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# Subtraction Meter with Load Balancing Switch. 

By Axel Widström.<br>Engineer of the Electric Power Works, Stockholm.

A constant mean load in the plant is obtained through the switching on and off of heat accumulating devices.

Rccently the form of tariff based on a fixed yearly rate increased with a certain rate per consumed kilowatt-hour has again been made the subject of much interested discussion. Although originally intended to stimulate the consumption of lighting energy as well as the increased use of various household conveniences such as irons, vacuum cleaners and the like, this tariff is now considered suitable also for the sale of electrical energy for cooking, on condition that the kilowatt-hcur rate is set sufficiently low, preferably under . 10 Swed. crowns.

However, if a consumer who has already been using electrical energy for cooking purposes with a direct acting range according to this tariff wishes to have the added convenience of a heat accumulating water heater, he will generally consider the rate of .08 or .09 crowns per kilowatt-hour for water heating purposes to be rather high, while on the other hand the power companies are generally satisfied with a lower rate for energy used for this purpose, on condition, however, that the consumption takes place during suitable hours of the day. Such an arrangement requires a regulating clock, which switches the water heater on and off at certain pre-determined times, however, and generally also a special meter for the energy consumed by the water heater. This complicated equipment means a higher cost of installation
which - specially for smaller hot-water installations - als means a considerable increase in the cost of energy.

A much simpler and cheaper method of solving this problem is generally found by using the household tariff meters manufactured by L. M. Ericsson* for D. C. as well as A. C. and which have been in use for several years and in such large numbers that their reliability and efficient service can well be vouched for.

## The Ericsson Household Tariff Meter.

This meter is an ordinary ampere-hour meter with total and excess recording trains. Also, it is provided with a small (sealed) mercury switch which breaks a circuit or closes the same depending on the load.

A skeleton diagram of the meter is shown in fig. 1. The water heater is connected between neutral and the outer pole over the mercury switch 39 ; the other devices, such as lamps, direct acting cooking range etc. being connected direct between neutral and the outer pole. To the left is shown the regular magnet motor meter 3 with shunt 4 , armature 8 , brake mag-

[^0]nets 7 and recording train 16 for registering the total amount of energy consumed by the entire plant, since all the consumed energy passes through either the


Fig. 1. Skeleton Diagram Showing Construction of Meter and Manner of Applying Loads.
meter shunt or the armature. The mechanical element which provides the constant speed which corresponds to the subscribed or subtraction limit is represented by the clockwork 23,34 . The movements of the clockwork and of the armature of the meter are mechanically transmitted to the gear wheels 17 and 18 of a differential gear, the planet wheel 25 of which imparts its movements to the excess recording train through the shaft 26,27 . Consequently, the speed with which this shaft rotates is proportional to the difference between the variable speed of the armature and the constant speed of the clockwork, i. e. the excess recording train registers the effect which - in a load diagram - lies over the load limit corresponding to the speed of the clockwork. The meter is adjusted to different values of subscribed effect by exchanging one of the gear wheels in the transmission 19, 20.
The necessary impulse required to start the clockwork is obtained in the following manner. If the armature 8 begins to rotate and we assume the clockwork and consequently also the planet wheel 18 to be at a standstill, the shaft $26-32$ of the planet wheel rotates an angle equal to one half of the angle of rotation of the mitre wheel 17. This movement is transmitted to the ratchet wheel 34 which lifts the control lever 35 up from the rest 41 , thus bringing about a tension in the spiral spring 43. The tension in the spring acts as a cog pressure between the gear wheels 17 and 25 and an equal pressure on wheel 18 .

This last force is transmitted over the gears 19-20 and $21-22$ to the clockwork which is set in motion on condition that the tension of the spring is correctly adjusted.

## Functioning of the Meter.

Three different cases may occur depending on whether the load is less, equal to, or greater than the bulk limit.

In the first-mentioned case, with a small loadmeaning that the speed of rotation of wheel 17 is less than the constant speed of wheel 18 , which latter corresponds to the speed of the clockwork -, the ratchet wheel moves clockwise and the control lever with the ratchet tooth is lowered towards the rest 41 , thus depriving the clockwork of its driving force and causing it to come to a standstill. After the armature 8 has made a few more revolutions the lever arm is again raised and the clockwork again starts to function, the entire procedure being repeated. For loads which do not reach the bulk limit, therefore, the clockwork works intermittently, the length of the pauses being inversely proportional to the size of the load, i. e. the smaller the load, the longer the pauses.

In the second case, with a load equal to the bulk limit, the ratchet wheel remains at rest after the clockwork has started to function, the wheels 17 and 18


Fig. 2. Subtraction Meter for 1). C. with Protecting Cover Removed.
having the same speed of rotation in opposite directions. In the first as well as in the second case the ratchet tooth 36 rests against the same tooth on the ratchet wheel, no consumption being registered by the excess recording train 31 .

In the third case, with a load exceeding the bulk limit, wheel 17 is constantly rotating with greater speed than wheel 18 ; consequently, the ratchet wheel 34 rotates counter-clockwise, lifting the control lever. The excentric hanging of this lever in relation to the ratchet wheel causes the ratchet tooth 36 to finally trip off of the tooth of the ratchet wheel against which it is resting and to fall down upon the next one. This takes place about opposite the number 34 on the circumference of the ratchet wheel. (In fig. 1 the control lever is merely schematically pictured, in reality it extends around about half of the circumference of the ratchet wheel, the point about which it pivots being on the same level as the shaft which carries the wheels 33 and 34.) The resisting moment on the ratchet wheel which is necessary in order to provide the motive force for the clockwork is still provided by the ratchet tooth.

In the respects heretofore mentioned the meter functions in exactly the same manner as a common subtraction meter, merely with the modification that the clockwork is driven by the meter instead of by a separate source of energy.

We now come to the switch 39 . This is a (sealed) mercury switch which, among the special features which make it suited for this purpose, embodies what may be termed a certain dead or idle movement; when, at a break, the mercury separates, the surface tension of the liquid metal causes the two parts of mercury to quickly contract so that a certain separating space is immediately formed between them. Thus, the switch must be tilted a certain angle from make to break position and vice versa. The make and break tilting angles for the same mercury switch are always the same; in varying designs the switching angle may vary between the limits $1.5^{\circ}$ and $3^{\circ}$. The mercury is connected to the control lever so that its angle movement is always proportional to that of the ratchet wheel and consequently also proportional to that of the planet wheel shaft as long as the ratchet tooth remains in position against the same tooth of the ratchet wheel. The switch is in make position when the control lever is resting against the rest 41 . When the total load exceeds the bulk limit, the ratchet wheel rotates counter-clockwise, bringing with it the control lever 35 which - by means of the rigidly attached arm 37 - tilts the mercury switch about the shaft 40 until it breaks the circuit and disconnects the water heater.

The mean load in the plant is regulated by the meter in the following manner. In fig. $3, B$ re-
presents that part of the load which cannot be disconnected, $A$ is the bulk limit, while $C$ is the load which can be disconnected by the mercury switch. If $B$ minus $C$, is greater than $A$, the ratchet wheel - as already mentioned - will rotate counter-clockwise un til the load $C$ has been disconnected. If the remaining load $B$ is smaller than $A$ the movement of the ratchet wheel will be reversed and after it has rotated clockwise a certain angle, $C$ will again be brought in circuit, after which the ratchet wheel will again reverse. When the ratchet wheel has rotated the same angle counter-clockwise, $C$ is again brought in circuit, and so forth. A certain angle of rotation of the shaft 26-27-32 of the planet wheel corresponds to a certain effect above or below the bulk limit, and since in the present case the angle of rotation clockwise is equal to the angle of rotation counter-


Fig. 3. The Load $C$ is Automatically Switched On and Off. Thereby Maintaining the Average Load of the Installation at the Subscribed Effect A.
clockwise, we arrive at the conclusion that the excess effect during the time that both $B$ and $C$ are in circuit is compensated by an equal deficiency during the time that $B$ alone is in circuit. The cross-hatched portions in fig. 3 above and below the bulk limit $A$ are therefore equal and the meter regulates the load to a mean value equal to the bulk limit by the alternate connecting and disconnecting of $C$. If the constant load $B$ is greater than the bulk limit $A$ it is no longer possible for the meter to accomplish such a regulation. In this case the load of the water heater is permanently switched off and the excess recording train starts registering the consumption of effect which exceeds the bulk limit.

## Tariff Rates and Charges.

When determining rates to be applied in conjunction with this meter, the manner in which the meter functions must be given due consideration. Let us take a concrete example and assume that a customer
consumes 300 kilowatt-hours for lighting etc. and 1500 kilowatt-hours for cooking, paid for at the rate of 60 Swed. crowns per year (calculated according to the number of rooms) plus an effect fee of .09 crowns per kilowatt-hour. The customer wishes to install a water heater for 300 watts and the energy which this requires is to be paid for at the rate of .05 crowns per kilowatt-hour. The household tariff meter should then be adjusted for a bulk limit of 300 watts. The total recording train registers the total amount of energy consumed by the plant while the excess recording train registers that part which exceeds the bulk limit of 300 watts. When the load for cooking, lighting etc. exceeds 300 watts the water heater is constantly switched off.

The charges are best calculated so that a fee of .05 crowns per kilowatt-hour is charged for the energy registered by the total recording train, with an additional charge of $.09-.05=.04$ crowns for the energy registered by the excess recording train. However, in this way the customer might obtain that part of the cooking and lighting load which lies below the bulk limit at a lower rate than before, i. e. at .05 instead of .09 crowns per kilowatt-hour.

The value of the compensation which, for this reason, should go to the power company, may suitably be figured as follows. Investigations show that a direct acting electric range is switched on an average of 3.5 hours per day. The amount of energy used for cooking purposes which lies below the bulk limit is therefore $3.5 \times A$ kilowatt-hours per day, if $A$ represents the bulk limit in kilowatts, or, figuring with 330 days, $330 \times 3.5 \times A$ kilowatt-hours per year. If the additional fee amounts to a crowns per kilowatthour, the total charges should include a yearly fee of

$$
330 \times 3.5 \times A \times a \text { crowns. }
$$

If we insert the values given in the above example we obtain

$$
330 \times 3.5 \times A \times .04=46 \times A \text { crowns, }
$$

or, in round figures, a tariff rate of 50 crowns per subscribed kilowatt-hour and year. The greater part of the lighting energy, estimated at two thirds or about 200 kilowatt-hours, also falls below the bulk limit, thereby giving cause for an increase of $200 \times .04=$ 8 crowns. Also, a certain rental should be paid for the expensive meter, say about 7 crowns. The metering fee as well as the increase for light energy may suitably be included in the set yearly fee.

The tariff rate would consequently include the following items:

1. A set yearly fee of $60+8+7=75$ crowns;
2. A yearly fee of 50 crowns per each subscribed kilowatt;
3. A fee of .05 crowns per kilowatt-hour registered by the total recording train;
4. An additional fee of .04 crowns per kilowatthour registered by the excess recording train.

A circemstance which should be accentuated in this connection is that the bulk limit of the individual consumer is not increased on account of the water heater, but quite naturally the condition that a small part of the water heaters take part in the excess load of the company's power plant is unavoidable.

In any case, the above-described meter provides a comparatively simple and cheap solution to the problem of obtaining long consecutive loading which does not heavily tax the service net of the power company and increases its maximum load in but a very small degree.


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the heat accumulating devices are automatically disconnected and the excess consumption of energy is registered by a separate recording train

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# On Junction Telephone Traffic Automatic to Automatic, or Manual to Automatic. 

by Professor R. Trechcinski, of the Warsaw Institute of Technology.

When establishing junction traffic between two or more telephone exchanges, it is usually stipulated that all signals shall be given in exactly the same manner as for connections between subscribers within the same exchange area, i. e. calling signals shall be suited to the systems of the respective exchanges, either the call is made between two subscribers within the same exchange area or belonging to different exchange areas. Should one of the exchanges serve in the capacity of sub-exchange, the signals at this exchange should be normal while at the central exchange they need not be influenced by manipulations made at the sub-exchange.

When referring to junction traffic between automatic exchanges, we differentiate between main exchanges which are inter-connected according to the compound system, and satelite exchanges, whose main characteristic is that their first group selectors and registers are placed at the main exchange. The connections between a satelite and the main exchange can be either direct or over an intermediate exchange (tandem connections). Certain main exchanges can serve as switching centres or junction points for the different exchange groups within an automatized area.

Special arrangements are required for junction traffic between automatic exchanges of different systems. Some of these arrangements will be described in the following.

The term 'small automatic' is here used to designate installations in which the number of subscribers' lines or of cord circuits is restricted by the very nature of the system, while the term 'large automatic' refers to installations in which the number of lines as well as of cord circuits can be extended at will by increasing the number of switching contacts or of switching devices.

By cord circuit is here meant the combination of switching devices required to establish a connection between two subscribers belonging to the same ex-
change. In addition, a connection to a compound, tandem or satelite exchange includes a junction line.

In the following we will touch especially on the apparatus at an automatic exchange which receives the trains of impulses sent cut by a subscriber's calling dial and which transmits them to another automatic exchange.

These trains of impulses correspond to the decimal system, which does not mean, however, that the automatic exchanges must operate on the decimal system.

Slow acting relays are used to separate the different trains of impulses at the automatic exchange. While normal acting relays actuate within a space of ten to thirty thousandths of a second, in slow acting relays the space of time required for this operation can be increased to as much as 300 thousandths of a second with the aid of various devices. An even longer space of time can be obtained with special types of relays.

In one very common type of slow acting relay the iron core is surrounded by a copper sleeve.

For relays with an iron core 8 mm . in diam, which has been magnetized to an induction of 5000 gauss, the time - expressed in milliseconds - during which the relay remains actuated after the breaking of the circuit, can be calculated by the aid of the following approximate formula which - as well as the following ones - is intended merely to give a clearer conception of what is meant.

$$
T_{a}=(100 \backslash D-8) \mathrm{ms},
$$

in which $\mathrm{D}=$ outer diam. of copper sleeve in mm .
The sensitiveness, i. e. the strength of current required to actuate normal relays provided with a contact spring group with a contact pressure - in normal as well as actuated position - of 20 gr . may be approximately calculated by means of the formula

$$
I_{a}=\frac{120}{1 R} \mathrm{~mA} \text { (milliamperes) }
$$

in which $R=$ resistance of winding in ohms.

As soon as the relay energizes there is a reduction of the magnetic resistance in the magnetic circuit. The strength of current required to hold the armature is then obtained from the formula

$$
I_{k}=\frac{60}{\mid \bar{R}} \mathrm{~mA}
$$

where $P=$ contact pressure in grams and $R=$ resistance of winding in ohms.

In automatic exchanges with cord circuits so arranged that two subscribers obtain a direct connection with each other without any condensers or with only one condenser in one of the line branches, the necessary


R $0 \mathrm{~N}+$
Fig. 1.

The maximum strength of current at which the armature with certainty will return to normal can, under similar conditions, be calculated from the formula

$$
I_{p}=\frac{30}{1 R} \mathrm{~mA} .
$$

The sensitiveness of the polarized relay is obtained by using the formula

$$
I_{a}=\frac{4 P}{1 R} \mathrm{~mA}
$$

translation of impulses may be accomplished by means of the cord circuit translator shown in fig. 1.

The upper part of the diagram represents the cord circcit in a small automatic exchange. $B 1$ och $B 2$ are the subscribers' line relays, $B$ a common feed induction coil, while $W a$ and $W b$ are selectors on the lines $L a$ and $L b$ respectively.

The lower portion of fig. 1 represents the diagram for the translation of impulses over the above-mentioned cord circuit. $P R$ is a polarized relay, on the one side connected to the line branches and on the other side to a current splitting device $D$. This lat-
ter may be substituted by a battery with lower tension than the feed battery for the exchange. The automatic exchange which receives the impulses is connected to the terminals $L a 4$ and $L b 4$.

As soon as the calling subscriber at the exchange in question has dialled the number of the line to which the impulse translator is connected the following circuit is closed.

Positive, $B, W a_{1}, L a_{1}$, the subscriber's instrument, $L b 1, B 1$, negative, and also in parallel $W b 1, L b 1$, $B 2$ to negative.

If we assume, for instance, that the induction coil $B$ has a resistance of 150 ohms and each of the relays $B 1$ and $B 2$ a resistance of 300 ohms, which, when connected in parallel, makes 150 ohms and that the feed battery for the automatic exchange has a tension of 24 volts; also, that the voltage between the positive pole of the current subdivider and point one is 2 volts, between points 1 and 2 the voltage is 20 volts and between point 2 and negative it is 2 volts, the resistance of the polarized relay being assumed to be $2 \times 100$ ohms. With a contact pressure $P=10 \mathrm{gr}$. , the sensitiveness of the polarized relay will then be

$$
I_{a}=\frac{4 \times 10}{\sqrt{200}}=2.85 \mathrm{~mA}
$$

In order to permit a current of this strength to pass through $P R$, the difference in voltage between point $D 1$ and the line branch $L a$ must amount to

$$
\frac{2.85 \times 100}{1000}=.285 \text { volts }
$$

The voltage drop in coil $B$ is then 2.285 volts, the strength of the current passing through the coil being 15.1 mA . This value together with the strength of the current passing through the polarized relay gives us a strength of line current equal to 17.95 mA .

Since voltage and current conditions for the bbranch are analogous with those for the a-branch, the voltage between the terminals $L a 1$ and $L b 1$ is

$$
24-2 \times 2.285=19.4 \text { volts }
$$

corresponding to a total resistance in the subscriber's line and telephone instrument of

$$
\frac{19.4 \times 1000}{15.1}=1280 \mathrm{ohms}
$$

If the resistance of the telephone instrument is about 280 ohms, the line resistance will be about 1000 ohms. With a lower line resistance, there is an in-
crease in the strength of the current passing through the induction coil $B$ and the polarized relay, a maximum value being obtained when the line resistance $=0$, i. e. when the telephone is connected direct to the exchange. Since the line resistance varies between the above-mentioned values, the relay $P R$ energizes and closes the upper contact $a$ with a contact pressure of 10 gr . or more.

When the subscriber replaces the microtelephone on the cradle rest the following circuit is formed,

Positive over $B, W a 2, L a 2, L a 3, P R$ to $D 1$, with a strength of

$$
\frac{2 \times 1000}{250}=8 \mathrm{~mA}
$$

A current of this same strength passes through the two parallel relays $B 1$ and $B 2$, giving each one 4 mA .

According to the above formula the current required to kecp relays $B 1$ and $B 2$ actuated is

$$
I_{k}=\frac{60}{1300}=3.45 \mathrm{~mA}
$$

From this we find that the current is of sufficient strength to hold relays $B 1$ and $B 2$ in their energized positions and that both relays remain actuated during the breaks in the circuit occuring in the telephone instrument. The current of 8 mA now passes through the polarized relay in another direction than previously and the armature of the polarized relay is reset to the lower contact of this relay due to the fact that the strength of current depasses the degree of sensitiveness of the relay.

If the circuit is closed in the telephone instrument, everything is restored to its previous condition and the upper contact of the relay is again closed. Thus it is clear that the position of the armature of the polarized relay depends on whether the circuit through the telephone instrument is closed or broken.

Since the transmission of impulses causes a making and breaking of the current through the telephone, the armature of the polarized relay moves back and forth resulting in makes and breaks in the circuit to the automatic exchange connected to the terminals $L a 4$ and $L b 4$, as shown in fig. 1.

When the calling subscriber replaces his microtelephone at the termination of the call, the armature of $P R$ returns to the lower contact $b$ causing a clearing signal to be sent out to the other automatic exchange.

The speaking circuit between the two subscribers is as follows:

Subscriber's instrument, La1, Wa1, Wa2, La2, $L a 3, C r, T r, L b 3, L b 2, W b 2, W b 1, L b 1$, and subscriber's instrument, and
from the other automatic exchange to $L a 4, T r$, upper contact of $P R, L b 4$, back to the exchange and from there to the other subscriber.

We will illustrate the above principle by means of an example, assuming telephone traffic between a private automatic exchange $A$ and another private or city exchange $B$. The principle of the switching process is shown in fig. 2. The direction of the traffic is indicated by arrows, 'TLIM $500 / 1000$ ' representing the impulse translating device schematically shown in fig. 3.

In exchange $A$ the connection in question differs from a standard connection in that the feed contact springs for generator current are insulated, due to the fact that a signal current is not necessary for the starting and functioning of the translator.

Circuit (1) is broken and $R R$ de-energizes. The current starts to pass through $P R$, whose armature is attracted, closing contact $P R a$ and the following circuit,

Positive, $E R \mathrm{~g}, P R a, I R$ to negative
$I R$ energizes and closes the circuit of the called exchange over $L a 2, T I 1, I R a$ and $L b 2$.

If the called exchange sends out a buzzer signal, this signal reaches the calling subscriber over the circuit (see figs. 1 to 3 )

Tl1, Cr1, La1, Wa, La, TF1, Lb, Wb, Lb1, and back to $T l 1$

When the calling subscriber receives a tone denoting that the connection to the called exchange is clear, he dials the desired number just like any subscriber belonging to the net of the called exchange. $P R$ transmits impulses while circuit (7) is alternately


Fig. 2.

In the following we will designate the contacts of a relay by the letters $a, b, c$ etc. counting from the top.

When the subscriber dials the number of the line to which the impulse translator is connected the following circuit is formed:

Positive, VRa, ERa, PR, Lal
and in parallel,
Positive, $B$ (fig. 1), $L a 1$, over the calling subscriber's telephone to the two relays in parallel and to negative.
$R R$ energizes and closes the following circuit,
Positive, $R R a, E R$ to negative
The relay $E R$ energizes and closes the following circuits,
Positive, $V R a, E R b, E R$ to negative
Pcsitive, ERf, DW, ERc to negative
La1, ERd, PR, DW
Lb1, ERe, PR, DW
broken and closed. $I R$ alternately de-energizes and energizes, causing makes and breaks to occur in the impulse relay circuit of the called exchange, thereby establishing the desired connection.

The pulsating of $P R$ causes the following circuit (9) to be closed over contact $P R b$,

Positive, $E R \mathrm{~g}, P R b, V R, L i$ to negative .. (9)
During this transmission of impulses, however, circuit (9) is closed for so short a time that the slow acting relay $V R$, which is connected in series with the induction coil $L i$, does not have time to energize. When the subscriber replaces his microtelephone, $V R$ energizes and circuit (3) is broken. $E R$ de-energizes, thereby breaking circuits (4), (5) and (6) and disconnecting $P R$ from Lal and Lb1. Also, circuit (7) is broken, $I R$ de-energizes and breaks the current circuit to the other exchange, a clearing signal being simultaneously sent out to this exchange. The condenser $C R 2$ and the series connected resistance of 500 ohms prevent the forming of sparks at $P R a$ in circuit (7).

Terminals $L 1$ and $L 2$ as well as $T I 2$ serve for
the connecting up of an amplifier if such a one should be found necessary.

If still ancther impulse translator is inserted between the second exchange and a third one, it is possible for a subscriber belonging to the first exchange to obtain a full-automatic connection over the second exchange to a number at the third one.

Furthermore, there is nothing to prevent a sub-

From the foregoing it is evident that the called exchange receives a clearing signal from the translator between the calling and the called exchanges as soon the calling subscriber has replaced his microtelephone. When the called subscriber also replaces his microtelephone the called exchange receives a double clearing signal and breaks the cord connection.

It may happen, however, that the called subscriber


Fig, 3.
scriber from obtaining automatic connections in this manner over several automatic exchanges. To accomplish this the calling subscriber must dial the number of each exchange in turn, each time awaiting the dial tone from the called exchange, finally dialling the desired subscriber's number after having reached his exchange. It is of importance that the calling subscriber does not dial more than one exchange number at the time and he must know the number of intermediate exchanges over which the connection is to pass.
for some reason or cther does not replace his microtelephone, causing the cord circuit translator to be blocked for further calls from the calling exchange, and a subscriber at this first exchange is unable to obtain a connection to the same called subscriber. For this reason it is desirable that the cord circuit at the called exchange becomes disengaged as soon as the conversation is ended, for which purpose a special arrangement for the release of the cord circuits is required.


Fig. 4 shows a circuit diagram for an arrangement of this kind and the method of connecting the same in relation to relays $B 1, B 2$ and $B$ in fig. 1. The slow acting relay $V R 4$ inserted in the line branch $L a$

Positive, B, VR4, La2 $T I 1, I R a, L b 2, B 1$, $V R 5 a, V R 4 b$ to negative ................. (10) $B 1$ and $V R 4$ energize, breaking circuit (10) and at the same time closing a new circuit,

and the slow acting relay $V R 5$ is connected up between negative and one of the line relays $B$. Simultaneously with the closing of the contact of $I R$, the following circuit is formed,

Positive, B, VR4, La2, TI1, IRa, Lb2, B1, VR5 to negative

After a disengaged cord circuit has been found the following circuit is closed,

Positive, VR4, La2, TI1, IRa, Lb2, B2, VR5 to negative, and from $L b 2$ in parallel over the resistance that causes the energizing of $B 1$ during the transmission of the impulses, to positive
$V R 5$ is kept energized over circuit (12), the selecting taking place as usual. The speaking currents circumvent VR4 through the condenser, which is connected in parallel with VR4. When the calling subscriber replaces his microtelephone but the called subscriber neglects to do this, VR5 and $B_{1}$ remain actuated while $V R 4$, on the contrary, de-energizes. The following circuit is closed,

$$
\begin{equation*}
L b 2, V R 5 a, V R 5, B 1, L b 2 \tag{13}
\end{equation*}
$$

resulting in the short circuiting of the two relays $B 1$ and $B 2$, which de-energize, thereby releasing the cord circuit. Also VR5 de-energizes, causing the relay B2 of the called subscriber (who has not replaced his microtelephone) to energize again, the disengaged cord circuit being sought out as usual. At a subsequent call from the cord circuit translator, $B 1$ is already de-energized but is now actuated again and the disengaged cord circuit is sought out as usual.

In certain cases, when the impulse translator connects two exchanges, and the line resistance between cne of the exchanges and the subscribers' stations is not greater than $2 \times 150$ ohms, the impulse relay in this exchange can be so adjusted as to be less sensitive and to surely de-energize at 6 mA , in which case a simpler connection, as in fig. 5, can be used. A polarized relay $P R$ which momentarily breaks the current circuit of the called exchange serves as a direct impulse relay at the calling exchange, this current circuit being again closed by the connecting up of $V R$ and Si with a total resistance of 3000 ohms. The current is completely cut off for a moment by the regular impulse relay at the called exchange, after which it passes through a resistance of 3600 ohms ( $V R, S i$ and the impulse relay at the called exchange), or at 22 volts with a current of about 6 mA . With such a strength of current it is impossible - according to our assumptions - for the regular impulse relay to remain energized. In the same moment as the calling subscriber replaces his microtelephone at the end of the conversation the armature of $P R$ moves over to contact $b$ and closes the following circuit,

From the called exchange, positive, $B, W a, L a 2$, $T I, S i, V R, P R b, E R c, L b 2$, over the two parallelled relays $B 1$ and $B 2$ at the called exchange to negative

Since we have assumed that the line resistance from the called exchange to a subscriber's station is not greater than $2 \times 150$ ohms and the subscriber's telephone is assumed to have a resistance of 200 ohms, the subscriber's line including $B$, line, telephone instrument, line and $B 2$ will have a resistance of not more than 800 ohms and the tension between the terminals $L a 2$ and $L b 2$ will not exceed 15 volts. This corresponds to about 5 mA through relay $V R$, which is adjusted so as to energize for a current of this strength. When the calling subscriber only replaces his microtelephone, the cord circuit as well as the cord circuit translator at the exchange are not released.

Should a new call from the first calling exchange be made to the same cord circuit translator, the calling subscriber will receive a busy signal from his own exchange. It is not until the called subscriber has replaced his microtelephone that the relay $V R$ receives more current on account of the fact that the voltage between $L a 2$ and $L b 2$ is increased. $V R$ energizes and the feed circuit for $E R$ is broken. $E R$ de-energizes and releases the cord circuit translator as well as the cord circuits in both exchanges.

If the junction line between two exchanges has a resistance between $2 \times 400$ ohms and $2 \times 900$ ohms, the junction traffic can be handled by the aid of an intermediate' translator placed so that the resistance between the first exchange and the intermediate translator is not greater than $2 \times 500$ ohms, and between the intermediate translator and the other exchange not greater than $2 \times 400$ ohms, a 24 volt battery and feed coils being required for the intermediate translator. The connections are made according to the diagram in fig. 6.

If feed coils with higher resistance are used, together with a special impulse translator, the line resistance - with a tension of 24 volts - between the first exchange and the intermediate translator can be increased to $2 \times 1000$ ohms. On the same conditions, but with a tension of 48 volts, this resistance may be increased to $2 \times 1600$ ohms. With such long lines, however, it is advisable to use amplifiers for the speaking current. An amplifier can be connected up while the cord circuit translator is working to obtain a connection.

Should the line resistance remain between $2 \times 100$ ohms and $2 \times 200$ ohms, the polarized relay in the first impulse translator may be replaced by a com-
mon relay. The circuit diagram for an arrangement of this kind is shown in fig. 7.

All telephones with a line resistance of less than $2 \times 100$ ohms should be provided with an extra re-
to obtain a connection through the translator to the other exchange for outgoing calls.

As will be seen from the foregoing, a cord circuit translator of the type here described will work only


R gass
Fig. 6.
 $C$ kind

A telephone with a line resistance of less than $2 \times 50$ ohms cannot use this translator arrangement
with one way impulses, i. e. impulses can be transmitted in one direction only, from terminals $L a 1$ and $L b 1$ to $L a 2$ and $L b 2$. The speaking currents, on the cther hand, can travel in both directions, from the

with an additional resistance, and cannot be used at all when the line resistance exceeds $2 \times 300$ ohms. Consequently, this arrangement can be used for the blocking of telephones which do not have permission
subscriber in the first exchange to the one in the second exchange and vice versa.

If there is but one junction line between two exchanges, it is possible to place a translator at each

end of the junction line. Each of these translators will work in one direction only.

Fig. 8 shows the diagram for such a translator and in fig. 9 are shown the connections between a translator and a junction line between two exchanges.
the difference in voltage between the two batteries should be so small that the strength of the equalizing currents - when it is at rest - is never sufficient to energize any of the relays.
When a subscriber at the first exchange dials the


In this case a closed circuit is formed over both the exchanges, the line relay and the junction lines, for which reason it is necessary that the feed batteries for both exchanges have the same voltage. In any case
number to which the translator is connected, the following circuit is formed at the same time as a ringing signal is sent out,

Positive, relay and relay contacts at first exchange,
$L d 1, B R a, A R, L c 1$, relay contacts and relay at first exchange to negative
$A R$ is energized and closes a circuit - over contact $A R a$ - to the second exchange and simultaneously closes the following circuit,
Positive, $A R b, E R$ to negative
$E R$ energizes and closes the circuit Positive, $V R a, E R k, E R$ to negative
$E R$ now receives a holding current and remains energized, although $A R$ de-energizes after the sending out of the calling signal.

The following circuits are closed when $E R$ energizes,
Positive, $E R h, P R a, I R$ to negative
Positive, $V R a, D, E R j$ to negative
D, PR, ERc, Lal
D, $P R, E R f, E R g, L b 1$
$I R$ obtains current over circuit (18) and the circuit to the second exchange is now closed over IRa after first having been closed over $A R a$. As soon as $A R$ de-energizes the dial tone can be sent out from the second exchange to the calling subscriber over $T I$,
La2, ERa, TI, IRa, ERd, Lb2

The calling subscriber dials the desired number and $I R$ transmits the impulses to the second exchange.

Relays $A R$ and $B R$ prevent two subscribers at different exchanges from obtaining simultaneous connections to the same junction line. When a subscriber belonging to the first exchange dials the exchange number and the register at this exchange sends out a current over the number line, relay $A R$ energizes and occupies the junction line as long as the selector for a line provided with a translator hunts for the cord circuit to which the selector of the calling subscriber is connected. At the same moment as the junction line is seized from either one side or the other, $B R$ in the exchange at the other end of the junction line is energized and closes the following circuit,

Pcsitive, $B R$, Le1, B2, junction line, La2, ARa, $L b 2$, junction line, $B 2$ to negative
$B R$ energizes ard breaks the circuit between $L c 1$ and $L d 1$, thereby preventirg the subscriber at the second excharge from obtaining a connection to the translator, a busy signal being sent out instead.

A diagram for such a cord circuit translation between exchanges of differert automatic systems is shown in fig. 10.

After the subscriber has dialled the exchange number, $A R$ energizes over the following circuit,

Positive from the register of one of the exchanges, $L c 1, A R, L d 1$ over contact and through relay at this exchange to negative
Relay $A R$ closes the circuit,
Positive, $A R a, E R$ to negative
$E R$ energizes and closes the following circuits,
Positive, VR1a, ERa, ER to negative
Positive, $E R e, D, E R f$, to negative
Lal, ERd, PR, D
$L b 1, E R c, P R, D$
$L b 2, E R b, A R c$ to earth
The circuit (24) is presently broken and $A R$ deenergizes, while circuit (26) keeps $E R$ energized. As long as $A R$ remained energized, $L b 2$ was earthed through circuit (30), whereby a calling signal was sent out to the other automatic exchange.

The armature of the polarized relay $P R$ is in the upper contact position, $P R b$. When the calling subscriber dials a number and impulses are sent out from the first exchange, the armature of $P R$ moves to $P R a$ and closes the following circuit,
Positive, $A R b, P R a, I R, E R f$ to negative .
$I R$ energizes and connects $L a 2$ to earth over circuit

## La2, IRb to earth

The second exchange now receives the train of impulscs. Each energizing of $I R$ closes the circuit

Positive, IRa, VR2 to negative
Since $V R 2$ is a slow acting relay, it remains energized during the transmission of the entire train of impulses for each digit and closes the following circuit,

Positive, VR3, VR2b to negative
$V R 2$ de-energizes as soon as the impulses for a digit have been trarsmitted. However, since VR3 is a slow acting relay, its armature remains attracted a little longer and connects $L b 2$ to earth by closing the circuit
$L b 2, E R b, A R d, V R 2 a, V R 3 a$ to earth .. (35)
$V R 3$ de-energizes, breaking the connection from $L b 2$ to earth and again connecting it to $T I$.

A s:gral is sent out to the second exchange over circuit (35) between the dialling of each digit. The switching process may be repeated as often as there are digits in the numbers of the second exchange.

After the dialling of all the digits in the desired
number, the following circuit is closed from the second exchange,

Negative, through the feed coil, La2, IRc, TI, $V R 3 b, V R 2 a, A R d, E R b, L b 2$, to negative (36)

When the subscriber at the first exchange replaces his microtelephone the following circuit is formed,

Positive, $A R b, P R a, S i, V R 1, E R f$ to negative

This circuit was closed already on the transmission of the impulses, but it was impossible for $V R 1$ to
$R R$ energizes and closes the following circuit,
Positive, $R R a, E R$ to negative
Relay $E R$ energizes and closes the following circuits,
Positive, $V R a, E R b, E R$ to negative .... (40)
Lal, ERc, PR, D
Lbl, Sil, ERe, D
Positive, $E R f, D, E R g$ to negative
Circuit (38) was broken when $E R$ energized; $E R$

energize at that time since the circuit was closed for so short a time and $V R 1$ is a slow acting relay connected in series with a self induction coil. $V R 1$ now energizes and breaks circuit (26), thereby de-energizing $E R$ and causing $L a 2$ to be connected from $L b 2$. In this manner the other exchange receives a clearing signal.

In exchanges with one condenser in one of the line branches and a common feed coil in the other the cord circuit translator is connected as shown in fig. 11.

As soon as the subscriber has dialled the exchange number a plunger key is depressed and the following circuit is obtained, on condition, however, that the line to the translator is disengaged,

Positive, $V R a, E R a, R R, L b 1$, through a resistance to negative
is slow-acting, however, for which reason the armature is not released until after a certain time has elapsed, during which relay $P R$ energizes and the following circuit is closed,

Positive, $R R b, E R d, P R b, I R$ to negative (44)
Relay $I R$ energizes. If the other exchange is of another type, a calling signal may be sent out over the following circuit,
La2, TI, IRa, Lb2

A dial tone is received by the calling subscriber at the first exchange, after which he can dial the desired number, on condition, however, that his calling dial is identical with those used by the called exchange. When the current is broken in the telephone instrument of the calling subscriber, the armature of $P R$ is moved to contact $P R a$, thereby breaking circuit

(44). $I R$ de-energizes and breaks the circuit to the other exchange. When the current is again closed, $I R$ energizes and circuit (45) is again closed. In this manner the trains of impulses are transmitted to the other exchange.
current impulses to energize, but is now actuated. This results in the breaking of circuit (40), causing all the relays to de-energize and the other exchange to receive a clearing signal.

When the junction traffic is between two exchanges


After the subscriber at the first exchange has replaced his microtelephone on the cradle rest, the armature of $P R$ moves over to contact $P R a$, where it remains, thereby closing the following circuit,
Positive, $R R b, E R d, P R a, V R, S i 2$ to negative

Relay $V R$ bs not priouly recel
of the same above-mentioned type, the connections will be according to the circuit diagram in fig. 12.

As in the previous case, the subscriber dials the exchange number and depresses a push button, closing the following circuit,
Positive, $V R a, E R a, R R, L b 1$, through a resistance coil to negative ..................... (47)
$R R$ energizes and closes the following circuits,
Positive, $R R a, R R, L b 1$, through a resistance coil to negative
Positive, $R R b, E R$ to negative
$E R$ energizes and breaks circuit (47), although $R R$ remains energized over circuit (48) until the subscriber depresses the button.

Relay $E R$ closes the following circuits, Positive, $V R a, E R b, E R$ to negative
Lal, ERe, $P R$ to $D$
Positive, $E R f, D, E R g$, to negative

La2, TI, WRb to earth
The $L b$ line of the called subscriber is connected to negative over a resistance coil causing the sending out of a calling signal. The called subscriber removes his handset, thereby closing the following circuit,
La2, TI, WRa, IRa to Lb2
If two such exchanges are to have junction traffic with cord circuit translation, this can be obtained according to the diagram shown in fig. 13.

After the dialling of the exchange number and the


R 996
Fig. 13.

The following circuits are closed after $R R$ deenergizes,

Positive, $R R c, E R c, P R b, I R$ to negative (53)
Lbl, WR, RRd, ERd, D
$W R$ cannot energize because the current between $L b 1$ - which is connected to positive - and D1 is too weak.

When the calling subscriber at the first exchange has dialled the number of the desired subscriber at the other exchange, he depresses the plunger key on his telephone, causing $L b 1$ to be connected to negative over a resistance coil and $W R$ receives a current over the following circuit,

Positive, ERf, D1, ERd, RRd, WR, Lb1 over a resistance coil to negative
$W R$ energizes, whereby $L a 2$ is earthed over the following circuit,
depressing of the plunger key, the following circuits are formed,
Positive, $V R 1 a, E R a, R R, L b 1$, over a resistance coil to negative

Positive, $R R a, E R$ to negative
Relay $E R$ energizes and closes the following circuits,
Positive, $V R 1 a, E R b, E R$ to negative .... (60)
Earth, $R R c, E R c, L b 2$................. (61)
La1, ERd, PR, D2 ..................... (62)
Lb1, Sil, ERe, D1
Positive, $E R f, D, E R g$ to negative
Shortly thereafter $R R$ de-energizes, thereby breaking circuit (61). The trains of impulses are now transmitted over the following circuits

Positive, $R R b, P R a, I R, E R g$ to negative (64)
$L a 2, I R a$ to earth
L.M.Ericsson


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Fig. 15.

During the transmission of the impulses the slow acting relays $V R 2$ and $V R 3$ are energized over the circuits

Positive, $V R 2, I R c$ to negative
Positive, $V R 3, V R 2 b$ to negative
After a train of impulses has been transmitted, the following circuit is momentarily closed,

Earth, VR3a, VR2a, RRd,ERc,Lb2..
The speaking circuit passes from $L a 2$ over $I R b$, $T I, V R 3 b, V R 2 a, R R d$ and $E R c$ to $L b 2$.

At the close of the conversation, $V R 1$ energizes, circuit (60) is broken and all the relays de-energize, causing a clearing signal to be sent out to the other exchange.

Cord circuit translation between exchanges wired according to the cord circuit system with two condensers takes place according to other principles. The diagram for an installation of this kind is shown in fig. 14. $R$ represents a resistance in the circuit. A polarized relay $P R$ - in series with a condenser Cr 3 - is connected up in parallel with the same.

When the line circuit for the calling exchange is closed, $R$ receives current and there is a certain difference in voltage between the terminals of $R$. This furnishes the condenser Cr 3 with a loading current which passes through $P R$ and sets the armature of this relay to contact $P R a$. As soon as the current in the circuit is cut off the difference in tension between the terminals of $R$ ceases, Cr 3 is subject to a discharge and the discharge current passing through relay $P R$ moves the armature of this relay to contact $P R b$. Thus each closing of the circuit sets the armature to $P R a$ and each break to $P R b$.

Still another circuit diagram is shown in fig. 15. Here $S i$ is a self-inductance coil with comparatively high self-inductance and low resistance. In parallel with this coil is a polarized relay $P R$ with high resistance and low self-inductance. When a circuit is closed over $L a 1$ and $L b 1, S i$ immediately makes a very high although merely apparent resistance which causes almost all of the current to pass through $P R$ and sets the armature to contact $P R a$. During the following moment almost all of the current passes through $S i$ and only a very small part through $P R$ on account of the high resistance of the coil Si. When the current is cut off, self-inductance in Si creates a reversed current which passes through $P R$ and causes the armature to be set to contact $P R b$.

Thus, for an exchange with two condensers, cord
circuit translation can take place according to the diagrams in figs. 14 and 15 . For exchanges with long, loaded lines or with lines having large, variable leakance line translation should be provided.

Fig. 16 shows a diagram for cord circuit translation between a manual exchange and an automatic exchange. A special switching device is arranged in the manual exchange for junction service to the automatic exchange. When a manual subscriber wishes to call an automatic subscriber, the local operator at the manual exchange connects the subscriber to a junction board where another operator plugs up the answering cord $A S t$ in the corresponding jack G1 and throws the speaking and ringing key $K S r$. She can now communicate with the calling subscriber over the transformer $\operatorname{Tr} 1$ and the following circuit,

Tr1, KSrc, CR1, TR2, T, KSrf, KSrb to $\operatorname{Tr} 1$

After the operator has been told the desired number, she inserts the distributing plug WSt in the jack G2 of the corresponding junction line, thereby closing the following circuit,

Positive, $R R b, L a 1$, junction line, $L a, K$ Sre, calling, dial, $K S r c, \operatorname{Tr} 1, K \operatorname{Sr} b, L b$, junction line, $L b 1$, $T r, S i$ and relay $P R, R R a$ to negative

The armature of $P R$ is set to contact $P R a$, closing the following circuit,

$$
\begin{equation*}
\text { Positive, } P R a, I R, V R \text { to negative } \tag{72}
\end{equation*}
$$

$I R$ energizes and closes the following circuit,
$L a 2, T r, I R a$, to $L b 2$
The automatic exchange now receives a calling signal and the selector hunts for a disengaged cord circuit. When a register connection has been obtained, which is indicated by means of a buzzer signal, the operator can dial the desired number. The breaks in the current occasioned by the impulses cause - by means of the armature of relay $P R$ - breaks in circuit (72), whereby $I R$ de-energizes and circuit (73) is broken. The automatic exchange now receives the impulses sent out by means of the calling dial and selects the desired number. If this number is disengaged the operator receives the calling tone and must wait on the line until the called subscriber answers, after which she places the speaking and ringing key in speaking position, thereby breaking circuit (71). The armature of $P R$ moves to contact $P R b$ and breaks circuit (72). $I R$ and $V R$ deenergize. Instead, the following circuit is closed,

Positive, $P R b, V R b, R R, L a 2$, over the cord

circuit of the called automatic exchange and the telephone instrument of the called subscriber to negative
$R R$ energizes and disconnects the battery from the junction line. The air pump causes the speaking and ringing key to return to normal after a certain determined time, thereby closing the following circuit,
Lb, KSra, SR, Trı, KSrd, La
Since the battery is disconnected, however, $I R$ remains de-energized. The speaking circuits are now as follows:
$T r 1, K S r d, L a$, junction line, $L a 1, C r, T r, L b 1$, junction line, $C_{r} 2$ and $\operatorname{Tr} 1 \ldots \ldots \ldots \ldots$................ (76)

La2, Tr, VRa, CR3 to Lb2
When the automatic subscriber replaces his handset, $R R$ de-energizes and the poles of the battery are connected to the junction line, closing the following circuit,

Positive, $R R b, L a 1$, junction line, $L b 1, T_{r}, S i$ in parallel with $P R, R R a$ to negative
$I R$ energizes and closes the following circuit,

Positive, $S L, S R a$ to negative
The clearing lamp $S L$ glows after which the operator pulls down the connection.

If it be undesirable that the operator waite until the called subscriber has answered, both clearing lamp and supervisory lamp will be required in the junction position, in which case the connections will be as shown in fig. 17.

The throwing of the speaking and ringing key KSr closes the following circuit,

Positive, $K L, K R, K S r f$ to negative
$K R$ is energized and the supervisory lamp $K L$ glows on account of the low resistance of $K R$. After the automatic subscriber has been given a calling signal by the operator - verified by means of a signal tone -, $K S r$ is thrown in speaking position and $K R$ deenergizes. The throwing of $K S r$ to speaking position ends the short-circuiting of $S R$ and $S R$ energizes quicker than $K R$ de-energizes, this latter being a slow acting relay. The following circuit is now closed,

Positive, $K L, K R, K R a, S R a$ to negative
During the calling of the desired number, the following circuit is closed,

Positive, $L d, A a, V R 2$ to negative
$V R 2$ energizes and closes the following circuit,
Positive, $V R 3, V R 2 a$ to negative
At the end of the calling signal circuit (82) is broken and $V R 2$ de-energizes. Since $V R 3$ is slow acting, the following circuit will be momentarily closed,

The resistances $r 1$ and $r 2$ are so calculated that the number of ampere turns in both windings of $K R 1$ are alike. Since these two windings counteract one another, $K R 1$ remains de-energized. At the same moment the called subscriber removes his microtelephone, the amount of current passing over circuit (87) is reduced, $K R 1$ energizes and cuts off the current supply to the junction line. This causes $S R$ to de-


Positive, $K R 2, V R 3 a, V R 2 b$ to negative (84)
When VR3 de-energizes, the closing of the following circuit keeps $K R 2$ energized,

Positive, $K R 2, K R 2 a, A d$ to negative
The following circuit is also formed,
Positive, $r 2, K r 1, K R 2 b, A d$ to negative ..
after which the current of the automatic exchange passes through the following circuit,

Positive, $A c, T r, I R a, r, K R 1$, over two $B$ 's in parallel to negative ....................... (87)
energize, whereby $K R$ de-energizes and $K L$ cease to glow.

When the called subscriber replaces his microtelephone, $K R 1$ again de-energizes and battery is connected to the junction line.
$S R$ is energized and closes the following circuit.
Positive, $S L, K R b, S R a$ to negative .... (88)
$S L$ glows, whereby the junction board receives a clearing signal.

The problem of obtaining two-way traffic with but one junction line may be solved on the aforementicned principles, the diagram for such a plant

being shown in fig. 18. (An additional supervisory relay must be included in the diagram, fig. 17.)

When two automatic exchanges are inter-connected

Impulses can be transmitted from a 48 -volt line battery over a cable with a resistance of 6000 ohms, a total capacity of 3 mF and an inductance of up to


R 1001
Fig. 19.
by means of loaded cables or long aerial lines, cord circuit translation is provided at the exchange which transmits the impulses and so-called line translation at the receiving exchange, as shown in fig. 19.

5 Henries. The battery must be individual for the line and be well insulated from earth. The diagram shown in fig. 14 can be used to advantage for aerial lines with considerable and irregular leakance.


# On Forest Fires and Forest Fire Protection. 

The Telephone as an Effective Agent in the Prevention of Forest Fires. by Folke Johansson, of the Swedish Government Forestry Service.

The tentative estimates which now and again are being made of the world supply of those raw products - iron ore, petroleum, gold, coal and timber - which constitute a dominating factor in our modern commercial life often lead to the prediction that these supplies will soon be exhausted. Prophecies of this sort generally result in the appearance of more or less irresponsible statements in publications of a professional character as well as in the daily press. Thus, an English prediction that the world supply of pine timber would be completely depleted within a space of 37 years recently found its way to all corners of the world. The truth of this prophecy which was avidly taken up by publications of all sorts - is a matter which we will not bother to discuss at the present moment, but the intense interest evoked by this "cry of distress" proves that many were fully aware of the importance of our pine forest reserves - not only on account of the importance of this product for various household uses, but also in its property of raw product for a number of exceedingly important industries, i. e. the lumber, wood pulp and paper industries - as well as of the necessity of adopting rational methods for the working up of the forests and for the utilization of the timber supply. Consequently, the assumption that a realisation -
even though more or less superficial - of the necessity for the care and protection of existing pine forests has permeated circles which are not directly irterested in forestry or any of the above-mentioned industries cannot be taken as an exageration.

Ever since time immemorial catastrophical and rapid changes in the nature and condition of the forests has been caused by fire, this scourge having later on found a serious competitor in man, however. In the presert case we will not touch on the human efforts of a purely selfish character whose sole aim is the ruthless devastation of our forest reserves for personal gain only and without a thought for the future, these efforts falling outside the scope of this article, but will devote ourselves solely to forest fires. It is true that - due to more effective protective measures and better fire fighting methods - the losses caused by fire have been restricted in the same proportion as the forest supply is undergoing a gradual reduction, but the actual economical losses caused by fire are nevertheless more and more keenly felt. In spite of all our most modern and advanced technical resources the forest fire remains to this day a largely uncontrollable and most important agent of destruction. Seen from a geographical point of view, this is especially true in Russia, Siberia, Canada and
the United States, whose climatic conditions tend to considerably increase the fire risk, although countries with such favourable climates as Sweden, Finland, Germany, Norway etc. also suffer great losses each year on account of forest fires.

A few figures taken at random will suffice to prove this statement. In Finland, for instance, during the summer of 1925, about 25,500 hectares (abt. 63,000 acres) of government forest land were laid waste by fire, the financial loss being estimated at 4 million finmarks. (The Finnish government forest reserves cover about one third of the total area of the country.) The devastated area of forest land in Sweden is estimated at about 8500 hectares (abt. 21,000 acres) per year during the last fifty years, corresponding to a monetary loss - including value of timber, cost of extinguishing fires etc. - of about 2 million Swedish crowns; in Sovjet Russia the destroyed area amounts to about 600,000 hectares ( $1,484,000$ acres), in the United States $7,000,000$ hectares (abt. 17,300,000 acres) and in Canada $1,000,000$ hectares (abt. 2,471,000 acres), all per year. In the two last mentioned countries the losses are estimated at 30 and 14 million dollars respectively. No additional comments are necessary.

Just as cities and other communities have been forced to adopt various measures in order to protect life and property from destruction by fire, so also has this been found necessary as regards forests, for in our present age with its enormous consumption of paper the forest supply is altogether too valuable to be allowed to merely go up in smoke before ever having had the chance of being utilized in some form or other. We will not here discuss the rather common temporary and more loosely organized forest fire brigades or other organizations which serve the same purpose; what we once for all want to establish is that the most important part of an organization for the fighting of forest fires - no matter how local conditions may affect the same - always is a combination of patrol duty and fire signalling, the purpose of which is to quickly discover and locate a starting forest fire and to report the same to the nearest headquarters from which aid may be obtained. At the outbreak of a fire every minute counts; a fire which at one moment may be extinguished by a child with a tuft of pine branches and a pail of water may, at the next, defy the efforts of hundreds of well equipped men. The most destructive forest fires have always had a very insignificant beginning.

The most effective alarm system for forest fires -
it might almost be called automatic, for reasons which we will touch on in the following - combining both patrol duty and fire alarm, is the so-called fire tower system, used with excellent results since many years back. Experience shows that the fire tower, placed on a mountain top or other rise in the ground from which an unobstructed view of the surrounding country is obtained, is the safest method of detecting the outbreak of forest fires in sparsely inhabited, desolate


Swedish Fire Tower from the Province of Härjedalen.
and hilly tracts of land. Even the aeroplane is considered inferior in this respect to the fire tower, since for reasons of safety it can only be used in regions with numerous lakes; also, patrol duty is exercised only while the machine is in the air, the entire district lying unprotected between flights. Such is not the case with fire towers, however, in which special guards are stationed during the summer whose sole duty it is to keep a sharp lookout from break of day until nightfall (and who may, in a sense, be compared to the thermo-contact or sensitive organ of the automatic fire alarm) for any suspicious looking smoke, which is then located on the map in the tower by means of a diopter, after which a tele-
phone report is made to headquarters from which a force may be sent out for the extinguishing of the fire. Thus, every fire tower must be able to communicate with headquarters and preferrably also with


R $\times 90$ American Fire Tower of Steel. The house at the foot of the tower contains the fire guard's living quarters.
other towers and points of observation within the same district. At the present time the desired communications are almost exclusively obtained by means of permanent telephone lines; formerly optical signals were used as well.
Just as the fire fighting equipment in our towns and cities has undergone successive improvements and become many times more effective than, let us say, only ten years back, so also has the equipment used for fighting forest fires been improved upon and perfected to a surprising degree. There are at present portable motor fire engines in which lightness of weight is combined with a most surprising efficiency, light types of fire hose in kilometer lengths which are easily transported to the site of the fire, in many localities horse, automobile or railway patrols equipped
with the most modern apparatus are organized etc. But if the signalling system is inadequate or does not function properly, what good is then derived from all this wonderful fire extinguishing apparatus? Intervention at the right moment, i. e. at the very outbreak of a fire, is of much greater value than a whole arsenal of fire engines and many large bodies of water; consequently, a campaign against forest fires should not be begun by the acquiring of all the latest models of fire engines and other paraphernalia. On the contrary, the only efficient method is to intervene immediately on the outbreak of a fire and thereby prevent it from doing serious damage, and this can be done only if a report of the fire is sent in quickly and accurately, in other words if the alarm system is in

good working order. In fact, it actually is better to have a reliable alarm system and antiquated fire extinguishing apparatus - naturally on condition that the latter is serviceable - than vice versa.

The duty of the fire guard up in the tower, therefore, is to turn in an alarm in the shortest possible time. Since, as has already been mentioned, minutes are precious and it is generally necessary to simultaneously make a short report, there is practically but one way in which this can be done, and that is with the aid of the telephone. Thanks to simple yet adequate telephone communications the alarming of forest fires has been made as quick and reliable as can well be desired; consequently, it cannot be regarded in the light of an exageration to emphasize that fire towers without telephone communications cannot even approximately fill present day requirements. In fact, the telephone can well be said to constitute the solid foundation for modern forest fire protection and what has here been stated should make clear the fact that the greatest responsibility born by any inert matter in this organisation rests upon the telephone alarm system. The fact that no fire towers are now erected without being provided with a telephone gives ample proof that this means of communication has stood the test, and proved its fitness for this purpose.



R 801 a
Schematic Drawing showing Construction of Telephone Line Using Live Trees as Poles. The wire is run through the shackle insulators.

One can be practically certain that no two telephone plants for forest service are exactly alike in all respects. It often happens that unskilled labor is used for line construction and other similar work, and under such conditions the result cannot be satisfactory. In other instances, however, men specially trained in this kind of work are employed for the purpose, the result being a plant which is first class in every respect.

West-European conditions have not, as a general rule, required the construction of such extensive fire protection telephone nets as are to be found in North America, for instance. In proceeding to describe a fire alarm telephone plant for the purpose of giving a clear idea of its outer contours and method of functioning, therefore, the writer prefers to choose an example from the new world, in this case from Canada, where colonization, climate and other conditions are such as to have developed the technic of forest fire protection to such a degree that it may well be held forth as an example for the world at large. The plant chosen for this purpose was made the object of a protracted stay on the part of the writer while travelling in North America some two years age for purposes of study and does not presume to be
constructed in every detail according to the most advanced theories in the field of applied low tension electricity, but in the writer's opinion it represents a satisfactory and instructive practical solution - both as to design and construction - of the problem of providing telephone communications at a reasonable

cost in the district in question. Consequently, it has been considered worthy of serving as an illustrative example.

The forest domains of the Abitibi Power and Pulp Co. are so extensive that it was considered wise to establish a special guard system in order to provide protection against forest fires. Nine fire towers have been erected, each one with an effective radius of 60 to 80 km . and placed so that the areas surveyed
from each tower slightly overlap. As is generally customary, the telephone net consists of single lines, earth being used for the return. This is also general practice in Scandinavian forestry, where, for the sake of єconomy, single lines are always used for fire alarm, lumber camp and forcst guard telephone communications, a practice in which no special difficulties are encountered due to the comparatively short lines and the general absence of troublesome high tension transmission lines.

The company has about 300 km . of single lines with a double line about 50 km . long following a railway track, making a total of 350 km . of telephone lines. Both single and double lines proceed from the headquarters' administrative building and are run as straight as possible between the towers, branch lines being provided at two or three places. A total of twenty-four telephone instruments are connected to the single line, twenty-one of these being constantly connected up during the warm season while the remaining three - which are situated at the branching points are used only now and then for trouble shooting by the line inspectors, for ordering repair material, and similar purposes. At headquarters another thirteen telephones are installed which can all be connected to the single line over a telephone switchboard. Another switchboard equipped with three vacuum protectors, one resistance coil, one transformer and two keys permits the establishing of connections between the single and double line through the transformer. Since each station has been given a separate calling signal it is possible - with the above arrangements - to speak between any two stations.

The lines of the Abitibi plant are almost without exception aerial lines passing through vast, uninhabited forest lands; between the Upper and Lower Abitibi Lakes, however, is a sound about 300 m . wide across which a $11 / 4^{\prime \prime}$ submarine cable has been laid. A 'pass' from 2.5 to 3 m . wide has been cleared through the forest for the erection of the lines, the trees along the edge of the 'pass' serving as poles. The insulators are large porcelain rings or shackles provided with a groove on the outside for receiving a 50 cm . long spliced stranded wire cord by means of which the insulators are hung to the tree. The wire cord is fastened to the trunk of the tree at a height of about 6 m . from the ground by means of strong $4^{\prime \prime}$ staples, light scaling ladders or specially built pole climbers being used. The hole in the insulator is sufficiently large to give the line wire 2.5 to 3 mm . diam. phosphorbronze wire - free play.


R 894
Canadian Line Erection Gang on the March. (Foto, Can. Forest Service.)

The line is erected so that every other insulator is hung on one side of the pass and every other on the


R 893
other side, the wire being run in zig-zag fashion with a distance of about 30 m . between the points of support. This method of construction provides ample
clearance for the wire and keeps it away from the tree trunks, thus eliminating all danger of short circuits


R $\times 93$
Telephone Cabinet for Fire Alarm Use.
(Foto, Can, Forest Service.)
in wet weather. The wire is not stretched very tightly, neither is it fastened at any point along the line, but is allowed to run freely through the insulators with

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practically no fixed points except at the two extreme ends. This manner of erecting lines, which possesses the advantage that a tree falling over the line does not break the wire but merely presses it down against the ground, does not seem to be in use outside of the United States and Canada, but the idea is undoubtedly a good one and deserves to be taken up for consideration in other countries as well. Experience shows that in dry weather there is almost no danger at all for short circuiting through an accident of this kind, and the trouble is easily remedied; the fallen tree is merely cut in two and the wire freed, after which it automatically rises up in the air again.
During the entire forest fire season while the telephone alarm system must be in perfect condition, the lines are inspected at regular intervals, each line inspector being responsible for a stretch of 40 to 50
km . Besides the necessary tools etc., the line inspectors are provided with portable telephones which can easily be connected up on the line. The previously mentioned telephone instruments at the branching points can also be used to advantage for trouble finding.

Of course, there is no denying the fact that the transmission of specch over a single line of such great length must be subject to the deleterious influences of currerts caused by variations in the potential of the ground and by the polarization of the ground plates, giving rise to disturbing noises in the telephone receivers. In order to remedy this condition and eliminate these noises as much as possible the Abitibi


R $\times \times 9$
Canadian Forest Service Emergency Communication Kit in Use.
The set contains in the smaller compartment 1 extension bell, 1 protector, 1 howler, 1 condenser. The larger compartment is fitted with 2 binding posts, from which wires lead to the external connections in the set and a portable telephone. There is also room for tools, etc.
line bas been provided with some twenty 'Lavite' discharge coils with a resistance of about 38,000 ohms each, vacuum lightning protectors being mounted in the same boxes as the discharge coils as an added precaution. These coils have proved so efficient in the stopping of undesirable extra currents, that the line is being successively equipped with more and more of them, although a too liberal use of the same may do more harm than good.

The parallel telephone instruments erected in the fire towers and elsewhere are all wall instruments of standard type with 5 -magnet generators and 2500 ohm bells, permitting the actuation of the signal bells of all the telephones on the same line with about the same degree of effectiveness. The telephones on the single line are equipped with a condenser - the six most distart ones with two each - and a key by means of which the telephone can be disconnected from the circuit while looking for faults. A Chapman protector has been mounted on the fourth pole from the headquarters' station building and the cable terminal box on the 'intake' pole.

The functioning of the fire alarm system is briefly as follows. If any suspicious looking smoke is observed from the fire tower, the guard sights the same through the diopter on the map table, notes the bearing in degrees of the spot with reference to the North point of the compass, calls up the man on duty at headquarters by giving the headquarters station signal and turns in his report about as follows, - "This is Smith in the ...... tower. Light smoke at 235." As soon as Smith has submitted his report, he makes haste to get off the line in order to permit guards in other towers to report their observations as quickly as possible. The information thus obtained makes it possible for headquarters to locate the site of the fire on a general map covering the entire district and to take suitable steps for extinguishing the same.

There is no doubt but that the alarm system with fire towers or other similiar points of observation equipped with telephone communications should be more extensively adopted in the entire northern pine forest belt than has hitherto been the case. In Sweden, for instance, whose forestry is considered to have reached a very high standard and whose wood pro-
ducts are of vital importance not only for home consumption but also as one of the country's most valuable sources of income, - representing, as it does, more than one half the value of the country's entire exports - large forest tracts for which this type of alarm system would be exceptionally suitable are still without effective fire protection, and this in spite of the fact that large rebates are allowed off premiums on forest fire risks when suitable precautions are taken, i. e. the use of one fire tower entitles the policy holder to a rebate of $10 \%$, this being increased to $15 \%$ where two fire towers are used. In Norway some fifty stationary points of observation have been established but many more are yet needed before the forest fire protection can be regarded as fully adequate. In Finland, where what has been said of Sweden holds true to an even greater extent, a severe yearly loss is occasioned by forest fires. Russia and Siberia are still more or less unknown quantities when it comes to forestry, depending on the inaccessibility of their forests and the attendant difficulties of timber cutting, due to which the standing timber in extensive forest areas has been considered almost valueless. In the same degree as the world demand and consequently also lumber prices experience an increase so also will these Russian and Siberian forest lands be subject to development and there will be a large demand for equipment for the purpose of fire protection. In the United States and Canada the forest areas protected by the fire tower system are rapidly increasing from year to year.

From the above statistical data it is evident that there still remains much to be done in this line. Existing conditions all seem to indicate serious future difficulties within pine timber production, due chiefly to the encrmous yearly increase in the worldconsumption of paper, and if the future needs of the paper industry as well as of other wood-consuming industries are to be provided for the rational development of the forest lands is an imperative necessity. But what permanent benefits are obtained from all the work spent on forest reclamation as long as the risk of losing in scme few hours' time the fruits of many years' labour and of invested capital is forever imminent? It is very probable that the forest fire is an inevitable evil, but its effects can most certainly be kept within bounds through efficient fire protection.

## On Subscribers' Meters.

The problem of making the operation of a telephone plant a paying proposition presented itself simultaneously with the planning of the first installation of this kind. The solution nearest at hand was naturally that those persons who had financed the undertaking should be the ones to use the plant and derive benefit therefrom. This matter was arranged in the same manner as at the present time, i. e. so that those

persons who had a telephone instrument connected to the net in question paid a certain yearly fee as rental for their telephone instruments. This system proved satisfactory in the beginning, but by degrees, as the telephone became more popular and more generally used, the steadily increasing traffic soon necessitated the extension of the exchanges as well as of the nets. In this connection it soon became apparent that only a comparatively small number of subscribers created this necessity through their frequent use of their telephones and since it did not seem more than fair that just these subscribers should stand for the increased costs there arose the problem of determining to what extent the different subscribers used their telephones.

First, an attempt was made to determine the total length of time per day during which the telephone instrument was in use; that is to say, what might be termed the service time was of minor importance since the cost of the plant proved to be considerably smaller than the cost of operation. The size of the staff
at the telephone exchange was determined by the number of effectuated connections per time unit, however, and consequently it became necessary to devise a means for the registration of the completed calls. Quite naturally, an attempt to let the operators themselves take care of this registration proved a failure and this task was then assigned to persons specially employed for this purpose. Even this arrangement

met with serious difficulties, however, at the same time proving to be all too expensive. Finally, there remained no other alternative but to design apparatus which would automatically register the calls, thus bringing into existance the problem of subscribers' meters.

To simply construct an instrument which could register the number of calls did not meet with any serious difficulties. However, a subscriber's meter intended for a telephone plant with several thousand subscribers - each one of whom must have his own meter must have certain other propertics as well; it must have a low cost of production and require a minimum of attention and maintenance. The first subscribers' meters did not meet these requirements, consequently it was not possible to manufacture them in such quantities as to permit of every subscriber's line being equipped with one of them.

The operating companies soon had another problem to face on account of the steady increase in the traffic.

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As soon as an exchange reached such proportions as to require the services of more than one operator it was found necessary to divide the work equally among them or so as to correspond to the efficiency and capacity for work of each one.

For this purpose it was necessary to obtain information as to the number of calls per time unit

effectuated by each operator and it was found that this could be accomplished with a comparatively small number of meters. Consequently, the first cost did not play such an important role and even the rather expensive apparatus already to be found on the market could be used for this purpose. Thus, one of the first duties of the subscriber's meter was to

provide the statistical information which served as a basis for the distribution of the service among the different operators.

Subscribers' meters of this type - the appearance of which is shown in figs. $1 \& 2$ - were first manufactured by L. M. Ericsson \& Co. in about 1893.
The mechanism consists of an armature which is attracted by an electromagnet and is restored to normal by means of a counterweight. The armature actuates two ratchet wheels on whose shafts are two
hands, one of which indicates units and tens while the other one indicates hundreds and thousands. The meter has a capacity of 10,000 . Both illustrations show front views of the meter, but in fig. 2 the dial has been removed in order to show the driving mecha-


Fig. 6.
nism. In spite of the fact that these subscribers' meters were a decided improvement on those previously used they were quite bulky and expensive.

Fig. 3 shows a more recent construction of meter for the same purpose as the foregoing but much smaller as well as more accurate in its functioning. The circular face or disc with its gradations and in-


R 915 Fig. 7.


Fig. 8 .
dicator hand, which often was the cause of mistaken readings, is here replaced by the rotating recording train now in general use; also the meter is of a much neater and less bulky construction, an important feature when it comes to the mounting of the meters as well as with regard to the cost of production and transportation.

Fig. 4 shows still another type in which the registering mechanism is similar to that generally to be found in gas meters.- This type is also of an older design

and has never gained any great amount of popularity, probably for the reason that it is not considered reliable.

The meter illustrated in figs. 5 and 6 is the first one constructed by L. M. Ericsson for use in conjunction with a subscriber's telephone instrument. The meter is sealed and is mounted beside the telephone instrument. It is wired so as to register a call on the pressing down of the button with the microtelephone removed from the cradle rest. The button is depressed after the desired number has answered and at the request of the operator, who is also able to tell whether the calling subscriber actually depresses the button or not.

Figs. 7 and 8 show a subscriber's meter of a type similar to the foregoing although of a more modern design. This type is intended to be incorporated in the telephone ir.strument in the manner illustrated in fig. 9, and can be used for manual as well as automatic installations.

The meter is wired so as to register only outgoing calls for which the connection has been effectuated. It is not difficult to see the advantage for a subscriber who is entitled to a certain limited number of calls per year to always be able to see the number of calls already made. This is probably one of the surest ways of eliminating all controversies between the subscribers and the telephone company.

It is only in exceptional cases, however, that subscribers' meters are placed anywhere except at the telephone exchange. Still, a number of telephone companies and administrations do practice this method, and it is to satisfy their demands that L. M. Ericsson manufacture the above described type.

The subscribers' meters described in the following and which are all intended for mounting at the exchange may therefore be regarded as of standard design. However, here also there are a number of varying designs.

Figures 9, 10 and 11 show three different designs of the hand and dial type for 500,1000 and 10,000 calls. The driving mechanism for all three consists of an electromagnet which drives a worm gear by
means of a ratchet wheel. The wheel of the worm gear is mourted on the same shaft as the indicator hand of the meter. This construction is unusually simple and functions with great accuracy.

These meters are very well adapted for a special type of subscription. The telephone subscriber purchases a card entitling him to, say 500 calls. His meter is then set to 500 and adjusted to go back-

wards, one unit for each call. When the meter is nearing the zero mark he is apprized of this by the cperator who asks if he does not wish to purchase a new card. If the subscriber does not comply with this request his telephone is shut off. This system can
be modified so that the subscribers are kept under surveyance from a special bureau equipped with automatic devices which give notice when a subscription has run out. Also, an arrangement can be made by means of which the subscriber is notified - with a special buzzer tone - when only a small number of calls remain to his credit.

A type of subscriber's meter which has been manu-


Fig. 13.
such a small device as this one can be provided with so many intricate details, but they will be recognized by the trained eye of the expert, some of them seemingly insignificant but still of considerable importance for the perfect furctioning of the meter.

What we have said about the meter in fig. 13 is also true for the one in fig. 14. This one, however, has been provided with a little arrangement which

permits of its being quickly and simply cleared and restored to its O-position, a characteristic which under certain conditions - is of the utmost importance. For irstance, if a subscriber is entitled to a certain number of calls during a given time period, the work of supervision is made considerably simpler if the meter can be cleared after each reading. If this were not possible it would be necessary to keep

better can be imagined. Our modern times have set up requirements of a much too rigorous character to be filled by these meters of an older construction, a condition which has resulted in the construction by L. M. Ericsson of a new type of subscriber's meter which represents all that is most modern and most perfect in this line.

The meter shown in fig. 13 is a direct development of the one previously mentioned. The principle is the same, but the design has been considerably simplified, a number of details having undergone modifications and improvements in order to make the meter perform it work with still greater precision and reliability. It may seem almost inconceivable that

a special record for each meter and, at each reading, to deduct the figures obtained at the previous one, a procedure in which unnecessary and annoying mistakes often occur.

In the foregoing we have stated that it is the meter which is placed beside the telephone instrument which gives the subscriber the greatest amount of satisfaction, since it puts him in a position to see for himself how large a number of the calls to which he is entitled have been made or - if the conditions of the subscription are such - the number of calls for which he will be charged. A meter of this type does not serve the telephone company as well, however. In the first place, an employee must be sent out to read
the meter. He makes out a bill for the number of calls made, but it often happens that the subscriber is unable to pay his bill just then, necessitating a second visit on the part of the collector.

When all the meters are placed in the exchange, a great saving of time is obtained in the reading of the
same; also, the telephone bills can be made out in advance and sent to the subscribers with information as to the date on which the collector will call. This system is without doubt much more economical for the telephone company as well as for the subscribers.


## Automatic Warning Signals at the Railway Crossing near the Henriksdal station on the Stockholm-Saltsjön Railway.

In an attempt to reduce operating expenses, the Steckholm-Saltsjön Railway has decided to replace the guards at the grade crossings with an automatic signalling system. The cost for protecting the crossings with guards - at least two men being re-


R 966
Fig. 2.
quired per crossing and day - is relatively high on account of the heavy traffic, trains being run at close intervals during both day and night except during a very few hours. A comparison between the operating and amortization costs for an automatic signalling system on the one side, and the cost of maintaining crossing guards, on the other, proved the advantage of adopting automatic signal protection. A grade crossing just East of the tunnel near the Henriksdal station has now been provided with automatic warning
signals. Since this crossing is quite close to the tunnel entrance, thereby cutting off a clear view of the crossing from the road, it is especially dangerous for the heavy automobile traffic. On account of this the requirements to be filled by the signalling system were


R 064
Fig. 3 ,
exceptionally strict and it was decided to use intermittent flashing signals combined with warning bells. The light signals - one on each side of the tracks show a white flashing light which changes to red on the approach of a train, when vehicles and pedestrians are not permitted to cross the tracks. The warning bell is mounted on the same pole as the light signal. One of the signal poles, bearing the crossed sign required by law, is shown in fig. 2.
»Signalbolaget» was entrusted with the work of

preparing estimates for the plant, the project being based on constant and uninterrupted track circuits ( $S_{1}$ and $S_{I I}$ in fig. 1). It was necessary, however, to take into consideration the fact that the railway was electrified, the traction current having a tension of 1300 volts D. C. and the rails serving as return conductors. For this reason single phase A. C. was adopted as feed current for the track circuits. Only one of the rails has been used for this purpose and been divided into insulated sections, one for each of the track circuits $\mathrm{S}_{\mathrm{I}}, \mathrm{S}_{\mathrm{II}}$ and $S_{\text {III }}$, the other rail having been left unchanged to serve as return for both traction and signal current.

The crossing being situated so near to the station, and since it was found desirable that the warning signals should not be made to function during normal switching movements when the train does not go up to or pass over the crossing, it was found impossible to make track section $S_{1}$ of sufficient length for the automatic switching on of the warning signals within the time prescribed by law (at least thirty seconds before the train reaches the crossing) to give warning of the approach with normal speed of a train just leaving the Henriksdal station. This problem has been solved by installing a plunger key in the signal cabin at Henriksdal, in which the interlocking ma-
chine is housed, by means of which - with the aid of a relay - the signal plant can be switched on for the giving of a warning signal within the prescribed time even though no train has entered on track section $S_{\mathrm{I}}$. In order to make it possible for the locomotive engineer of such a train to verify that the warning signals have been switched on at Henriksdal, a light signal - $T$ in fig. 1 - has been set up in the tunnel, the lamps of this signal being connected in series with the signal lamp at the crossing so as to show a white flashing light when the warning signals show red,

and an orange flashing light when the warning signals show white. As soon as the train reaches the track section $\mathrm{S}_{\mathrm{I}}$, the auxiliary relay co-operating with the plunger key in the signal cabin is disconnected and the system functions quite automatically. Thus, the signals again show a white flashing light and the warning bells cease to ring as soon as the train leaves track sections $S_{1}$ and $S_{\text {III }}$. When the train has also left section $\mathrm{S}_{\mathrm{II}}$, the entire system is restored to normal. If the engineer of a train leaving Henriksdal should observe an orange coloured light signal at $T$, he must cut down the speed of the train to 25 km . per hour as soon as the train enters on track
section $\mathrm{S}_{\mathrm{I}}$ and the warning signals are automatically switched on in order that the length of the time which elapses before the train reaches the crossing shall fill the requirements of the law. When a train approaches from the other direction the signal system functions quite automatically, the warning signals being switched on as soon as the train enters section $\mathrm{S}_{\text {II }}$ and switched off when the train has completely left sections $S$ and $S^{1}{ }_{1 I}$.

In order to be able to verify at the Henriksdal station that the warning signals at the railway crossing are in good working order, the same board on which the above-mentioned plunger key is mounted (see fig. 3) has been provided with supervisory lamps in series with both the white and red crossing signal lamps, while in the office of the station master a lamp and a buzzer have been mounted in series with the red signal lamps. Besides supervising the condition of the signal plant at the crossing, the last mentioned lamp together with the buzzer announce the approach of trains from the East in a most satisfactory manner. All the supervisory lamps are provided with a shunt resistance, thereby eliminating any danger of the warning signals at the crossing being extinguished in case a supervisory lamp is removed or has become broken.

The relays for this plant are mounted in a cabinet (fig. 4) which has been placed close to the railway crossing. The track circuits $\mathrm{S}_{\mathrm{I}}$ and $\mathrm{S}_{\mathrm{II}}$ - as already mentioned - are fed by single phase alternating current, the relays which serve this purpose and which are mounted on top and to the left in the cabinet being specially adapted therefore. The remaining ones are all D. C. relays. The necessary A. C. is obtained from the existing service net and is transformed down to a suitable voltage for the track circuits and signal lamps. Direct current for the other relays and the warning bells is obtained from a storage battery which is under constant charging from the A.C. net by means of a rectifier mounted in the middle of the cabinet in fig. 4. This is a so called metallic rectifier, noted for its sturdy construction, absence of moving parts and lamps, and for the fact that it requires no attention whatever after once having been correctly adjusted; also, it functions with such precision that the well-known saying 'install and forget' may well be applied to the same.

This plant has been in service since the beginning of 1928 and has given entire satisfaction with respect to the manner in which it has functioned as well as from an economical point of view.


CONTENTS: Subtraction Meter with Load Balancing Switch. - On Junction Telephone Traffic Automatic to Automatic, or Manual to Automatic. - On Forest Fires and Forest Fire Protection. - On Subscribers' Meters. - Automatic Warning Signals at the Railway Crossing near the Henriksdal Station on the Stockholm-Saltsjön Railway.


[^0]:    * The idea of using the household tariff meter for installations with direct heating electric ranges and water heaters originated with chief engineer N. Forssblad.

