Dec. 19, 1939. F. ETZEL 2,183,832

TELEPHONE SYSTEM

Filed Feb. 24, 1938 2 Sheets-Sheet 1

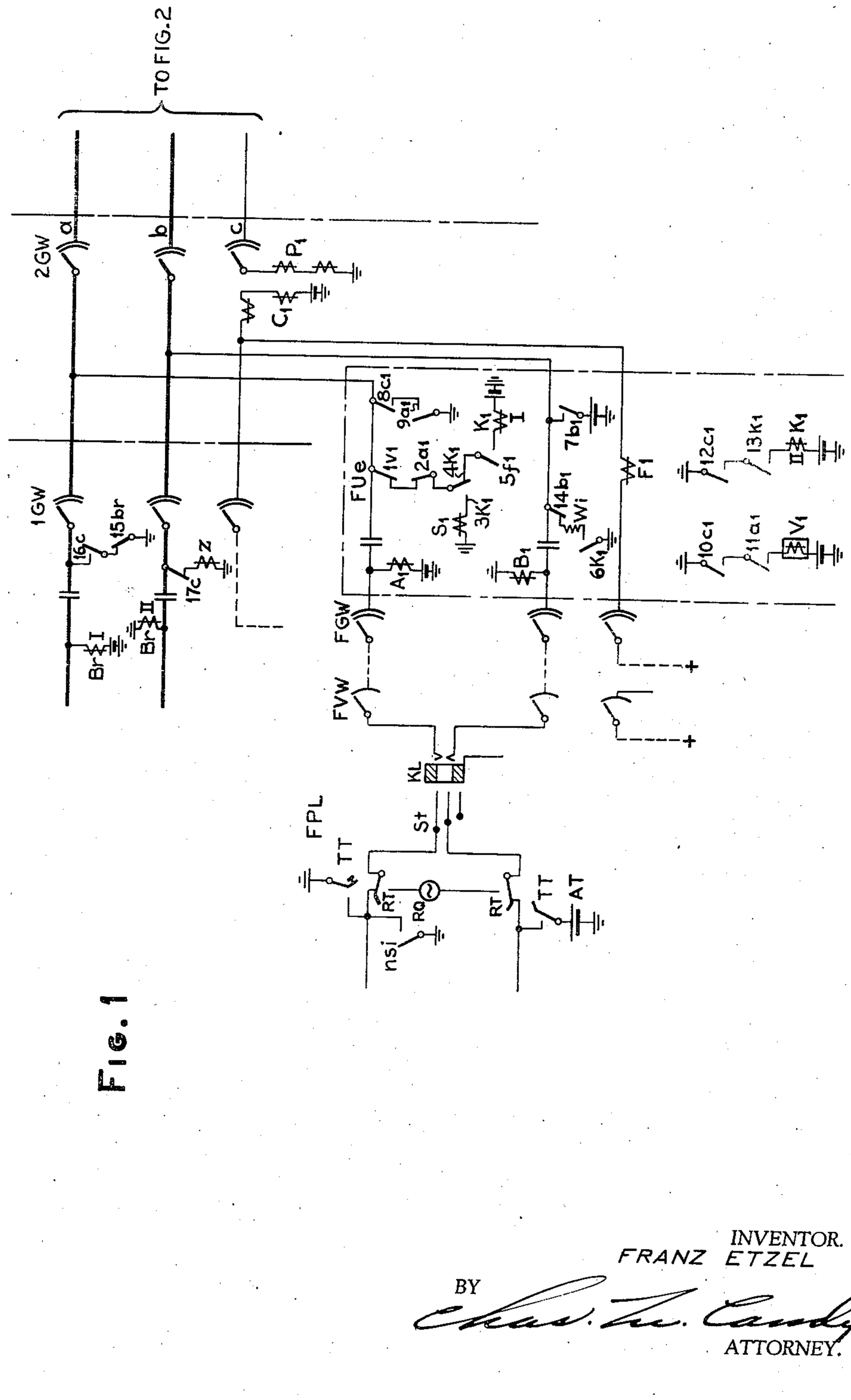

FIG. 1

INVENTOR.
FRANZ ETZEL

BY Chas. Inc. Candy

ATTORNEY.

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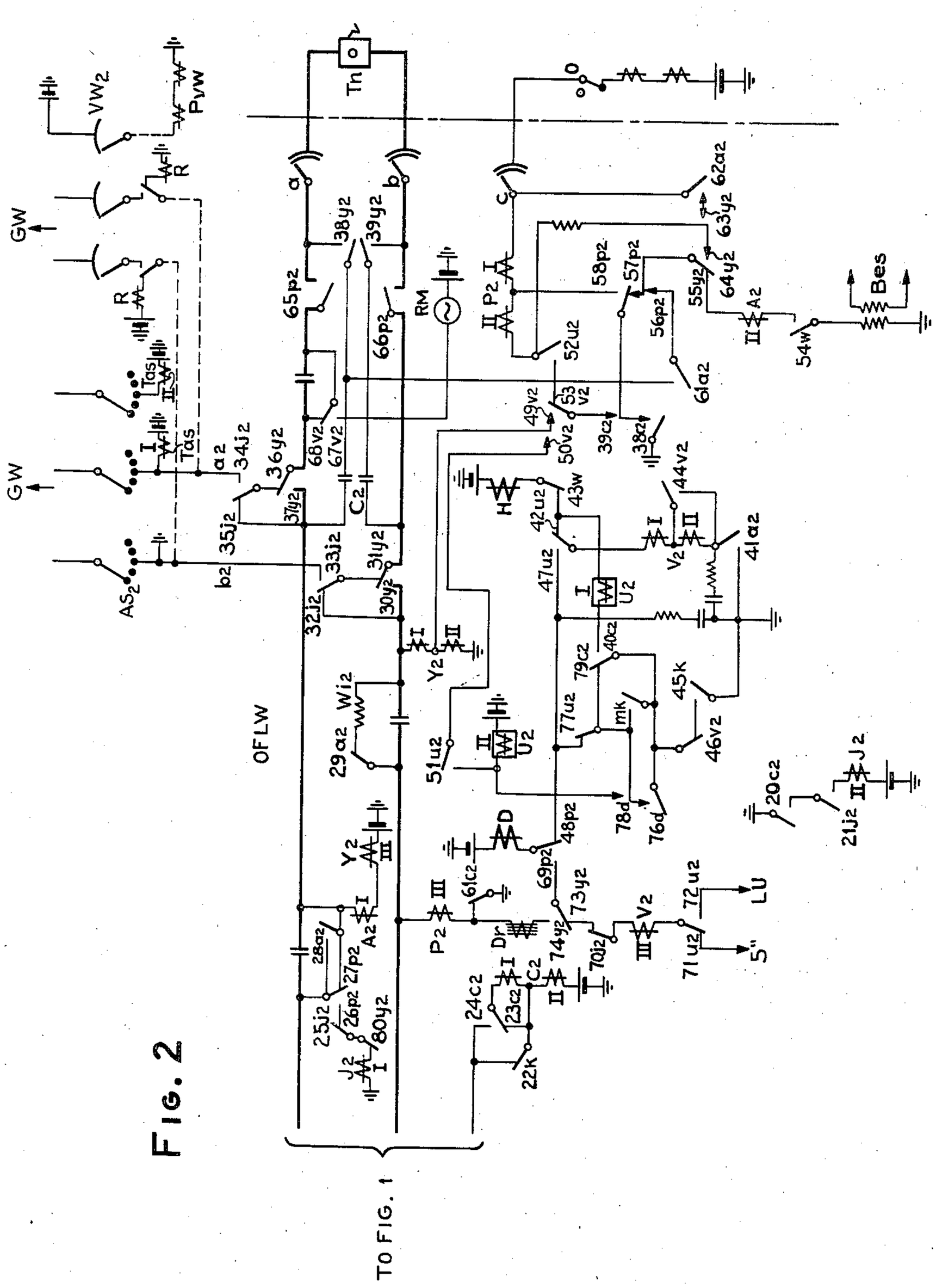

FIG. 2

INVENTOR.
FRANZ ETZEL

BY Chas. Tu. Candy.
ATTORNEY.

Patented Dec. 19, 1939

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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Franz Etzel, Berlin-Siemensstadt, Germany, assignor to Siemens & Halske Aktiengesellschaft, Wernerwerk, Siemensstadt, near Berlin, Germany

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9 Claims. (Cl. 179—27)

The invention relates to a circuit arrangement for setting up the variously rated calls in automatic telephone systems and in particular to such arrangements in which when setting up a highly rated call the wanted subscriber's line is immediately blocked preparatorily in the event of the highly rated call only being completed after a certain time.

In addition to arrangements in which the called subscriber is no longer able to establish or to receive less expensive calls in the period between the blocking of his line and the final establishment of the highly rated call, there are also arrangements known in which the called subscriber is still able at least to set up outgoing calls. These arrangements require a considerable amount of switching means, in particular because the switching means provided for this purpose are associated with subscribers' lines.

The invention is to avoid this objection. This is achieved in that a preselecting device is associated with a connecting device disposed in the connecting path and is at the disposal of subscribers who are preparatorily blocked on the establishment of a highly rated call, for the purpose of setting up outgoing calls.

The attached drawings, comprising Figs. 1 and 2, with Fig. 1 placed to the left of Fig. 2, represent an embodiment of the invention. A description will first be given of the establishment of an inexpensive, i. e., a local call and then of the establishment of a more highly rated, i. e., a trunk call. Circuit details which are of no importance for the understanding of the invention are not shown.

A local call passes in the normal way, first over the preselecting device of the calling subscriber, then over the local group selector 1GW, a second group selector 2GW and a final selector OFLW to the wanted subscriber indicated by T*n*. The final selector OFLW is thus adapted for the establishment both of local and trunk calls.

Trunk calls pass from the trunk operator's position FPL over a trunk preselector FVW, a trunk group selector FGW, a trunk exchange repeater FU*c* which is multipled to the local selector 1GW, the second group selector 2GW and the trunk final selector OFLW to the wanted subscriber T*n*.

In the case of a local call the preselector associated with the calling subscriber is set on a free first group selector 1GW in the known way after the calling subscriber has taken up his receiver. After the local group selector 1GW has been seized the feeding bridge relay B*r* energizes over the closed subscriber's loop. The group selector is set up by the first impulse train and searches for a second group selector. When this has been found the seizing relay C1 of the second group selector 2GW energizes over the testing relay of the group selector 1GW (not shown) and the testing wiper of the selector. Thereupon the second group selector 2GW is set by the next impulse train. This also hunts freely this time for a free final selector. The switching operations for the setting of the two group selectors have no bearing on the invention and are therefore not indicated. When a free final selector has been found the testing relay of the selector 2GW and the seizing relay of the final selector OFLW energizes in the following circuit: earth, the windings of the testing relay P1, the wiper *c* of the second group selector, off-normal contact 22*k*, winding II of relay C2, battery and earth. The testing relay P1 of the second group selector brings the switch to rest in the known way and guards the seized line against further seizure and finally switches through the speaking leads. The seizing relay C2 in the final selector connects its high resistance winding I in the testing circuit over contact 24*c*2. Through the closing of contacts 38*c*2 and 39*c*2 the testing circuit is prepared. A circuit for the control relay U2 is prepared by the closing of contact 40*c*2.

The impulse trains for setting the final selector on the wanted subscriber's line are now transmitted. As the impulses are transmitted the feeding bridge relay B*r* in the first group selector releases intermittently. The following circuit is accordingly completed for the impulse receiving relay A2 in the final selector: earth, contacts 15*br* and 16*c* (contact of a seizing relay C which is not shown) wiper *a* of the first group selector, wiper *a* of the second group selector, contact 27*p*2, winding I of relay A2, winding III of relay Y2, battery and earth. Relay A2 in the final selector energizes intermittently and transmits impulses to the vertical magnet H of the final selector over the following circuit: earth, contact 41*a*2, windings II and I of relay V2, contact 42*u*2, rotary off-normal contact 43*w*, vertical magnet H, battery and earth. The switch is raised to the desired level by the impulse train. On the first impulse relay V2 is energized in series with the vertical magnet. Relay V2 short-circuits its winding II over its contact 44*v*2 and in consequence is rendered slow-to-release and holds up throughout the impulse train. At the end of the impulse train relay A2 releases permanently. Relay V2 also releases. The follow-

ing circuit is now closed for the control relay U2: earth, off-normal contact 45*k* (closed on the first vertical step), contacts 46*v*2 and 40*c*2, winding I of relay U2, rotary off-normal contact 43*w*, vertical magnet H, battery and earth. Relay U2 energizes in this circuit but the vertical magnet does not energize.

On the next impulse train the impulse receiving relay A2 again energizes intermittently. The following circuit is completed for the rotary magnet of the final selector: earth, contact 41*a*2, windings II and I of the slow operating relay V2, contacts 47*u*2 and 48*p*2, rotary magnet D, battery and earth. The rotary magnet responds to the impulses and rotates the switch to the desired subscriber's line. On the first impulse relay V2 is energized again in series with the rotary magnet V2 and holds up during the impulse train. Since a circuit for winding I of relay U2 is opened at contact 46*v*2 on the first impulse the following locking circuit is established for relay U2 during the impulse train: earth, contacts 38*c*2, 39*c*2, 49*v*2, 50*v*2, 51*u*2, winding II of relay U2, battery and earth. At the end of the impulse train relay A2 first releases permanently. Relay V2 then releases. During the release period of relay U2 the following testing circuit is established: earth, contacts 38*c*2, 39*c*2, 53*v*2 and 52*u*2, the windings II and I of the testing relay P2, wiper *c* of the final selector, the testing wiper of the called subscriber's preselector in the zero position, the testing relay of the calling subscriber's preselector, battery and earth. This testing circuit is only completed if, as has been assumed, the calling subscriber is free.

If the called subscriber is not free the testing relay P2 does not energize. The following circuit is completed for transmitting the busy signal: earth, busy signal transformer Bes, rotary off-normal contact 54*w* (closed on the first rotary step) winding II of relay A2, contacts 55*y*2, 57*p*2, 38*c*2 and earth. The busy signal is transmitted inductively from winding II to winding I of relay A2 and from there is transmitted over the line to the calling subscriber. The calling subscriber must in this case replace his receiver whereupon the switches are released and he must later attempt once more to set up the call.

When the testing relay P2 in the final selector has energized. the wanted subscriber's line being free, the rotary stepping circuit is broken through the opening of contact 48*p*2. Through the closing of contact 56*p*2 the high resistance winding II of relay P2 is short-circuited and the seized subscriber's line is guarded against further seizure in the known way. The speaking leads are switched through to the subscriber at contacts 65*p*2 and 66*p*2. Through the closing of contact 69*p*2 the following circuit is completed for relay V2 so long as relay U2 has not yet released: earth, interrupter LU, contact 72*u*2, winding III of relay V2, contacts 70*j*2, 73*y*2, 60*p*2, rotary magnet D, battery and earth. The rotary magnet does not energize in this circuit but relay V2 does energize. Relay V2 serves as a "ring-connecting" relay at this stage of the connection. It brings about the transmission in this circuit of the first ringing pulse and applies ringing current to the called subscriber's line over: earth, battery, ringing machine RM, contacts 67*v*2, 65*p*2, wiper *a* of the final selector, the bell circuit at the called subscriber's station, wiper *b* of the final selector, contacts 66*p*2, 31*y*2 and 32*j*2, windings I and II of relay Y2 and earth. Winding II of relay Y2 is short-circuited during the ringing periods over contacts 38*c*2, 39*c*2 and 49*v*2 so as to prevent the relay being energized by the ringing current. After release of relay U2 the "ringing connecting" relay V2 is connected to the so-called 5 seconds interrupter over contact 71*u*2 so that ringing current is transmitted to the called party every 5 seconds.

If the called subscriber takes up his receiver during the transmission of ringing current the feeding bridge relay Y2 lying in the ringing circuit is energized over the closed subscriber's loop. If the subscriber takes up his receiver during a pause in the ringing the feeding bridge relays Y2 and A2 are energized over the loop. The circuit in the latter case runs as follows: earth, the windings II and I of relay Y2, contacts 32*j*2, 31*y*2 and 66*p*2, wiper *b* of the final selector, the subscriber's loop, wiper *a* of the final selector, contacts 65*p*2, 68*v*2, 36*y*2 and 35*j*2, winding I of relay A2, winding III of relay Y2, battery and earth. Through the energizing of relay Y2 the circuit for the ring connecting relay V2 is opened immediately at contact 73*y*2. Relay Y2 closes its contacts 30*y*2 and 37*y*2, thereby switching through the speaking leads and by-passing contacts 35*j*2 and 32*j*2. Relay Y2 by closing its contact 74*y*2 temporarily applies metering potential to the *b*-lead: earth, battery, rotary magnet D, contacts 69*p*2 and 74*y*2, choke coil Dr, winding II of relay P2 and the *b*-lead.

The two subscribers can now converse together.

At the end of the call the two subscribers replace their receivers. If the called party puts up his receiver first relay A2 releases first in the final selector. Relay Y2 holds up in the following circuit: earth, windings II and I of relay Y2, resistance Wi2, contact 29*a*2, winding III of relay P2, choke coil Dr, contacts 74*y*2 and 69*p*2, rotary magnet D, battery and earth.

When now the calling subscriber replaces his receiver, the feeding bridge relay Br first releases and then the seizing relay C of the first group selector. This initiates the release of the first group selector and of the preselector. After the release of the seizing relay C in the first group selector the metering relay Z is energized over the following circuit: earth, winding of relay Z, contact 17*c*, wipers *b* of the group selectors 1GW and 2GW, winding III of relay P2, choke-coil Dr, contacts 74*y*2 and 69*p*2, rotary magnet D, battery and earth. Through the release of the seizing relay in the first group selector the testing circuit to the second group selector is broken and as a result of this the second group selector is released and the testing circuit to the final selector is broken. In the final selector therefore the seizing relay C2 releases. Relay C2 breaks the circuit for the testing relay P2 at contact 38*c*2. Relay P2 releases and thereby breaks the locking circuit for relay Y2. The following circuit is completed for the rotary magnet D; earth, contacts 45*k*, 46*v*2, 79*c*2, 77*u*2, 48*p*2, rotary magnet D, battery and earth. The rotary magnet energizes and advances the switch one step. On the energizing of the rotary magnet D contacts 76*d* and 78*d* are closed. In consequence relay U2 energizes: earth contacts 45*k*, 46*v*2, 76*d*, winding II of relay U2, battery and earth. Relay U2 energizes and at contact 77*u*2 breaks the circuit for the rotary magnet. The latter releases and in consequence relay U2 releases. Now, however, the circuit for the rotary magnet is completed again over contact 77*u*2. The magnet therefore energizes once more and the switch executes a further step. This inter-action con-

tinues until the switch reaches the rest position where the off-normal contact 45*k* finally breaks the rotary stepping circuit.

The establishment of a trunk call to subscriber T*n* proceeds as follows: The trunk operator at the trunk position FPL inserts the plug ST in the jack KL and thereby seizes a free trunk preselector FVW. This hunts freely for a free trunk preselector FGW. When one has been found the trunk operator transmits impulses by way of her dial switch, of which only the impulse contact *nsi* is represented, for setting the trunk group selector. The setting takes place in the usual way. The switch is raised to a certain level by the impulse train and searches for a free line to second group selector 2GW. In the line between the trunk group selector and the second group selector there is connected a so-called trunk exchange repeater FU*e*. This serves to transmit to the local and trunk final selector the special switching operations required in trunk working. When the trunk group selector has found a free line relay F1 in the trunk exchange repeater energizes over the testing lead as does also the seizing relay C1 in the second group selector.

By means of the next impulse train transmitted from the trunk operator's position relay A1 in the trunk exchange repeater FU*e* is energized impulsively over: earth, dial switch contact *nsi*, ringing key RT, plug S*t*, jack KL, wiper *a* of the trunk preselector and of the trunk group selector, the winding of relay A1, battery and earth. Relay A1 transmits impulses by applying earth to the *a*-lead, over contacts 9*a*1 and 8*c*1 to the impulse receiving relay in the second group selector. After the setting of the second group selector the final selector OFLW is again seized and is now set in turn and tests on the subscriber's line. The seizing and stepping of the switches takes place in the same manner as in a local call.

The trunk call differs from the local call in that after the testing relay P2 of the final selector is energized the following circuit is completed for relay K1 of the repeater FU*e* and for relay J2 of the final selector OFLW: earth, winding I of relay J2, contacts 80*y*2, 25*j*2, 26*p*2, wiper *a* of the second group selector, contacts 1*v*1, 2*a*1, 4*k*1, 5*f*1, winding I of relay K1, battery and earth. In this circuit relays J2 and K1 energize. Relay J2 in the final selector now locks up in the following circuit: earth, contacts 20*c*2, 21*j*2, winding II of relay J2, battery and earth. By opening its contact 25*j*2, relay J2 disconnects its winding I from the *a*-lead. Relay J2 moreover opens its contacts 32*j*2 and 35*j*2 and closes its contacts 33*j*2 and 34*j*2. Connection between the trunk operator's position and the called subscriber's line is thus broken and at the same time a connecting path is established to call finder AS2 over the leads *a*2, *b*2. By opening its contact 70*j*2 relay J2 breaks the circuit for winding III of the "ring connecting" relay V2. The subscriber is thus not automatically called in trunk working.

If subscriber T*n* whose line is now guarded against other local or trunk calls through the high resistance winding II of the testing relay P2 being short circuited, now wishes to set up a further local call the calling relay T*as* of the call finder AS2 is energized over the closed subscriber's loop as soon as he takes up his receiver; earth, lead *b*2, contacts 33*j*2, 31*y*2 and 66*p*2, wiper *b* of the final selector, contacts 65*p*2, 68*v*2, 36*y*2, 34*j*2, lead *a*2, winding I of relay T*as*, battery and earth. The call-finder AS2 starts up in the known manner and sets itself on the calling line. When this has occurred relay T*as* energizes over the winding II of the call-finding testing circuit. The connection is thus switched through to the group selector connected to the call finder AS2. The subscriber T*n* is now able to set up a call by means of his dial switch over this group selector which is multipled to other group selectors of the local exchange.

Naturally in place of the call-finder AS2 a preselector VW2 can be arranged in the branch line *a*2/*b*2 as indicated in dotted lines. In this case when the subscriber T*n* takes up his receiver the calling relay R is energized and starts up the preselector in the known way.

In the trunk exchange repeater FU*e* relay K1 was energized over its winding I as already mentioned. Relay K1 locks up in the following circuit: earth, contacts 12*c*1, 13*k*1, winding II of relay K1, battery and earth. Winding I of relay K1 is disconnected from the *a*-lead at the same time through the opening of contact 4*k*1 and relay S1 is connected to the *a*-lead by contact 3*k*1. When the trunk operator finally wishes to set up the trunk call she first operates the key AT at the trunk operator's position. This energizes relay B1 in the trunk exchange repeater: earth, battery, key AT, plug S*t*, jack KL, *b*-wiper of the trunk preselector, the winding of relay B1 and earth. Relay B1 energizes and closes the following circuit over relay Y2 in the final selector, earth, battery, contact 7*b*1, wiper *b* of the second group selector, contact 29*a*2, resistance W*i*2, windings I and II of relay Y2, battery and earth. Relay Y2 energizes and by opening contacts 31*y*2 and 36*y*2 breaks the connecting path between the subscriber and the branch line *a*2/*b*2. A local call over this path will thus be disconnected and at the same time a connecting path between the trunk operator's position FPL and the line of subscriber T*n* is set up over contacts 30*y*2 and 37*y*2. The operator at the trunk position then operates the ringing key RT and this transmits ringing current directly to the wanted subscriber. After the key AT has been released relay Y2 locks up in the following circuit: earth, windings II and I of relay Y2, resistance W*i*2, contact 29*a*2, winding III of relay P2, choke-coil D*r*, contacts 74*y*2, 69*p*2, rotary magnet D, battery and earth. When subscriber T*n* replies the feeding bridge relay A2 also energizes over the closed subscriber's loop.

In the foregoing it was considered that the local and trunk final selector found the subscriber's line free. The case in which the wanted subscriber's line is not free but the local and trunk final selector is engaged at the moment of testing will now be considered. The testing relay P2 cannot energize in this case and the operator receives the busy signal just as a subscriber does in local calls.

The trunk operator, however, has the facility for connecting to the line and "knocking down" a low value local call. She will normally use only this facility directly before finally completing the trunk call. For this purpose she depresses the "connecting" key AT at the trunk position. In consequence relay B1 and the repeater FU*e* and relay Y2 in the final selector are energized as already described. Relay Y2 closes its two contacts 38*y*2 and 39*y*2. A speaking path is thus established to the wanted subscriber over the condensers C2, this path bridging the opened

contacts 65*p*2 and 66*p*2. The trunk operator informs the subscriber of the presence of the trunk call and asks him to replace his receiver, indicating that the connection will be disconnected. The operator thereupon depresses the disconnecting key TT in addition to the "connecting" key. Consequently in the trunk exchange repeater relay A1 is energized in addition to relay B1 over the following circuit: earth, key TT, ringing key R*t*, plug S*t*, jack KL, *a*-wiper of the trunk preselector and the trunk group selector, the winding of the relay A1, repeater and earth. In the battery FU*e* earth is applied to the *a*-lead over contact 9*a*1 and thus relay A2 in the final selector is energized. Thus both relays A2 and Y2 are energized in the final selector. Disconnecting earth is applied directly to the testing lead over earth, contacts 38*c*2, 57*p*2, 64*y*2, 63*y*2, 62*a*2, and the *c*-wiper of the final selector. Disconnecting earth is also applied to the *a*-lead of the final selector over earth, contacts 38*c*2, 57*p*2, 56*p*2, 61*a*2, 38*y*2, and wiper *a*, of the final selector. The disconnection of the local call is now promoted whether the wanted subscriber is the calling or called party in the local call. As soon as the trunk operator releases the disconnecting key testing relay P2 of the local and trunk final selector seized by the trunk operator energizes. The operator then restores the "connecting" key AT. Relay Y2 locks up locally after the release of the "connecting" key, over its windings I and II, winding III of relay P2, the choke-coil D*r* and rotary magnet D. The subscriber T*n* is now rung from the trunk operator's position. As soon as he replies and takes down his receiver the feeding bridge relay A2 energizes. If, however, after the inexpensive call has been disconnected the final establishment of the trunk call to the wanted party is delayed and if the wanted subscriber is again to be able to set up outgoing calls the trunk operator releases the whole connection by withdrawing the plug at the trunk position and setting up the connection afresh. In this case the same switching operations are involved as have been described when setting up a trunk call to a free subscriber. The subscribers are thus able to set up calls in the period up to the final completion of the trunk call over the subscriber's equipment associated with the final selector.

After the called subscriber has replied the following circuit is completed for relay S1 in the trunk exchange repeater FU*e*: earth, battery, winding III of relay Y2, winding I of relay A2, contact 28*a*2, wiper *a* of the second group selector, contacts 1*v*1, 2*a*1, 3*k*1, winding of relay S1 and earth. Relay S1 energizes and transmits a signal to the trunk operator's position indicating that the called party has replied.

The disconnection of a trunk call by a second trunk operator is prevented in the following way.

Winding I of relay P2 in the final selector can be short-circuited by the application of direct earth to the *c*-lead by a second trunk operator but the relay does not release since it is held energized from the trunk exchange repeater over its third winding in the following circuit: earth, contact 6*k*1, resistance W*i*, contact 14*b*1, wiper *b* of the second group selector, winding III of relay P2, the choke-coil D*r*, contacts 74*y*2, 69*p*2, rotary magnet D, battery and earth.

When the called party hangs up the feeding bridge relay A2 first releases and relay Y2 holds up. The release of relay A2 breaks the circuit for relay S1 in the trunk exchange repeater. Relay S1 on releasing indicates to the trunk operator that the called party has replaced his receiver.

The connection is released by the trunk operator withdrawing the plug S*t* from the jack K1, whereupon relay F1 in the repeater FU*e* and relay C1 in the second group selector releases. In the repeater FU*e* the locking circuit of relay A1 is broken and the second group selector is released. As a result of this the testing circuit from the second group selector to the final selector is broken. In the final selector relay C2 releases and brings about the release of the final selector in the manner already described.

What is claimed is:

1. In a telephone system, subscribers' lines, a combination toll and local connector having access to said lines, means in said connector for seizing any one of said lines and making the same busy to incoming calls preparatory to the completion of a toll call thereto, and means for thereafter extending an outgoing call from said one line over said connector before said toll call is completed.

2. In a telephone system, subscribers' lines, an automatic switch over which said lines are accessible, means for seizing any one of said lines over said switch and for making said one line busy to other incoming calls preparatory to the completion of a call thereto over said switch, and means for thereafter extending an outgoing call from said one line over said switch before said completion of the call thereto.

3. In a telephone system, a pair of associated automatic switches, subscribers' lines accessible to said switches, means for seizing any one of said lines over one of said switches and for making said one line busy to other incoming calls preparatory to the completion of a call thereto over said one switch, and means for thereafter extending an outgoing call from said one line over said pair of switches in series before the completion of said call thereto.

4. In a telephone system, subscribers' lines, two automatic switches, means for seizing any one of said lines over one of said switches, for making said one line busy to other incoming calls preparatory to the completion thereto of a call over said one switch, and for completing a connection from said one line to the other switch, and means for thereafter extending an outgoing call from said one line over said connection and said other switch before the completion thereto of said call over said one switch.

5. A telephone system as claimed in claim 4, wherein said connection from said one line to said other switch is completed over the wipers of said one switch.

6. In a telephone system, subscribers' lines, switching means having an incoming line and an outgoing line, means controlled over said incoming line for completing a connection from said outgoing line to any desired subscriber's line and making the same busy, means for holding said incoming and outgoing lines temporarily disconnected, means controlled over said subscriber's line and said outgoing line for then extending a connection from said subscriber's line to another subscriber's line, and means controlled over said incoming line for interrupting said last connection and completing the connection between said incoming line and said outgoing line.

7. In a telephone system, subscribers' lines, two automatic switches, means for extending a

connection to one of said switches and for controlling said one switch thereover to make any desired one of said lines busy to incoming calls without completing said connection to that line, means for completing a connection over said one switch from the desired line to the second automatic switch, means including said last connection and said second switch for then extending an outgoing call from the desired line, and means controlled over said first connection for interrupting said last connection and completing said first connection to the desired line.

8. In a telephone system, calling stations of two classes, called stations, switching means over which a call may be extended from a calling station of either class under control of that calling station to any desired called station, other switching means, and means in said first switching means operated only if the calling station is of a particular class for completing a connection from the desired station to said other switching means before the call to the desired station is completed, and means at the desired station for extending an outgoing call over said other switching means before the incoming call thereto is completed.

9. In a telephone system, switching means having an incoming line, a primary outgoing line and a secondary outgoing line, said incoming line being normally connected to the primary outgoing line, calling lines of two classes, called lines, means for extending a connection from a calling line of either class to said switching means and for controlling said switching means thereover to complete a connection from said primary outgoing line to any desired called line, means in said switching means operated only if the calling line is of a particular class to disconnect the incoming line from the primary outgoing line and to connect the outgoing lines together, and means operated thereafter over the incoming line to disconnect the outgoing lines from one another and to reconnect the incoming line to the primary outgoing line.

FRANZ ETZEL.