Nov. 19, 1940. M. LANGER ET AL 2,222,108

AUTOMATIC TELEPHONE SYSTEM

Filed April 23, 1938 5 Sheets-Sheet 1

FIG. 1

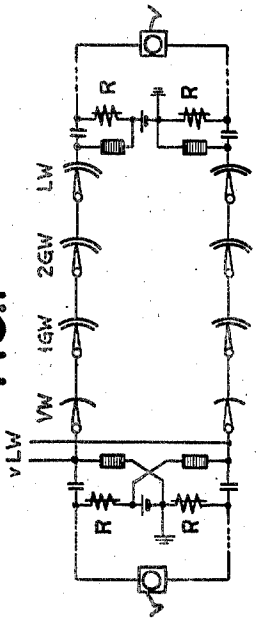
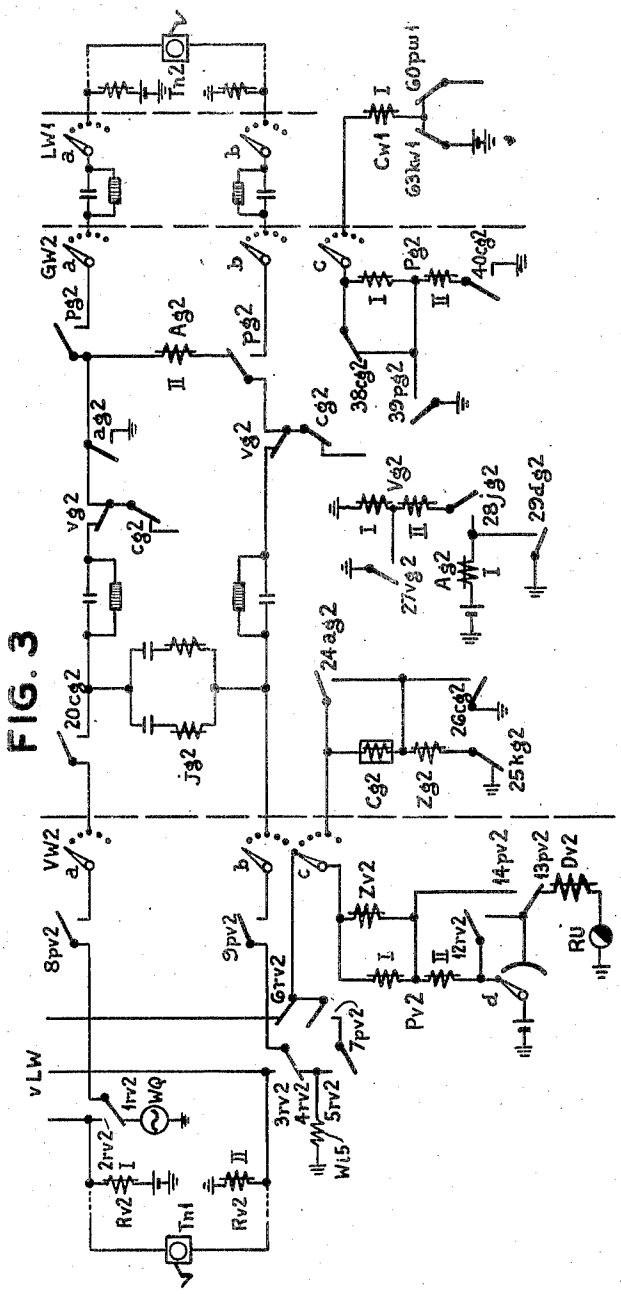


FIG. 3



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AUTOMATIC TELEPHONE SYSTEM

Filed April 23, 1938 5 Sheets-Sheet 2

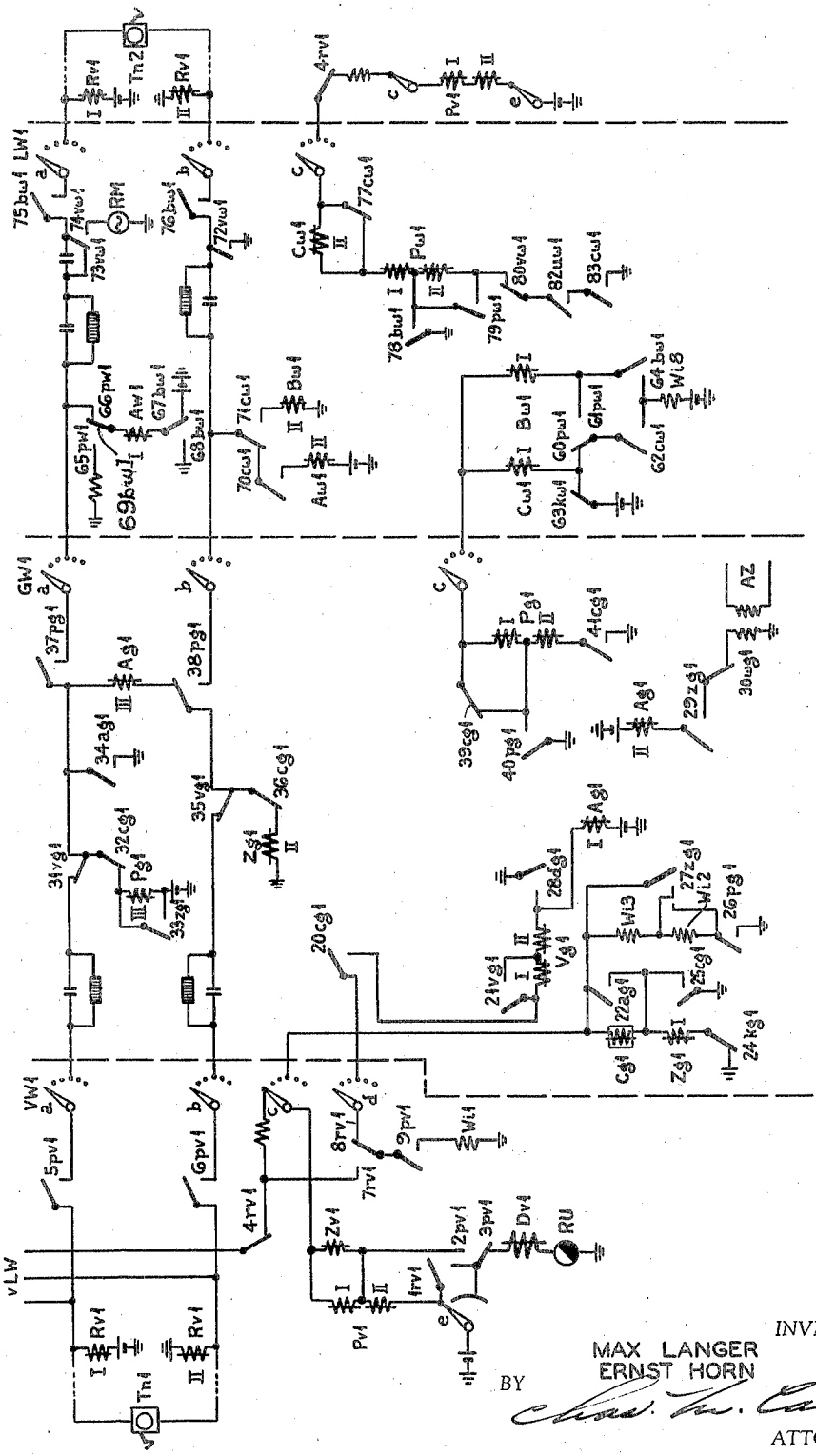


FIG. 2

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AUTOMATIC TELEPHONE SYSTEM

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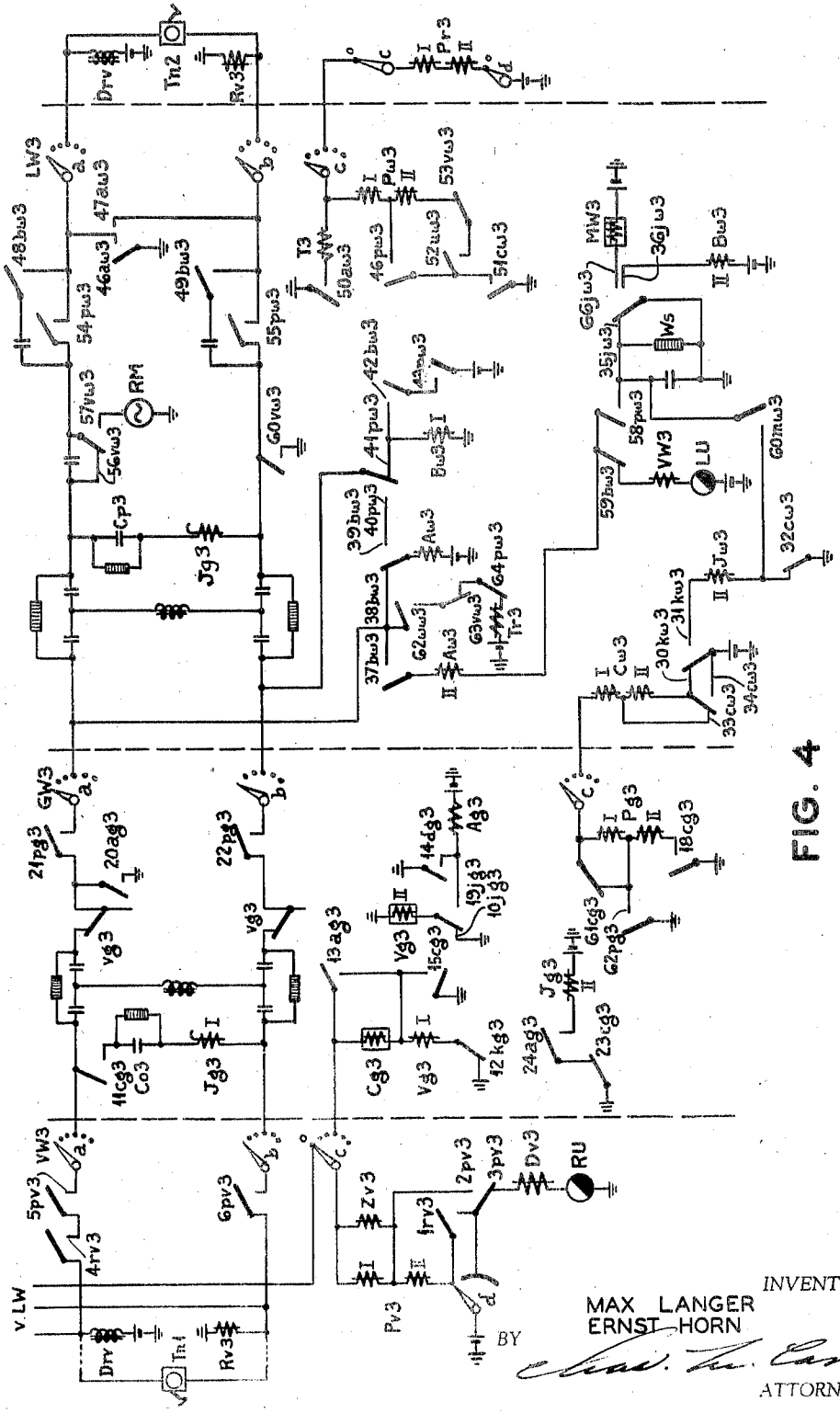


FIG. 4

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AUTOMATIC TELEPHONE SYSTEM

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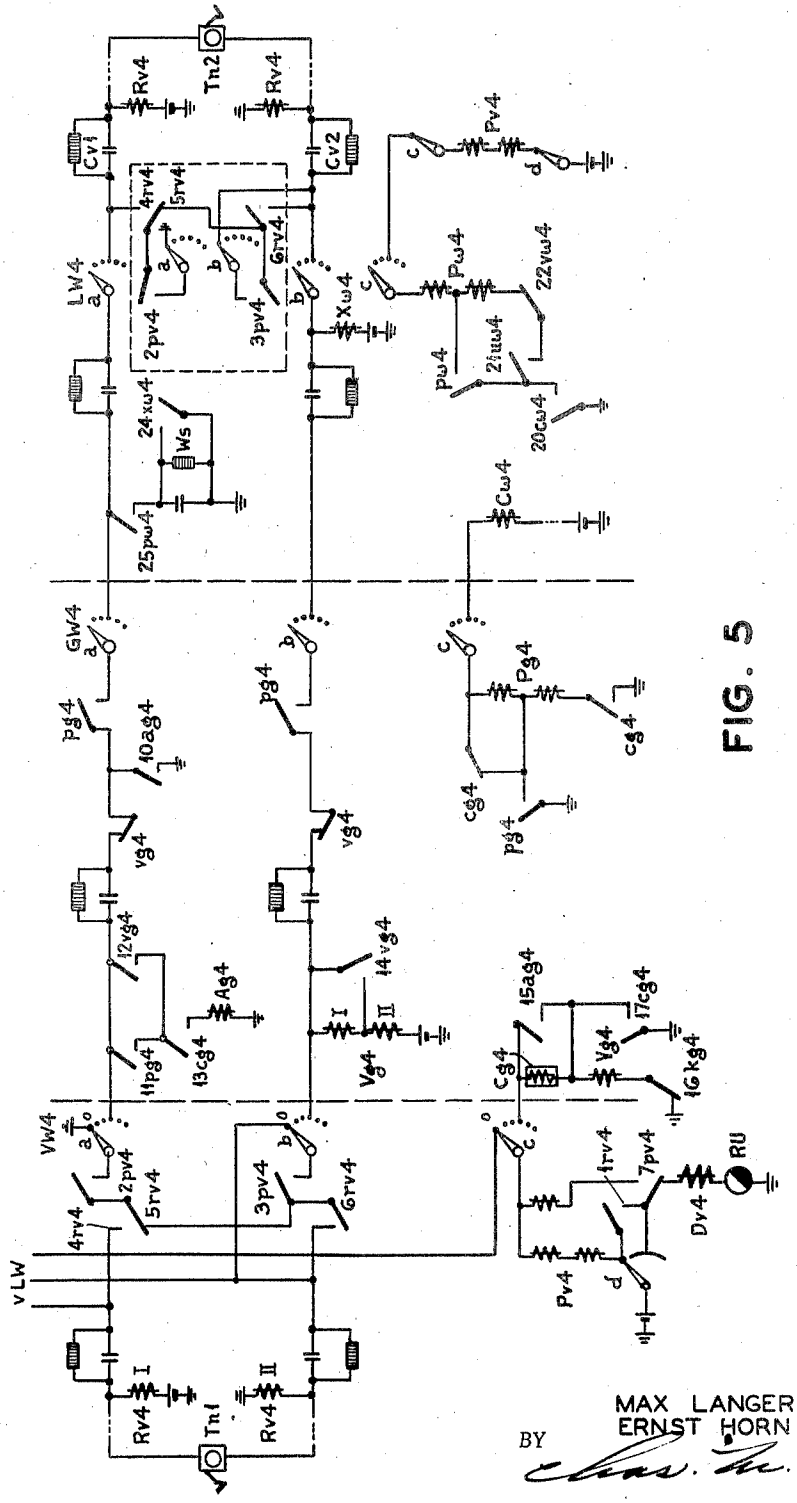


FIG. 5

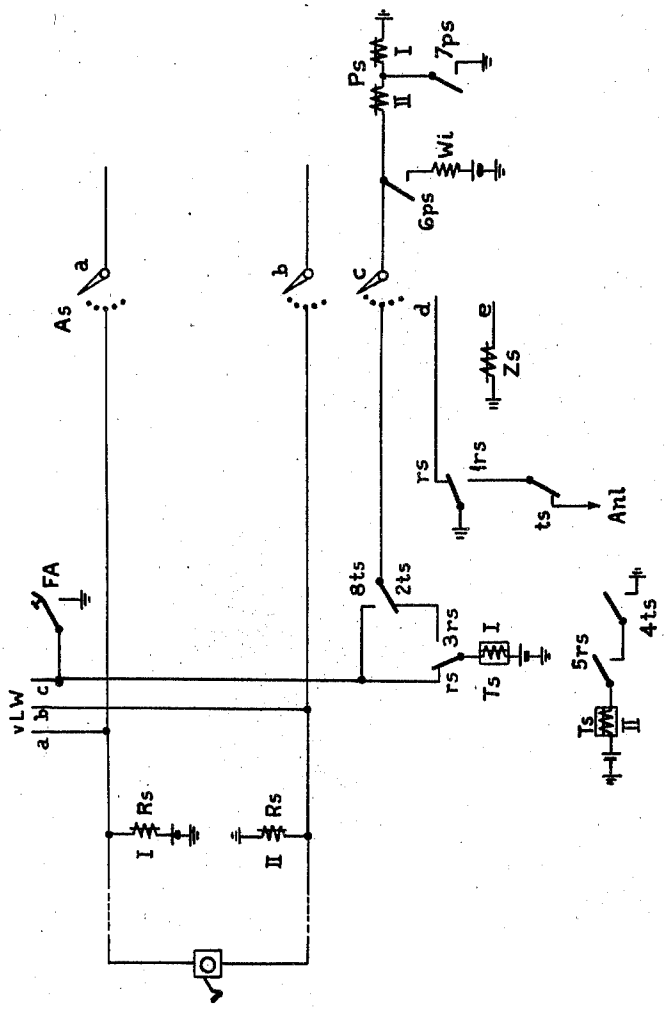
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AUTOMATIC TELEPHONE SYSTEM

Filed April 23, 1938 5 Sheets-Sheet 5

FIG. 6



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Patented Nov. 19, 1940

2,222,108

UNITED STATES PATENT OFFICE

2,222,108

AUTOMATIC TELEPHONE SYSTEM

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Application April 23, 1938, Serial No. 203,926
In Germany April 26, 1937

16 Claims. (Cl. 179—27)

The invention relates to combating disturbances affecting intelligibility in automatic telephone systems.

The calls in such systems are established over switch wipers and relay contacts which in all systems are exposed to a certain amount of chattering. When the contacts conduct substantial currents, such as feeding current or holding currents, for supervisory or release purposes, the chattering leads to undesirable crackling noises in the subscribers' receivers because the chattering varies the resistance of the contacts and thus the strength of the current flowing over these contacts. It has been shown by experiments and experience that the variations in resistance are dependent upon the strength of the current. With large currents considerable variations in resistance arise and with small currents small variations.

On the other hand lengths of line in which no strong currents such as feeding or supervisory currents pass over the switch wipers and relay contacts, but only the weak speech currents, the undesirable phenomenon termed "fading" occurs. The "fading" occurs through the resistance at the contacts becoming very large and this frequently amounts almost to a complete break. The physical cause of this phenomenon has not been altogether satisfactorily explained. It is, however, assumed that the smallest chattering effect already diminishes the specific contact pressure, for example, at switch wipers, to such an extent that the highly polished layer at the contact points represents an insulating layer. Further conditions which assist this phenomenon are the accumulation of dust, oil, and moisture at the contacts. It is known that the blocking layer which is produced is broken down by the application of a potential of the order of 1–60 volts. In the known arrangements for applying the potential at the contacts the switching means such as condensers, which block the passage of direct current are bridged by high resistances which are termed "sintering" resistances.

Although the "sintering" resistances are now used to a large extent, up to the present the whole of the two effects, namely the cracking noises and fading, has not been removed. The invention resides in the new discovery that the known means for neutralizing the disturbances have not been used to a sufficient extent at all the potential points of danger. According to the invention, therefore, all the currents which are liable to prejudice the intelligibility through their variations are only passed over parts of the speaking path which are free from contacts which are sensitive to chattering or over auxiliary leads while all contacts which are exposed to chattering have a high enough potential passed over them to break through the insulating layer produced at the contacts by the "fading" phenomenon.

The attached drawings represent embodiments of the invention:

Fig. 1 shows a circuit layout from which the feeding of the two subscribers connected in a call may be seen. The feeding no longer takes place as in known arrangements from the first group selector for the calling subscriber and from the final selector for the called subscriber, but the subscribers are fed over feeding bridges associated individually with the subscribers' lines, while the wipers of the preselectors and of the final selectors are cut off by means of condensers. The feeding bridge relays are represented by R in the drawings. As may be seen from the circuit layout, the sintering circuits flow separately over one lead of the connecting line from the one pole of the feeding battery of one subscriber to the corresponding opposite pole of the feeding battery of the other subscriber while bridging the condensers over high resistances. The signalling and supervisory circuits which are required for the impulses and clearing signal transmission are not shown in this diagrammatic layout.

These circuits also must, of course, be so arranged that during the speaking condition only the speech currents and the "sintering" currents pass over the switch wipers and relay contacts disposed in the connection. Figs. 2–6 represent the solutions of this problem as well as disclosing the new manner of feeding the subscribers.

Fig. 2 shows an arrangement in which the impulsing and transmission of the clearing signal on the part of the calling subscriber is controlled over a special auxilary group selector. In contrast with this the clearing signal is transmitted by the called subscriber over the testing leads; in detail the figure shows the first preselector VW1, a first group selector GW1 and a local-and-toll final selector LW1.

The mode of operation of the arrangement is as follows: When the calling subscriber Tn1 takes up his receiver the feeding bridge relay Rv1 energizes over the closed subscriber's loop: earth, winding II of relay Rv1 the *b*-lead, the closed loop over subscriber Tn1, *a*-lead, winding I of relay Rv1, battery and earth. At contact 1rv1 the following circuit is completed over the rotary magnet of the preselector: earth, interrupter RU, rotary magnet Dv1, contact 3pv1 and 1rv1,

wiper *e* of the preselector in the zero position, battery and earth. The preselector commences to rotate. After leaving the zero position the circuit for the rotary magnet is maintained over wiper *e* and the continuous contact segment. When the switch has found a free line, the following testing circuit is closed: earth, battery, wiper *e* of the preselector, the contact segment, contact *1rv1*, windings II and I of relay P*v1*, wiper *c* of the preselector, the winding of relay C*g1* of the first group selector, the winding of relay Z*g1*, off-normal contact **24***kg1* and earth. In the first preselector the testing relay P*v1* energizes and by opening contact **3***pv1* brings the switch to rest. High resistance winding II of **5***v1* is short-circuited at contact **2***pv1* and the seized line is guarded against further seizure. Contacts **5***pv1* and **6***pv1* switch the two speaking leads through to the first group selector.

In the first group selector GW1 the seizing relay C*g1* energizes and also relay Z*g1* in series with it. Relay Z*g1* at contact **29***zg1* completes a circuit for transmitting the public exchange signal to the calling subscriber. This passes over earth, transformer AZ, rotary off-normal contact **30***wg1*, contact **29***zg1*, winding II of relay A*g1* and earth, and is thence transmitted inductively to winding III of relay A*g1* and from there back to the calling subscriber. Relay C*g1* closes its contact **25***cg1* and holds up after the first vertical step of the switch. Furthermore, relay C*g1* closes its contact **20***cg1* and thereby prepares the impulsing circuit for the impulse receiving relay A*g1*.

When the calling subscriber dials, the subscriber's loop is opened and closed alternately. Each time the loop is interrupted the feeding bridge relay R*v1* of the calling subscriber releases transitorily. When relay R*v1* releases the following impulse circuit is closed: earth, resistance W*i1*, contacts **9***pv1* and **8***rv1*, wiper *d* of the first preselector, the *d*-lead, contact **20***cg1*, windings I and II of relay V*g1*, winding I of the relay A*g1*, battery and earth. Relay A*g1* transmits the impulses to the first vertical magnet of the first group selector. The switch is raised on the level corresponding to the impulse train. On the first impulse relay V*g1* is energized in series with relay A*g1*. Relay V*g1* acts as a slow relay on account of the short-circuit across its winding I at contact **21***vg1*. It holds up during the impulse train. At the end of the impulse train relays A*g1* and V*g1* release. Relay V*g1* switches over to the rotary magnet. The switch hunts freely over the selected level. Each time the rotary magnet draws up contact **28***dg1* is closed and relay A*g1* is energized and controls the rotary magnet circuit. When the switch has found a free line, the following testing circuit is closed: earth, contact **41***cg1*, windings II and I of relay P*g1*, wiper *c* of the first group selector, winding I of relay C*w1*, off-normal contact **63***kw1*, battery and earth. The testing relay in the group selector brings the switch to rest, the high resistance windings II of relay *Pg1* is short-circuited at contact **40***pg1* and the selected line is guarded against further seizure. The two speaking leads are switched through by the closing of contacts **37***pg1* and **38***pg1*.

In the final selector LW1 the seizing relay C*w1* energizes. Relay C*w1* closes its contact **62***cw1* over which the relay holds up after the off-normal contact **63***kw1* is opened after the first vertical step of the switch. The impulses for setting the final selector which are transmitted by the calling subscriber are transmitted from the first group selector to the final selector impulse receiving relay over the following path: earth, contacts **34***ag1*, **37***pg1*, wiper *a* of the first group selector, contact **66***pw1*, winding I of relay A*w1*, contact **67***bw1*, battery and earth. Relay A*w1* energizes impulsively and transmits the impulses to the vertical magnet of the final selector in a manner which is not shown. The switch is raised to the level corresponding to the impulses. At the end of this impulse train the operating circuit is switched over to the rotary magnet of the final selector in the known way by the aid of two slow relays V*w1* and U*w1*. The last impulse train is also transmitted to the impulse receiving relay A*w1* of the final selector by contact **34***ag1*. The final selector switches round in the selected level on to the wanted subscriber's line. After the switch has been set the relays V*w1* and U*w1* make delayed releases in succession. The following testing circuit is therefore closed before relay U*w1* has released: earth, contacts **33***cw1*, **82***uw1*, and **80***vw1*, windings II and I of relay P*w1*, winding II of the relay C*w1*, wiper *c* of the final selector, contact **4***rv* of the first preselector, wiper *c* of the first preselector in the zero position, windings I and II of relay P*v1*, wiper *e* of the preselector in the zero position, battery and earth. In this circuit the two testing relays P*w1* of the final selector and P*v1* of the preselector energize. Relay P*w1* in the final selector opens the rotary stepping circuit (not shown). Through the closing of contact **79***pw1*, the high resistance winding of the testing relay is short circuited and the seized line is guarded. Relay P*w1* now closes the following circuit for relay A*w1*: earth, contact **65***pw1*, winding I of relay A*w1*, contact **67***bw1*, battery and earth. Relays A*w1* and P*w1* complete a circuit for relay V*w1* which is not shown and which at this stage of the connection serves as a "ring-connecting" relay. Relay P*w1* moreover breaks the circuit for winding I of seizing relay C*w1* at contact **60***pw1*. Relay C*w1* holds up however over its winding II which is in series with the testing relay P*w1* in the testing circuit. Relay B*w1* is energized over contact **61***pw1* over the testing lead from the first group selector: earth, contact **40***pg1*, winding I of relay P*g1*, wiper *c* of the first group selector, winding I of relay B*w1*, contact **61***pw1*, **62***cw1*, resistance W*i8*, battery and earth. Relay BW1 closes its contact **64***bw1* and thus locks up in the seizing circuit independent of relays P*w1* and *Gw1*.

The ringing current of the called subscriber passes over the following path: earth, the ringing machine RM, contacts **74***vw1* and **75***bw1*, wiper *a* of the final selector, the closed loop at subscriber's station T*n2*, wiper *b* of the final selector, contacts **76***bw1* and **72***vw1* and earth. When the called subscriber replies his feeding bridge relay R*v1* energizes over the closed loop. Relay R*v1* breaks the testing lead in the called party's preselector by opening contact **4***rv1*. Accordingly the testing relay P*w1* releases in the final selector LW1. Relay C*w1* in series with this relay also releases. The testing relay in the called party's preselector on the other hand now holds up in the following local circuit: earth, resistance W*i1*, contacts **9***pv1* and **7***rv1*, wiper *c* of the preselector in the zero position, windings I and II of relay V*w1* wiper *e* of preselector in the zero position, battery and earth.

In the final selector relay A*w1* releases after the release of relay P*w1*. The release of relays

Pwl and Cwl also caused the interruption of the circuit for the "ring-connecting" relay Vwl. After the release of relay Pwl earth is applied to the a-lead over: earth, contact 68bwl, winding I of relay Awl, contact 66pwl, and the a-lead as a signal that the wanted party has replied. After relay Cwl has released metering potential is applied to the b-lead over: earth, battery, winding II of relay Awl, contacts 69bwl and 70cwl and the b-lead.

The two subscribers can now converse together.

When at the end of the call the called party replaces his receiver, his feeding bridge relay Rvl releases. The release of relay Rvl causes the testing lead to be switched through to the final selector over contact 4rvl. Over this circuit the testing relay Pvl on the one hand holds up in the called subscriber's preselector and on the other hand the testing relay Pwl in the final selector energizes in this circuit over: earth, battery, wiper e of the preselector, windings I and II of relay Pvl, wiper c of the preselector, contact 4rvl, wiper c of the final selector, contact 77cwl, winding I of relay Pwl, contact 78bwl and earth. It is not possible for relay Cwl to energize over its winding II in series with the testing relay because this winding is finally short-circuited over contact 77cwl on the release of the relay. Relay Pwl in the final selector removes the earth from the a-lead by opening contact 66pwl. By this means in long distance working the called subscriber's clearing signal is indicated at the long distance operator's position.

If now the calling subscriber also replaces his receiver his feeding bridge relay Rvl likewise releases. After relay Rvl is released the following circuit is completed for relay Agl in the first group selector GWl: earth, resistance Wil, compacts 9pvl and 8rvl, wiper d of the preselector VWl, contact 20cgl, windings I and II of relay Vgl, winding I of relay Agl, battery and earth. Relay Agl energizes over a prolonged period in this circuit. At contact 22agl the seizing relay Cgl is short circuited for a similar period and deenergizes. Before it does so, however, the call is metered. A long earthing impulse is transmitted to the final selector LWl over the a-lead by contact 34agl when relay Agl energizes and this causes switching in the final selector so that in the case of local traffic earth potential is again applied to the a-lead. Through this potential, winding III of Pgl of the first group selector is energized. Thus relay Pgl does not release in spite of relay Cgl having short-circuited its winding I at contact 39cgl. The connection to the succeeding switch is maintained over: earth, contacts 40pgl and 39cgl and the connection to the preceding selector over earth contact 26pgl and resistance Wi2 and Wi3. After relay Cgl has released the metering relay Zgl energizes over: earth, the winding II of Zgl, contacts 36cgl and 38pgl, wiper b of the group selector, contacts 70cwl and 69bwl, winding II of relay Awl, battery and earth. Relay Zgl of the first group selector energizes and by closing its contact 27zgl short-circuits the resistances Wi2 and Wi3, and thereby increases the current over the c-lead whereby the meter ZVl in the preselector of the calling subscriber is energized. Relay Zgl short-circuits winding III of relay Pgl at contact 33zgl. Relay Pgl releases. Consequently both the seizing circuit to the calling party's preselector and also the testing circuit to the final selector are broken. In the preselector VWl relay Pvl releases. The selector steps around over its wiper e, the contact segment and contact 3pvl until it reaches the zero position.

On account of the breaking of the test lead from the first group selector relay Bwl in the final selector releases. Relay Bwl first breaks the testing circuit to the called party's preselector at contact 78bwl. In addition it disconnects the metering potential from the b-lead and also by opening contacts 75bwl and 76bwl it disconnects both the speaking leads and finally completes a circuit (not shown) for the rotary magnet of the final selector over which this is restored to normal. When the testing circuit to the preselector of the called party is broken, the test relay Pwl in the final selector also releases as does the testing relay Pvl in the called party's preselector.

For the sake of completeness it will be mentioned at this point that the final selector LWl is also adapted for trunk working for on the establishment of trunk calls which in the normal way are set up over a trunk group selector which is multipled to the first group selector GWl which is shown, it is possible in the event of the wanted subscriber being engaged in a local call to establish connection to the engaged line by means of the relay Bwl. The connection to the engaged line is effected by the application of potential to the b-lead at the trunk operator's position, whereupon the following circuit is completed. Potential applied to the b-lead at the trunk operator's position, contact 71cwl, winding II of relay Bwl and earth. The connection takes place at contact 75bwl and 76bwl. The permanent energizing of relay Bwl after the "busy" connecting impulse has terminated, is prevented in that after the closing of contact 64bwl, winding I of this relay is disposed in a branch circuit in parallel with the seizing relay Cwl over resistance Wil and contacts 62cwl and 60pwl (relay Pwl is not yet energized) over which circuit winding I of relay Dwl does not receive sufficient current to maintain its armature attracted. Moreover, winding I of relay Bwl is arranged as a counter winding II.

The "sintering" circuit for the contacts passes separately over the two speaking leads, namely from earth in the final selector over contact 68bwl, winding I of relay Awl, contact 66pwl and the a-lead in both directions to potential at the two feeding batteries. The "sintering" current for the b-lead passes over earth, battery, winding II of relay Awl, contacts 69bwl and 70cwl in both directions to the earthed pole of the feeding batteries of the two subscribers. The condensers disposed in the speaking leads are shunted by high resistances in the usual way.

Fig. 3 shows a further embodiment of the invention. The first preselector is denoted by VW2 and the first group selector by GW2. The final selector used in the final selector LWl shown in Fig. 2. In this embodiment in contrast to the embodiment according to Fig. 2, a separate auxiliary lead between the first preselector and the first group selector is dispensed with. The transmission of the impulses in this case is by means of alternating current, for example ringing current. Also the calling subscriber's clearing signal is transmitted from the

first preselector to the group selector by means of alternating current. Signals are received in the first group selector by an alternating current relay which is disposed in a bridge across the speaking leads and is guarded against direct current by condensers. The two subscribers are fed as in all the embodiments of the invention over feeding bridges associated individually with the subscribers' lines. By this arrangement the sections of the connecting path containing relay and switch contacts which are exposed to vibrations are kept clear of large currents such as the feeding currents or supervisory currents.

The mode of operation of the arrangement is as follows: When the calling subscriber takes up his receiver his feeding bridge relay R*v*2 energizes over the closed subscriber's loop. The rotary magnet of the preselector is switched on over contact 12*rv*2; the preselector is in operation. As soon as it finds a free line, the testing relay P*v*2 energizes over the testing wiper *c* of the preselector and the seizing relay C*g*2 of the first group selector which is also disposed in the testing circuit energizes over: earth, battery, wiper *d* of the selector VW2, the contact segment, contact 12*rv*2, windings II and I of relay P*v*2, wiper *c* of the preselector VW2, the winding of relay C*g*2, the winding of relay Z*g*2, off-normal contact 25*kg*2 and earth. Relay P*v*2 in the preselector brings the preselector to rest and switches the speaking leads through to the group selector.

Relay C*g*2 in the group selector GW2 switches through the *a*-lead at contact 20*c*2 and at contact 26*cg*2 a holding circuit is established for relay *cg*2, which is independent of the off-normal contact. Finally, through the closing of contact 40*cg*2 and the opening of contact 38*cg*2, the testing circuit to the final selector is prepared.

When the calling subscriber dials the wanted number, his feeding bridge relay R*v*2 releases impulsively. When relay R*v*2 releases, alternating current is applied to the speaking leads and the impulse receiving relay J*g*2, in the first group selector is energized over: earth, resistance W*i*5, contacts 4*rv*2 and 9*pv*2, wiper *b* of the preselector, the alternating current relay J*g*2, contact 20*cg*2, wiper *a* of the preselector, contacts 8*pv*2 and 1*rv*2, the source WQ of alternating current and earth. Relay J*g*2 in the group selector GW2 energizes in response to these impulses and repeats them to relay A*g*2 over: earth, windings I and II of relay V*g*2, contact 28*jg*2, winding I of relay A*g*2, battery and earth. In this circuit the relays V*g*2 and A*g*2 energize. Relay V*g*2 short-circuits its winding in the usual way over its contact 27*vg*2. It consequently works as a slow relay and holds up throughout the impulse train. Relay A*g*2 repeats the impulses to the vertical magnet of the group selector. At the end of this impulse train relay V*g*2 releases and switches on the rotary magnet of the group selector. The selector rotates over the level which has been selected. As soon as it finds a free line the testing relay P*g*2 energizes: contact 40*cg*2, the windings of relay P*g*2, wiper *c* of the group selector, winding I of relay C*w*1, the off-normal contact 63*kw*1, battery and earth. In the test circuit, the seizing relay C*w*1 of the final selector also energizes.

The further switching operations take place in the same way as has been described in the preceding embodiment.

The signal for taking up of the receiver by the called subscriber is controlled over the testing lead between the preselector of the called party and the final selector as is also the signal for the replacement of the receiver.

When at the end of a call, the calling party hangs up his feeding bridge relay R*v*2 releases. The speaking leads between the calling subscriber and the first group selector are broken through the opening of contacts 2*rv*2 and 3*rv*2. Alternating current is applied to the leads of the line of the first group selector GW2 over the contacts 1*rv*2 and 4*rv*2. The alternating current relay J*g*2 energizes over a prolonged period and short-circuits the seizing relay C*g*2 over its contact 24*ag*2 for a corresponding time. Relay C*g*2 is caused to release. After the metering has been carried out as described in the preceding example, the first group selector releases and therefore also the first preselector in the final selector.

Fig. 4 shows a third embodiment of the invention in connection with the establishment of a connection comprising a first preselector VW3, a first group selector GW3 and a local and final trunk selector LW3. This embodiment is similar to the preceding one in so far as a separate auxiliary lead for impulsing and supervising the calling party between the first preselector and the first group selector is dispensed with. The impulse and supervision of the calling subscriber also takes place over the speaking leads in this arrangement, not by means of alternating current and alternating current receiving relays but by the aid of the charging and discharging currents of condensers by means of which serially arranged polarized bridge relays are operated. In this arrangement also all sections of the line which at the contacts are exposed to vibration, are kept free of feeding and supervisory currents.

The mode of operation of the arrangement is as follows: When the calling party T*n*1 takes up his receiver the feeding bridge relay R*v*3 is energized over the closed subscriber's loop. At contact 1*rv*3 the rotary magnet D*v*3 of the preselector is operated over: earth, battery, wiper *d* of the preselector, contacts 1*rv*3 and 3*pv*3, the rotary magnet D*v*3, interrupter RU and earth. The preselector is set in operation and searches for a free line. As soon as this is found the testing relay P*v*3 energizes over the test wiper *c* of the preselector. Relay P*v*3 brings the switch to rest and guards the seized line against further seizure. Finally the two speaking leads are switched through to the first group selector by contacts 5*pv*3 and 6*pv*3.

In the first group selector GW3, the seizing relay C*g*3 also energizes in the testing circuit: earth, battery, wiper *d* of the first preselector, contact 1*rv*3, the windings of the testing relay P*v*3, wiper *c* of the preselector VW3, the windings of relays C*g*3 and V*g*3, off-normal contact 12*kg*3 and earth. Relay V*g*3 connects the public exchange signal to the calling subscriber in a manner which is not shown here. Relay C*g*3 prepares the testing circuit by closing its contact 18*cg*3. Relay C*g*3 holds up over contact 15*cg*3 after the switch has made its first vertical step. The polarized relay J*g*3 is connected across the leads of the line over contact 11*cg*3. The condenser C*o*3 is therefore charged over the following circuit: earth, the winding of relay R*v*3, contact 6*pv*3, wiper *b* of the first preselector VW3, winding I of relay J*g*3, condenser C*o*3, contact 11*cg*3, wiper *a* of the first preselector VW3, contacts 5*pv*3 and 4*rv*3, the choke-coil D*rv*, battery and earth. The polarized relay J*g*3 is so adjusted that it does not switch over its arma-

ture in response to this charging impulse. It may be mentioned at this point that beyond the polarized relay there is arranged a blocking circuit in the speaking leads comprising two condensers in each lead and a choke coil which prevents the charging and discharging impulses from being extended.

When the calling subscriber dials the wanted number, the subscriber's loop is alternately opened and closed. When the subscriber's loop is opened the circuit for the bridge relay R*v*3 of the calling subscriber is broken. The "disconnect" impulse of relay R*v*3 operates to discharge the condenser C*o*3, the discharge current flowing over the windings of relay R*v*3. A fresh charging of the condenser (relay R*v*3 releases) is prevented by the opening of the *a*-lead at contact 4*rv*3. When the subscriber's loop is closed relay R*v*3 is energized again. Contact 4*rv*3 switches the *a*-lead through again and the condenser is charged afresh. These operations are repeated alternately throughout the course of the dialling. In response to the discharge impulse over the condenser C*o*3 when the loop is broken for the first time, relay J*g*3 switches over its contacts. When the loop is closed it restores its contacts to normal. When relay J*g*3 has operated its armature the following circuit is closed: earth, winding II of relay V*g*3, contact 19*jg*3, the winding of relay A*g*3, battery and earth. In this circuit the relays V*g*3 and A*g*3 energize. Relay V*g*3 holds up during the impulsing because it is slow to release. Relay A*g*3 repeats the impulses to the vertical magnet of the group selector. After this impulse train, the operating circuit is transferred to the rotary magnet of the group selector by relay V*g*3. The rotary magnet searches freely for a free line. As soon as such a line is found, relays P*g*3 and C*g*3 energize in the testing circuit: earth, contact 18*cg*3, windings II and I of the testing relay P*g*3, wiper *c* of the first group selector, winding I of the relay C*w*3 in the final selector, contact 33*cw*3, off-normal contact 30*kw*3, battery and earth. The testing relay in the group selector brings the switch to rest in the known way, guards the seized line against further seizure and switches through the speaking leads.

The seizing relay C*w*3 in the final selector LW3 opens its contact 33*cw*3 and closes its contact 34*cw*3. The high resistance winding II of relay C*w*3 is thereby connected in the seizing circuit. The relay holds up in this circuit independently of the off-normal contact of the final selector.

When the calling subscriber transmits the impulses for setting the final selector, his feeding bridge relay R*v*3 energizes and deenergizes impulsively. In response to this the polarized receiving relay J*g*3 alternately moves its contact into the operated and rest positions. Consequently relay A*g*3 is operated impulsively in the first group selector. Relay A*g*3 transmits the impulses to the impulse receiving relay A*w*3 of the final selector over the following circuit: earth contacts 20*ag*3 and 21*pg*3, wiper *a* of the first group selector, contact 38*bw*3, winding I of relay A*w*3, battery and earth. Relay A*w*3 repeats the impulses to the vertical magnet of the final selector. The switch is raised to the desired level. The last impulse train is similarly transmitted to the receiving relay A*w*3 of the final selector. This repeats the impulses to the rotary magnet and the final selector is stepped to the wanted subscriber's line. If the wanted subscriber is free the following testing circuit is completed during the release period of slow relay U*w*3 which is not shown: earth, contacts 51*cw*3, 52*uw*3 and 53*vw*3, windings II and I of relay P*w*3, wiper *c* of the final selector, wiper *c* of the preselector of the called party in the zero position, windings I and II of relay P*v*3, wiper *d* of the preselector in the zero position, battery and earth. Relay P*v*3 in the preselector opens its contact 3*pv*3 and thereby prevents this switch from operating. The test relay P*w*3 of the final selector brings the switch to rest, guards the seized line against further seizure by short-circuiting high resistance winding II at contact 46*pw*3 and switches through the speaking leads to the called line over its contacts 54*pw*3 and 55*pw*3.

In the final selector there is disposed the winding I of a polarized relay J*w*3 across the speaking leads in series with a condenser C*p*3. After the speaking leads have been switched through to the called line the condenser C*p*3 receives a charging impulse over the called party's feeding bridge: earth, winding of relay R*v*3, wiper *b* of the final selector, contact 55*pw*3, relay J*w*3, condenser C*p*3, contacts 56*vw*3 and 54*pw*3, wiper *a* of the final selector, choke-coil D*rv*, battery and earth. Relay J*w*3 is so adjusted as not to energize in response to this impulse. Consequently a circuit is closed after the energization of relay P*w*3 over a winding of relay VW3, which now serves as the ring-contacting relay: earth, contacts 35*iw*3, 38*pw*3 and 59*bw*3, winding of relay VW3, interrupter LU, battery and earth. Relay VW3 applies ringing current to the speaking leads over its contacts 57*vw*3 and 60*vw*3.

When the called subscriber replies in response to the ringing current, the subscriber's loop is closed when he takes up his receiver and the called party's feeding bridge relay R*v*3 is energized. Through the closing of the called subscriber's loop the potential over the line is altered and this acts as a discharging impulse over the condenser C*p*3. In response to this discharging impulse relay J*w*3 switches over its armature. Relay B*w*3 is now energized in the final selector LW3 over: earth, contact 36*jw*3, winding II of relay B*w*3, battery and earth. At the same time the slow relay MW3 is energized over: earth, contact 66*jw*3, the winding of relay MW3, battery and earth. Relay B*w*3 locks up in the following circuit: earth, winding I of relay B*w*3, contacts 42*bw*3 and 43*pw*3, battery and earth. Relay B*w*3 breaks the circuit for the ring connecting relay at contact 59*bw*3. Furthermore metering potential is applied to the *b*-lead over: earth, battery, winding I of relay A*w*3, contacts 39*bw*3 and 40*pw*3 and the *b*-lead. Finally for the purpose of "sintering" the contacts earth is applied to the *a*-lead over: earth, the high resistance W*s*, contact 58*pw*3, winding II of relay A*w*3, contact 37*bw*3 and the *a*-lead.

The two subscribers can now converse together. The called party replaces his receiver at the end of the call. A circuit for the feeding bridge relay R*v*3 of the called party is broken. The "break" impulse operates to reverse the polarity of the condenser C*p*3 in the final selector. The charging impulse is in such a direction that the relay J*w*3 restores its contact to normal and closes contact 35*jw*3. A counter-impulse which on account of the neutralizing of the magnetic field of relay J*w*3 might return the armature of the relay into the operated position, is prevented

in that after the armature of relay Jw3 has been restored the following circuit for a second winding of relay Jw3 is completed over contact 60mw3: earth, contacts 35jw3 and 60mw3, winding II of relay Jw3, off-normal contact 31kw3, battery and earth. The second winding of the relay is arranged so that it holds the armature of the polarised relay in the rest position. The locking circuit for winding II of relay Jw3 remains closed until relay MW3 has released. In the meantime the counter-impulse has died down. The direct connection of earth to the *a*-lead after the called party has replaced his receiver over contact 35jw3, 58pw3, winding II of relay Aw3 and contact 37bw3 gives the clearing signal at the trunk operator's position in the case of trunk calls.

When the calling party also replaces his receiver his feeding bridge relay Rv3 releases. This reverses potential over the line and results in a discharge impulse at the condenser Co3 of the first group selector GW3. Relay Jg3 consequently switches over its armature and closes contact 19jw3. Relay Ag3 in the first group selector is energized for a prolonged period and short-circuits the seizing relay Cg3 for a corresponding period over its contact 13ag3. Relay Cg3 releases. By opening its contact 15cg3, relay Cg3 initiates the release of the preselector VW3 of the calling subscriber. By short-circuiting winding I of the testing relay Pg3 at contact 61cg3 this relay is caused to de-energize and opens the testing circuit to the final selector at contact 62pg3. In the final selector the seizing relay Cw3 releases in consequence. Relay Cw3 by opening its contact 51cw3 releases the testing relay Pw3. Relay Pw3 brings about the release of the final selector when it releases.

Trunk calls can also be set up over the final selector LW3. These pass from the trunk operator's position in the usual way over a trunk group selector connected in multiple with the first group selector. The switching operations up to the setting of the final selector on the wanted subscriber's line are the same as in the case of a local call. If the called subscriber is engaged in a local call, the trunk operator can connect to the engaged line by applying potential at the trunk position to the *b*-lead, whereby relay Bw3 of the final selector is energized in the following circuit: the potential applied to the *b*-lead at the trunk operator's position, contact 41pw3, winding I of relay Bw3 and earth. The operator is connected to the busy subscriber over contacts 48bw3 and 49bw3. The trunk operator is enabled to break down the call by applying earth to the *a*-lead after establishing connection with the engaged subscriber and thereby energizing relay Jw3: earth on the *a*-lead, contact 38bw3, winding I of relay Aw3, battery and earth. Relay Aw3 connects direct earth to the speaking leads on the one hand over contacts 46aw3 and 47aw3 and on the other hand connects earth over contact 50aw3 and a low resistance of the testing relay T3 to the testing lead of the called subscriber. If the wanted subscriber is the calling subscriber in the existing low-rated call the condenser Co3 is discharged over the earth connected to the *a*-lead and to the *b*-lead. At the same time the feeding bridge relay Rv3 releases. Relay Jg3 of the first group selector switches over its contacts and energizes relay Ag3 for a prolonged period over contact 19jg3. Relay Ag3 short-circuits relay Cg3. This releases and initiates the releasing of the existing local call. Relay Jg3 is restored to normal locally over a second winding: earth, contacts 23cg3, 24ag3, winding II of relay Jg3, battery and earth.

If the subscriber who is wanted for the trunk call is the called party in the existing local call, the testing relay Pw3 of the final selector in the local connection is short-circuited by the application of earth over contact 50aw3 in the final selector seized by the trunk operator. This relay releases and brings about the disconnection of the local call.

It should be mentioned at this point that the "trunk knock down" can of course be brought about in a similar manner to that in the present embodiment in the other embodiments of the invention. Thus in the embodiment I, the feeding bridge relay of the subscriber engaged in a local call is deenergized and the release of the first group selector seized in the local call is brought about over the *d*-lead.

Fig. 5 shows a further embodiment of the invention. The first preselector is indicated by VW4 and the first group selector GW4. Only those parts of the local and trunk final selector indicated by LW4 which concern the invention are shown. Both the subscribers are fed as in all the embodiments over feeding bridges associated with the subscribers' lines. The impulsing and clearing signals of the calling subscriber are transmitted over the two leads of the calling line by direct current while the clearing signal from the called subscriber is transmitted over one of the two speaking leads. All sections of the line which contain contacts which are liable to vibrations are protected from disturbing currents by the position of special condensers Cv1 and Cv2 between the subscriber's feeding bridge and the multiple field of the switches.

The mode of operation of the arrangement is as follows: When the calling subscriber takes up his receiver his feeding bridge relay Rv4 energizes. The rotary magnet of the preselector is switched on over contact 1rv4. The preselector is set in operation and searches for a free line. When such a line has been found, the testing relay Pv4 of the preselector and the seizing relay Cg4 of the first group selector energize in the testing circuit. In the testing circuit relay Vg4 energizes in series with relay Cg4 and transmits the exchange signal to the calling subscriber. Moreover, the impulse receiving relay Ag4 is connected to the *a*-lead over contacts 13cg4 and 12vg4.

When the calling party dials the feeding bridge relay Rv4 releases impulsively. Consequently the following circuit is completed for the impulse receiving relay Ag4 of the first group selector: earth, the winding of relay Ag4, contacts 13cg4 and 12vg4, wiper *a* of the first preselector, contacts 2pv4, 5rv4 and 3pv4, wiper *b* of the first preselector, winding I and II of relay Vg4, battery and earth. In this circuit relays Av4 and Vg4 energize. Relay Vg4 holds up throughout the impulse train. Relay Av4 repeats the impulses of the vertical magnet to the group selector. After this impulse train the switch rotates freely and searches for a free line. When a free line has been found the testing relay Pg4 energizes in the first group selector and the seizing relay Cw4 in the final selector. Relay Cw4 prepares the setting circuit and also the testing circuit.

The further impulse trains from the calling subscriber are taken up by relay Ag4 and are extended as earth impulses over contact 10ag4 to

the final selector. The final selector LW4 is raised to a certain level and stepped round. If the final selector LW4 finds the wanted subscriber's line free the following testing circuit is completed. Earth, contacts 20*cw*4, 21*uw*4 and 22*vw*4, the windings of the test relay P*w*4, wiper *c* of the final selector, wiper *c* of the preselector VW4 in the zero position, the windings of the test relay P*v*4, wiper *d* of the preselector VW4 in the zero position, battery and earth. In this circuit the two test relays energize. The testing relay of the final selector carries out its own functions. The testing relay P*v*4 in the preselector applies earth to the *b*-lead leading to the final selector, whereby a relay X*w*4 in the final selector is energized over: earth, wiper *a* of the preselector VW4 in the zero position, contacts 2*pv*4, 5*rv*4 and 3*pv*4, wiper *b* of the preselector *vw*4 in the zero position, wiper *b* of the final selector LW4, the winding of relay X*w*4, battery and earth. Relay X*w*4 applies earth directly to the *a*-lead over contacts 24*xw*4 and 25*pw*4 which indicates at the trunk operator's position the termination of the selection of a trunk call.

When the called subscriber replies his feeding bridge relay R*v*4 energizes. Through the opening of contact 5*rv*4 earth is disconnected from the *b*-lead to the final selector. Relay X*w*4 releases; accordingly the earth is disconnected again from the *a*-lead at contact 24*xw*4 and this gives the signal at the trunk operator's position that the called party has replied. Earth is applied to the *a*-lead over contact 25*pw*4 and the high resistance W*s* for the purpose of "sintering" the contacts.

When the called subscriber hangs up at the end of the call, his feeding bridge relay R*v*4 releases on account of the interruption of the loop. Earth is applied again to the *b*-lead of the final selector over contact 5*rv*4. Relay X*w*4 energizes again and gives the clearing signal at the trunk operator's position.

When the calling subscriber also hangs up his feeding bridge relay R*v*4 releases. A loop is set up in consequence to the first group selector in the manner already described over: earth, the winding of relay A*g*4, contacts 13*cg*4, and 11*pg*4, wiper *a* of the first selector VW4, contacts 2*pv*4, 5*rv*4 and 3*pv*4, wiper *b* of the first preselector, windings I and II of relay VG4, battery and earth. In this circuit the two relays A*g*4 and V*g*4 in the first group selector energize permanently. Relay A*g*4 short-circuits the relay C*g*4 over contact 15*ag*4. Relay C*g*4 releases and promotes the release of all the switches in the manner which has frequently been described before.

Fig. 6 shows details of a further embodiment of the invention, namely the circuit of a call finder serving as the preselecting device.

The feeding is again over a feeding bridge R*s* associated individually with the subscriber's line. Moreover, a relay T*s* is associated with each subscriber's line. When the calling subscriber takes up his receiver the feeding bridge relay R*s* is energized and switches over contact 1*rs*. A starting relay is operated in the known way and sets the call finder in operation and in addition relay R*s* prepares the testing circuit by closing contact 3*rs*. When the call finder has found the calling line its testing relay P*s* energizes in the following circuit: earth, windings I and II of relay P*s*, wiper *c* of the call finder, contacts 2*ts* and 3*rs*, winding I of relay T*s*, battery and earth. In this circuit relays P*s* and T*s* energize. Relay P*s* brings the call finder to rest and switches the line through to the first group selector. Relay T*s* locks up in the following circuit: earth, contacts 4*ts* and 5*rs*, winding II of relay T*s*, battery and earth. After relay T*s* has energized the testing circuit is broken at contact 2*ts*. The testing relay P*s* of the call finder holds up, however, in the following local circuit: earth, contact 7*ps*, the low resistance winding II of the testing relay P*s*, contact 6*ps*, resistance W*i*, battery and earth. Another call finder is thereby prevented from testing on the calling line and also a final selector.

When the calling subscriber who has established a local call over the call finder A*s* is wanted from the trunk exchange earth is applied to the c-lead in the final selector which is set by the trunk operator on the subscriber's line. This is represented as being connected over a key contact F*a* in the figure for the sake of simplicity. If the trunk operator desires to break down the connection the testing relay P*s* of the call finder is short circuited over: earth, key contact F*a*, contact 8*ts*, wiper *c* of the call finder, winding II of the testing relay P*s*, contact 7*ps* and earth. The relay P*s* releases and promotes the release of the call finder and thus of the wanted subscriber.

What is claimed is:

1. In a telephone system, an exchange, a plurality of subscribers' lines terminating at the exchange, a plurality of feeding bridges at the exchange each individual to one of said lines and connected to the terminus of that line, each of said bridges containing a source of direct current to supply talking current to the associated line, switching means for completing a connection between any of said lines for the transmission of speech currents therebetween, said switching means including variably operable contacts over which said speech currents pass, and means for enabling the bridges connected to the lines between which said connection has been completed to supply to said connection current of sufficient value from said source to break down the contact resistance of said contacts.

2. In a telephone system, an exchange, a plurality of subscribers' lines terminating at the exchange, a plurality of feeding bridges at the exchange each individual to one of said lines and connected to the terminus of that line to supply talking current thereto, switching apparatus having variably operable contacts, and means for controlling said apparatus to complete a connection between any of said lines over said contacts, the potential of said feeding bridges being thereby applied to the ends of said connection and effective to break down the contact resistance of said contacts.

3. A telephone system as claimed in claim 2, wherein said connection comprises a two-conductor path for the transmission of speech currents, wherein said switching apparatus includes a plurality of switches for extending both said path and a control path, and wherein said last means controls certain of said switches over said control path thereby to extend said connection.

4. In a telephone system, an exchange, a plurality of subscribers' lines terminating at the exchange, a plurality of feeding bridges at the exchange each connected to the terminus of a line to supply talking current thereto, switching means for completing a connection between any of said lines for the transmission of speech currents therebetween, said switching means including variably operable contacts over which said speech currents pass, and means for apply-

ing potential to said connection continuously during the transmission of speech thereover to break down the contact resistance of said contacts.

5. In a telephone system, an exchange, a plurality of subscribers' lines terminating at the exchange, a plurality of feeding bridges at the exchange each connected to the terminus of a line to supply talking current thereto, switching means for completing a connection between any of said lines for the transmission of speech currents therebetween, said switching means including variably operable contacts over which said speech currents pass, and means for causing said contacts to be traversed by current continuously during the transmission of speech thereover, said current being of sufficient value to substantially eliminate the contact resistance of said contacts.

6. In a telephone system, a plurality of telephone substations, means for completing a speech transmission path between said substations, a plurality of feeding bridges each individual to one of said substations and having a source of direct current potential for supplying talking current to that one substation, each bridge supplying said talking current to its associated station over a portion of said path which includes no variably operable contacts, variably operable contacts included in another portion of said path, and means enabling said bridges also to supply to said other portion of said path potential of sufficient value to break down the contact resistance of said contacts.

7. In a telephone system, a plurality of telephone substations, means for completing a speech transmission path between said substations, a plurality of feeding bridges each individual to one of said substations and supplying talking current to that one substation over a portion of said path which includes no variably operable contacts, variably operable contacts included in another portion of said path, condensers separating said last portion of said path from said portions which include no variably operable contacts, and means enabling said bridges also to supply to said last portion of said path potential of sufficient value to break down the contact resistance of said contacts.

8. In a telephone system, a plurality of subscribers' lines each having a feeding bridge for supplying talking current thereto, switching apparatus having variably operable contacts and means for completing a two-conductor connection between any of said lines over said contacts, the potential of the feeding bridges of the lines between which said connection is completed thereby being applied to the ends of said connection and being so poled that substantially no current flows over either conductor of said connection, and means for applying to said connection another current feeding bridge so poled with respect to the bridges applied to the ends of said connection that current of sufficient value to break down the contact resistance of said contacts flows over said conductors.

9. In an automatic telephone system, a subscriber's station and a line therefor, a relay having a winding bridged across said line in series with a source of current, switching apparatus having variably operable contacts, means at said station for controlling said relay over said line thereby to control said apparatus to extend a connection from said line over said contacts, and means for bridging said relay winding across certain of said contacts in series with said source thereby to break down the contact resistance of said certain contacts.

10. In an automatic telephone system, a subscriber's station and a line therefor, a relay bridged across said line in series with a source of current, switching apparatus having variably operable contacts, means at said station for controlling said relay over said line thereby to control said apparatus to extend a connection from said line over said contacts, means for bridging said relay across the extended connection in series with said source, and means including said bridge of said relay and said source across the extended connection for causing said contacts over which said connection is extended to be traversed by current of sufficient value to substantially eliminate the contact resistance thereof.

11. A telephone system as claimed in claim 10, having a source of alternating current, wherein said relay, responsive to said control over said line, transmits to said apparatus impulses of alternating current from said last source to control said apparatus to extend said connection.

12. A telephone system as claimed in claim 10, wherein said apparatus includes a condenser, and wherein said relay, responsive to said control over said line, transmits to said condenser impulses of charging current to control the extension of said connection by said apparatus.

13. In a telephone system, a plurality of subscriber lines, a plurality of relays each bridged across one of said lines in series with a source of current, switching apparatus having variably operable contacts, means for controlling any of said relays over its associated line to transmit impulses of current to said apparatus, a condenser in said apparatus charged by said impulses and effective in accordance with said charging impulses control said apparatus to extend a connection from said line over said contacts to any desired other one of said lines, the relays associated with said first line and said last line being thereby bridged across said connection each in series with a source of current and causing said contacts over which said connection was extended to be traversed by current of sufficient value to break down the contact resistance thereof.

14. In a telephone system as claimed in claim 13, means for controlling, over said last line, the relay associated therewith thereby to transmit impulses to said apparatus, and impulse responsive means for controlling said apparatus, said last means including a condenser charged and discharged under a control of said last relay.

15. In a telephone system wherein the circuit for the transmission of speech between subscribers' stations extends over one or more variably operable contacts, the method of preventing said contacts from adversely influencing said transmission of speech comprising dividing said circuit into a plurality of serially related sections so chosen that the end-sections include no variably operable contacts, impressing potential upon said end-sections to provide talking current for the subscribers' stations which terminate said end-sections, and utilizing said potential to break down the contact resistance of variably operable contacts included in the section adjacent to each end-section.

16. In a telephone system wherein the circuit for the transmission of speech between subscribers' stations extends over one or more variably

operable contacts, the method of preventing said contacts from adversely influencing said transmission of speech comprising dividing said circuit into a plurality of serially related sections so chosen that the sections which terminate at the subscribers' stations include none of said contacts, and, during the transmission of speech over said circuit, causing each section to be traversed by direct current which does not traverse any other section.

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