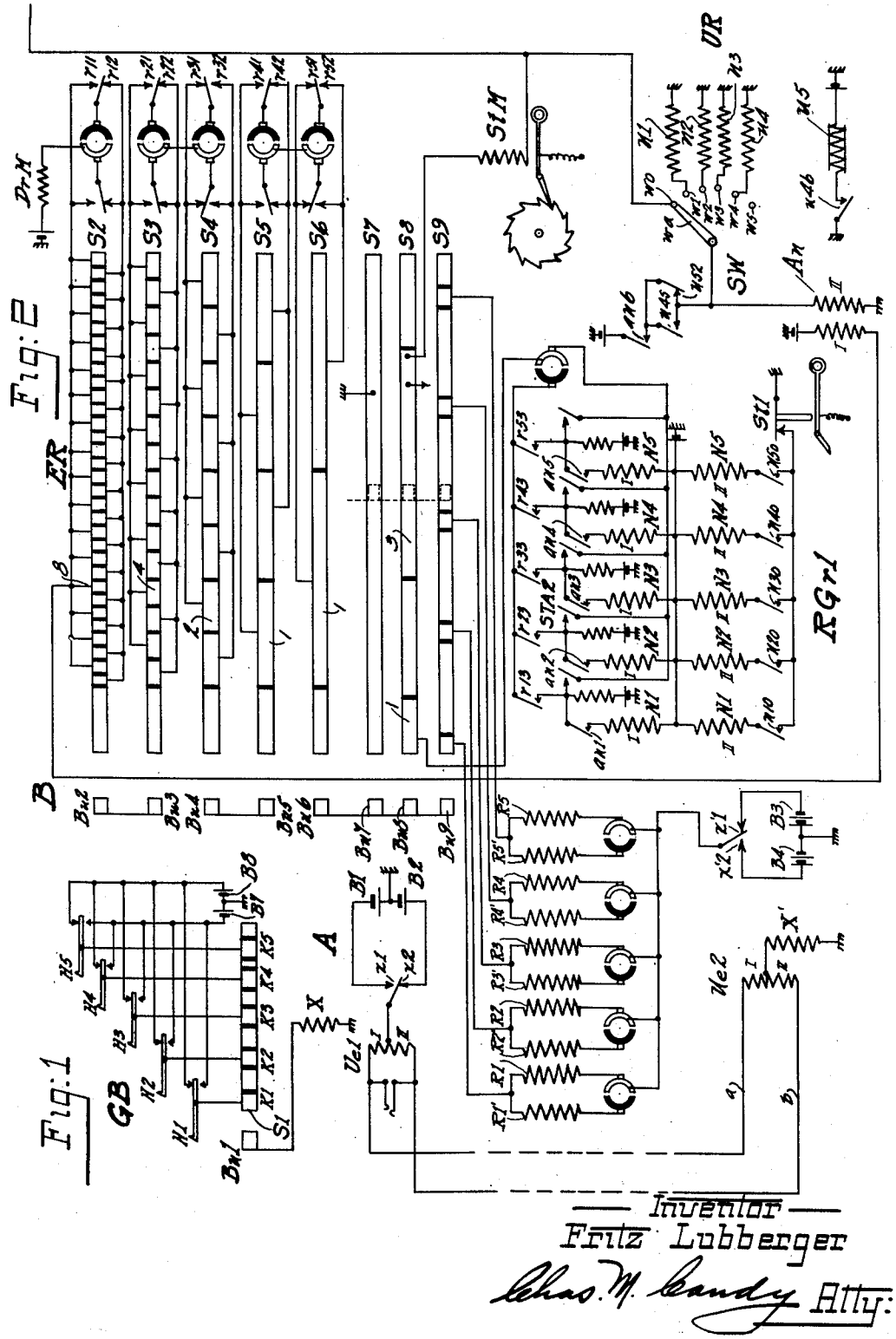
June 15, 1926. 1,588,764

F. LUBBERGER

TELEPHONE SYSTEM

Filed March 17, 1922 4 Sheets-Sheet 1



June 15, 1926. 1,588,764

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TELEPHONE SYSTEM

Filed March 17, 1922 4 Sheets-Sheet 2

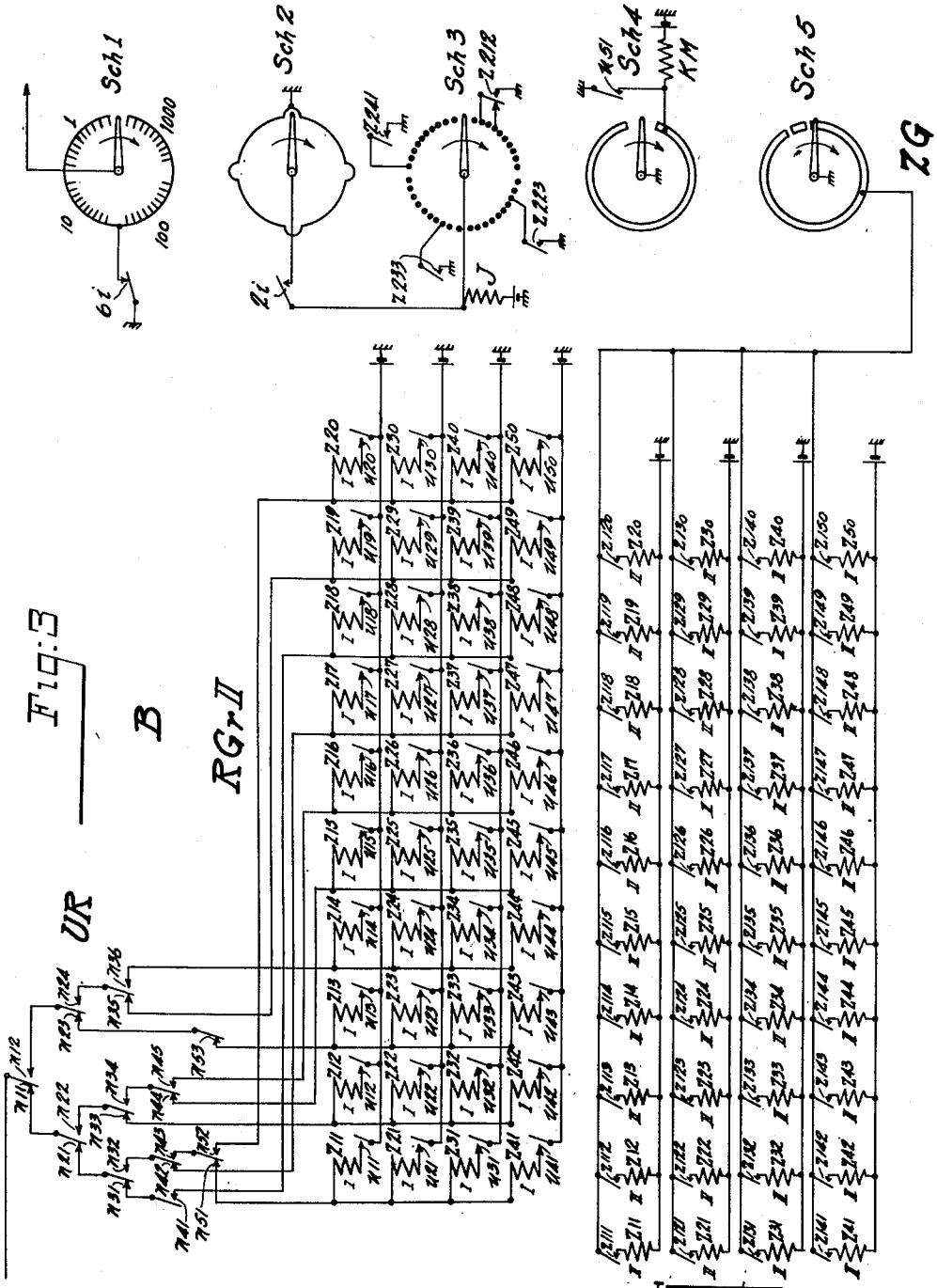



Fig. 3

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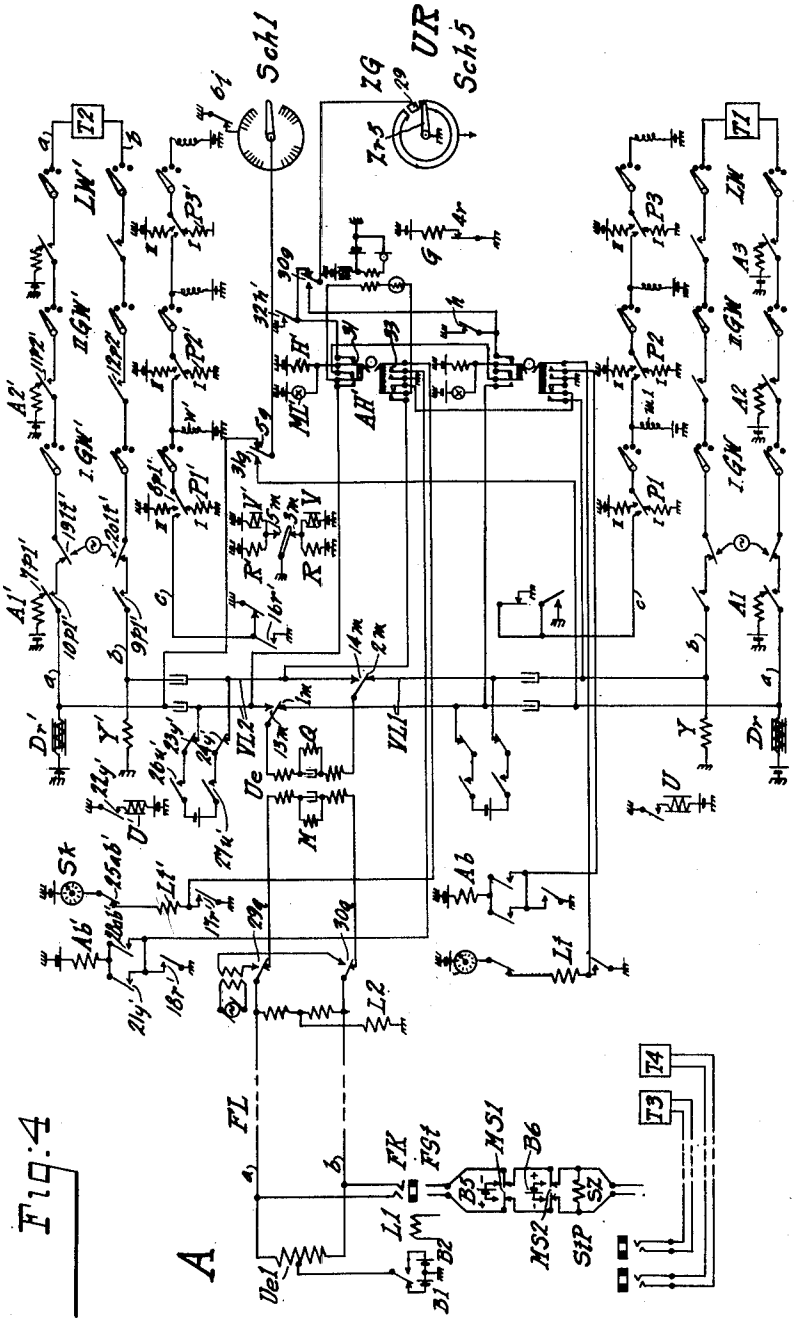
Chas. M. Candy Atty.

June 15, 1926. 1,588,764

F. LUBBERGER

TELEPHONE SYSTEM

Filed March 17, 1922 4 Sheets-Sheet 3



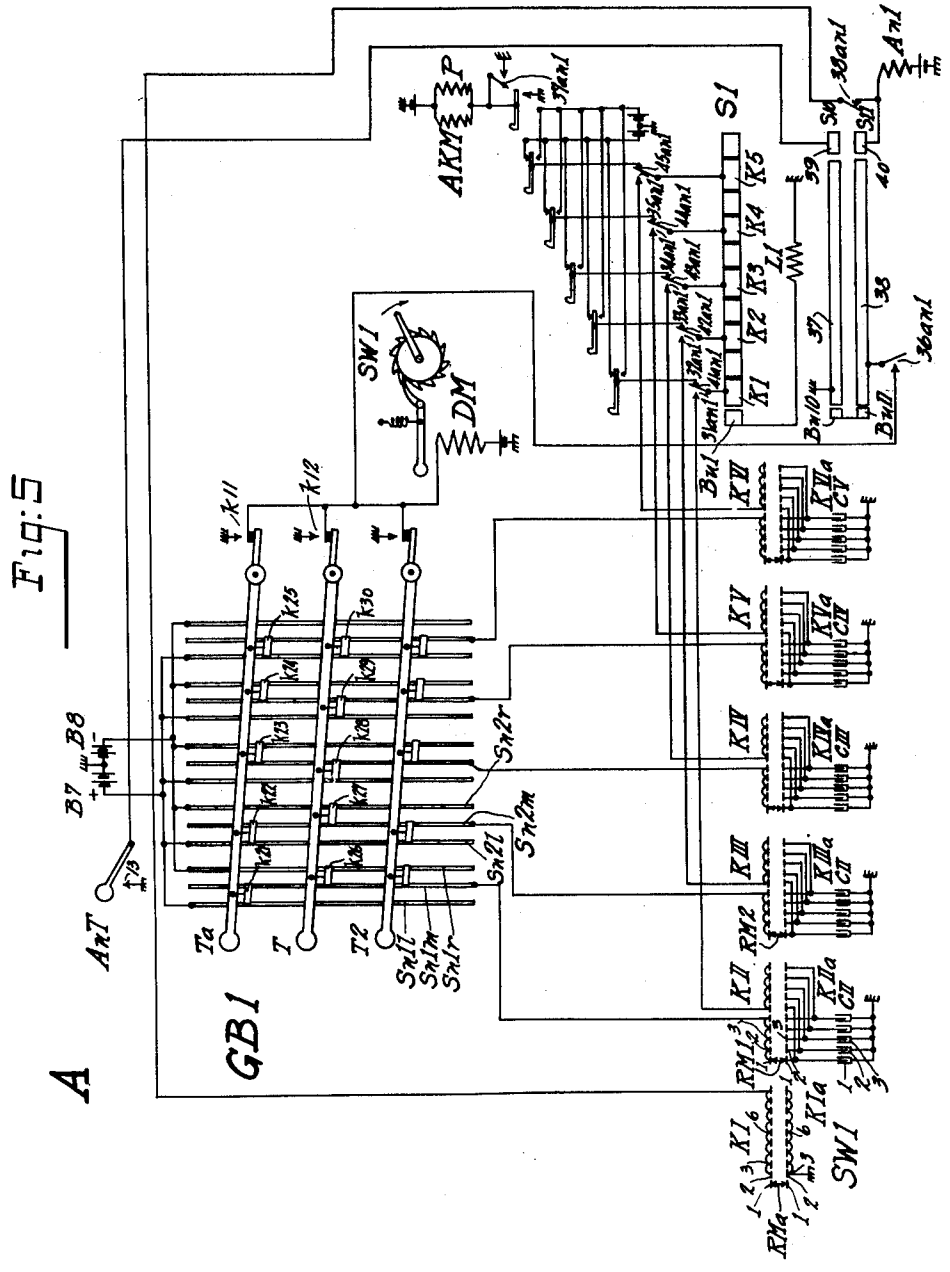

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June 15, 1926. 1,588,764

F. LUBBERGER

TELEPHONE SYSTEM

Filed March 17, 1922 4 Sheets-Sheet 4


Fig. 5
A
GB1
AxT
B7
B8
Ta
T
T2
SW1
DM
AKM
P
S1
SW1
K1
K2
K3
K4
K5
KI
KII
KIII
KIV
KV
RM1
RM2
RM3
KIa
KIIa
KIIIa
KIVa
KVa
CI
CII
CIII
CIV
CV
A ml
B ml
B ml
B

Patented June 15, 1926. 1,588,764

# UNITED STATES PATENT OFFICE.

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## TELEPHONE SYSTEM.

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Circuit arrangements are already known for setting selecting devices used for telephone purposes over long distance lines used for speaking purposes. The construction and maintenance of long lines is however very expensive. Endeavours are therefore made to use the long distance lines for transmitting various kinds of communications (e. g. telephone, printing telegraph, high frequency telephony, etc.) with the assistance of special circuit combinations. To use such long distance lines for setting selecting devices for telephone purposes causes difficulties.

According to the invention these difficulties are overcome in a simple manner by using the means for transmitting telegraph symbols also for setting the selecting devices for telephone traffic over long distance lines. The setting of selecting devices can for instance be effected with the assistance of an automatic type printing high speed telegraph instrument, which is preferably used for long telephone lines carrying a heavy traffic. This high speed telegraph is described in the periodical "Telegraphen und Fernsprechtechnik" 1913, Nos. 12, 13, and 14.

The drawing shows diagrammatically several examples of the new circuit arrangement that are based on the above mentioned high speed telegraph.

In Figures 1 to 3 is shown a complete arrangement of the transmitting and receiving devices used for setting the selecting devices. Figure 4 shows a switching arrangement, by means of which, during the maintenance of a speaking connection, the selecting devices for the next connection can be set and this connection can be so far prepared that at the end of the conversation the subscriber's lines can be connected to the long distance line without loss of time.

In Figure 5 an arrangement is shown which is associated with the long distance operator and is constructed similar to the transmitter of a high speed telegraph; this arrangement enables the long distance operator herself, without the assistance of the telegraph operator, to transmit the number impulses necessary for setting the selecting devices.

In the circuit arrangement shown in Figures 1 to 3 two long distance exchanges A and B are shown connected together by a trunk line FL. The setting of the selecting devices for long distance calls is accomplished in the following manner: It is assumed that a subscriber of the local exchange belonging to the long distance exchange A desires to speak to a subscriber of the local exchange belonging to the long distance exchange B. The record operator in the exchange A takes a note of the call and hands it on to the required long distance position. At the same time, the record operator gives the required subscriber's number to the telegraph operator in the telegraph instrument room at the exchange A. The telegraph operator perforates a strip according to the number of the wanted subscriber. The long distance operator is connected with the telegraph operator by means of an order wire or any other desired signalling arrangement; if no long distance call is yet set up she verbally gives the telegraph operator, over an order wire or other signalling arrangement, instructions to set up the number of the wanted subscriber. The telegraph operator in exchange A inserts the perforated strip into the sender, whereupon current impulses for setting the selecting devices are transmitted. The long distance operator completes the connection by inserting the calling plug into the long distance jack. If the telegraph operator happens to be sending a telegram, he interrupts the telegram and first transmits the number. The telegraph operator in the other exchange B recognizes, by the calling signal for setting the selecting devices, that the following number does not belong to the telegram, and cuts out this number. As soon as the number has been transmitted, the transmitting telegraph operator in the exchange A again inserts the telegraph strip (a few letters being taken back) and the further transmission of the telegram takes place.

For preparing the representation of the number impulses for setting the selecting devices a certain key of the key set belonging to the high speed telegraph is used at

the transmitter GB (Fig. 1). This key corresponds at the receiver ER (Fig. 2) to a particular set of the repeater rings described below. In the example shown it is for example assumed that the position 8 of the repeater rings serves also for taking the preparatory signal. As the preparatory signal, 5 impulses are to be given, which correspond to five holes in the perforated strip. In exchange A the telegraph operator has inserted the perforated strip into the automatic transmitter GB. It is assumed that the subscriber No. 2679 of the exchange B is wanted. The preparatory or calling signal is transmitted corresponding to the first row of holes in the perforated strip (5 holes in the strip equal five number impulses). Thereby the following circuit is established: The contacts $H_1$, $H_2$, $H_3$, $H_4$ and $H_5$ connect in succession the contacts $K_1$ to $K_5$ of the slip ring $S_1$ to the positive pole of the battery $B_7$, whereby the rotation of the brush $Bu_1$ over the slip ring $S_1$ repeatedly closes the circuit for the polarized relay X. The relay X responding to the five impulses, operates five times in quick succession and sends, by closing its contact $x_1$ five positive current impulses over the long distance line FL connected for simultaneously telegraphing: earth, battery $B_1$, contact $x_1$ winding I of the repeater $Ue_1$, winding II of $Ue_1$ connected in parallel, $a$ and $b$ leads of the trunk line FL connected in parallel winding I of the repeater $Ue_2$ in the exchange B, winding II of $Ue_2$ connected in parallel, polarized line relay X′ earth. The polarized line relay X′ connects its armature $x'_1$ to the positive pole of the battery $B_3$ five times, so that by the rotation of the brushes $Bu_2$ to $Bu_9$ of the receiver ER, which rotate simultaneously with the transmitting brush $Bu_1$, the five polarized relays $R_1$ to $R_5$ are in succession energized, since they are connected to the five contacts of the receiver ring $S_9$: earth, battery, $B_3$, contact $x'_1$, $R_1$ or $R_2$ and so on, contact 1 or 2 etc., of the receiving ring $S_9$, contact brushes $Bu_9$ and $Bu_7$, slip ring $S_7$, earth. The relays $R_1$ to $R_5$ move their contact arms into the position $r_{11}$, $r_{21}$, $r_{31}$, $r_{41}$ and $r_{51}$ (the first number behind each $r$ corresponds to the corresponding relay $R_1$, $R_2$, etc.).

During the rotation of the brushes $Bu_2$ to $Bu_9$ the relays $R_1$ to $R_5$ serve for starting the signal to be repeated. During the succeeding rotation of the brushes this signal, in the manner described below, is repeated to the repeater rings $S_2$ to $S_6$. At the same time, with the assistance of a second set of relays $R_{1'}$ to $R_{5'}$ which correspond to the relay set $R_1$ to $R_5$, a new signal is started, which during the succeeding rotation of the brushes is repeated to repeater rings $S_2$ to $S_6$ by means of contact arms, of this relay set. The relay set $R_1$ to $R_5$ and $R_{1'}$ to $R_{5'}$ are alternately connected to the receiver ring $S_9$. Both these relay sets thereupon interchange their functions at each rotation of the brushes. While during one rotation one relay set receives a new character from the long distance line, the other relay set translates the character it received during the preceding rotation.

As above explained, the relays $R_1$ to $R_5$ were so energized during one rotation of the brushes $Bu_2$ to $Bu_9$ that their contact arms were brought into position $r_{11}$, $r_{21}$, $r_{31}$, $r_{41}$ and $r_{51}$. At the beginning of the succeeding rotation of the brushes, the relays $R_1$ to $R_5$ are disconnected from the receiver ring $S_9$, by the arrangement shown. On this rotation as soon as the brushes $Bu_2$ to $Bu_9$ reach a position, in which contact 8 corresponds to the repeater ring $S_2$, the following circuit is closed: earth, slip ring $S_7$, brushes $Bu_7$, $Bu_8$, contact 1 of slip ring $S_6$, contact $r_{51}$ of $R_5$, contact $r_{41}$ of $R_4$, contact 1 of slip ring $S_5$, brushes $Bu_5$, $Bu_4$, contact 2 of slip ring $S_4$, contact $r_{31}$ of $R_3$, contact $r_{21}$ of $R_2$, contact 4 of slip ring $S_3$, brushes $Bu_3$, $Bu_2$, contact 8 of slip ring $S_2$, winding I of the starting relay A$n$, battery, earth. The starting relay A$n$ operates and locks itself over contact $an_6$ in the operating circuit: earth, battery, $an_6$, $U_{52}$, winding II of A$n$, earth. By the energizing of the starting relay A$n$ the operation of a translator UR is prepared by the setting of the selecting devices; this translator is provided with a group of relays RG$r_I$ (Fig. 2), a stepping switch (setting switch or the like) SW, a group of relays RG$r_{II}$ (Fig. 3) and a number sender ZG. Simultaneously with the relay A$n$, the printing magnet D$r$M is energized over $r_{11}$ so that the calling signal also appears printed on the paper strip, and the telegraph operator recognizes, that the following four characters (the number of the characters depend on the size of the automatic exchange) do not belong to the telegram.

The brushes have moved over the slip rings $S_2$ to $S_9$ and have run to the dotted position. Now the rotary magnet S$t$M of the stepping switch SW is energized as follows: earth slip ring $S_7$ brushes $Bu_7$, $Bu_8$ contact 3 of the slip ring $S_8$, starting magnet S$t$M contact $wo$, switch arm $wa$ of the switch contact $U_{52}$ of the relay $U_5$, contact $an_6$ of relay A$n$ battery, earth.

The switch arm W$a$ is set in the first contact $w_1$ whereby a circuit is closed for the relay $U_1$: earth, winding $U_1$, contact $w_1$ and switch arm $wa$ of the stepping switch, contact $u_{52}$, $an_6$ battery earth. The relay $U_1$ is energized and closes its contacts $u_{11}$, $u_{12}$, $u_{13}$ and $u_{14}$ to $u_{20}$ (Fig. 3), thereby a circuit is prepared for the relay e. g. $Z_{12}$ of the relay group RG$r_{II}$ of the translator UR, by

means of which, in the manner described below, at the thousand section of the number sender ZG earth is connected to the contact corresponding to the contact of the wanted subscriber.

As in the present case it is assumed that the subscriber 2679 is desired, the sender GB (Fig. 1) transmits a signal corresponding to the number 2. This signal corresponds to the hole in the second row of holes of the transmitter strip. The transmitter brush $Bu_1$ generates a negative current impulse when it moves over contact $K_1$, by moving over the contact $K_2$ it generates positive current and by moving over the contacts $K_3$ to $K_5$ it generates again negative currents. The positive current holds at the receiver ER the relay $R_2$ in the position $r_{21}$, while the negative currents cause the relays $R_1$ and $R_3$ to $R_5$ to return to the position $r_{12}$, $r_{32}$, $r_{42}$ and $r_{52}$.

The relay A*n* (Fig. 2) by its operation closes the contacts $an_1$, $an_2$, $an_3$, $an_4$, and $an_5$. The relay $R_2$ furthermore has closed its contact $r_{23}$. On the next rotation of the brushes relay $N_2$ is therefore energized as follows: earth, slip ring $S_7$, brushes $Bu_7$, $Bu_8$, contact 1 of the slip ring $S_8$, contact $r_{23}$, contact $an_2$, winding I of the relay $N_2$, battery, earth. The relay $N_2$ locks itself over its contact $n_{20}$ in the following circuit: earth, battery winding II of $N_2$ contact $n_{20}$, contact S*t*I earth, and moves its armature so that the contact $n_{22}$ and $n_{24}$ are closed. The punching magnet $STA_2$ is energized at the same time as the relay $N^2$. This magnet can be used for making a corresponding strip of holes at the receiver of the installation.

When on further rotation the brushes reach the dotted position the following circuit is established:—Earth, slip ring $S_7$, brushes $Bu_7$, $Bu_8$, contact 3 of the slip ring $S_8$, winding of the switching magnet S*t*M, contact $n_{11}$ (Fig. 3) of $N_1$ operated contact $n_{22}$ of $N_2$, contact $n_{33}$ of $N_3$ winding I of relay $Z_{12}$ contact $u_{12}$ of $u_1$, battery earth. The relay $Z_{12}$ locks itself over its contact $z_{112}$ in the holding circuit: earth, battery, winding II of $Z_{12}$, $z_{112}$, slip ring $Sch_5$ and contact arm of the number sender ZG earth; it connects over its contact $z_{212}$ earth to the second contact of the thousand group of the selecting device $Sch_3$ of the number sender ZG. Simultaneously with $Z_{12}$ the switch magnet S*t*M (Fig. 2) of the stepping switch is operated as soon as the brush $Bu_8$ leaves the contact 3 of the ring $S_8$, the switch magnet S*t*M is de-energized so that its contact arm W*a* is moved on to the second contact $W_2$. When the armature has been fully attracted the switch magnet S*t*M opens its contact $St_1$ whereby the holding circuit of relay $N_2$ is opened and this relay is de-energized. All the N relays have now returned to their normal position. Over the corresponding contacts of the translator, slip rings $S_2$ to $S_6$ a circuit over the printing magnet D*r*M is closed so that the selected number is printed on the paper slip of the telegraph operator.

On the further movement of the stepping switch SW on to the second contact $w_2$ the relay $U_1$ is de-energized and the relay $U_2$ connected up. The relay $U_1$ opens its contacts $u_{11}$ to $u_{20}$ (Fig. 3) whereby the receiving relays $Z_{11}$ to $Z_{20}$ are disconnected for the first train of impulses. The relay $U_2$ by closing its contacts $u_{21}$ to $u_{30}$ has connected up the receiving relays $Z_{21}$ to $Z_{30}$ for the second train of impulses. The impulses for the second contact of the wanted subscriber's number are repeated in the same manner. When the last (for instance 4th) train of impulses is transmitted the relay $U_4$ is energized and closes its contacts $u_{45'}$ and $u_{46'}$. At contact $u_{46'}$ the slow acting relay $u_5$ is energized. The relay $U_5$ has opened its contact $u_{52}$. Since the relay $U_4$ locks itself over its contact $u_{45}$, it only releases after the switching magnet S*t*M has set the contact arm W*a* of the stepping switch onto the fifth contact $w_5$ at the end of the impulse transmission (the fourth train). In this position the stepping switch in known manner automatically releases itself electrically or mechanically. The relay $U_4$ quickly releases and opens its contacts $u_{45'}$, $u_{46'}$, whereby the relays A*n* and $U_5$ are caused to release. Since the relay $U_5$ is slow acting; it releases after a fixed delay and closes its contact $u_{52}$, so that in the meantime the relay A*n* is reliably de-energized and has opened its contacts $an_1$ to $an_5$. The high speed telegraph is now again free for the reception of telegrams.

By the energization of relay $U_5$ the circuit for the coupling magnet KM of the sender ZG was closed over contact $u_{51}$ (Fig. 3) earth, $u_{51}$, winding of the coupling magnet KM, battery, earth. This magnet causes the sender ZG to operate. As soon as the coupling magnet KM has moved the switch arm one step forward, it remains energized over a special contact till the switch arms have completed a whole revolution. On reaching normal position the switch arm associated with segment $Sch_4$ removes the earth potential from the coupling magnet KM, whereby the impulse sender ZG is stopped. The contact rows $Sch_2$ and 3 form a hunting device, while the contact row $Sch_1$ represents the impulse sender. Over the contact row $Sch_5$ the receiving relays $Z_{11}$ etc., in the manner before described, lock themselves for indicating the trains of impulses that are to be generated by the impulse transmitter of the number sender. When the switch arm of the contact row $Sch_5$ reaches the last contact, the locking circuit for these relays is opened, so

that they are released. The number sender makes one further step and thus likewise reaches the normal position.

The circuit arrangement shown in Figure 4 represents diagrammatically how the before described installation, by means of which the wanted subscriber's number is transferred to the register by means of the telegraph, is connected with a telephone system at the receiving side of the whole installation. The arrangement shown in Fig. 4 has the special advantage that while a speaking connection is maintained the selecting devices for the next connection can be operated, so that there is no loss of time between succeeding calls (during the setting of the selecting devices, answering the call etc). The method of operating the arrangement according to Figure 4 is as follows:

It is assumed that the subscriber $T_3$ of the A exchange is connected with a subscriber $T_1$ of the automatic exchange B over the long distance line FL. The next connection to be set up is assumed to be a similar one, for instance between the subscriber $T_4$ of the exchange A with a subscriber $T_2$ of the automatic exchange B. During the setting up of the connection between the subscriber $T_1$ and $T_3$ battery $B_5$ was so connected to the long distance line FL, by means of a switch $MS_1$, located in the cord circuit S*t*P of the long distance operator, over the plug FS*t*, which has been inserted into the long distance jack FK of the cord circuit S*t*P, that the positive pole is connected to the *a*-lead and the negative pole to the *b*-lead, whereby a polarized relay M in the long distance exchange B was so energized that the contacts $1_m$, $2_m$ and $3_m$ of this relay were closed. Over contacts $1_m$ and $2_m$ the long distance line FL is connected with a connection-means-of-access $VL_1$ leading to the first selector I.GW and over the selectors I.GW, II.GW a connector LW is connected with the subscriber $T_1$. At contact $3_m$ the circuit is closed for relays R and V. As soon as relay R is energized the relay G is connected up over contact $4_r$. The relay G at its contact $5_g$ has connected the impulse transmitter $Sch_1$ (Figs. 3 and 4) of the sender ZG to a second (free) junction line which likewise leads to a first selector I.GW'.

The long distance operator at A now wishes to prepare the connection with the subscriber $T_2$ of the exchange B. She sets the number sender ZG in the manner before described, by means of the high speed telegraph. In order to render the drawing clearer the parts $Sch_2$ to $Sch_4$ already shown in Figure 3 have been omitted from Figure 4. As soon as the number sender has received the last train of impulses it starts to operate automatically and over its impulse sender $Sch_1$, transmits the first train of impulses; earth $6_j$, contact row of the impulse sender $Sch_1$, $5_g$, $7_{p1'}$, relay $A_{1'}$, battery, earth. The relay $A_{1'}$ repeats the number impulses to the switching magnet of the first selector I.GW', so that it is set in known manner. The test magnet $P_{1'}$ of the first selector I.GW' operates over earth, winding I of $P_{1'}$, *c* wiper and contact of the selector resistance $w_{1'}$, battery, earth, and connects itself in the holding circuit over its contact $8_{p1'}$ and the winding II. At contacts $9_{1'}$ and $10_{p1'}$, the test relay $P_{1'}$ connects the line through to the second selector II.GW'.

If an impulse sender $Sch_1$ now transmits the second row of impulses, the relay $A_{2'}$ repeats the impulses to the switching magnet of the second selector II.GW. This is accordingly set. The test relay $P_{2'}$ operates, locks itself over winding II and connects the line through at the contacts $11_{p2'}$, and $12_{p2'}$. The next two trains of impulses operate the connector LW'. The test relay $P_{3'}$ effects the switching over or switching through, but the connection at present is still open at the switch contacts $13_m$ and $14_m$ of the polarized relay M, associated with the long distance line, set up to subscriber $T'_2$. If the number sender ZG has transmitted the last train of impulses it finds itself again in normal position.

On the completion of the conversation between the subscribers $T_3$ and $T_1$, the connection is set up over the cord circuit S*t*P by the long distance operator with whom the subscriber $T_4$ was connected over the local exchange that is associated with the long distance exchange A, but which is for the sake of clearness not shown. The long distance operator A, by means of the key $MS_2$, so connects battery to the long distance line that the negative pole of battery $B_6$ is now connected to the *a*-lead and the positive pole to the *b*-lead, hence the polarized relay M, associated with the long distance line at the exchange B, is operated, thus opening its contacts $1_m$, $2_m$ and $3_m$ and closing $13_m$, $14_m$ and $15_m$. At contacts $13_m$ and $14_m$ the long distance line FL is connected with the trunk line $VL_2$ giving access over the selecting devices I.GW, II.GW' and LW' to the subscriber $T_2$. Over contact $15_m$, the circuit for relays R' and V' are closed. The relay R' on operating closes its contacts $16_{r'}$, $17_{r'}$ and $18_{r'}$. By closing contact $17_{r'}$ a circuit for the ringing relay L*t*' is closed, so that the relay L*t*' connects up every 10 seconds over a 10-second switch SK and at its contacts $19_{1t'}$ and $20_{1t'}$ connects ringer generator to the subscriber's line. Thereby the subscriber $T_2$ is called.

When the subscriber $T_2$ answers, the relay Y', located in the speaking circuit, is operated over: earth, battery, choke coil D*r*', *a*-lead of the trunk line I.GW', II.GW' LW', *b*-lead of the subscriber's line LW'; II.GW', IGW', *b*-lead of the trunk line,

Y′, earth. The relay Y′ closes its contacts $21_{y'}$ and $22_{y'}$. At contact $21_{y'}$ a circuit for the cut-off relay A*b*′ is closed and at $22_{y'}$ a circuit for the damped relay U′ is closed. The relay A*b*′ connects itself over contact $28_{ab'}$ in a holding circuit: earth, battery, A*b*′, $28_{ab'}$; $18_{r'}$, earth and at contact $25_{ab'}$ disconnects the circuit for relay L*t*′, so that the generator for calling the subscriber is disconnected. Relay U′ by closing its contacts $26_{u'}$ and $27_{u'}$, has prepared a circuit for the clearing signal.

The subscribers $T_4$ and $T_2$ are now connected and conversation can proceed. At the end of the conversation both subscribers hang up. The subscriber $T_4$ gives the clearing signal direct to the exchange A. The means for giving this signal are known and are therefore not shown in the drawing. By hanging up the receiver at station $T_2$ the relay Y′ is de-energized. It releases and closes the contacts $23_{y'}$ and $24_{y'}$ whereby the following circuit is established; battery $26_{u'}$, $23_{y'}$, $13_m$, repeater U*e*, winding I, relay Q, repeater U*e*, winding II, $14_m$, $24_{y'}$, $27_{u'}$, battery. The relay Q operates, connects ringing current over $29_q$ and $30_q$ to the long distance line FL so that the clearing signal SZ in the cord circuits S*t*P in exchange A is operated. By the release of Y′, U′ was also de-energized, because Y′ has opened its contact $22_{y'}$. Since relay U′ is slow acting it opens its contacts some time after the release of the relay Y′. The contacts $26_{u'}$ and $27_{u'}$ remain closed for a little while, so that the relay Q is energized and only again released after a little while. The trunk operator at A has received the clearing signal. She cuts in in the usual manner and then releases the connection with the local subscriber $T_4$ by withdrawing the plug and releases the connection with the subscriber in the distant automatic exchange by connecting up battery $B_5$ at the key $MS_1$. Thus the positive and negative poles of the battery $B_5$ are again connected to the *a* and *b* leads, respectively, of the trunk line FL. Hence the polarized relay M again operates its contacts, openings $13_m$, $14_m$ $15_m$ and closing $1_m$, $2_m$, $3_m$. By opening the contact $15_m$ the relays R′ and V′ are released. The relay R′ opens its contacts $16_{r'}$, $17_{r'}$, $18_{r'}$. Hence at contacts $17_{r'}$ and $18_{r'}$ the relays L*t*′ and *ab*′ are disconnected, while at contact $16_{r'}$, the test circuit for the automatic connection is released.

Since relays R and V were not energized during the connection of subscriber $T_4$ with subscriber $T_2$, the relay G was likewise de-energized. Hence the impulse sender $Sch_1$ of the number sender was at contact $31_g$ connected to a free line to the first selector I.GW so that already during the conversation between $T_4$ and $T_2$ a new connection could be prepared. For this purpose, the selecting devices were set in the manner already described.

With pre-announced long distance calls, the wanted subscriber is reached as soon as the connection is set up, so as to use the long distance lines to the maximum extent, it is preferable that the call for notifying the wanted subscriber should not be sent over the line FL by the long distance operator at the calling exchange A, but the wanted subscriber should have the coming conversation notified by a special long distance operator in the wanted long distance exchange B. The call can for instance be effected as follows:—

The calls arriving at the long distance exchange A are announced to the operator at B, in the order of their arrival, in the shape of a telegram (subscriber's number and name) by means of high speed telegraph instrument. The operator at B noted in succession the wanted subscriber's numbers (with corresponding remarks). Assuming that conversation is taking place over the long distance line FL, trunk line $VL_1$, and the selecting devices I.GW, II.GW and LW, the, as described, the devices I.GW′ and II.GW′ and LW′ for preparing the next connection are set. As soon as the contact arm $Zr_5$ of the number sender ZG reaches the last contact 29, the relay H′ is energized as follows: earth, contact arm $Zr_5$, contact 29, contact $30_g$, 31, relay H′, battery, earth. The relay H′ connects itself over its contact $32_{h'}$ in a holding circuit. On operating, the relay H′ lights the lamp ML′ connected in parallel. Thereby the operator recognizes that a new connection is prepared and calls the subscriber, e. g. $T_2$ by throwing in to the speaking position the key AH′ associated with a trunk line $VL_2$. At contact 33 of the key a circuit is closed for the ringing relay LT′, earth 33, L*t*′, $25_{ab'}$, 10-second switch SK′, battery, earth. The relay L*t*′ is energized every 10-seconds and sends ringing current over its contacts $19_{lt'}$ and $20_{lt'}$ to the subscriber. Furthermore by throwing the listening key AH′ into the speaking position at contact 31, the circuit for relay H′ and lamp ML′ is opened, whereby the relay H′ is de-energized and the lamp ML′ is extinguished. As soon as the subscriber answers, relay Y′ is energized by speech current. Thereby its contact $21_{y'}$ is closed, so that the relay A*b*′ is energized. The relay A*b*′ at contact $25_{ab'}$ disconnects the relay L*t*′, thus ringing ceases. The operator now informs the subscriber that he will be called by the trunk exchange in a few minutes. If the wanted subscriber cannot be reached, the trunk call must be deferred. The operator at B notifies this to the operator at A by means of the high speed telegraph.

If it is to be made possible for the op-

erator at exchange A to send the impulses (signals) for setting the selecting devices without the assistance of the telegraphist at the high speed telegraph transmitter, her sender is arranged as shown in Fig. 5. In this arrangement a key set is provided which resembles the transmitting key set of the high speed telegraph and has 10 number keys $T_1$ to $T_{10}$ and T*a* and a key A*n*T. For the sake of clearness the drawing only shows the keys $T_1$, $T_2$, T*a* and A*n*T. By depressing key T*a* the transmission of impulses for connecting up the register UR (Figs. 2 and 3) at the distant exchange B is started. With the sending arrangement according to Fig. 5 moreover a stepping switch $SW_1$ is provided, which has 12 contacts rows, $K_I$ to $V_I$ and $K_{Ia}$ to $V_{Ia}$ located in pairs opposite each other. Each contact row has 10 contacts. The contact rows $K_{IIa}$ to $V_{Ia}$ are provided with five groups $C_I$ to $C_V$ of five condensers. The condensers 1 to 5 of each group $C_I$ to $C_V$ are so connected in multiple with the ten contacts of the corresponding rows of contacts $K_{IIa}$ to $V_{Ia}$, that the same condenser is connected at contacts 1 and 6, 2 and 7, 3 and 8, 4 and 9 and 5 and 10.

Since each signal comprises a combination of five positive or negative impulses in a definite order, there are fitted below the keys T*a*, $T_1$, etc., five groups of three metal rails $Sn_{11}$, $Sn_{1m}$, $Sn_{1r}$ etc., perpendicular to the swinging direction of the keys, one of the outer of these rails, e. g. $Sn_{11}$, of each group is connected to the positive pole of the battery $B_7$ and the other outer rail, e. g. $Sn_{1r}$, of each group is connected with the negative pole of battery $B_8$, while the middle rails $Sn_{1m}$, $Sn_{2m}$, etc., are connected to contacts of the stepping switch $SW_1$. For the sake of clearness, the rails $Sn_{11}$, $Sn_{1m}$, $Sn_{1r}$, etc., are shown located in the plane of the paper, although they actually run at right angles to the plane of the paper on the assumption that the keys T*a*, $T_1$, etc., swing parallel to the plane of the paper. At the under side of the keys, the contact pieces $K_{21}$, $K_{22}$, are pivotally fixed and connect the positive pole of the battery $B_7$ or the negative pole of battery $B_8$ with the corresponding middle rail e. g., $Sn_{1m}$, on the depression of each key corresponding to the number of the key, thus combinations of positive and negative currents corresponding to the number, are generated.

The stepping switch $SW_1$ is so arranged that by closing the loop arm RM*a*, $RM_1$, etc., the similarly numbered contacts 1, 2, 3 etc., of the contact rows $K_I$, $K_{Ia}$ and $K_{II}$, $K_{IIa}$, etc., located opposite each other are bridged in succession.

It is assumed that the operator at the exchange A wants to set up a connection with the subscriber 1475 in the distant exchange B. For this purpose the operator depresses for the key T*a*. This key corresponds to the preparatory or calling signal, the current combination of which at the distant exchange B effects the connecting up of the register UR (Fig. 2). The contact pieces $k_{2i}$ of the key T*a* connect the positive pole of the battery, with the middle rails $Sn_{1m}$, $Sn_{2m}$, etc., since the switch arms $RM_1$, R*ma* etc., of the stepping switch $SW_1$ normally rests on the contacts are connected over the contacts 1 of the contact rows $K_{II}$ $V_I$ and $K_{IIa}$ to $V_{Ia}$ with the condensers 1 of the groups $C_I$ to $C_V$. However at the next movement the switch arms RM*a* etc., of the switch $SW_1$ move into position 2, since the rotary magnet was energized over contact $k_{11}$, closed by the depressing of the key T*a*; earth, contact $k_{11}$, of key T*a*, winding of rotary magnet DM, battery, earth. The switch arms RM*a*, $RM_1$, etc., for the present remain in position 2.

If now the key T is depressed, the middle rails $Sn_{1m}$ are by the contact pieces $k_{20}$ to $k_{30}$ connected with the positive pole of battery $B_7$ or with the negative pole of battery $B_8$. The condensers 2 of the groups $C_I$—$C_V$ are now, over contacts 2 of the contact rows $K_{II}$ to $V_I$ or $K_{IIa}$ to $V_{Ia}$ of the switch and over the middle rails $Sn_{1m}$, $Sn_{2m}$ etc., connected to the batteries and correspondingly receive a positive or negative charge. Over contact $k_{12}$ of key $T_1$ the rotary magnet DM again receives an impulse, so that it moves the wipers RM*a*, $RM_1$, etc., into position 3. On depressing the keys corresponding to the numbers 4, 7 and 5 the third, fourth and eight condensers of the groups $C_I$ to $C_V$ were charged. The wipers RM*a*, $RM_1$, etc., are now brought into position 6.

The operator having a set the wanted number now depresses a key A*n*T, whereby a starting relay $An_1$ is energized as will now be explained.

The sender $GB_1$ according to Figure 5 is provided, in addition to the usual ring $S_1$ for sending signals to the distant exchanges, with two contact rings $S_{10}$, $S_{11}$, over which run the brushes $Bu_{10}$, $Bu_{11}$ that are coupled to the brush $Bu_1$.

The rings $S_{10}$, $S_{11}$ are provided with a long contact 37 and 38 respectively and a short contact 39 and 40 respectively. These contacts are so arranged that the brushes $Bu_{10}$, $Bu_{11}$, run over the contacts 37, 38 during the time in which the brush $Bu_1$ in succession comes in contact with the contacts $K_1$ to $K_5$. As soon as the brush $Bu_1$ has left the contact $K_5$ the brushes $Bu_{10}$, $Bu_{11}$, come in contact with the contacts 39, 40.

As soon as the brushes $Bu_{10}$, $Bu_{11}$ run onto the contacts 39, 40 the circuit for the starting relay $An_1$ is closed as folows if the before mentioned key A*n*T is depressed: earth, contact 13 of A*n*T, contact 39, brushes $Bu_{10}$,

$Bu_{11}$ contact 40 winding of relay $An_1$, battery, earth. The relay $An_1$ operates and locks itself over it contacts $38_{an1}$: earth, contact 6 of the row $K_{Ia}$ wiper $RMa$, contact 6 of $K_I$, $38_{an1}$, $An_1$, battery, earth. The relay $An_1$ furthermore closes the contacts $31_{an1}$ to $35_{an1}$ as well as the contacts $36_{an1}$ and $37_{an1}$ and opens the contact $41_{an1}$ to $45_{an1}$. By opening the contacts $41_{an}$ to $45_{an1}$ the testing levers, operating in conjunction with the perforated strip, are disconnected. At contact $37_{an1}$, the circuit for the coupling and disconnecting magnet AKM is closed as well as for the switching relay P; whereby the paper strip at the sender is stopped and thus the transmission of the telegram is interrupted. Over the contacts $31_{an1}$ to $35_{an1}$ the contacts 6—10 of the contact rows $K_{II}$ to $K_{VI}$ of the stepping switch $SW_1$ are connected to the ring $S_1$ of the high speed telegraph transmitter, so that on the further operation of this stepping switch the first, second, etc., condensers of the group $C_I$ to $C_V$ discharge themselves in succession over the brush $Bu_1$, corresponding contacts $K_1$, $K_2$, etc., and the line relay $L_1$. This line relay therefore operates its contacts $121_1$ and $131_1$ (Fig. 1) corresponding to the positive or negative discharge of the condensers, so that corresponding current combinations (positive and negative impulses) are transferred over the long distance line FL to the receiver ER (Fig. 2) in the distant exchange.

As soon as, at each rotation of the brushes, the brushes $Bu_{10}$, $Bu_{11}$, run on the contacts 37, 38, the rotary magnet DM of the stepping switch $SW_1$ is energized as follows: earth, contact 37, brushes $Bu_{10}$, $Bu_{11}$, contact 38, contact $36_{an}$, DM, battery, earth. By each operation of the rotary magnet DM the arms $RMa$, $RM_1$, etc. are moved on one step. As soon as the switch arms $RMa$, $RM_1$ etc., have made a complete rotation; that is from the tenth row again onto the first contact, earth potential is withdrawn from the relay $An_1$. The relay $An_1$ opens its contacts. By opening its contact $36_{an1}$, the circuit of the magnet DM is opened. The stepping switch $SW_1$ is again in its normal position. By closing the contacts $41_{an1}$ to $45_{an1}$, the hunting device for the perforated strip is again connected up, while by opening the contact $37_{an1}$, the coupling magnet AKM and the switching relay P are again disconnected. Thereby the coupling for the perforated strip is moved in, so that the perforated strip is moved on and the telegram is transmitted.

I claim:

1. In a code sender, a plurality of condensers, means for charging said condensers, means for successively discharging said condensers over a line circuit after they are all charged to transmit a series of code impulses and a wiper forming part of said charging means and forming also a part of said discharging means.

2. In a code sender for transmitting numbers, a plurality of condensers arranged in sets, there being one set for each digit of a number to be transmitted, means for charging the condensers of each set according to a code representing a particular digit, means for associating each set with a line circuit in turn, one set after the other, means for discharging the condensers of each set over the line circuit in succession to transmit sets of code impulses, and a set of wipers forming a part of the said charging means and forming also a part of said discharging means.

3. In a telephone system, a toll line connecting two exchanges, a toll operator's switchboard in each exchange, automatic switches in the second exchange controlled over said toll line by the operator in the first exchange to connect with a called line, means for automatically signalling the operator in the second exchange responsive to the establishment of the connection, and means controlled by the said last mentioned operator for signalling the subscriber on the connected called line.

4. In a telephone system, a toll line connecting two exchanges, a toll operator's switchboard in the first exchange, automatic switches in the second exchange, means whereby the operator at said switchboard can control a train of said switches over said toll line to establish a talking connection over the toll line between subscribers in said exchanges, means whereby said operator can control a second train of said switches over said toll line to prepare a second connection while the conversation is in progress, and means in the second exchange controlled by said operator for switching the toll line from the first train of switches to the second to complete the prepared connection when the first is finished.

5. In a telephone system, a toll line connecting two exchanges, a toll operator's switchboard in the first exchange, automatic switches in the second exchange, means whereby the operator at said switchboard can control a train of said switches over said toll line to establish a talking connection over the toll line between subscribers in said exchanges, means whereby said operator can control a second train of said switches over said toll line to prepare a second connection while the conversation is in progress, means in the second exchange controlled by said operator for switching the toll line from the first train of switches to the second to complete the prepared connection when the first is finished, and means for automatically transmitting a disconnect signal back over

said toll line to advise the toll operator when each called subscriber hangs up.

6. In a combined telephone and telegraph system, a circuit, means for transmitting sets of code impulses over said circuit, each set corresponding to a letter or figure of a telegram or to a digit in a telephone number, the digits in each telephone number being preceded by a special set of code impulses, a printing telegraph for printing all letters and figures received, and a telephone number decoder responsive to said special code whenever it is received for decoding the number immediately following.

7. In a combined telephone and telegraph system, a circuit, means for transmitting sets of code impulses over said circuit, each set corresponding to a letter or figure of a telegram or to a digit in a telephone number, means for decoding and printing all characters received, means for decoding and registering the telephone numbers, and means for transmitting a special set of code impulses just ahead of each telephone number to indicate a pause in the telegram being transmitted and to start the operation of the telephone number decoding means.

8. In a telephone system, two exchanges, means for connecting a calling line in one exchange with a called line in another exchange comprising a trunk line connecting said exchanges and a train of automatic switches in the second exchange for connecting with the called line, means in the first exchange for translating the called number into a non-decimal code, means for transmitting impulses over said trunk line in accordance wtih said code, a translator at the second exchange responsive to said impulses for decoding the number, and a sender in the second exchange for operating said switches in accordance with the number after it is decoded.

9. In a combined telephone and telegraph system, a telephone line having a telegraph circuit superimposed thereon, a telegraph sender for sending telegraph messages over said line, telegraph receiving apparatus on the distant end of said line responsive to the operation of said sender, operator controlled means for temporarily removing said telegraph circuit from under the control of said telegraph sender and for transmitting impulses representing a telephone number over said line, and automatic switching mechanism on the distant end of said line non-responsive to said telegraph sender, but responsive to said operator controlled mechanism to extend a connection from said line to a desired called line.

10. In a combined telephone and telegraph system, a line, means for transmitting current impulses over said line representing telegraph messages and for transmitting similar impulses representing telephone numbers, telegraph receiving apparatus on the distant end of the line responsive to all of said impulses, and automatic switching mechanism also on the distant end of the line responsive only to the impulses representing telephone numbers.

11. In a combined telephone and telegraph system, a line, means for transmitting current impulses over said line, a telegraph recording device for controlling said means, and a telephone-number recording device also for controlling said means.

12. In a combined telephone and telegraph system, a line, means for sending current impulses over said line, a telegraph recording device for controlling said sending means, a telephone-number recording device for controlling said sending means, and means responsive to the setting of said telephone-number recording device for removing said sending means from under the control of said telegraph recording device and for placing it under the control of said telephone-number recording device.

13. In a combined telephone and telegraph system, a line, means for sending current impulses over said line, a telegraph recording device for controlling said sending means, a telephone-number recording device for controlling said sending means, and means for removing said sending means from under the control of said telegraph recording device and for placing it under the control of said telephone-number recording device.

14. In a combined telephone and telegraph system, a line, means for sending current impulses over said line, a telegraph recording device for controlling said sending means, a telephone-number recording device for controlling said sending means, means for removing said sending means from under the control of said telegraph recording device and for placing it under the control of said telephone-number recording device, and means for rendering the last named means effective responsive to the arrival of said sending means in a given position.

15. In a combined telephone and telegraph system, a line, means for sending series of current impulses over said line, each series representing a separate character, a telegraph recording device for controlling said sending means, a telephone-number recording device for controlling said sending means, means for removing said sending means from under the control of said telegraph recording device for placing it under the control of said telephone-number recording device, and means for rendering the last named means effective responsive to the completion of the transmission of any partially transmitted character.

16. In a combined telephone and tele-

graph system, a line, means for sending current impulses over said line, a telegraph recording device for controlling said sending means, a telephone-number of recording device for controlling said sending means, means for removing said sending means from under the control of said telegraph recording device and for placing it under the control of said telephone-number recording device, and means for delaying the action of the last named means until the sending means arrives in a predetermined position.

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