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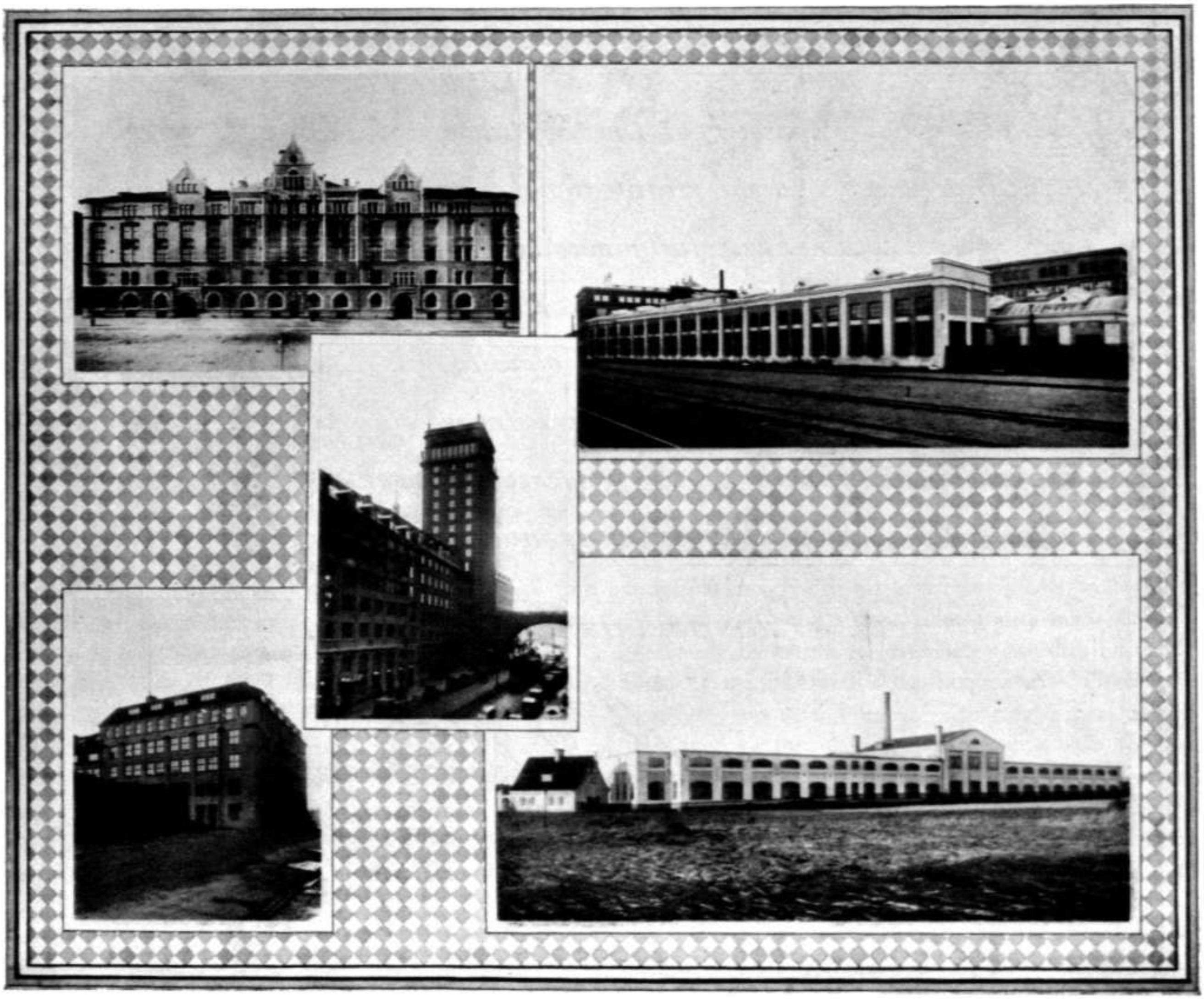
Swedish Factories and Offices of the Ericsson Concern.



Telephone Works in Stockholm.
Head Office, Ericsson Tower Building.
The Radio Factory, Stockholm.
The Sievert Cable Works, Sundbyberg.
The Cable Works at Älvsjö.

ENGLISH EDITION

L. M. Ericsson

THE L. M. ERICSSON REVIEW

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The hopes expressed at the beginning of the past year concerning a continued strong development of our associated enterprises have been fully realized. The situation at the beginning of the present year is such that in all probability the expansion will be at least equally great during 1929.

I herewith beg to express my sincere thanks to all associates and members of the Ericsson organization to whose efforts this favourable result is due and wish them

A Prosperous New Year.

The Activities of Max Sieverts Fabriks Aktiebolag.

A Retrospect. By Otto Sundell.

Since there has been expressed a wish that various articles touching on the activities of the Sievert Cable Works should appear in an early number of "The L. M. Ericsson Review" — the ownership of these works having been transferred to the Ericsson concern on July 1st, 1928 — it is with a feeling of pleasure and satisfaction that I will now attempt to present a somewhat concentrated retrospect of the history of the Sievert company.

R 1090 Max Sievert.

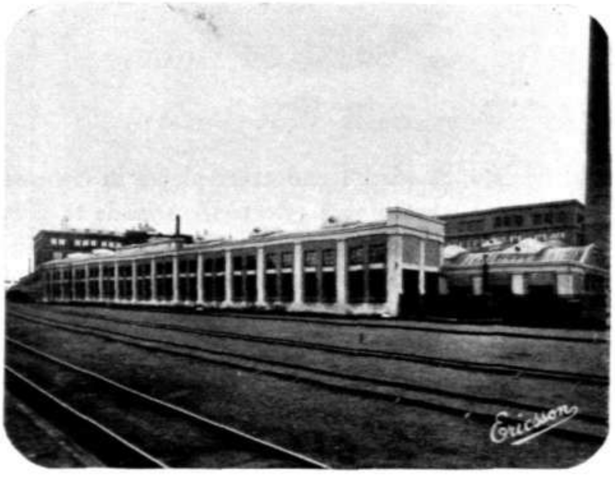
R 1089 Ernst Sievert.

On the 17th of May last it was just forty years since the brothers Max and Ernst Sievert began the work which was to develop into that industrial enterprise which has now gone over to L. M. Ericsson, May 17th 1888 being the date on which the winding of electric wire was first started in a little rented room in Sundbyberg — just outside of Stockholm — which to this day forms a part of the Sievert cable works, and it was at the instigation of L. M. Ericsson that this work was taken up.

It was in the early eighties that the American Bell company gave Stockholm its first telephone net, and it was at about this time that L. M. Ericsson constructed the first Swedish telephone instrument, which was pronounced by experts to be far superior to the American ones. Hand in hand with the ever increased popularity of the Ericsson telephones — which were introduced first in Stockholm, then in Gothenburg, Malmö, Sundsvall and other places in Sweden — more and more serious efforts were made to give preference to telephone material of Swedish make instead of the imported American material which had been used up to this time. The greater part of the wire used in the winding of induction coils for the Ericsson phones was obtained from "Max Sieverts Maskinaffär", a company formed by Max Sievert immediately after his arrival in Sweden in 1881. In order to avoid imports as much as possible, however, Ericsson made the suggestion that the insulation of the wire for the induction coils be done in Sweden, and he put the question to Max Sievert whether this line of manufacture would not appeal to him and his younger brother Ernst, at that time gaining experience in the foundry of the Bolinder Machine Shops in Stockholm. This proposition — which had its conception in Ericson's unbounded confidence in the

R 1091 The Sievert Factory in the Nineties.

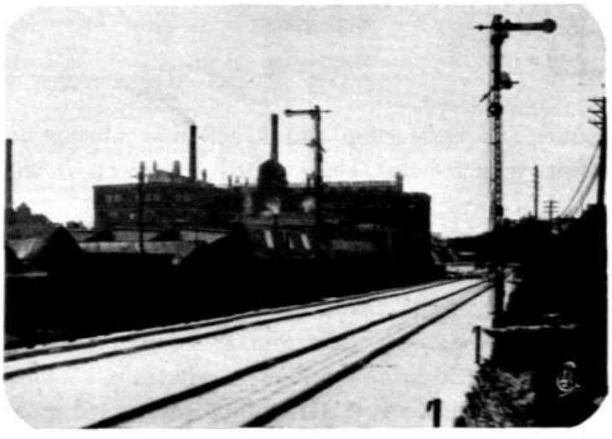
brothers Sievert as well as in his farsightedness — was accepted and this "handycraft", as previously mentioned, was started in a small room in Sundbyberg on the 17th of May 1888.



R 1092 Part View of the Present Works, North Exposure.

Since the unwonted expansion of this "handycraft" during the passed forty years is mostly due to the two leaders Max and Ernst Sievert, I will beg permission of my readers to give a few personal impressions before continuing with the relation of the development of this concern.

Max Sievert was born in 1849 and his brother Ernst in 1863 in Zittau, Saxony. The former came to Stockholm in 1881, at which time he founded "Max Sieverts Maskinaffär" which later developed into Aktiebolaget Max Sievert. He also founded the



R 1093 Part View of the Present Works, from Vasa Street.

Alpha manufacturing concern in Sundbyberg, the present "Aktiebolaget Alpha" (The Alpha Company, Ltd.). Up to his death on June 2nd, 1913, Max Sievert was the leader of all three companies, i. e. the wire and cable works in Sundbyberg, the machine company in Stockholm and the Alpha concern in Sundbyberg. The technical leadership of the wire shops in Sundbyberg was placed in the hands of Ernst Sievert from the very beginning, however, and after Max Sievert's death he became managing director of the same. Since 1895 the wire and cable works have operated under the form of a stock company and under the name of "Max Sieverts Fabriks Aktiebolag".

The reasons for the exceptional growth of the Cable Works are quite naturally to be found in part in the existing general conditions, but also to quite a large extent in the power of the leaders of this concern to take advantage of these conditions in a wide-awake and farsighted manner. As we are well aware, the development of telephone communications in Sweden dates back to the early eighties and there is no doubt but that we have Lars Magnus Ericsson to thank for the fact that Sweden has advanced to the foremost ranks among those nations in which the telephone is most widely used and where the quality of this means of communication stands on the highest level. The development of the Sievert company in the field of applied low tension electricity is therefore directly connected with that of the telephone, and it is already some years back since the Sievert Cable Works — in cooperation with The Western Electric Company — took up the manufacture of long distance cables, a subject to which I will revert later on.

It was some time in the early nineties that the Sievert works in Sundbyberg started to manufacture vulcanized wire for electric light installations. The requirements have become more and more stringent and much experience has been gained in this line also, however, and since some years back special material and methods are required for installations in buildings where the danger of fire is great or where acids are used. After much experimental and research work, the Sievert Cable Works have developed and marketed what is called the acid proof wiring system or the "SS" system, specially devised to meet the above requirements.

It was about 1910, after chief engineer Bernhard Ell had become associated with the firm, that the manufacture of lead covered cable for low as well as high tensions was taken up. The abovementioned exceptional growth of the telephone industry was soon followed by a corresponding growth in applied high tension electricity, and it was another proof of farsightedness on the part of the leaders of this enterprise that they took up the manufacture in Sweden of high tension cable, an undertaking which, at that time, was connected with no small amount of risk. The difficult position in which this country would have been put during the war, had it not been for a well qualified domestic cable industry, may well be immagined.

Among the various high tension fixtures manufactured by the Sievert works may be mentioned their oil filled cable junction and end boxes. Another important line is the manufacture of condensers for the balance of the reactive effect in alternating current nets.

I will now take the liberty of enumerating a number of more important deliveries of both low and high tension cable effectuated by the Sievert Cable Works.

Since the fall of 1924 Sievert's and Western Electric cooperate on the subject of loaded long-distance cable, Sieverts furnishing the cable and Western Electric the loading coils, except where the customer uses his own make of coils.

Effectuated deliveries of these types of cable are as follows:

For the Swedish Railway Administration.

Distance Stockholm—Järna and Järna—Falköping Ranten.

Delivered between Febr. 21, 1924 and Jan. 23, 1925.	Abt. 50,000 metres 7 × 2 × 1.4 mm. +18 × 2 × .9 mm. and abt. 305,000 metres 7×2×1.4 mm. + 14 × 2 × .9 mm., with a total net weight of abt. 1,679,000 kg.

For the Swedish Telegraph Administration.

Distance Stockholm—Nyköping and Nyköping—Norrköping.

Delivered between May 28, 1924 and Dec. 15, 1924.	Abt. 113,000 metres 44 ×4×1.3 mm. + 70 × 4 × .9 mm. and abt. 65,000 metres 44 × 4 × 1.3 mm. + 65×4×.9 mm. with a total net weight of abt. 2,205,400 kg.

Distance Helsingborg—Höganäs.

Delivered between Sept. 25, 1925 and Oct. 28, 1925.	Abt. 24,000 metres 10 × 4 × 1.1 mm. + 40 × 4 × .8 mm. with a total net weight of abt. 110,000 kg.

Distance Stockholm—Märsta.

Delivered between July 17, 1926 and Nov. 15, 1926.	Abt. 40,000 metres 64 × 4 × 1.3 mm. + 41 × 4 × .9 mm. with a total net weight of abt. 464,000 kg.

Distance Märsta—Upsala.

Delivered between Dec. 9, 1926 and March 18, 1927.	Abt. 34,000 metres 64 × 4 × 1.3 mm. + 41 × 4 × .9 mm. with a total net weight of abt. 390,000 kg.

Distance Upsala—Tierp.

Delivered between May 25, 1927 and Sept. 3, 1927.	Abt. 59,000 metres 50 × 4 × 1.3 mm. + 38 × 4 × .96 mm. with a total net weight of abt. 612,000 kg.

Distance Tierp—Gävle.

Delivered between Jan. 11, 1928 and April 13, 1928.	Abt. 53,000 metres 50 × 4 × 1.3 mm. + 38 × 4 × .96 mm. with a total net weight of abt. 550,000 kg.

As regards dry core lead sheathed cable for high tension currents a number of deliveries have been made, all of which are noteworthy either on account of the high tension of the current, the great length of the cable or — for submarine cable — the great depth at which it was laid.

I have made mention, in the foregoing, of the high tension of operation. Development is a rapid process, and to-day no one considers a tension of 60,000 volts to be anything very exceptional. I wish to emphasize, therefore, that when the Sievert Cable Works, in 1914, delivered an underground cable to the Borås power plant, 3×35 sq. mm, with a total length of 1368 metres (in 6 lengths of about 4000 kg. each) and for a tension of 33,000 volts, no cable had at that time yet been put in service anywhere for such a high operating tension. Since that time this cable has been in uninterrupted use.

A large number of deliveries of high tension cable have been made since that time, but I have wished to call attention to the Borås cable since, as already stated, it was exceptional in more ways than one for its day. At the present moment the cable works are occupied with an order for the Stockholm power plant comprising a 3000 metre 3×150 sq. mm. submarine cable for 33,000 volts and a 10,000 metre underground cable with the same cross-section and for the same tension. This order is mentioned because it is the first time that the municipal power plant of Stockholm makes use of such a high voltage.

With regard to the great continuous lengths of submarine cable and the great depths at which they have been laid I take the liberty of mentioning the following deliveries.

1917, to the Royal Waterfalls Administration, Sweden.	1100 metres, in one length, of 3 × 25 sq.mm. submarine cable for 20,000 volts, weighing abt. 17,700 kg. and laid at a depth of 120 metres.
1918, to the Bruvik Electric Power Plant in Norway.	2000 metres, in one length, of 3 × 16 sq.mm. submarine cable for 7500 volts, weighing abt. 20,000 kg. and laid at a depth of 360 metres.
1918, to the Asköy Municipal Electric Society, Norway.	1700 metres, in one length, of 3 × 35 sq.mm. submarine cable for 7500 volts, weighing abt. 20,000 kg. and laid at a depth of 360 metres.
1918, to the Christiansund Power Plant, Norway.	7200 metres, in two lengths, of 3 × 50 sq.mm. submarine cable for 11,000 volts, weighing abt. 52,000 kg. and laid at a depth of abt. 200 metres.

During September of last year a submarine cable was laid between Stora Rör on Öland and Skäggenäs on the mainland, for the Finsjö Power Company. This cable is intended for the transmission of electric power to Öland and was delivered in four lengths, the total length being 4450 metres and the weight abt. 175,000 kg. The cross section of this cable is 3×95 sq. mm. and the cable is constructed for an operating tension of 55,000 volts.

In order to complete this very concentrated account on the development of the Sievert Cable Works, it may be opportune to say a few words also on the financial development. As has already been mentioned, the concern was organized as a stock company on the first of June 1895, the paid up capital amounting to 200,000 Swedish crowns. In 1897 the paid up capital was increased to 300,000 crowns, in 1900 to 600,000 crowns, in 1912 to 1,200,000 crowns and in 1916 to 2,400,000 crowns which is the paid up capital at the present time.

The first deposition in the form of emergency funds was made in 1897 with 57,000 crowns, while the first deposition towards a reserve fund was made in 1908 with 60,000 crowns. The reserve fund now amounts to 5,100,000 crowns.

The first real estate to come into the ownership of the company was valued at 80,000 crowns; this was in 1897. At the present time, the value of the real estate owned by the company — according to the books — amounts to 3,700,000 crowns, the total assessed value of all the real estate, according to the new tax appraisal which took effect last year, amounting to about 4,600,000 crowns.

The books of the company do not show a value for the machine equipment of the works of more than

850,000 crowns due to the fact that the profits of the company have been largely used for making cancellations.

The above figures give sufficient proof of how successfully the Sievert Cable Works passed through the critical years during the war and immediately following the same. Up to the present time, the Sievert Cable Works have been owned by the Sievert family and Ernst Sievert — the leader of the concern after the death of Max Sievert — always made it a principle, as did his brother Max, to permit an extension of the works to take place only when the company itself had sufficient funds to finance the undertaking.

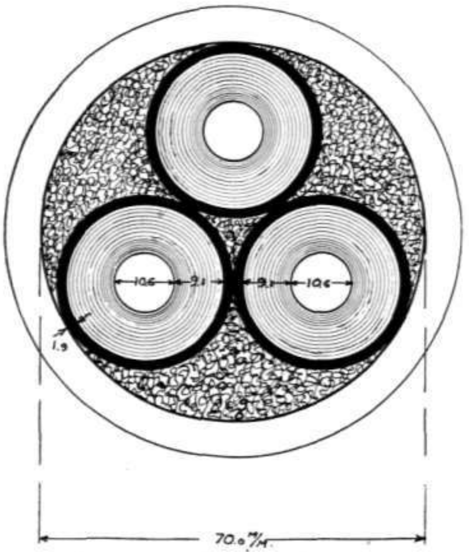
When the ownership of the Sievert works now passes over to Telefonaktiebolaget L. M. Ericsson, I take the liberty — as an old employee of this company — to express my gratitude for the joy it has given me to work for a man whose benevolence, broad views and fair judgement have always made collaboration easy.

Even though Sievert products may have found their way to various parts of the world during past years, this company has catered mostly to the domestic trade. Now that the Sievert Works have become a unit of the Ericsson concern, the Sievert products will, no doubt, become known within the entire great market which now belongs to L. M. Ericsson. May the uniting of two such well known and honoured names as L. M. Ericsson and Max Sievert augur well for the future.

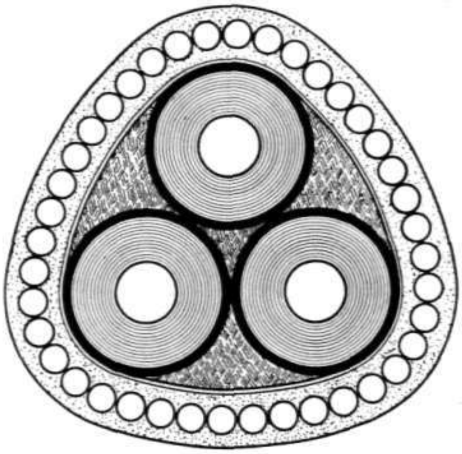
Developments in the Manufacture of Lead Sheathed Cable by Max Sieverts Fabriks Aktiebolag (The Max Sievert Cable Works) at Sundbyberg, Sweden, from 1910 to 1928.

Although lead sheathed electric cable dates back to 1877, when the first cable press was constructed by the Swedish engineer Bror Henning Weslau at the initiative of Werner von Siemens, it was not until 1910 that the manufacture of this type of cable was taken up in Sweden.

It is characteristic of the conditions existing within the cable industry at the beginning of the 20th century that each cable manufacturing concern kept its methods secret, thus putting an effective check on a rapid development within this industry. Two separate works covering the manufacture of electric cables were the only ones published up to 1910, and technical literature in general contained but few items on this subject. So, for instance, in 'Electrotechniche Zeitung' for 1906, on page 101, we find the statement that cable for 3-phase current cannot be manufactured for higher voltages than 10,000 volts. In 1908 cables had been manufactured that would stand up under a tension of 20,000 volts. It is not until quite recently that cable experts have vied with each other in the publishing of their theories and experiences for the benefit of the cable manufacturing industries, thereby enabling these latter to advance by leaps and bounds during latter years. The manufacture of cables for tensions up to 132,000 volts is no longer a Utopian dream.



R 1101 Fig. 1. Lead Sheathed 3-Core Cable.

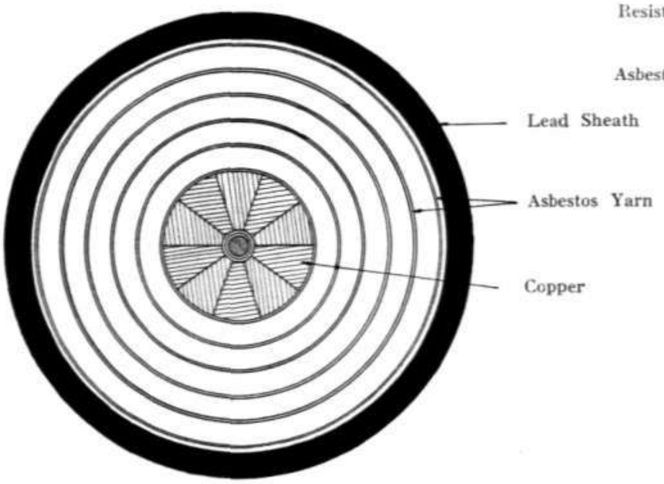


R 1102 Fig. 2. Lead Sheathed 3-Core Cable, Triangular Section.

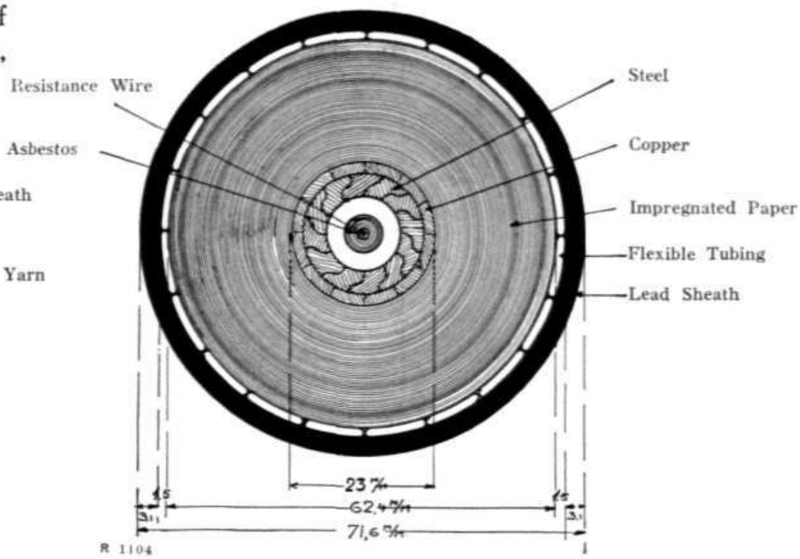
Thanks to the modern machines with which the Sievert shops were equipped from the very start, it has been possible to obtain products of the very best, the quality of which has won recognition not only in Sweden but also in foreign countries. The machines required for this purpose were for the most part designed by the Sievert Cable Works and made by the Alpha Company Ltd., a subsidiary of the first-mentioned.

Hand in hand with the manufacture of cables, scientific research work of a most serious nature has been carried on, making possible the manufacture of cables for excessive tensions and with very small dielectric losses as well as of telephone cables with exceedingly small unbalances of capacity, so that competition with other countries has been possible. This scientific research work has, first of all, had to do with the materials required for the insulation of the conductors, their production, their chemical and physical properties and their behaviour within an electric field as much as possible resembling that existing in a cable while in operation.

As a result of this research work quite a number of different types of cable have come into existance,



R 1103 Fig. 3. Cable with Asbestos Wrappings, for Distribution of Tension.



R 1104 Fig. 4. Section of Cable for 132,000/√3 Volts with Enclosed Expansion Spaces.

many of which are protected by patents. Among these we will mention the following.

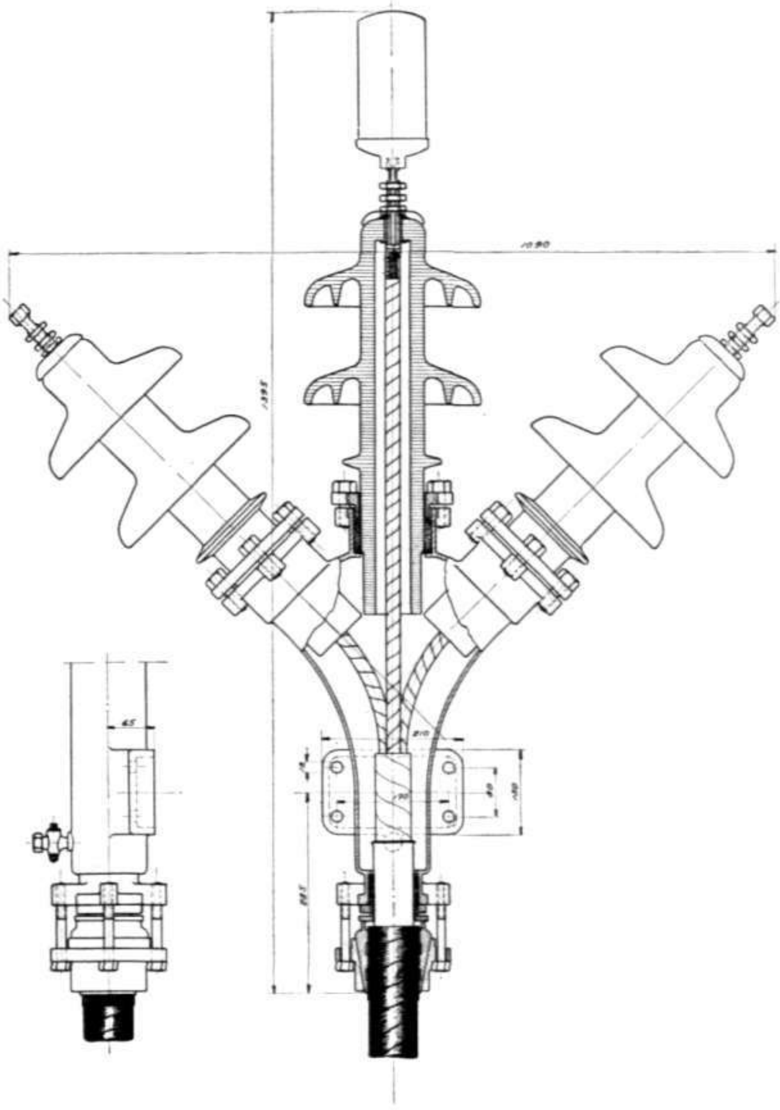
1915. Lead sheathed 3-core cable (see fig. 1).

The main characteristic of this cable is that each insulated core is provided with a separate lead sheath, these lead sheated cores being then cabled together so as to form one single cable. In this manner a homogeneous electric field is obtained in the insulation layer of each core, at the same time as the insulation oil in the cable is reduced to a minimum, or, in other words, to consist of activ oil only. This type of construction has reduced to a minimum those disadvantages which accompany the use of insulation oil.

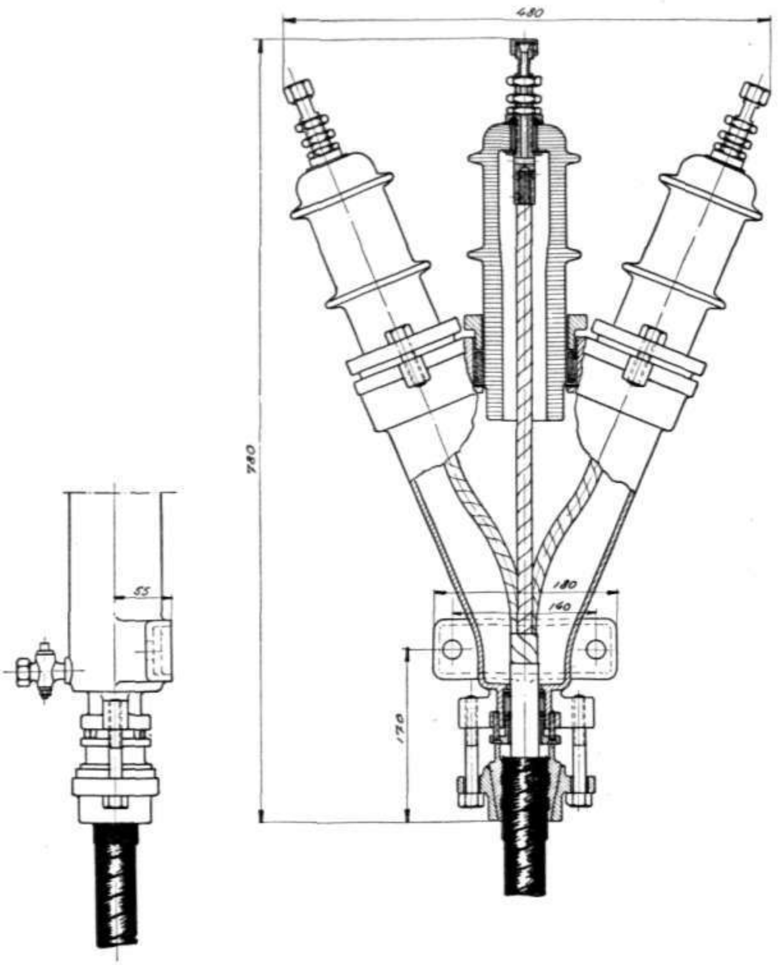
1917. Lead sheathed 3-core cable with triangular section, obtained by reducing the filler strands between the cores so as to give the cable section a triangular contour, the object being to obtain a more economical construction as well as a better means of carrying off the heat engendered within the cable (see fig. 2).

1926. Cable with asbestos introduced in the insulating layer, giving a better distribution of tension in the same. Swedish patent No. 61512 (see fig. 3).

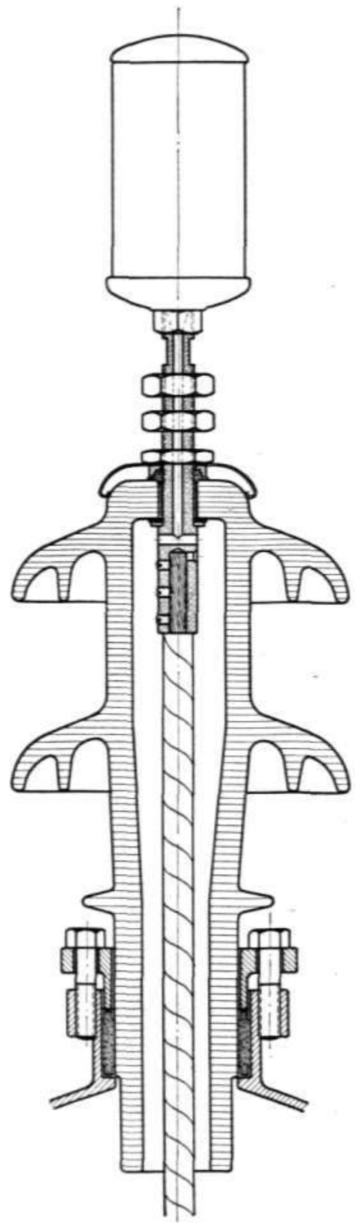
1926. Cable with expansion space inside of the lead sheath along the entire cable (fig. 4) by means of which the



R 1105 Fig. 5. Outdoor End Box for 25,000 Volts for 3-Core Cables with Insulated Lead Sheath.



R 1106 Fig. 6. Indoor End Box for 10,000 Volts.



R 1108
Fig. 8. Method of Mounting Insulator.

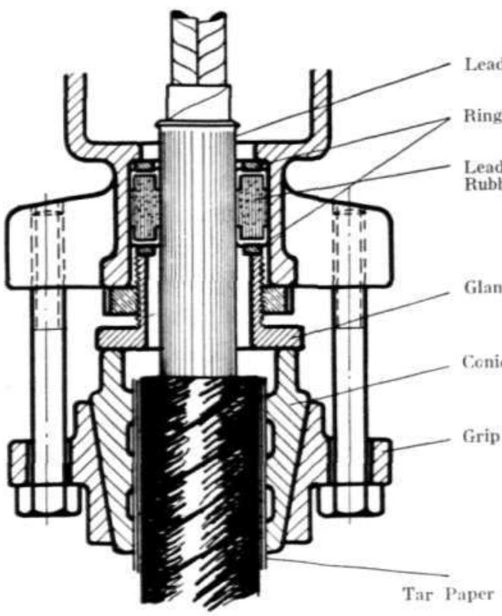


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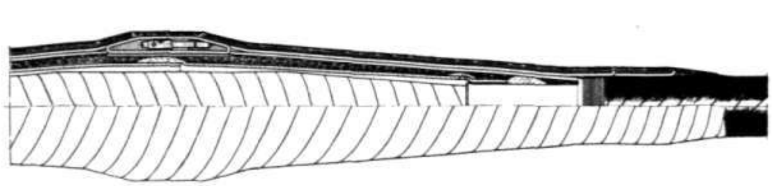
Fig. 7. The Sievert Lead and Rubber Packing.



R 1109 Fig. 9. Junction Box for Submarine Cable.

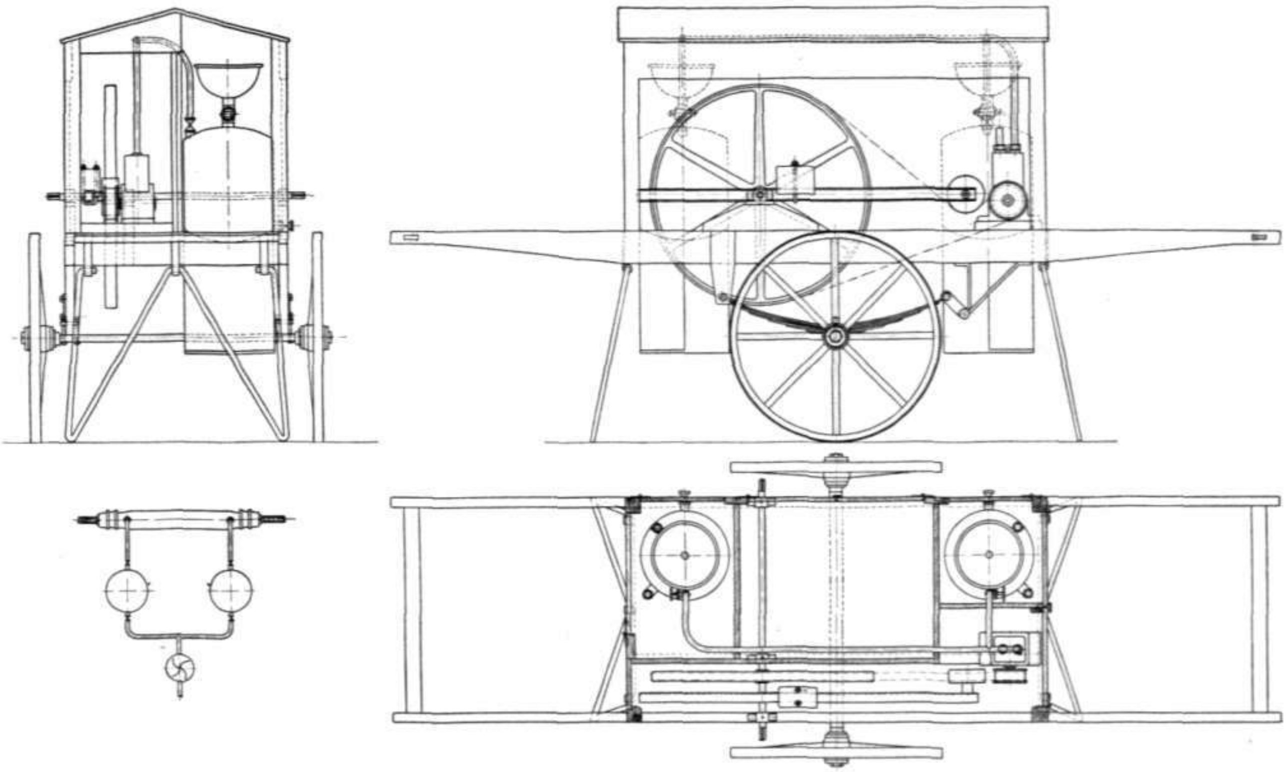
movement of the oil within the insulating layer is reduced to a minimum during its expansion and contraction, the movement of the oil being radial instead of longitudinal. The danger of vacuum forming in the insulating layer is thereby materially reduced. (Patented.)

1927. Cable with resistance wire introduced in the core. The resistance wire serves in part for heating purposes and in part for locating faults. (Swedish patent No. 64249.) See fig. 4.

covering of the cable at the same time as its function is to protect the rubber from the disintegrating influence of oil and air.

1924. The use of half-conductors in junction and end boxes in order to obtain a uniform distribution of tension on that part of the insulation from which the lead covering has been removed. Swedish patent No. 61848.

Junction box for submarine cable (see fig. 9) without cast iron muff. The wire armour of this cable



R 1110

Fig. 10. Vacuum Drying and Impregnating Cart.

In addition to these, patents are pending for a number of new cable designs.

As regards junction and end boxes, many important improvements have been made with regard to the electric as well as to the mechanical properties. The following may be mentioned.

1922. Oil filled junction and end boxes, the construction of which was made possible through Sievert's patented lead and rubber packing. This latter serves partly in the capacity of packing between the box and the lead sheath of the cable (fig. 7) and partly as a packing between the insulator and the outlet muff (fig. 8). In the former case the channel-shaped lead ring of the packing serves as an earth connection between the junction box and the lead

provides the necessary protection against mechanical injury and takes up all longitudinal tension of the cable, so that this will not be detrimental to the splices of the conductors. Furthermore, the cable box is given a certain degree of elasticity.

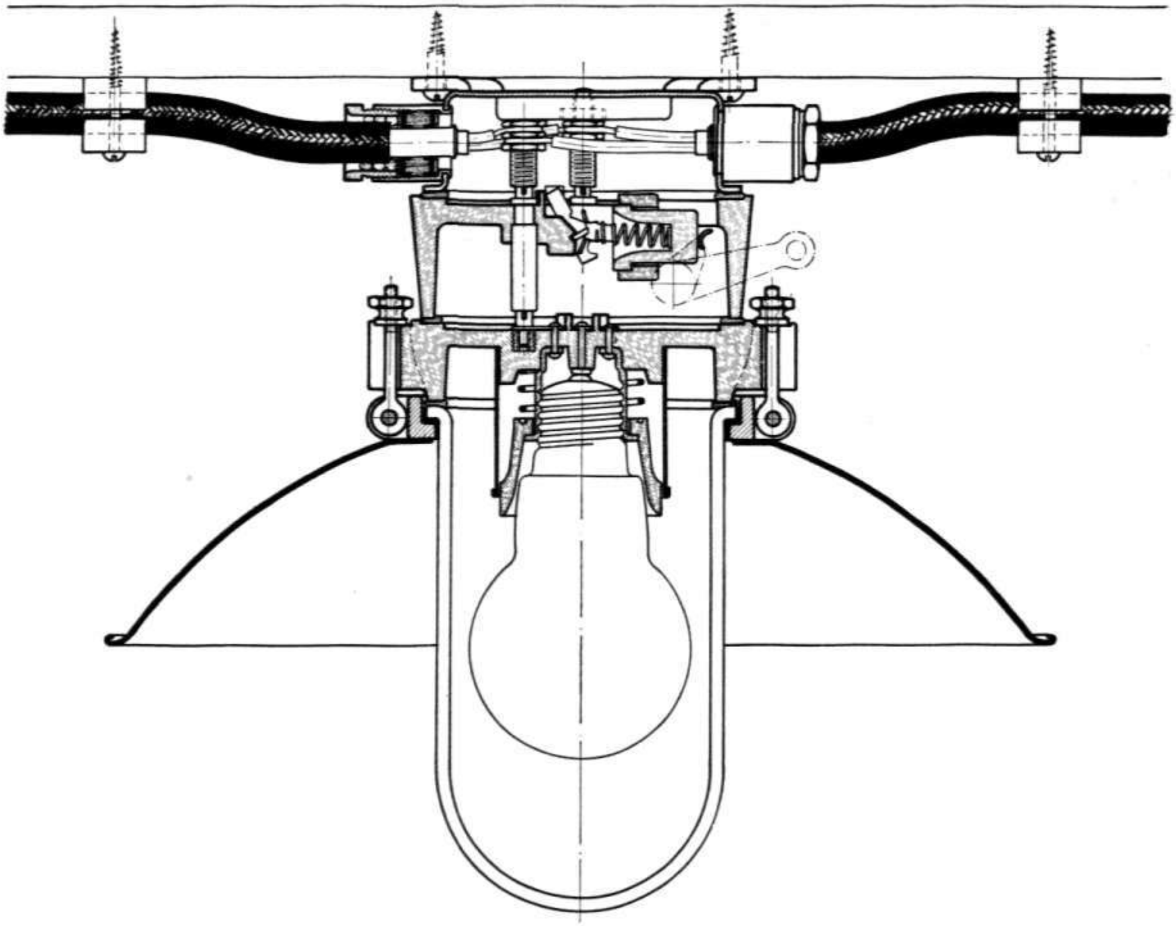
When splicing high tension cables, the drying out and impregnating processes are carried out with the aid of a specially constructed vacuum impregnating cart (see fig. 10).

In the fixture line, the Sievert Cable Works have devoted much labour towards the development of water and acid proof constructions (see fig. 11) suitable for use with the previously constructed acid proof, vulcanized and lead sheathed cable (fig. 12). It was the previously mentioned lead and rubber packing which made possible the construction of such fixtures, the purpose of the packing being to provide an air tight joint as well as earth connection between the fixture and the lead sheath of the cable.

Due to the fact that it is possible to combine the terminal box, switch and lamp socket and that their construction permits all connections to be made with screws or pins, all soldering or the use of a flame is made unnessary so that this material may safely be installed in places where the danger of fire is great. This feature is patented.

The higher and higher working tensions for which cables must be constructed have made their length of life an actual problem and much work has been devoted, not only to the finding of a method for judging this quality in a finished cable, but also towards the discovery of the causes for the gradual deterioration of a cable and of means for preventing the same.

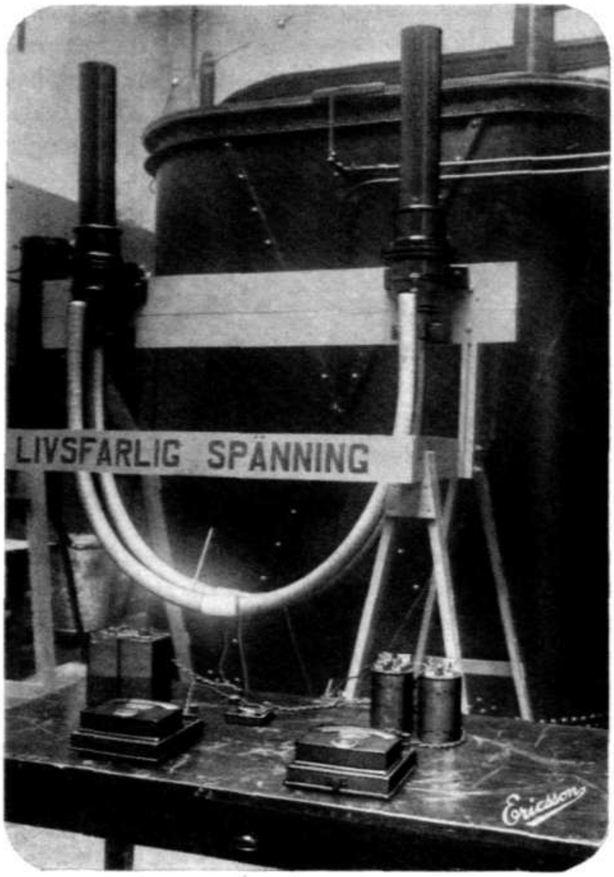
The length of life of a cable may best be obtained by measuring the dielectric losses in the same (figures 13 and 14) and by termining the tension of ionisation and the time disruption curve, which latter may be obtained with short pieces of cable taken from the regular factory lengths. For instance, the dielectric losses in the 33,000-volt cables delivered to the Stockholm Electric Power Plant are reduced to a value of cos $\varphi = 0.0022$, while according to the V. D. E. standards the permissible value of cos. φ is 0.02 at 20° centigrade. Thus, the value obtained at the Sievert works is but one tenth of what is permissible according to the German standards.



R 1111 Fig. 11. Base with Terminals (3 contact sleeves), Switch, Flange Ring and Lamp Socket with Glass Globe, Necessary Packings and Screws.

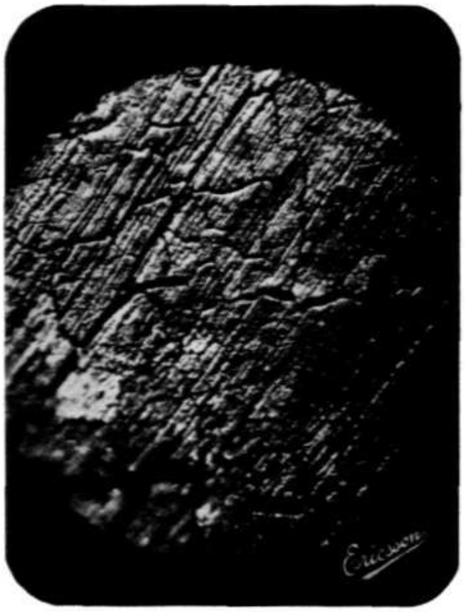
R 1112 Fig. 12. EDJL and FDJL Twin Conductor.

The dielectric loss curve is the sum of two curves

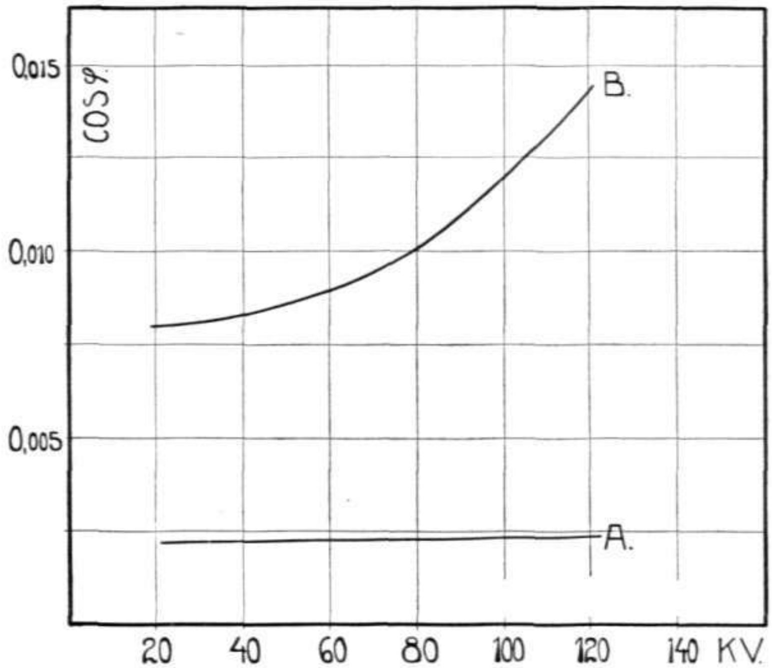


R 1113 Fig. 13. Arrangement for Measuring Dielectric Losses According to Spanne.

which vary with the temperature and of which the one depends upon the actual passage of current through the insulation, while the other depends on hysteresis which latter, in turn, is caused by the air (dampness) or vacuum bubbles existing in the insulation. These bubbles may, during manufacture,



R 1116 Fig. 15. Crystalization in a Lead Sheath (Magnified 80 times).



R 1114 Fig. 14. Factor of Dielectric Effect for High Tension Cables. Above, according to Del Mar. Below, according to tests made at the Sievert cable works.

be reduced to a minimum if suitable materials and modern working methods are used. The testing for drying and impregnating at the Sievert works has been accomplished since many years back through the measuring during manufacture of dielectric losses. On the other hand, it is possible for vacuum bubbles to form in a cable in service, caused through the expansion of the oil during an increase in temperature and a subsequent contraction on cooling. Thus, in cable manufacture, it is not only the electric properties which must be taken into account, but also the thermic properties. In every cable that is in service there are losses which are transformed into heat and which must be carried off from the cable. In such cases the temperature of the cable must not exceed a maximum value of 25° C.

A fenomenon which has but recently appeared in lead covered cables is the crystalization of the lead sheath (fig. 15) which takes place in cables which are laid over bridges that are subjected to constant vibrations, or in submarine cables which do not lie on the bottom and therefore are made to swing by the motion of the water. An exhaustive study of this fenomenon — in pure lead as well as in an alloy of lead and tinn or antimony — has been made at the Sievert cable works.

Many problems in regard to the design and manufacture of cables for excessively high tensions as well as for telephone purposes still remain to be solved, but thanks to the keen interest on the part of the world's cable manufacturing concerns the goal is being brought nearer for each passing day.

Bernhard Ell.

The Patent Controversy.

It is a known fact that the Ericsson concern, during latter years and especially since the Ericsson automatic systems have begun to gain favour in the world at large, has been an object of very special interest on the part of competing telephone companies. This interest has in part taken the form of a competitive campaign resulting in our becoming involved in patent controversies with The Automatic Electric Co. and The Western Electric Co., this latter firm being represented in Europe by The Standard Electric Co.

The Western Electric Co. claims especially to control, through its patents, the entire field of power driven telephone systems. The absurdity of this claim is obvious to any one who has devoted any time at all to the study of the patent situation within automatic telephony, and this fact has also been fully proved by several prominent experts who have given their verdict in the patent lawsuits which have been brought up against us. The true condition is that the basic principles of the power driven telephone systems have been known for such a long time that they no longer can be made the subject of a valid patent. Furthermore, it is a well known fact that an exchange according to such a power driven automatic telephone system (the Lorimer system) was in operation for practical purposes before the Western Electric company began to construct its system. Actually the Ericsson and Western Electric systems have developed along widely diverging lines on the basis of the principles for power driven systems which have been well known since many years back.

The investigations which have been made following the patent lawsuits have proved beyond a doubt that the claims brought against us are unfounded. Also, on the basis of statements by several authorities on such matters, we have been able to refute on every count the accusations of infringement of patents. It is impossible for us in this connection to go into the various patents mentioned in the proceedings, but one circumstance which is characteristic for the patent situation is well worth mentioning, however. We are aware that there is nothing unusual in the fact that — due to inadequate investigations — patents are often granted on inventions that must be considered public property on account of descriptions of the same having previously appeared in print. This condition is especially prominent within automatic telephony, the reason lying not only in the relatively complicated nature of automatic telephone systems but also in the vast amount of patent litterature on this subject, which makes it practically impossible for the patent authorities to make an exhaustive investigation as to the novelty of inventions in this field. As a result we will find that in all countries there have been granted within automatic telephony large numbers of patents which are actually invalid on account of their lack of novelty.

Furthermore, it should be emphasized that those patents which hold good at the present day do not form any obstacle to free competition as regards automatic telephone systems. Some twenty years ago certain groups were of the opinion that a world-wide competition was impossible, due to the fact that some few of the larger concerns were supposed to be in possession of patents covering those principles which were practically indispensable for the construction of such a system. The patent situation has changed considerably since then, however. The fundamental principles for the construction of automatic telephone systems are actually, at the present day, public property, existing patents applying in general only to details of construction.

In the construction of the Ericsson system due consideration has been taken to existing patents with the exact intention of avoiding patent controversies. Aside from the new inventions which have given our system its characteristic form, only such technical features have been used as are already incorporated with the art of telephony and are now regarded as public property.

In the proceedings instituted by The Automatic Electric Company against Telefonaktiebolaget L. M. Ericsson in Sweden — regarding which we refer our readers to an article which appeared in The L. M. Ericsson Review, Vol. I, Nos. 11 & 12, page 133 — the Magistrates Court of Stockholm has recently brought a verdict nullyfying each and every claim of The Automatic Electric Company. The decision reads as follows:

> "Whereas the investigation in the case may be considered to have proved that the invention referred to in the said current Swedish patent No. 31511, granted May 27th 1910 to The Automatic Electric Company, has previous to this date, in Vol. XVII, No. 9, dated February 27th 1909, of 'Telephony', a printed journal available to the general public, and also in British patent No. 197 of the year 1908, been described in such manner as to enable a competent person, with the aid of the information therein contained, to execute the said invention, and

Whereas, consequently, the said Swedish patent should not have been granted;

Therefore, and since under said conditions and through the actions of which Telefonaktiebolaget L. M. Ericsson has been charged by the American company, the Ericsson company cannot be considered to have infringed upon any of the patents rights of the American company,

Be it known that the Magistrate's Court, overruling the claims of the American company against the Ericsson company and its managing director, Jakob Hemming Johansson, has found it just, to sanction the claim of the telephone company against Ivar I. Stäck, engineer, in the capacity of representative for the American company with regard to said patent, and to declare said patent as granted under No. 31511 to be null and void,

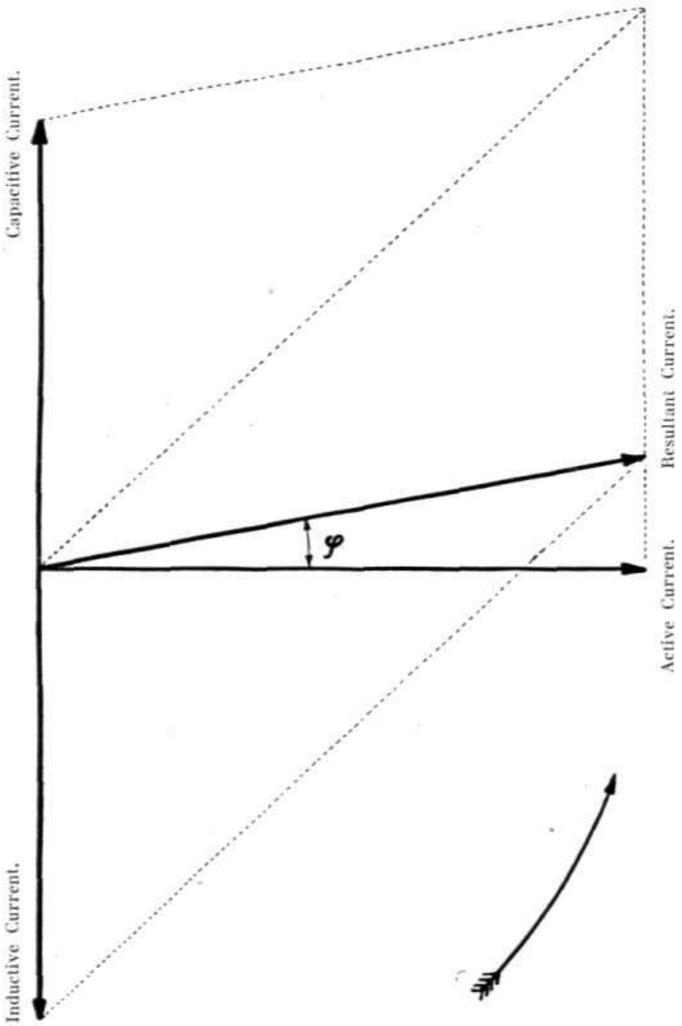
And shall the American company make good the costs of the telephone company and Johansson with a sum, considered fair and just, of nine thousand crowns together with whatever sum the telephone company and Johansson may rightly claim as having been paid for the taking out of a common copy of the Court's decision in the case".

In the legal proceedings instituted against us by Standard Electric a large number of Swedish and foreign experts have made statements in our favour. The case is still pending in the Magistrate's Court in Stockholm. The foreign patent lawsuits have not yet emerged from the preliminary stages of their development.

High Tension Condensers for Compensating Reactive Effect in Alternating Current Nets.

By H. Spanne, engineer with The Sievert Cable Works, Sundbyberg, Sweden.

The increasingly widespread use of electricity in new fields and for new purposes has caused a steady increase in the consumption of electrical energy,



R 1094 Fig. 1.

and it has been found more and more necessary to seriously consider the transmission losses, which constitute a total loss of energy. Also the cable nets are often called upon to transmit such great quantities of effect that the capacity of the lines no longer adequately meets the requirements.

The maximum effect which may be transmitted over a distribution net is directly proportional to the factor of effect "Cos. φ", the losses in the lines — for a certain transmission of effect — being inversely proportional to the square of the same factor.

A compensation of the reactive effect raises the effect factor, thereby enabling the net to carry a greater maximum effect at the same time as the transmission losses are reduced.

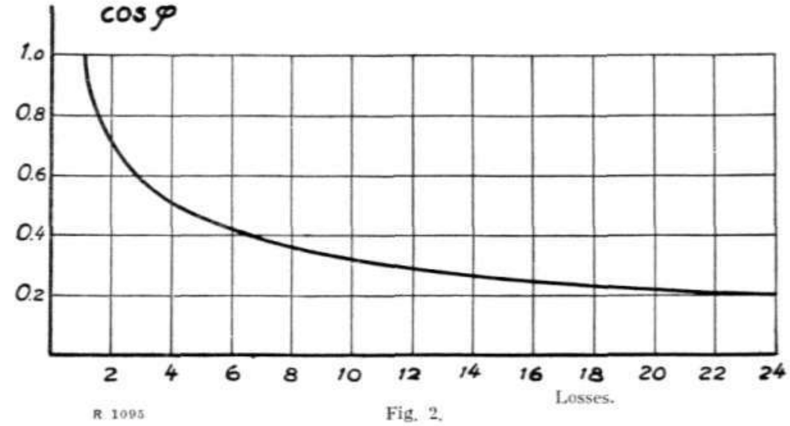
The reactive effect is primarily caused by the magnetizing currents of the motors and transformers in the net (reactive currents), these currents being geometrically added to the service currents (active currents). The magnetizing currents are practically independent of the strength of the active currents, i. e. independent of the load and are thus, with constant tension, dependent only on the number and size of the machines or apparatus.

It is generally more advantageous to generate the reactive effect at the point of consumption than to transmit the same from a power house which is often situated at quite some distance. All that is necessary is to introduce a suitable condenser in the circuit at the point of consumption, thus reducing the magnetizing currents in the transmission lines.

This will cause the flow of a reactive current, a so-called capacitive current, towards the condenser also, but this current is ¼ cycle in advance of the active current, contrary to what is the case with the reactive current of a motor, the so-called inductive current, which lags ¼ cycle behind the active current (see fig. 1). The two types of reactive current, therefore, are shifted ½ cycle apart, which gives them opposing directions. Consequently, if the capacitive and inductive currents are equivalent, they completely counteract each other, i. e. their sum will be equal to 0.

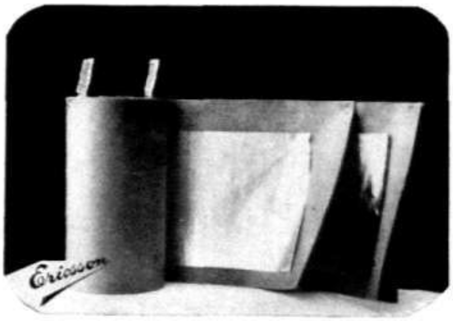
The factor of effect equals cosine for the angle between the active current and the resultant current.

$$\cos.\ \varphi = \frac{\text{active current}}{\sqrt{(\text{active current})^2 + (\text{reactive current})^2}}$$

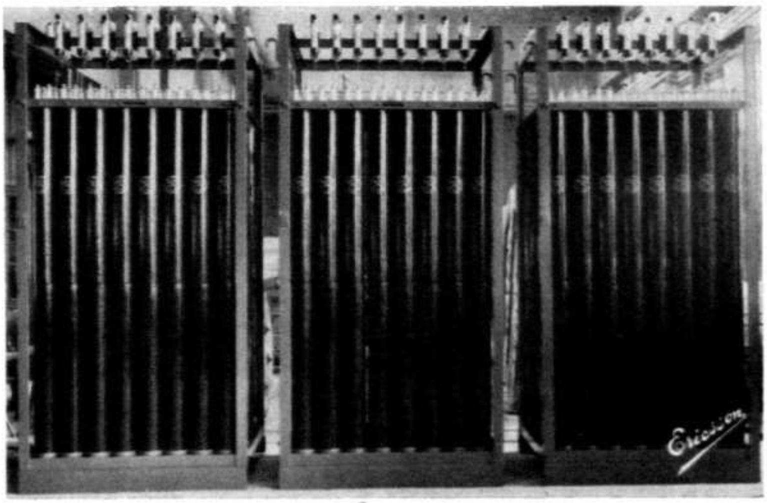


R 1095 Fig. 2.

When the load is principally capacitive the factor of effect is also capacitive, and when the load is principally inductive, the factor of effect is also inductive.



R 1096 Fig. 3.



R 1098 Fig. 4.

The manner in which the losses of transmission vary with the factor of effect is shown in fig. 2.

Condensers for improving the factor of effect are now manufactured for all existing voltages, and as they are usually made in small standard units it is an easy matter to build up condenser batteries of any desired size. In fig. 3 is shown a cylinder shaped condenser cell consisting of a wrapping of metal ribbon with an insulating layer of impregnated cellulose. One or more such cells are introduced in a metal cylinder which is then filled with oil and hermetically sealed. The units thus obtained are connected up into batteries of various sizes (see figs. 4 and 5).

In fig. 6 we see a smaller condenser battery connected direct to a motor and arranged so that it may be switched on or off by means of the motor switch. The size of a condenser for compensating reactive effect is given in terms of kVA*) and is as follows:

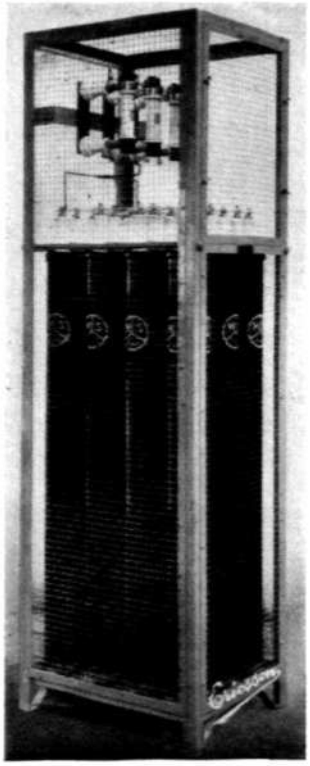
$$kVA = \frac{kV^2 \times 2\pi \sim C}{1000} \text{ kilovoltamperes}$$

where kV = the tension in kilovolts, $\sim$ = cycles per second and C is the capacity in microfarads.

In order to determine the reactive effect in a power net — the factor of effect and the active effect being known — the graph shown in fig. 7 has been drawn up.

A rather important advantage when using the static condenser for improving the factor of effect is the extraordinarily low consumption of own effect, which

*) The designations *ksine* (kilosine) or *krw* (kilorewatt) are also used.



R 1097 Fig. 5.

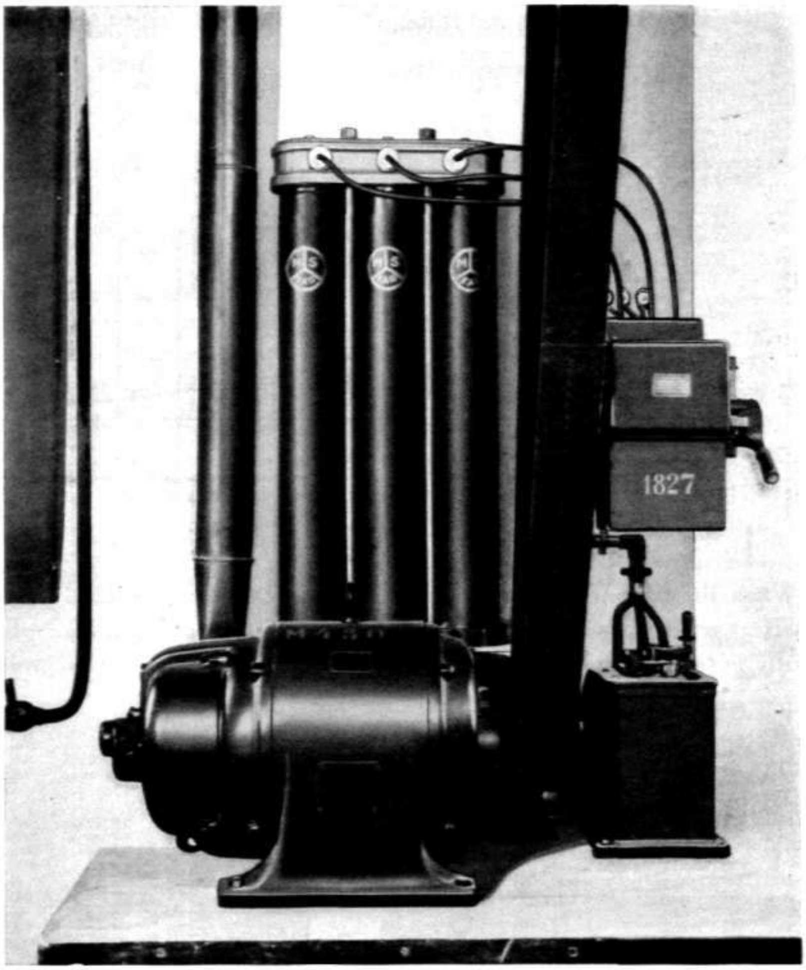
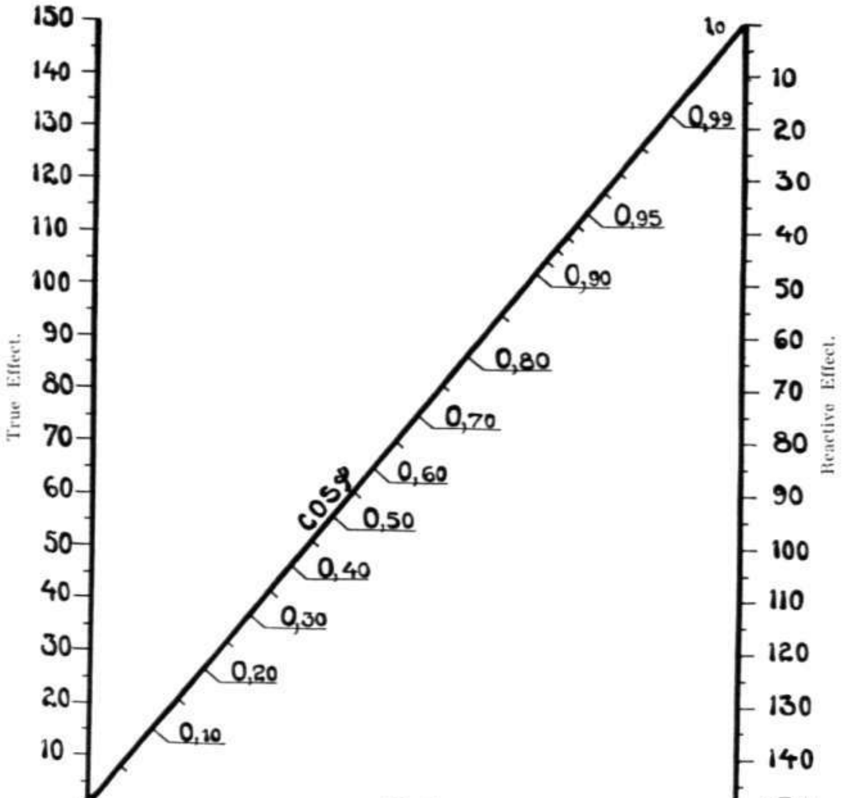
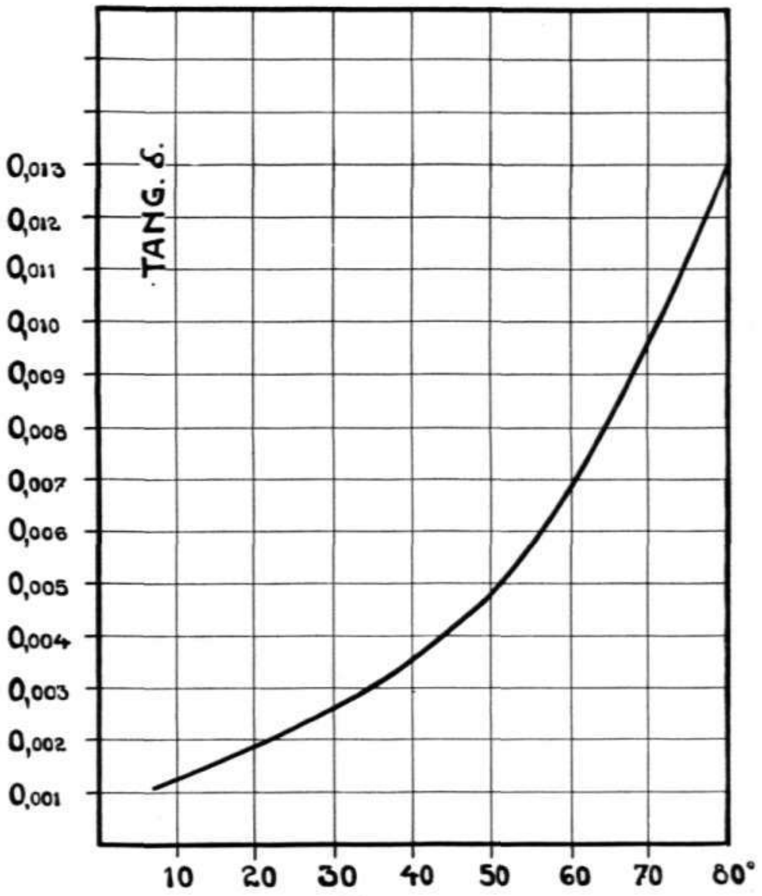


Fig. 6. Condenser Connected up with Fan Motor.



R 1099 Fig. 7.

does not amount to more than one or two watts per compensated *kVA*. This consumption of effect is composed in part of dielectric hysteresis losses in the



R 1100

Fig. 8.

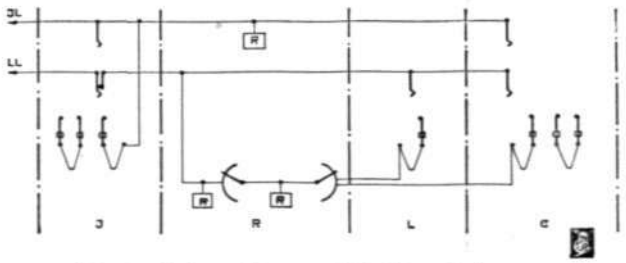
insulating layer and in part of thermic current losses in the metal ribbons and their connection wires.

The losses in the dielectric substance are higher with higher temperatures, as shown in fig. 8, this being the reason for adopting a cylindrical construction. The diameter of the cylinder is chosen so that the temperature within the active unit does not rise more than 5° to 10° above that of the surrounding air.

It is self-evident that the lower the two losses for the insulating material the greater may the diameter of the cylinder be without the temperature being unduly high. As a basis for the dimensioning of condensers, therefore, some very exhaustive research work has been done in regard to the thermic and dielectric losses for different insulating material.

Modern Manual Exchanges.

At the present time there is a strong tendency towards the universal adoption of machine switching within the field of telephony. Considering the great technical advances and developments which are the keynote of our present day, this tendency is really not very surprising. The construction of the automatic telephone systems has been developed so that it is both desirable and legitimate, with larger capacities, to replace manual exchanges with automatic ones, even though the firstmentioned are often still giving satisfactory service. Since automatic switching possesses so many advantages, there is an opinion prevalent among wide circles of telephone men that the introduction of this type of switching is the only rational solution for all new erection problems. This is not the case, however, and a number of points of view, based on the operating statistics obtained from the manual exchanges described here below, will be given in the following.



R 1185 Fig. 1. Skeleton Diagram of the Vasa Exchange.
Designations: JL = toll line, LL = local line, R = relays, J = toll board, R = relay and selector room, L = local switchboard, C = concentration board.

The telephone exchanges in Vasa and Kuopio, in Finland.

The Vasa exchange was put in operation in the summer of 1925 and comprises one local exchange with 1600 subscribers' lines and one toll and rural exchange equipped for 10 toll lines, 60 rural lines and 6 junction lines from the government toll exchange.

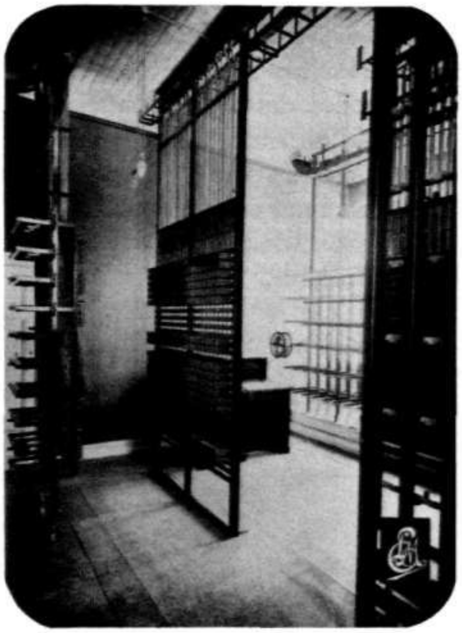
The local exchange is built according to the Ericsson C. B. system with a two-wire multiple and is equipped with selectors for the automatic distribution of incoming calls among disengaged positions.

Depending on their function, the selectors are divided into two groups, line finders and cord-circuit selectors. The subscribers are divided up into groups of forty, each such group forming a selector multiple among which connections are obtained by means of six line finders. Six cord circuit selectors, to whose multiple field forty cord circuits are connected, have direct connections to the six line finders. This multiple field comprises seventeen groups of subscribers' lines. One group of forty cord circuits, therefore, corresponds to 680 subscribers' lines. The total number of cord circuits is 120, distributed among five positions with twenty-two cords each and one position with ten cord circuits. The latter position serves as a concentration position for the local as well as for the toll and rural traffic. A skeleton diagram of the exchange is shown in fig. 1.

R 1129 Fig. 2. Operating Room, Vasa.

The cords are keyless. When a call is made, the operator's head-gear is automatically connected up to the calling subscriber and the indicator lamp of the cord in question glows. A ringing signal is automatically sent out to the called subscriber when the operator plugs up the cord in the multiple. The periodic ringing signal continues until the called subscriber answers or the calling subscriber replaces his handset on the cradle rest. Each cord is provided with two clearing lamps which function in the ususal manner. When a double clearing signal is given the calling subscriber is automatically disconnected and is consequently free to immediately make a new call.

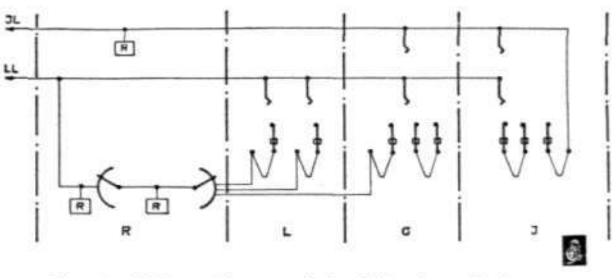
Plugging up in the toll and rural switch boards,



R 1130 Fig. 3. View of Relay Room, Vasa.

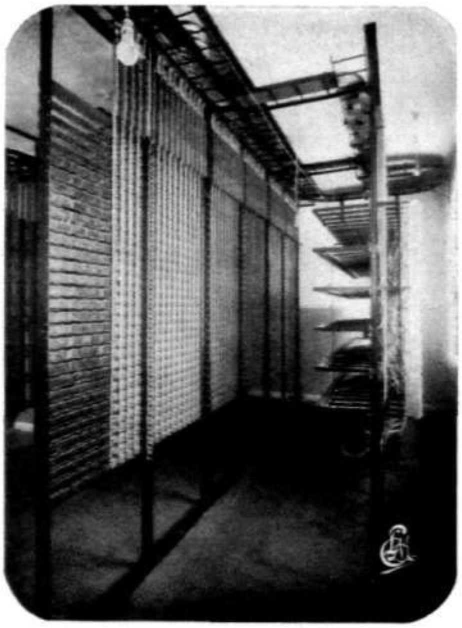
comprising four positions and one order position, takes place direct in the series jacks of the local multiple, on which an existing local connection is broken.

The Kuopio exchange was put in operation on January 1st 1927 and has practically the same equipment as the Vasa exchange, i. e. it is built on the same system and with the same number of subscribers' lines (1600). Each cord multiple field for forty



R 1184 Fig. 4. Skeleton Diagram of the Björneborg Exchange. *Designations:* JL = toll line, LL = local line, R = relay, L = local switchboard, J = toll board, R = relay and selector room, C = concentration board.

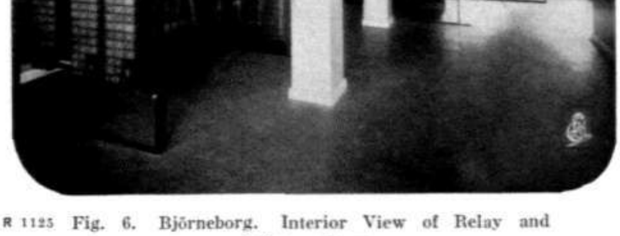
cord circuits comprises sixteen groups of subscribers' lines, which corresponds to 640 subscribers' lines. The total number of cord circuits is ninety-eight distributed among four positions with twenty-two cords each and ten cords in the concentration positions. In the three positions of the toll and rural exchange ten toll lines, fifty rural lines and five junction lines obtain service from the government toll exchange. The ultimate capacity of the telephone exchange is 5000 lines.



R 1131 Fig. 5. Björneborg. Main Distributing Frame and Line Relay Rack.

The telephone exchange in Björneborg, Finland.

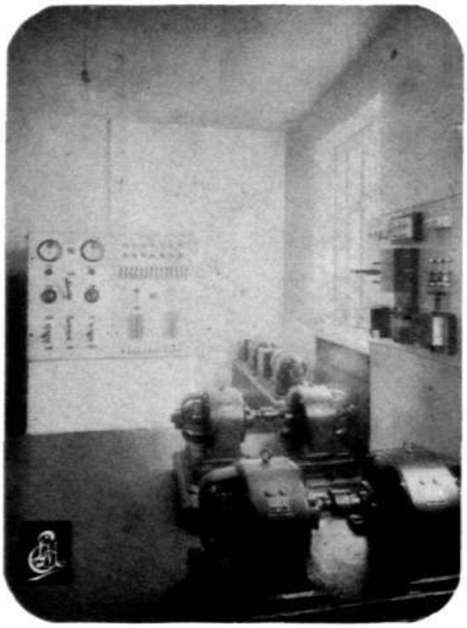
This exchange was opened for service in June 1928 and is built for 1600 local subscribers' lines, sixty



R 1125 Fig. 6. Björneborg. Interior View of Relay and Selector Room.

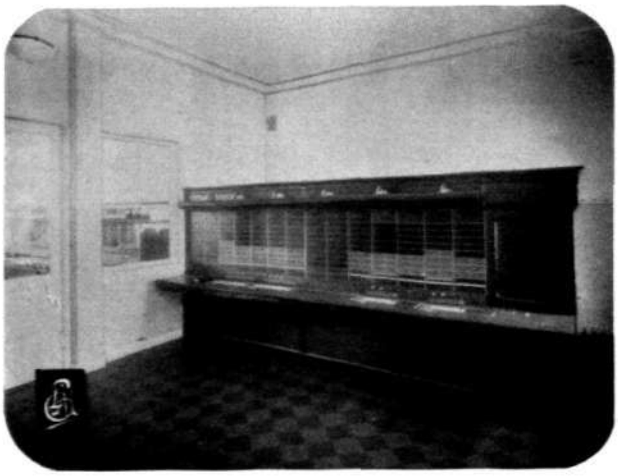
rural lines, fifteen toll lines and five junction lines from the government toll exchange. The ultimate capacity is 5000 subscribers' lines.

The local exchange is designed on practically the same principles as the Vasa and Kuopio exchanges, but with the difference, however, that it is provided with a 3-wire multiple. Line finders and cord circuit selectors of the same type as at Vasa and Kuopio are used. The subscribers' lines are brought together in groups of thirty, each group being provided with five



R 1133 Fig. 7. The Björneborg Power Plant.

line finders. Each cord circuit selector cylinder, comprising a number of cord circuit selectors corresponding to four hundred subscribers' lines, has thirty outgoing cord circuits. There is a total of ninety-eight cord circuits, distributed among four positions with

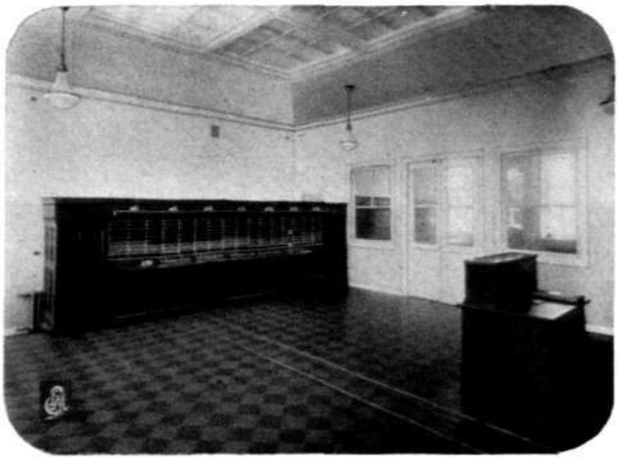


R 1132 Fig. 8. Toll and Rural Switchboards at Björneborg.

twenty-two each, and one concentration position with ten cord circuits. The building up of the system is clearly shown on the skeleton diagram in fig. 4.

The switching process for a speaking connection is the same at Björneborg as at Vasa and Kuopio, although the diagram has a different appearance on account of the differences in the systems. The connecting up of the operator and the sending out of a calling signal is automatic here also, and at the termination of a conversation both subscribers may obtain new connections independently of whether the operator has pulled down the connection or not.

The principle difference between the system used at Björneborg and the one at Vasa and Kuopio is that the toll and rural exchanges at Björneborg have a parallel multiple, while at the two other exchanges it is a series multiple. At Björneborg an existing local connection can be broken only by depressing a special key common for the position. Some views from this exchange are shown in the accompanying illustrations.



R 1126 Fig. 9. The Local Exchange, Björneborg.

The telephone exchange in Lemberg, Poland.

This exchange has a capacity of 1200 subscribers' lines and is equipped with line finders of the same type as those used in the Ericsson automatic system. These have the advantage of dispensing with cord circuit selectors, since the subscribers' lines are brought together in sufficiently large groups. The multiple has 2-wire lines but can be provided with 3-wire lines if desired. A more detailed description of this exchange, is contained in a separate article in the present number of this journal.

The basic principle for telephone systems with automatic distribution of incoming calls may be said to be that all work of a lower order, such as the finding of the calling subscriber's line, the connecting up of the operator and the sending out of a ringing signal is accomplished mechanically, the operator being burdened only with more qualified work such as the receiving of the desired number and the selecting of the desired line. In such a system the operator is put to more effective use, ample proof of which is obtained from the number of effectuated calls.

The following service figures are obtained from the Kuopio telephone exchange.

On June 4th 1928, one position handled 470 calls during the busy hour, *one* operator working at *two* positions handling 747 calls. On July 7th the corresponding figures were, for one position, 518 calls and for two positions with one operator 911 calls between 11 a. m. and 12 m. and 952 calls between 12 m. and 1 p. m. The telephone society owning this exchange states, however, that at the two positions some assistance was given during the busiest minute. Consequently, these figures indicate that the capacity of the operator lay somewhere between 911 and 952 connexions per hour.

The following figures are from the Björneborg exchange.

The present number of subscribers' lines amounts to 1050, the service being handled by two operators during the busy hour. As a result of a test which was made it was found that the number of calls per position during one half hour amounted to 407.

Should we compare the system here described with a common manual system, it will be found that for capacities of about 1500 lines and higher, the first cost of the former — on account of the reduction in the number of positions and therefore also of the multiple — is but negligibly higher than that of the latter while the cost of operation, quite naturally, is exceedingly lower.

When making a comparison with an automatic system the following points should be born in mind. Toll and rural traffic is handled by operators even in automatic exchanges. In an exchange of the type here described it is possible to put the operators to more effective use, resulting in a lower cost for the handling of the toll traffic. At night, for instance both local and toll traffic can be handled by one operator, a condition which would exist even if the local exchange were full automatic.

Another point of view which should not be forgotten is that in addition to the increased first cost for an automatic exchange one must figure with the higher cost of the telephone instruments which must be provided with a calling dial.

We will find that the work of the subscriber is actually simpler in systems with automatic distribution than in full automatic ones, a fact which is in favour of the former. The most important consideration is that of operation, however, and this depends on two factors, i. e. rate of interest and salaries, and must be determined in each case separately.

When choosing a system it is sometimes difficult to give all these points of view due consideration, as, for instance, when changing over from an old L. B. exchange it is undesirable to tie up the capital required for new telephone instruments and for the rebuilding of the net. In such a case it is best to choose a regular manual system with pairs of cords, arranged for local battery working with lamp signals, but in such a manner as to permit its being changed into C. B. by making only smaller alterations in the wiring.

An example of such an arrangement will be found at the Wilmanstrand exchange in Finland which was opened for service in April 1927. The initial capacity of this exchange is 800 lines, the ultimate capacity being 2600 lines, and it is equipped with four local positions, one toll position with ten toll lines, one rural position with twenty rural lines and one concentration position. Only a few alterations in the wiring are necessary to change over from L. B. to C. B.

In choosing a system for a telephone exchange, due consideration must in each separate case always be taken to the special local conditions, the passing of a sweeping judgement on this question being absolutely condemnable.

E. J. L. & E. H. L.

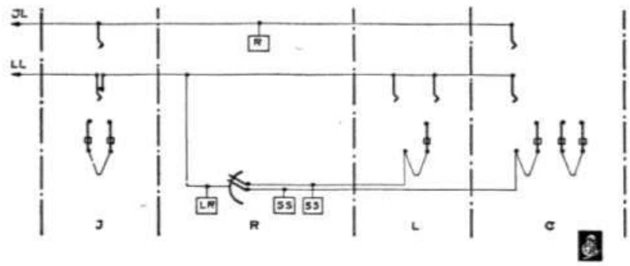
The Lemberg (Poland) Telephone Exchange.

The recently erected telephone exchange in Lemberg being of good example of a modern manual exchange, a description of the same may prove of interest to our readers.

This exchange has a capacity of 12 000 subscribers' lines and is built for manual switching with automatic distribution of incoming calls. Also, the system is designed so as to spare the services of the operator for work requiring a higher degree of competency such as the receiving of the called number and the plugging up of the called line jack. The connecting up of the operator, the sending out of a calling signal and testing are consequently operations which are handled altogether automatically.

A skeleton diagram of this exchange is shown in fig. 1.

There are two multiple fields, i. e. the jack multiple with 2-conductor jacks and the line finder multiple. This latter, together with the line finders (see page 24) are of the same type as those used in the Ericsson automatic system, consequently there is no need of going into a detailed description of the same (see The L. M. Ericsson Review, Vol. I, nos. 1 & 2,

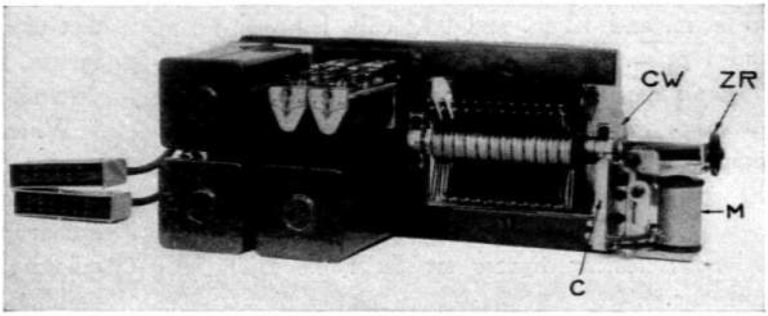


R 1180 Fig. 1. Skeleton Diagram of the Lemberg Exchange.
Designations: JL = toll line, LL = local line, R = relay, LR = line relay, SS = sequence switch, J = toll board, R = relay and selector room, L = local switchboard, C = concentration board.

and separate descriptive booklet on the Ericsson Automatic System).

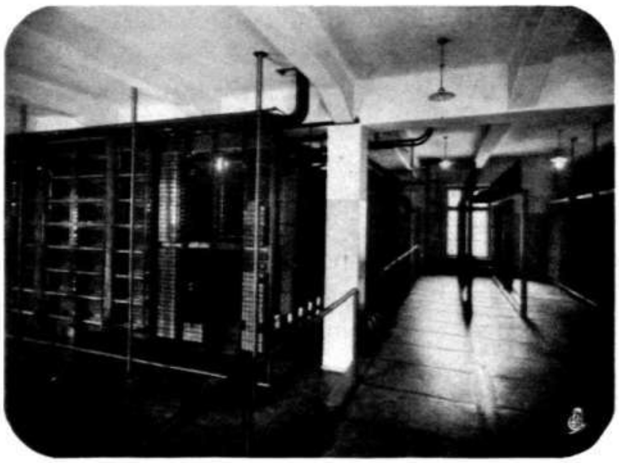
The subscribers' lines are brought together in the line finder multiple in groups of 500 each. By using such large groups it is possible to dispense with cord circuit selectors, the line finders being connected to cord circuits direct.

The main switching device for each pair of cords is a sequence switch (see fig. 2), this switch also



R 14 C Fig. 2. Sequence Switch.

being similar to that used in the automatic system. The sequence switch has twelve contact positions, each position corresponding to one of the special functions performed by the sequence switch during a switching



R 1181 Fig. 3. View of Switching Room.

operation. A study of these functions gives a clear idea of the structure of the entire system. The home or rest position of the sequence switch is numbered one. When a subscriber in a certain group makes a call, only those line finders whose sequence switches are in home position are set in motion. Further, the condition that the cords belonging to these line finders are in positions whose operators are momentarily disengaged must be complied with. A starting distributor sees to it that not more than from seven to nine line finders are simultaneously set in motion.

The line finders rotate until one of them reaches a position exactly opposite the twenty-line group or "multiple frame" in which the line of the calling subscriber is located, a contact bar in front of this frame

R 1183 Fig. 4. Sequence Switches and Selector Racks.

being connected to negative, those in front of the other frames having earth potential.

The above-mentioned line finder stops its rotating movement, the sequence switch advancing to position 2 and immediately thereafter to position 3. The other line finders which have been hunting the calling subscriber's line now stop moving. Should two line finders reach the multiple frame in question at exactly the same moment, neither of them will stop rotating. Further, in order that a line finder shall stop, it is required that the operator is disengaged at that very moment. The line finders belonging to the cords of a certain position are placed in different groups, making it possible for a line finder in another group to engage the operator while the aforementioned line finder is still hunting. The advancing of the sequence switch to contact position 3 causes the contact arm of the line finder to enter the multiple frame, hunting for the line of the calling subscriber. When this has been found, the arm stops moving and the sequence switch advances to position 4 and thereafter of its own accord to position 5.

Position 5 is a "waiting" position. During the busy hour and the quietest hour a calling subscriber may be connected up to a busy operator, the system being devised so as to prevent the blocking of a call on account of a busy operator when *all* the operators are busy. This arrangement has been introduced in order to cut down the waiting time on such occasions, the calling subscriber being connected up as soon as an operator becomes disengaged.

In most cases, however, the sequence switch is advanced to position 6, causing the signal lamp of the

R 1182 Fig. 5. View of operating Room.

cord in question to glow and the operator is connected up to the calling subscriber. On receiving an answer from the operator, the calling subscriber gives the desired number and the operator plugs up the cord in the multiple without any preliminary testing. In case the jack of the desired line is already occupied by another cord, the operator inserts the plug in a "busy jack".

As soon as the plug has been inserted in the jack of the called subscriber's line, the sequence switch is advanced to position 7, and the line of the called subscriber is tested to discover whether it is busy or not. If it is disengaged a calling signal is sent out at the same time as the calling subscriber receives a modulated buzzer tone. If the called line is busy, a busy tone — easily distinguished from the first mentioned — is sent out to the calling subscriber.

If the called subscriber is disengaged and answers the call, the sequence switch passes position 8 and comes to rest in position 9. This is the speaking position.

On the conclusion of the conversation and when both subscribers have replaced their handsets on the respective cradle rests, the sequence switch is set in motion, passes over positions 10 and 11 and stops in position 12. On passing over contacts 10 and 11 a current impulse is transmitted to a subscriber's meter and the call is registered.

In position 12 the arm of the line finder is withdrawn from the multiple and the clearing lamp of the cord in the operator's position glows. When the connection is pulled down the sequence switch is restored to home position.

If the called subscriber does not answer, the calling subscriber — after a short wait — replaces his handset. The sequence switch is then advanced to position 8 and the arm of the line finder is withdrawn from the multiple, after which the sequence switch advances to position 12 and stops there. The clearing lamp glows, and — after the connection is pulled down — the sequence switch is restored to home position. In this case no impulse is transmitted to the subscriber's meter and the call is not registered.

The illustrations accompanying this article show some views of the Lemberg exchange. Figs. 3 and 4 show the switching room with racks for line finders, sequence switches and relays, while fig. 5 gives a view of the operating room.

K—n.

The Electrotechnical Propaganda Courses in Sweden 1925 to 1927.

A specialty of the Sievert Cable Works which has an interest all its own is their acid and fire proof lighting fixtures. This special interest is due to the origin of these fixtures as well as to the manner in which they were introduced to the general public.

It is now some ten years since the fact was established that the electric wiring in general use at that time was not suitable for use in damp localities and places with an abundance of combustible dust particles or where there occured corrosive fumes which were soluble in moisture; such places being very often the scenes of short circuits, fires and other dangerous occurences. It became imperative to design a type of conductor which would fill the necessary requirements as to safety and still be manufactured at a reasonable price. The Sievert Works took up this problem and after exhaustive experiments and research work finally developed a type of armoured cable which has been approved by the authorities and which, in its simplest form, consists of vulcanized conductors enclosed in a steel armoured lead sheath.

It soon became evident, however, that the fixtures to be obtained on the market at that time could not compare with the new type of cable from a point of view of safety, so that an electric light installation in localities of the aforementioned character became more or less heterogeneous in this respect and possessed the same risks as before. The only remaining alternative, therefore, was for the Sievert Works to go about the designing and construction of fixtures on a par with the leaded cable. After the invention of a new type of packing, to be used between the cable and the armature — a so-called rubber and lead packing — the problem was practically solved. Thus did the "Sievert System" — or the "S. S. system", as it is also called — come into existance. It would be all too lengthy to go into a detailed description of this system at the present time.

The question now arose as how best to give this system the necessary publicity. Descriptive pamphlets were printed and distributed in large numbers, advertisements were printed in the professional press, insurance companies were notified and lectures were held within certain engineering societies, but all with very unsatisfactory results, both as to sales and inquiries.

While travelling in the provinces during the summer of 1925 representatives of the Sievert Works seemed to note a certain aversion to the new system, apparently based merely on a lack of knowledge of the same. It was then that the idea originated of arranging practical demonstrations at all more important centers, illustrated with lantern slides and for which special invitations were to be extended to interested parties. It was not very difficult to forecast a rather meager interest in these demonstrations, however, if the "Sievert System" was to be the only feature on the program, and consequently it was decided to extend the scope of these demonstrations to include lectures of general interest on electricity as well as electric heating and lighting practice. For this purpose the Sievert Works took up the matter with the Swedish Fire Protection Society, as well as with the Swedish Electric Power Society, both of which offered to cooperate on certain stated conditions, while two of the largest Swedish concerns in their lines — electric heating devices and electric lighting — agreed to sponsor these two lines. These companies were "Nya Elektriska A.-B. Volta" and "Aktiebolaget Elektraverken", respectively.

At a meeting held in October 1925 between representatives for the various organizations and concerns, the planned demonstrations were christened "The Electrotechnical Propaganda Courses", the organization being composed as follows:

1. An executive organizing committee in Stockholm for the purpose of making up a program and extending invitations (personal, if possible) to interested parties within a zone determined by the available means of communication with the city in which the course was to be held.

2. A local committee in each of the respective towns for the purpose of procuring a suitable hall and of transporting the exhibits to the same etc.

The organizing committee has been composed of representatives for the various interested parties, with chief engineer Torsten Holmgren as chairman and the writer as secretary.

The local committees have had the heads of the respective city power plants as chairmen, the members — from two to six in number — being resident engineers.

Each program has generally been extended over a time of three days, i. e. Friday, Saturday and Sunday, the lectures of a more general interest being generally held on a Friday and those of a more practical nature on Saturday and Sunday.

The courses have generally been opened by the governors of the provinces in which they were held, and it is with genuine satisfaction that we are able to look back upon the large interest evinced from this quarter.

The main outstanding points which were featured in practically all of the programs were as follows,

1. Tendencies of development in the distribution of electric power.
2. Natural power resources of the province.
3. Supply of energy of the city.
4. On dangers in electric plants and measures to prevent same.
5. Electricity as an instigator of fires.
6. The importance and manner of obtaining good lighting facilities.
7. Cooking with electricity.
8. Underground cables and method of laying same.
9. Leaded, vulcanized cable and method of laying same.

In addition, the program has included the showing of an industrial film from the Sievert Cable Works as well as moving pictures demonstrating the splicing of cables and the laying of leaded, vulcanized cable.

The first propaganda course was held in the city of Falun, beginning on Friday, November 13th 1925. The reason for giving this small city first choice was, in part, that this locality was to a certain extent prepared for the event through a preliminary visit, made some time before, and in part that the organizing committee wished to obtain some practical experience before attacking the larger communities. In spite of the fact that the only hall obtainable — a cinema theatre whose regular evening performances must not be disturbed — was not very suitable, and in spite of the fact that other reunions and conferences were being held simultaneously, this first course was a decided success, the participants numbering over 225 persons.

The next course was held in the middle of January 1926 at Gothenburg, in the lecture hall of the Chalmers Technical Institute. Although this hall seated 360 persons, the interest for the course was such that it proved altogether inadequate and some fifty of those who had announced their intention of participating had to be refused this privelege. Clearly, the success of this campaign was assured.

The courses following this one were held as follows. In February at Jönköping (250 participants), in March at Malmö (over 600 participants), in April at Borås (250 participants), and in May at Örebro (300 participants), where the tour ended for the time being.

Up to this time the various concerns who sponsored the courses had defrayed all their own expenses except in some few instances when transportation within a city for the exhibits was furnished free of charge. In the fall of 1926, however, the cities of Sundsvall and Karlstad entered into negotiations for similar courses, both of them agreeing to defray all general expenses. These negotiations resulted in a course being held in Sundsvall in October 1926 with about 300 participants from all the northern provinces, proving the great popularity of these courses. At Karlstad, where a course was held in December of the same year, the number of participants was about the same.

Since by now the more important districts in Sweden had been canvassed, this propaganda work was discontinued, especially as plans were materializing for the forming of a special society with courses of this nature on their program. In the summer of 1927, however, the city of Norrköping put in a request for a course similar to the foregoing, sponsord by the Public Works Department of Norrköping. Also, the Linköping electric power plant made a similar, request, proposing that a course be held in that city immediately following the one in Norrköping. This proposal could not be accepted for technical reasons, however. Norrköping and Linköping then united as common promoters, resulting in the holding of a course in Norrköping in September 1927 at which about 300 persons were present.

We will not attempt to estimate the value of these courses in this article. As secretary of the organizing committee, the writer is prejudiced and apt to treat the subject a trifle too optimistically. However, I cannot refrain from calling attention to the steadily increased interest centering about these courses and which culminated in the expansion of the program of "The Society for the Rational Use of Electricity" to include the same. Most favourable mention of these courses is also made by State Inspector Holmer in the introductory preface to the first number of the journal "Era", organ of this association.

B. Waeger.

Calculation of the Required Number of Switches with Consideration for the Value of the Subscribers' Time.

By Professor R. Trechcinski.

The average cost per speaking connection in an automatic telephone exchange depends in part on the interest and amortization on the first cost and in part on the operating and maintenance costs of the exchange. It is not sufficient, however, when calculating the cost of a speaking connection, to consider these factors only; the value of the subscriber's time is also a factor to be taken into consideration. If we assume that the income of the subscriber is proportional to his effective working time, it is clear that every ineffectual waiting time — which is a clear loss of time for the subscriber — is responsible for a corresponding decrease in the subscriber's income, a decrease which it is possible to estimate in actual monetary value depending upon the salary or wages of the subscriber.

This loss of time to which the subscriber is subjected is caused through an inadequate number of disengaged switches at the moment of making the call and can, therefore, be eliminated through the installation of a suitable number of such devices. Thus, in automatic telephony, the waiting time is understood to mean the time with which a connection is delayed through a wait for disengaged switching devices.

The mean waiting time per call, therefore, is very intimately related to the cost per speaking connection. For instance, if a certain group of subscribers' lines have been bestowed with a large number of cord circuits, the waiting times will be short, this being counterbalanced by a high first cost and consequent expensive calls. A smaller number of cord circuits will reduce the costs but will increase the waiting times. From the point of view of the subscriber, the actual cost of a call is equal to the sum of the direct cost and the monetary value of the total waiting time. Since these two factors change in opposite directions for a change in the number of switches, there must naturally be a certain number of switching devices which gives a minimum cost of speaking connections. As long as the value of the reduction in waiting time obtained through the adding of one more switching device is greater than the increase in cost for this same device, the above-mentioned minimum cost has not yet been reached.

As a result of the above we find that a uniform switching equipment for all subscribers is not desirable, but that it would be more advantageous to group together subscribers whose demands as to service are more or less alike and to provide each group with switching equipment corresponding to these demands. Railway transportation, with its different classes and different types of trains — local and express — provides us with an excellent example of service adapted to various requirements as to comfort and speed. Similarly, one might conceive the telephone subscribers divided up into categories with different numbers of line finders for each five hundreds group, for instance forty for the first category, thirty for the second category and twenty for the third. If the telephone subscription rates within the different categories were adapted to the corresponding expenditures for interest, amortization and operation, it would be of no consequence to the telephone company to which of the existing categories a subscriber might wish to belong.

From a technical point of view, such a system demands the apportioning, as much as possible, of the cord circuits among the different categories, this being very easily accomplished when the line finders have a large contact field. The main difference in the service obtained is that a subscriber in the first category, for instance, would immediately obtain a disengaged cord circuit during the busy hour, while one belonging to the third category might have to wait more or less before obtaining a similar connection.

Assuming that the exchange is not very heavily taxed as to service, the optimal number of cord circuits, i. e. that number which will give a minimum cost per speaking connection, is calculated for a class of subscribers lying within certain demand limits according to the approximate formula

$$S,l = K \times 5 \times M \times \sqrt[3]{C^2}.$$

In this formula, K is a function of the first cost per line of the automatic exchange, of the rate of interest, of the time of amortization, of the operating cost and, lastly, of the value of the subscriber's time.

Under certain conditions as to these respects, an approximate value of K is obtained from the formula

$$K = .13 + .1\sqrt[3]{A_{tp}},$$

where A_{tp} is the value of the subscriber's time, figured in Swed. Crowns per second.

Further, in the above formula for the number of cord circuits,

S = number of calls per subscriber during the busy hour,
M = average length of call during busy hour,
C = size of group of subscribers' lines.

Since the highest taxed subscribers, in all probability, are those who make the most calls, the difference between the number of switching devices for the different categories will be still more accentuated. When traffic is light the service obtained by the different categories of subscribers will differ but slightly.

If those subscribers which belong to a category with lower subscription rates are duly informed that they in all probability will have to wait more or less before obtaining a connection during the busy hour they will probably make arrangements to take advantage of the quicker service obtainable at other times of the day, thereby helping to bring about a more uniform and evenly distributed traffic at the automatic exchange.

The above described principles for the calculation of the required number of switches differ from those generally accepted — based on Erlang's curves — in that it is not a certain determined permissible loss of 1 % for the entire plant that is decisive but — with a certain determined first cost and cost of operation — the value of the subscriber's time.

The following table gives the different results which are obtained with the two different methods, with varying numbers of subscribers in the group and with different numbers of speaking minutes per busy hour.

C	SM	Sch	At 1 ‰ according to Erlang	S'_{rL}	At 1% according to Erlang
		$K = .23$		$K = .17$	
10	1				
20	1	2			
50	1	3	5		
100	1	5	7	4	5
200	1	8	10	6	8
500	1	15	19	11	15
1000	1	30	30	22	26
10	2	2			
20	2	3	5		
50	2	6	7	5	5
100	2	10	10	8	8
200	2	16	16	12	13
500	2	29	30	22	26
1000	2	58	50	44	45
10	3	3			
20	3	5	6	4	
50	3	9	9	7	7
100	3	15	13	11	11
200	3	23	21	17	17
500	3	43	40	33	35
1000	3	86	70	66	63
10	4	4	5		
20	4	17	6	5	
50	4	13	10	9	8
100	4	20	16	15	13
200	4	31	26	23	22
500	4	58	50	43	45
1000	4	116	90	86	81

The value of the subscriber's time has been assumed at .1 oere and 1 oere (100 oere = 1 Swed. crown) per second. The above-mentioned coefficient K in these two cases will then be .17 and .23 respectively. In the table, the permissible loss for calculating according to Erlang has also been assumed for two different cases, i. e. one pro mill and one percent.

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