 lines, Ystad is the largest with 4,000 lines and is expected to be in service by March next year, by which time practically the whole of south Skåne will be fully automatized.

An automatic exchange has also been recently delivered to Nässjö. The Nässjö exchange was cut into service on July 4, and the material supplied by L M Ericsson comprises equipment for 4,000 lines and junction equipment for the 17 tandem and terminal exchanges within the group.



The outfit can be carried on jeeps of different types. It has been widely employed on L M Ericsson's large network construction projects all over the world and has proved its worth as a cutter of labour costs.



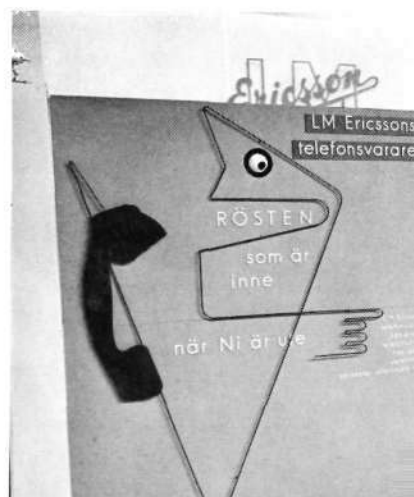
## New Sales Office in Zürich

For the sale of L M Ericsson products in Switzerland a branch has been opened in Zürich at Stampfenbachstrasse 63. The manager of this office is Mr. Kurt Klöpfer (seen in the photograph above), and his assistants on sales and technical service are Messrs. Weber and Hintermann. The main sales lines are time control equipment, intercom telephone systems and *Centralograph*. A well assorted stock of spare parts enables the Zürich organization to render prompt service to L M Ericsson's Swiss clientele.

## Cable Laying by Jeep

Among the exhibitors at the Spring Motor Car Show in Stockholm was L M Ericsson. A jeep-driven cable

L M Ericsson's stand at this year's Swedish Fair in Gothenburg. The public were given the opportunity of listening to recordings they had themselves made on L M Ericsson's telephone answerer — a chance that was eagerly seized upon by large numbers of visitors to the Fair.



U.D.C. 621-755  
TÖRNROS, H: *Balancing Machine for Objects Rotating at High Speed*. Ericsson Rev. 31 (1954) No. 2 pp. 62—64

L M Ericssons Mätinstrument AB has included a new type of balancing machine, YRB 30, in its production schedule, which is specially designed for balancing the rotors of reamotors. The machine, presented in this article, ensures a high degree of precision when balancing rapidly rotating objects. The machine may also be used for rotors that do not require extremely accurate balancing, such as pump rotors, fans and rotors for electric motors.

U.D.C. 621.319.416.3  
HARRIS, P O: *Plastic Film Capacitors*. Ericsson Rev. 31 (1954) No. 2 pp. 56—61.

AB Rifa has for several years been manufacturing capacitors of polystyrene—a plastic material obtainable in thin sheets. Due to their unusual properties these capacitors are now being used for a number of special purposes. In addition to describing these capacitors in the form in which they are manufactured by Rifa, the article gives examples of their use.

U.D.C. 621.315.211.4

HENCKEL, A: *Gas Control on Telephone Cables by Gas Flow Meters and Automatic Pressure Compensation*. Ericsson Rev. 31 (1954) No. 2 pp. 34—47.

In an article entitled »Gas Control on Telephone Cables» published in the Ericsson Review No. 4/1952 a new method was described by means of which, on the occurrence of a leak, gas is also fed into the cable automatically simultaneously with the gas control, whilst at the same time the drop of pressure in the gas is recorded. The following article describes this method in greater detail as well as the necessary apparatus and materials employed. The method itself and a part of the apparatus have been patented.

U.D.C. 621.395.26  
621.395.655

ADENSTEDT, W: *New Type of Cordless C. B. Private Branch Exchanges*. Ericsson Rev. 31 (1954) No. 2 pp. 48—52.

A new line in the range of L M Ericsson's modern manual telephone switchboards has been brought out in the form of cordless C.B. private branch exchanges. These switchboards possess a number of advantageous features which make them simple to handle. The article deals principally with their construction and operation.

U.D.C. 621.385.1

EDSMAN, S & LAGERHOLM, G: *Review of SER Electron Tubes: Standard and Long Life Types*. Ericsson Rev. 31 (1954) No. 2 pp. 53—55.

This article presents a summary description of the range of standard and long life electron tubes at present being manufactured by AB Svenska Elektronrör.



# The Ericsson Group

## Associated and co-operating enterprises

### • EUROPE •

#### Danmark

L M Ericsson A/S København F, Finsens Vej 78, Tel: Fa 6868, tgm: ericsson-kobenhavn  
Telefon Fabrik Automatic A/S København K, Amalgegade 7, tel: C 5188, tgm: automatic-kobenhavn  
Dansk Signal Industri A/S København F, Finsens Vej 78, tel: Fa 6767, tgm: signaler-kobenhavn

#### Deutschland

Ericsson Verkaufsgesellschaft m. b. H. Essen-Bredney, Daimlerstrasse 2, tel: 41927, tgm: ericcl-essen

#### España

Cia Española Ericsson, S. A. Madrid, Conde de Xiquena 13, tel: 31 53 03, tgm: ericsson-madrid

#### France

Société des Téléphones Ericsson Colombes (Seine), Boulevard de la Finlande, tel: CHA 35-00, tgm: ericsson-colombes-seine  
Paris 17e, 147 Rue de Courcelles, tel: Carnot 95-30, tgm: eric-paris  
Société Cinéris Paris 20e, 111 Rue Villiers de l'Isle Adam, tel: Mémilmonant 87-51, tgm: cin-ericsson-paris

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Production Control (Ericsson) Ltd. London, W. C. 1, 329 High Holborn, tel: Holborn 1092, tgm: productrol holb-london

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F. A. T. M. E. Soc. per Az. — Fabbria Apparecchi Telefonici e Materiale Elettrico «Brevetti Ericsson» Roma, C. P. 4025 Appio, tel: 780 021, tgm: fatme-roma  
S.E.T. Soc. per Az. — Società Esercizi Telefonici Napoli, C.P.C. 20833, tel: 50 000, tgm: sel-napoli

#### Nederland

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den Haag—Scheveningen, Gevers Deynootplein 30, tel: 55 55 00, tgm: ericcl-haag

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A/S Elektrisk Bureau Oslo, P. B. Mj 2214, tel: Centralbord 461820, tgm: elektriken-oslo  
A/S Industrikontroll Oslo, Teatergaten 12, tel: Centralbord 335085, tgm: indroll-oslo  
A/S Norsk Kabelfabrik Drammen, P. B. 205, tel: 12 85, tgm: kabel-drammen

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AB Alpha Sundbyberg, tel: 28 26 00, tgm: aktialpha-stockholm  
AB Ermex Solna, tel: 27 27 25, tgm: elock-stockholm  
AB Rifa Ulvsunda, tel: 26 26 10, tgm: elrifa-stockholm  
AB Svenska Elektronrör Stockholm 20, tel: 44 03 05, tgm: electronics-stockholm  
L M Ericssons Driftkontrollaktiebolag Solna, tel: 27 27 25, tgm: powers-stockholm  
L M Ericssons Svenska Försäljningsaktiebolag Stockholm, Kungsgatan 33, tel: 22 31 00, tgm: ellem-stockholm  
L M Ericssons Mätinstrumentaktiebolag Ulvsunda, tel: 26 26 00, tgm: elmux-stockholm  
L M Ericssons Signalaktiebolag Stockholm 9, tel: 19 01 20, tgm: signalbolaget-stockholm  
Mexikanska Telefonaktiebolaget Ericsson Stockholm 32, tel: 19 00 00, tgm: mexican-stockholm  
Sieverts Kabelverk Sundbyberg, tel: 28 28 60, tgm: sievertsfabrik-stockholm  
Svenska Radioaktiebolaget Stockholm, Alströmergatan 12, tel: 22 31 40, tgm: svenskradio-stockholm

### • ASIA •

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New Delhi, 45, Indra Palace, Connaught Place, tel: 444 90, tgm: inderic-newdelhi

#### Indonesia

Ericsson Telephone Sales Corporation AB Bandung, Djalan

Dago 151, tel: 2135, tgm: javeric-bandung

#### Liban

Telefonaktiebolaget L M Ericsson, Technical Office Beyrouth, Rue du Parlement, Immeuble Bisharat, tel: 33555, tgm: ellem-beyrouth

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### • AMERICA •

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Corp. Sudamericana de Teléfonos y Telégrafos S. A. Buenos Aires, Belgrano 894, tel: 332071, tgm: carlefes-buenosaires  
Cia Argentina de Teléfonos S. A. Buenos Aires, Perú 263, tel: 305011, tgm: cecea-buenosaires  
Cia Entrerriana de Teléfonos S. A. Buenos Aires, Perú 263, tel: 305011, tgm: cecea-buenosaires  
Cia Comercial de Administración S. A. Buenos Aires, Perú 263, tel: 305011, tgm: cecea-buenosaires  
Industrias Eléctricas de Quilmes S. A. Quilmes FCNGR, Eva Perón 1090, tel: 203-2775, tgm: ind-elqui-buenosaires

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São Paulo C. P. 5677, tgm: ericsson-saopaulo  
Empresa Sul Americana de Teléfonos S. A. Rio de Janeiro, C. P. 4684, tel: 43-0990, tgm: emsulatel-riodejaneiro

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J. Martins Marques Lourenço Marques, P. O. B. 456, tel: 5953, tgm: tinsmarques-lourensomarques

#### Nigeria

Scan African Trading Co. Yaba Lagos 32, Commercial Avenue, tgm: swedafrica

#### Tangier

Elcor S. A. Tangier, Francisco Vitoria, 4, tel: 2220, tgm: elcor-tangier

#### Union of South Africa and Rhodesia

Reunert & Lenz, Ltd. Johannesburg, P. O. B. 92, tel: 33-5201, tgm: rockdrill-johannesburg

### • AMERICA •

#### Bolivia

Johansson & Cia, S. A. La Paz, Casilla 678, tel: 2700, tgm: johansson-lapaz

#### Costa Rica

Tropical Commission Co. Ltd. San José, Apartado 661, tel: 3432, tgm: troco-sanjose

#### Cuba

Mc Avoy y Cia Havana, Apartado 2379, tel: U-2527, tgm: mac-avoy-havana

#### Curaçao N. W. I.

S. E. L. Maduro & Sons, Inc. Curaçao, P. O. B. 172, tel: 1200, tgm: maduros-sons-curaçao

#### República Dominicana

García & Gautier, C. por A. Ciudad Trujillo, Apartado de Correos 771, tel: 3645, tgm: gartier-ciudadtrujillo

#### Ecuador

Ivan Bohman & Co. Guayaquil, Casilla 1317, tel: Centro 208, tgm: boman-guayaquil

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Teléfonos de México S. A. México D. F., Paseo de la Reforma 107 Bis, tel: 21-91-00, tgm: telmex-mexicocity

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Soc. Telefónica del Perú, S. A. Arequipa, Casilla de Correo 112, tgm: telefonica-arequipa

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The North Electric Mfg. Co. Galion, Ohio, 501, South Market Street, tel: 24201, tgm: north-phone-galionohio

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#### Venezuela

Cia Anónima Ericsson Caracas, Apartado 3548, tel: 57467, tgm: ericsson-caracas  
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#### Haïti

F. Georges Naudé Port au Prince, P. O. B. A 147, tel: 3075, tgm: nodeco-portauprince

#### Honduras

Cia de Comisiones Inter-Americana, S. A. Tegucigalpa D. C., P. O. B. 114, tel: 15-63, tgm: inter-tegucigalpa

#### Jamaica

Morris E. Parkin Kingston, P.O.B. 354, tel: 4077, tgm: morrispark-kingston

#### Nicaragua

J. R. E. Tefel & Co. Ltd. Managua, Apartado 24, tel: 387-1169, tgm: tefello-managua

#### Panama

Productos Mundiales, S. A. Panama, R. P., P. O. B. 2017, tel: 2 2003, tgm: mundi-panama

#### Paraguay

H. Petersen S. R. L. Asunción Casilla 592, tel: 268, tgm: parg-trade-asuncion. (Agent of Cia Sudamericana de Teléfonos L M Ericsson S. A. Buenos Aires)

#### El Salvador

Dada-Dada & Co. San Salvador, Apartado 274, tel: 4860, tgm: dada-sansalvador

#### Surinam

C. Kersten & Co. N. V. Paramaribo, P. O. B. 216, tel: 2541, tgm: kersten-paramaribo

### • AUSTRALIA & OCEANIA •

#### New Zealand

ASEA Electric (N Z) Ltd. Wellington C. 1., Huddart Parker Building, Post Office Square, tel: 70-614, tgm: aseaburd-wellington

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### • EUROPE •

#### Belgique

Electricité et Mécanique Suédoises Bruxelles, 56 Rue de Stassart, tel: 11 14 16, tgm: electrosuede-bruxelles

#### Grèce

»ETEP», S. A. Commerciale & Technique Athènes, 41 Rue W. Churchill, tel: 31 211, tgm: aeter-athenes

#### Ireland

E. C. Handcock, Ltd. Dublin, C 5, Handcock House, 17 Fleet Street, tel: 76 534, tgm: forward-dublin

#### Island

Johan Rönning H/F Reykjavik, P. O. B. 883, tel: 4320, tgm: rönning-reykjavik

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#### Österreich

Inglomark, Markowitsch & Co. Industrie-Belieferungs-Gesellschaft Wien XV, Maria Hilferstrasse 133, tel: R 32-0-11, tgm: inglomark-wien

### • ASIA •

#### Burma

Vulcan Trading Co. Ltd. Rangoon, P. O. B. 581, tel: S. 878, tgm: suecia-rangoon

#### China

The Ekman Foreign Agencies Ltd. Shanghai, P. O. B. 855, tel: 16242-3, tgm: ekmans-shanghai

#### Hongkong

The Swedish Trading Co. Ltd. Hongkong, Prince's Building, Ice

House Street, tel: 20 171, tgm: swedetrade-hongkong

#### Indochine (Viet-Nam)

Compagnie Internationale de Commerce Saigon, P. O. B. 204, tel: 20253, tgm: intercom-saigon

#### Iraq

Swedish Oriental Company AB Baghdad, Mustansir Street, 5 A/38, tel: 848 19, tgm: swede-orient-baghdad

#### Iran

Irano Swedish Company AB Teheran, Khiaban Sevom Esfand 201-203, tel: 36761, tgm: irano-swede-teheran

#### Israel

Jos. Muller, A. & M. Haifa, P.O.B. 243, tel: 3160, tgm: mullerson-haifa

#### Japan

Gadellus Co. Ltd. Tokyo, Shiba Park No. 7 Minato-ku, tel: (43)-1847, tgm: golicus-tokyo

#### Jordan

H. L. Larsson & Sons Ltd. Levant Amman, P. O. B. 647, tgm: larsson-hus-amman

#### Liban

Swedish Levant Trading Beyrouth, P. O. B. 931, tel: 6142, tgm: skefko-beyrouth

#### Malaya

Thoresen & Co. (Malaya) Ltd. Singapore, P. O. B. 653, tel: 6818, tgm: thoresenco-singapore

#### North Borneo

Thoresen & Co. (Borneo) Ltd. Sandakan, P. O. B. 44, tgm: thoresen-sandakan

#### Pakistan

Vulcan Trading Co. (Pakistan) Ltd. Karachi City, P. O. B. 4776, tel: 2506, tgm: vulcan-karachi

#### Philippines

Koppel (Philippines) Inc. Manila, P. R., P. O. B. 125, tel: 3-37-53, tgm: koppelrail-manila

#### Saudi Arabia

Mohamed Fazil Abdullah Arab Jeddah, P. O. B. 39, tel: 405, tgm: arab-jeddah

#### Syrie

Georgiades, Moussa & Cie Damas, Rue Ghassan, Harika, tel: 10289, tgm: georgiades-damas

#### Thailand

Thoresen & Co. (Bangkok) Ltd. Bangkok, Radio and Electrical Appliances Dept., Wat Yanawa, tel: 30730, tgm: thoresen-bangkok

#### Türkiye

Genel Sanayi Tecizati T. A. O. Istanbul, P. K. Galata 455, tel: 44510, tgm: telotomat-istanbul

### • AFRICA •

#### British East Africa

Transcandia Ltd. Nairobi, Kenya, P. O. B. 5933, tel: 3312, tgm: transcandia-nairobi

#### Egypt

Swedish Industries Cairo, P. O. B. 1722, tel: 51408, tgm: ecoproduit-cairo

#### Ethiopia

Swedish Ethiopian Company Addis Abeba, P. O. B. 264, tel: 1447, tgm: eliocomp-addisabebe

