April 26, 1932. C. E. BEALE ET AL. 1,855,701

TELEPHONE SYSTEM

Filed June 13, 1930 3 Sheets-Sheet 1

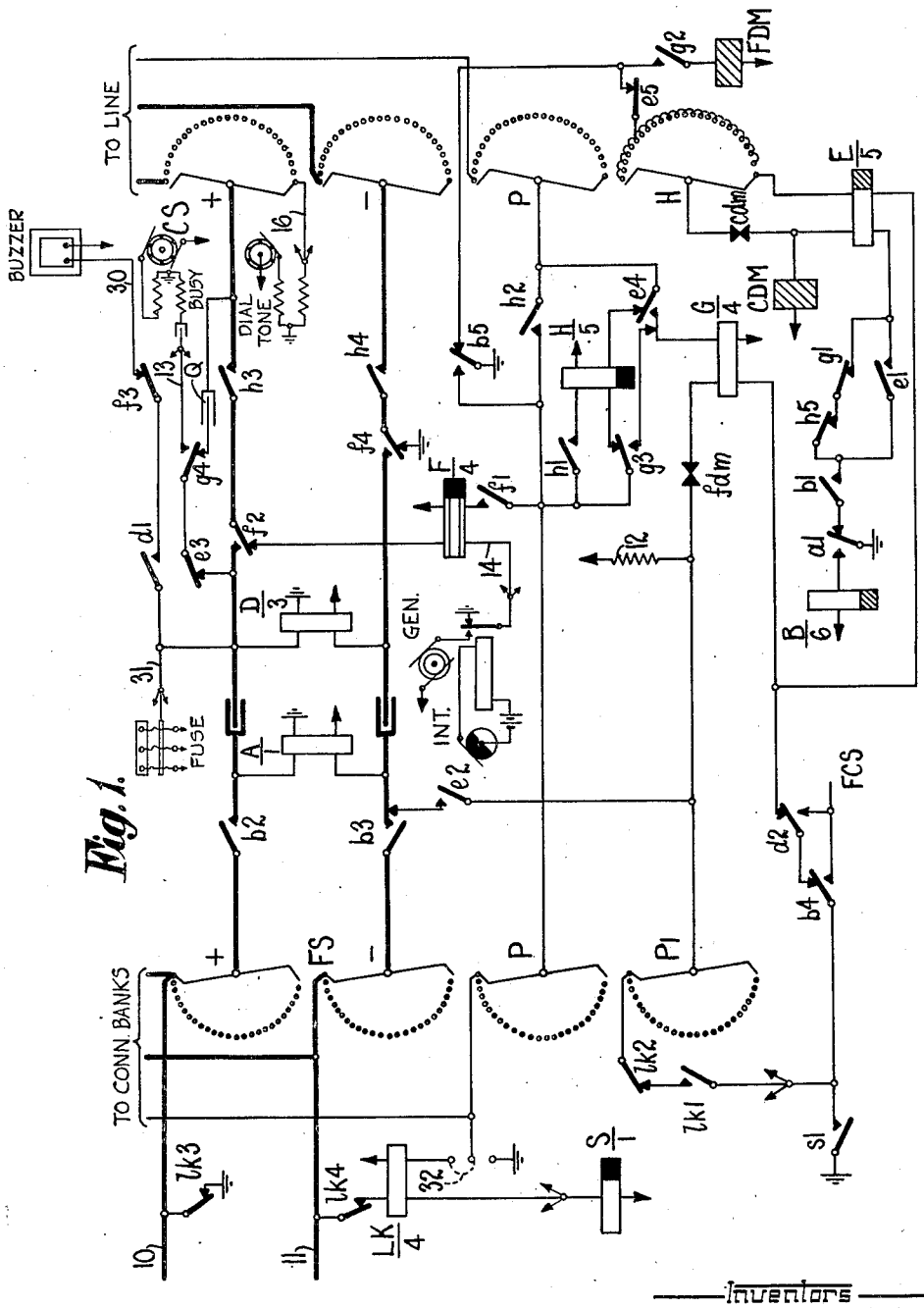


Fig. 1.

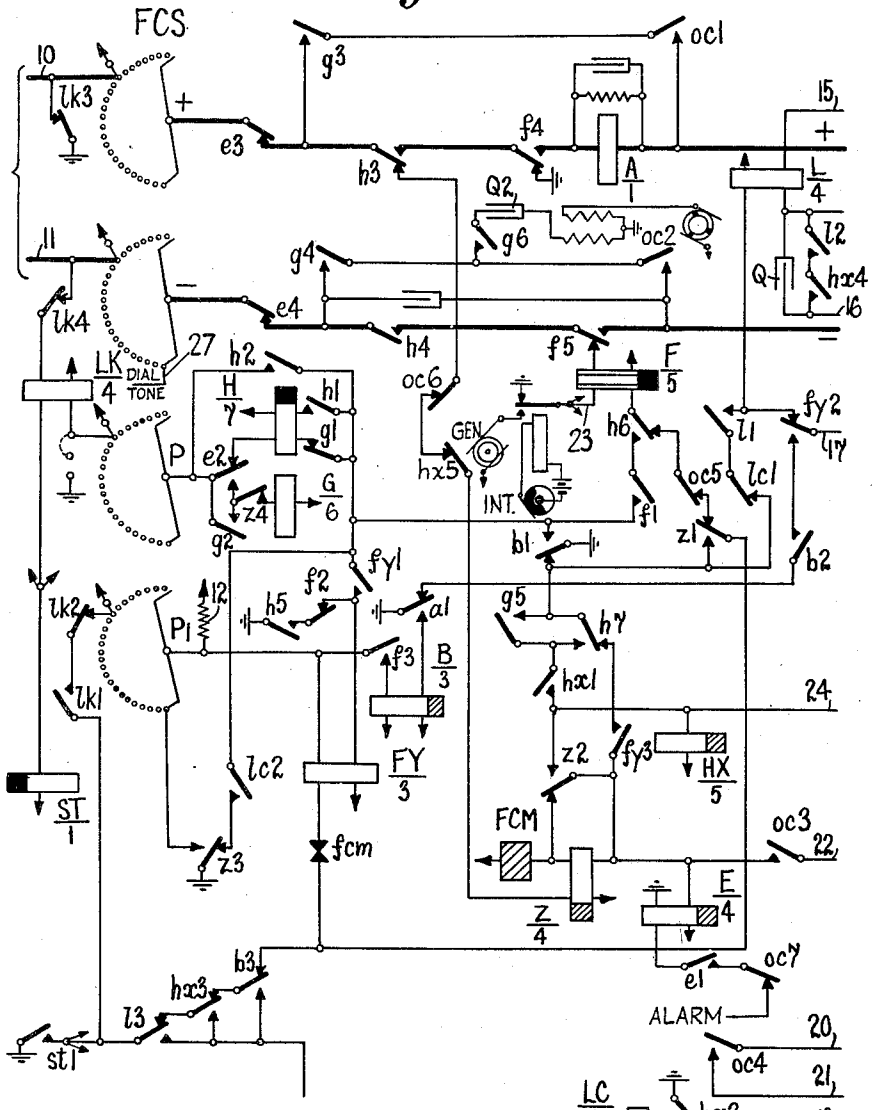
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Fig. 2.



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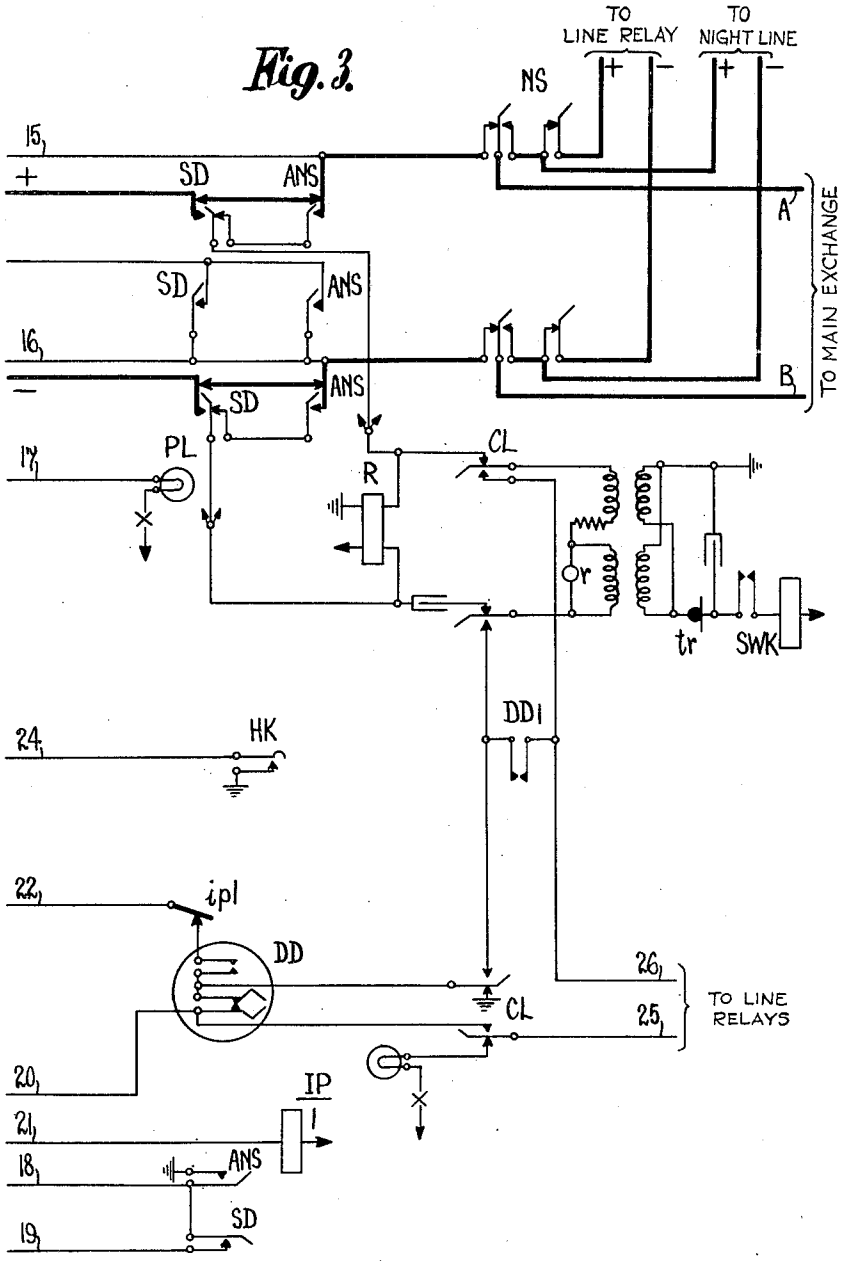
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TELEPHONE SYSTEM

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Fig. 3.



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Patented Apr. 26, 1932 1,855,701

UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed June 13, 1930, Serial No. 461,026, and in Great Britain June 25, 1929.

The present invention relates to telephone systems and is more particularly concerned with private branch exchanges arranged for inter-connection with a public automatic network. The invention provides an automatic private exchange consisting of relays and single motion rotary step-by-step switches having a capacity in the examples given of 22 local lines. Subscribers having access to both local lines and main exchange lines are provided with two pairs of speaking conductors, and these are preferably connected to the same instrument which may be of the type described in the Stehlik application, Serial No. 400,402, filed 17th October, 1929. This type of instrument is provided with keys whereby it may be connected to either of the pairs of conductors dependent upon whether the call is a local call or a call necessitating connection at the main exchange.

One feature of the invention relates to a telephone system in which calls local to the branch exchange are set up by the subscriber over one line while calls to and from the main exchange are set up over a further line by means of an automatic switch which is adapted to operate as a finder switch or as a connector switch dependent upon whether the calls are to or from the main exchange.

A further feature of the invention relates to a telephone system in which connections local to the branch exchange are set up by the calling party over a finder switch and a connector switch and outgoing calls from the branch exchange to the main exchange are set up by the subscriber over a further finder switch which is taken into use over a separate line while incoming calls from the main exchange to the branch exchange are set up by an operator who directively controls the said further finder switch to connect with the wanted line.

A still further feature of the invention relates to a telephone system having connections from the main exchange to the branch exchange set up by an operator over an automatic switch in which when the operator sets up a connection and the called subscriber is busy the performance of a special manual operation by the operator serves to hold the calling subscriber's line and causes the wanted subscriber to be automatically rung when he replaces his receiver at the end of his conversation and to be switched through to the calling subscriber at the main exchange when he again lifts his receiver.

In order that the invention may be better understood, the following description will now be given of one method of carrying it into effect which should be taken in conjunction with the accompanying drawings, and it will be understood that this is given by way of example only, and that various modifications may be made in the circuit details by those skilled in the art without departing from the spirit of the invention.

Referring now to the drawings, Fig. 1 shows a finder and connector link, by means of which local calls are established, while Figs. 2 and 3 show the apparatus which is taken into use over the second set of conductors, and which establishes connections to and from the main exchange.

Referring now more particularly to Fig. 1, when the subscriber removes his receiver prior to setting up a local call, relay LK will be energized over the circuit, earth at armature *lk*3, conductor 10, circuit via the calling subscriber's instrument, conductor 11, resting contacts of armature *lk*4, left hand winding of relay LK via the winding of the common start relay S to battery. Relay S is operated fully in this circuit while relay LK is operated only partially, and sufficient to make its light armature *lk*1, whereupon a marking circuit may be traced to the bank of the finder switch FS from earth at armature *s*1, operated armature *lk*1, resting contacts of armature *lk*2 to the associated bank contact, and moreover, a parallel circuit may be traced by way of resting contacts of armature *b*4, and armature *d*2, left-hand winding of relay G, interrupter springs *fdm*, of finder switch driving magnet FDM to battery by way of the resistance 12. Relay G thereupon operates over the circuit described and completes a circuit from earth at the resting contacts of armature *b*5, operated armature *g*2, winding of the finder switch driving magnet FDM to battery. The magnet thereupon energizes

preparatory to advancing the wipers of the finder switch FS one step, and when the interrupter springs *fdm* are operated the circuit of relay G is opened and this relay releases and in turn opens the energizing circuit to the magnet FDM, so that the latter de-energizes and advances the wipers to the next set of bank contacts. Inter-action between relay G and the finder switch driving magnet FDM will cause the wipers of that switch to be advanced in search of the calling bank contacts which it will be remembered were marked by the connection of earth potential thereto. When these marked contacts are reached, relay G will be prevented from again operating due to the short-circuiting earth which is now encountered by the testing wiper P1, and the wipers of the switch are held in this position.

No further circuit changes now take place until the wipers of the connector switch CS arrive at the home position, whereupon relay E will be operated in a circuit which includes earth at the operated armature *s*1 of the start relay, resting contacts of armatures *b*4 and *d*2, right-hand winding of relay E, home bank contacts and wiper H, interrupter springs *cdm*, and winding of the connector switch driving magnet CDM to battery. Relay E accordingly operates in the circuit described and at armature *e*1 prepares the impulsing circuit to the connector switch driving magnet CDM, at armature *e*2 extends earth from the wiper P1, via the resting contacts of armature *b*3 to the lower winding of relay A to battery, and finally at armature *e*4 prepares a circuit to the right-hand winding of the interrupter and busy test relay G. Relay A in operating over its lower winding at armature *a*1 completes the circuit to the guard relay B which also operates. Relay B at armature *b*1 prepares a further point in the connector switch stepping circuit, at armatures *b*2 and *b*3 connects up the positive and negative wipers of the finder switch FS to the impulse accepting relay A, at armature *b*4 extends the common start lead on to the next finder connector switch circuit, and at armature *b*5 prepares various locking circuits and extends earth via the wiper P and bank contact to the right-hand coil of the subscriber's line relay LK. Relay LK thereupon fully operates in order to clear the calling line of its normal battery and earth connections at armatures *lk*3 and *lk*4, and at armature *lk*2 removes the marking potential from the associated P1 bank contact. The jumpering block 32 is provided in order that all unused contacts of the switch FS can be earthed. Dial tone from conductor 16 is now extended over the positive wiper of the switch CS and the circuit is prepared for the reception of the dial impulses from the subscriber's calling device, upon the reception of which relay A will impulse in synchronism therto. Relay A at armature *a*1 will repeat these impulses over a circuit which includes, the operated armature *b*1, resting contacts of armatures *h*5 and *g*1, low resistance left-hand coil of relay E, winding of the connector switch driving magnet CDM to battery. The wipers of the connector switch CS are accordingly advanced the appropriate number of steps into engagement with the contacts of the desired line, and it will be appreciated that owing to the copper slug which surrounds the core of relay B, this relay will be maintained operated during the impulsing period, while in a similar manner relay E will also be held operated, so as to extend the right-hand winding of relay G to the testing wiper P of the connector switch CS.

In case the desired subscriber should be busy at this time, wiper P will encounter earth on the associated bank contact and during the slow release period of relay E, this earth will be extended to the right-hand winding of relay G, thereby causing this relay to operate and when relay E eventually releases, relay G will then lock up over the circuit, earth at the operated armature *b*5, operated armature *g*3, resting contacts associated with armature *e*4, winding of relay G to battery. Relay G in operating, at armature *g*1 opens the impulsing circuit to prevent any further impulses being received by the connector switch driving magnet CDM, at armature *g*2 prepares a homing circuit to the finder switch driving magnet FDM which is not effective at this stage, and at armature *g*4 extends busy tone over conductor 13, resting contacts of armature *e*3, the positive speaking conductor to the calling subscriber, thereby producing an audible signal in the calling subscriber's receiver to indicate that the required subscriber is busy. If, however, the calling line is idle at this time, wiper P will not encounter earth on the associated bank contact so that relay G will not be operated, and when relay E finally releases after its slow period a circuit may be traced from earth at armature *b*5, resting contacts of armature *g*3, lower winding of relay H, resting contacts of armature *e*4, wiper P of switch CS and bank contact to battery via the winding of the called subscriber's line relay. The called subscriber's line relay and relay H are therefore operated in series over this circuit, the former clearing the called subscriber's line of the normal battery and earth connections, while the latter relay completes a circuit by way of its light armature *h*1, its upper locking winding to battery. Relay H is therefore fully operated over this latter circuit and at armature *h*2 extends direct earth to the wiper P of switch CS in order to guard the connection and hold operated the called subscriber's line relay, at armature *h*5 opens a

point in the stepping circuit to the connector switch driving magnet CDM and at armatures *h*3 and *h*4 completes a circuit to ring the called subscriber's bell which may be traced from ringing current over conductor 14, left-hand winding of the ring trip relay F, armature *f*2, armature *h*3, positive wiper and bank contact of switch CS, called subscriber's circuit, bank contact and negative wiper of switch CS, armature *h*4, to earth at armature *f*4. The called subscriber's bell is therefore rung in the usual manner and an audible signal to this effect is provided to the calling subscriber over a leak on the main ringing circuit by way of the low capacity condenser Q, resting contacts of armatures *g*4 and *e*3, the positive speaking conductor to the calling subscriber.

When the called subscriber replies the direct current circuit thereupon completed, causes ring trip relay F to be operated so that it locks by way of its light armature *f*1 to earth at armature *b*5, while at armature *f*3 it opens the circuit which extends to the fuse alarm bell, over conductor 30, and at armature *f*2 and *f*4 completes the transmission circuit between the two subscriber's instruments.

Owing to the operation of relay F a circuit is completed for relay D which operates and at armature *d*1 closes a point in the circuit of the fuse alarm bell. The fuse alarm bell will not be operated as its circuit will be open at armature *f*3. This bell is only operated when a fuse blows as battery is then connected up from the fuse alarm stud over conductor 31 to the upper winding of relay D. This relay thereupon operates and at armature *d*, closes the circuit to the fuse alarm bell as relay F is not operated at this time.

Owing to the operation of relay F as mentioned above, conversation may now take place between the two subscribers, and at its conclusion when the calling subscriber hangs up his telephone, relay A releases and is followed shortly afterwards by relay B which is in turn followed by relays F, H and LK.

Consequent upon the release of relay B a homing circuit may be traced to the connector switch CS from earth at the resting contacts of armatures *b*5 and *e*5, bank commoning and wiper H, interrupter springs *cdm*, winding of driving magnet CDM to battery. The connector switch driving magnet CDM is accordingly energized in a self-interrupted circuit until wiper H is advanced to the home position, that is, out of engagement with the bank commoning and it will be noticed as mentioned previously in the description, relay E cannot again operate to complete the dial stepping circuit until this home position is reached.

It should also be mentioned that the numbers of the subscribers may be any of the following, 1—9, 01—09, 001—004. This arrangement is made possible by leaving the 10th and 20th sets of contacts unwired so that if, for example, 0 is dialled as a first digit the switch will be advanced in the manner described so that the wipers come to rest on the 10th set of bank contacts, and since wiper P does not encounter either earth or battery the switching operations will be suspended, and upon the reception of further trains of impulses the wipers of the switch may be set on any of the succeeding line contacts, or similarly if a further 10 impulses are transmitted the switching operations will again be suspended until the reception of the third digit which will set the wipers of the switch on one of the remaining contacts.

Referring now to Figs. 2 and 3 which show the equipment provided to give out-service, it will be seen that Fig. 2 shows a combined finder and connector switch FCS, while Fig. 3 shows the equipment at the attendant's cabinet. When a subscriber wishes to originate a main exchange call he lifts his receiver in order to complete a circuit across conductors 10 and 11 so that relays LK and ST are operated in series in a manner similar to that described in connection with Fig. 1, and it will be seen that the former in operating its light armature *lk*1, only, prepares a marking on the appropriate bank contact, of the switch FCS, while the operation of the common start relay ST completes the following circuit, earth at armature *st*1, resting contacts of armatures *l*3, *hx*3, *b*3, interrupter springs *fcm*, left-hand coil of relay FY to battery via the resistance 12. Similarly a parallel circuit may also be traced by way of the resting contacts of armatures *z*1, *oc*5, and *h*6, right hand coil of relay F to battery so that this latter relay operated and at its armature *f*1 prepares a locking circuit which will become effective at a later period, and at armatures *f*4 and *f*5 prepares points in the speaking circuit. Upon the operation of relay FY over the circuit previously traced, earth at the resting contacts of armature *b*1 will then be extended by way of armature *h*7, operated armature *fy*3, resting contacts of armature *z*2, winding of the finder connector switch driving magnet FCM to battery, and in parallel thereto via the right-hand coil of relay E to battery. The magnet FCM is thereupon energized in this circuit in order to prepare the stepping the wipers of the switch FCS on to the next set of bank contacts, and upon the full operation of the magnet FCM the holding circuit to relay FY is opened at the interrupter springs *fcm*, so that the latter relay releases and in turn opens the energizing circuit to the magnet FCM at armature *fy*3. Upon the de-energization of the magnet FCM the associated wipers are advanced on to the next set of bank contacts, and when this has been done, springs *fcm* will again make contact thereby

re-operating relay FY. Inter-action between relay FY and the magnet FCM will result in the wipers of the switch FCS being automatically rotated in search of the marked bank contact, and since relay E is operated in parallel with the magnet circuit and is equipped with a copper slug it remains operated throughout the stepping period. Relay E at armature *e*1 connects up an alarm circuit which is without effect at this time, at armature *e*2 prepares a circuit to relay G, and at armatures *e*3 and *e*4 disconnects the negative and positive wipers so that the apparatus will not be influenced by potential picked up on these wipers during their rotation to the marked line. When the marked line is reached relay FY will not again be operated due to the short-circuiting earth encountered by wiper P1, so that the wipers will be held in this position and relay B will be operated from earth applied at the operated armature *f*3. Relay B in operating, at armature *b*1 prepares various holding circuits, at armature *b*2 prepares a circuit to the pilot lamp PL, at the attendant's cabinet and at armature *b*3 connects the common start lead onto the next finder connector switch. Upon the release of relay E at the end of the impulsing period, the following circuit is completed to relay H, from earth at armature *b*1, armature *g*1, lower winding of relay H, armature *e*2, wiper P and bank contact, to battery via the right-hand coil of the line relay LK. Relays LK and H are thereupon operated in series, the former at armatures *lk*3 and *lk*4 clearing the calling line of the normal battery and earth connections, while the latter at its light armature *h*1 completes a locking circuit to its other locking winding. Relay H then fully operates and at armature *h*2 connects direct earth to the wiper P in order to guard the connection and hold operated the line relay LK, at armatures *h*3 and *h*4 completes the circuit to the main exchange, at armature *h*5 prepares a circuit to relay FY, at armature *h*6 transfers the holding circuit to relay F by way of its own armature *f*1, and at armature *h*7 opens a further point in the stepping circuit to the magnet FCM. The speaking circuit is now completed to the main exchange, and includes relay A; this relay therefore operates and at armature *a*1 maintains the holding circuit to relay B on its right-hand coil since the left-hand coil is disconnected upon the full operation of the line relay LK.

No further circuit changes now take place until the operator at the main exchange answers the call, and in case the connection should be to an automatic exchange the subscriber will receive the dial tone from the switch taken into use thereat, and will then proceed to transmit the digits of the required subscriber's number by way of the coil of relay A which has been bridged by a condenser and a non-inductive resistance so as to offer a low impedance to the impulse train. It will be noted during the speaking condition that relays H and F are held operated dependent on relay B, while relay B is in turn dependent upon relay A, and is equipped with a copper slug so as to remain operated during the impulsing period. Since in the example described it is desirable that at the end of the conversation the switch should be returned to a home position, the circuit for effecting this will now be described.

When the calling subscriber hangs up his receiver at the conclusion of the conversation, relay A will release owing to the opening of the loop circuit and is followed shortly afterwards by relays B, F, H and LK. Relay LK in releasing extends earth at armature *lk*3 by way of the bank contact and positive wiper, resting contacts of armatures *e*3 *h*3, *oc*6 and *hx*5, lower winding of relay Z to battery. Relay Z thereupon operates in the circuit described and at armature *z*3 connects earth to mark the home bank contact of the switch FCS, at armature *z*2 removes the short-circuit off the upper winding of relay Z, and finally at armature *z*1 extends earth from the resting contacts of armature *b*1, operated armature *z*1, interrupter springs *fcm*, left-hand coil of relay FY to battery via the resistance 12. Relay FY thereupon operates and at armature *fy*3 extends earth from the resting contacts of armature *b*1, armature *h*7, armature *fy*3, low resistance upper winding of relay Z, winding of the driving magnet FCM to battery. Relay FY and the driving magnet FCM thereupon inter-act in order to advance the wipers into the home position and it will be noticed when the circuit is opened to the lower winding of relay Z when the wipers make the first step, this relay remains operated over its upper winding in series with the driving magnet FCM during the automatic rotation of the switch. Moreover relay E is also operated in a parallel circuit, in order to disconnect the negative and positive wipers during the homing operation at armatures *e*3 and *e*4, while the private wiper is disconnected at armature *z*4. Although it will be seen from the drawings that relays HX and LC are also operated during this homing period, these operations are without function at this stage. When wiper P1 encounters the home bank contact which is marked by the connection of earth thereto via armature *z*3, relay FY cannot again be operated so that the wipers are held in this position, whereupon relays Z, HX and E restore after their slow period and finally relay LC also releases, so that the circuit is now prepared for use by other calling subscribers.

A description will now be given of the circuit operations which take place on an incoming call. Relay L is operated from ring-

ing current over the circuit from conductor A, resting contacts of night switch key NS, conductor 15, right-hand coil of relay L, condenser Q, conductor 16, other resting springs of night switching key NS, conductor B to the main exchange. Relay L thereupon operates its light armature *l*1 in order to complete a locking circuit to its left-hand locking winding from earth at the resting contacts of armature *b*1, resting contacts of armature *lc*1, operated armature *l*1, winding of relay L to battery. Relay L then fully operates and at armature *l*3 switches the start lead on to the next finder connector switch. A parallel circuit may also be traced from armature *l*1, by way of the resting contacts of armature *fy*2, over conductor 17, to light the pilot lamp PL associated with the calling line at the attendant's cabinet. The operator on seeing the lamp light thereupon operates the answering key ANS, in order to connect her telephone circuit across the calling line so as to enable her to receive the request from the calling subscriber. The operation of the answering key ANS at a pair of springs located in the lower half of the drawing extends earth over conductor 18, to operate relay LC, so that the latter relay then at armature *lc*2 prepares an operating circuit for relay H and at armature *lc*1 opens the locking circuit of the calling relay L, which however, does not release owing to its right-hand winding being now energized over a circuit extending from earth, upper winding of the retard R, springs of key SD, springs of key ANS, conductor 15, right-hand winding of relay L, short-circuiting springs of the key ANS, springs of the key ANS, springs of the key SD, lower winding of the retard R to battery.

When the operator has ascertained the wanted subscriber's number she will then operate the so-called speak and dial key SD which connects her telephone circuit on to the calling side of circuit and short-circuits the condenser Q so as to hold relay L, and also at a lower set of springs extends earth from the answering key over conductor 19 to operate relay OC. Relay OC operates and at its armatures *oc*1 and *oc*2 prepares points in the speaking circuit for the operator which will become effective in case the wanted subscriber tests busy, at armature *oc*3 prepares an impulsing circuit to the driving magnet FCM, at armature *oc*4 completes a circuit to the impulsing relay IP which may be traced from earth at the resting contacts of the local call key CL (Fig. 3) resting springs of the dial DD, conductor 20, armature *oc*4, conductor 21, winding of relay IP to battery, at armature *oc*5 opens a point in the circuit to relay F, at armature *oc*6 disconnects relay Z from the positive wiper of the switch FCS and at armature *oc*7 opens a point in the alarm circuit.

The operator then proceeds to dial the wanted number thereby causing relay IP to impulse in synchronism with the interruptions of the dial impulse springs, and for each break period a circuit may be traced from earth at the resting springs of the local call key CL, operated shunt springs of dial, resting contacts of armature *ip*1, conductor 22, operated armature *oc*3, right-hand coil of relay E to battery, and in parallel thereto via the resting armature *z*2 and the winding of the driving magnet FCM to battery. The intermittent operation of the driving magnet FCM causes the wipers of the switch FCS to be advanced into engagement with the desired bank contact, and as the relay E is also operated in a parallel circuit, the positive and negative wipers are disconnected at armatures *e*3 and *e*4 during the rotation, and at armature *e*2 a circuit is prepared for the busy test relay G. If now the wanted line is idle when the wipers encounter the associated bank contact, relay E will be released after its slow period and circuit will then be completed for the operation of the switching relay H from earth at armature *z*3, operated armature *lc*2, armature *g*1, lower winding of relay H, armature *e*2, wiper P and bank contact, winding of the called subscriber's line relay LK to battery. Relays LK and H are thereupon operated in series, the former clearing the called line of its attachments while the latter relay completes a locking circuit to its upper locking winding by way of the light armature *h*1, and upon the full operation of the relay over this latter circuit, ringing current will then be extended to the called subscriber's instrument over the circuit, ringing current connected to conductor 23, winding of relay F, armatures *f*5, *h*4, and *e*4, negative wiper and bank contact, conductor 11, circuit via the called subscriber's instrument, conductor 10, bank contact and positive wiper, armatures *e*3, *h*3 and *f*4 to earth. The called subscriber's bell is thereupon rung in the usual manner and when he replies a direct current circuit completed through the instrument causes relay F to operate and lock by way of its right-hand locking coil, thereby at armatures *f*4 and *f*5 completing the speaking circuit to the calling subscriber. Under these conditions the operator will then restore her keys to normal and permit the conversation to proceed.

If, however, the wanted subscriber is busy when his lines are connected with, wiper P will then encounter earth so that during the slow release period of relay E, relay G is operated and at its armature *g*2 maintains a locking circuit for itself when relay E is released. Relay G in fully operating at armatures *g*3 and *g*4, extends the speaking circuit for the operator to the called subscriber's circuit, at armature *g*5 prepares a point in a locking circuit for relay HX and

at armature *g*6 connects a low tone by way of the condenser Q2 to the negative speaking conductor in order to inform the subscriber that the operator is on the line and wishes to offer a call. If the busy subscriber agrees to take the call immediately, the operator will request both subscribers to replace their telephones on the switch hooks, and when this is done relay LK will be released and earth will be removed from the bank contact associated with wiper P, whereupon relay G releases and relay H is permitted to operate in the usual manner from battery via the line relay LK, so that, by this means the wanted subscriber is automatically re-called. If now the wanted subscriber agrees to take the call in say, two minutes' time, the operator will then ask the main exchange subscriber if he is able to wait, and should he agree the operator will then immediately depress the non-locking holding key HK which extends earth over conductor 24, to operate relay HX which thereupon locks operated by way of its armature *hx*1, operated armature *g*5 to earth at the resting contacts of armature *b*1. Relay HX in operating at armature *hx*2, maintains relay LC, at armature *hx*3 connects the common start lead to the next finder connector switch, at armature *hx*4 maintains relay L over a circuit extending from battery via the main exchange equipment and at armature *hx*5 opens a point in the circuit to the lower winding of relay Z.

The operator may now restore her answering and dial keys and the circuit will be held in the above condition until the busy subscriber has finished his conversation. When the busy subscriber replaces his telephone on the switch hook at the end of his conversation relay G will release as previously explained and relay H will extend ringing current to the said subscriber's instrument circuit, and although the release of relay G opens the holding circuit to relay HX, the operation of relay H at armature *h*7 maintains relay HX in an operated condition. When the wanted subscriber replies, relay F operates and connects the speaking circuit through, and upon the operation of relay A, relay B will operate and open the holding circuit to relay HX, which will accordingly release together with the other relays which were held over circuits including its operated contacts.

In case the operator desires to originate a call to the main office she will operate the local call key CL, thereby completing a circuit over conductors 25 and 26 which extend to a line relay such as LK and the banks of the finder connector switch FCS over the circuit, conductor 25, operated contacts of key CL, resting contacts of dial impulse springs, to other operated contacts of key CL, via further operated contacts of key CL, winding of operator's induction coil, other operated contacts of key CL to conductor 26. When the operator receives the dial tone which is connected over conductor 27 to the home bank contact associated with the negative wiper of the switch FCS, she will then proceed to dial after the fashion of an ordinary subscriber in order to set up the required connection, and it will be noticed that during the dialling period the operator's listening circuit is shunted by further shunt springs DD1 of the dial, in order to prevent clicks being heard by the operator in the telephone receiver.

During night periods, the night switching key NS is operated, and since a particular subscriber's telephone line is connected by way of the resting contacts of this key, the normal circuit will be disconnected from the P. A. X. equipment, and at the operated springs of the key the main exchange line will be extended direct to the subscriber's instrument. By this arrangement calls incoming from the main exchange during night periods will be received direct on this particular subscriber's instrument which might be for example, located at the night watchman's premises.

We claim:—

1. In a telephone system, a main exchange and a branch exchange connected by a trunk line, a subscriber's station connected with the branch exchange over two separate lines, local switching apparatus co-operating with one of said lines for establishing connections between said station and other branch exchange stations, an automatic switch terminating said trunk line at the branch exchange, means controlled by the subscriber at said station over the other of said lines for operating said switch as a finder to establish a connection with said trunk line, and means effective on an incoming call over the trunk line for directively operating said switch as a connector to establish a connection with said station via the other of said lines.

2. In a telephone system, a main exchange and a branch exchange connected by a trunk line, a subscriber's station connected with the branch exchange by two separate lines, an attendant's switchboard at the branch exchange, local switching apparatus co-operating with one of said lines for establishing connections between said station and other branch exchange stations, an automatic switch terminating said trunk line at the branch exchange, means controlled by the subscriber at said station over the other of said lines for operating said switch as a finder to establish a connection with said trunk line, and means controlled from said switchboard for directively operating said switch to extend an incoming call over the trunk line to said station via said other line.

3. In a telephone system, an automatic

switch operating as a finder to hunt for and connect with a calling line and operating as a connector under directive control to connect with and test a called line for its busy or idle condition, means in the switch operated responsive to the establishment of a connection with an idle called line for applying signalling current to the line, and means in the switch operated responsive to the establishment of a connection with a busy called line for preventing the operation of said last means until the called line becomes idle.

4. In a telephone system, an automatic switch operating as a finder to hunt for and connect with a calling line in outgoing calls and operating as a connector under directive control of an operator in incoming calls to connect with and test a called line for its busy or idle condition, means in the switch operated responsive to the establishment of a connection with an idle called line for applying signalling current thereto, and means in the switch operated responsive to the establishment of a connection with a busy called line for applying a distinctive tone thereto to notify the subscribers of the waiting call.

5. In a telephone system, two exchanges, a trunk line connecting said exchanges, a switch terminating said trunk line at one exchange, said switch operating to hunt for and connect with a calling subscriber's line and operating under directive control of an attendant at said one exchange to connect with and test a called subscriber's line, means in the switch operated responsive to the extension of a connection to a busy called line for establishing a temporary talking connection between the called line and the attendant, means controlled by the attendant for causing said switch to remain in connection with the busy line while the attendant withdraws from the connection, means responsive to the called line becoming idle for signalling the line, and means responsive to the subscriber answering for connecting the called line with the trunk line.

6. A telephone system as claimed in claim 5 in which the switch effecting the connection with the called subscriber's line restores to normal position responsive to the called subscriber replacing his receiver to terminate the call.

7. In a telephone system, a switch equipped with a pair of line wipers and a test wiper, called lines accessible to the switch via said wipers, means for operating the switch to establish a connection with a called line, a relay for restoring the switch to normal position, and means for operating said relay over a circuit including one of said line wipers.

8. In a telephone system, a switch equipped with a pair of line wipers and a test wiper, a home position for the switch, means for operating the switch from home position to establish a talking connection with a called line via said line wipers, a relay for stepping the switch, a second relay for controlling said first relay, means for operating the second relay over a circuit including one of said line wipers, and means controlled by said second relay for marking the home position of said switch to prevent said first relay from stepping the switch after the home position is reached.

9. In a telephone system, a main exchange and a branch exchange, a trunk line connecting said exchanges, a switch terminating said trunk line at the branch exchange, means for operating said switch as a finder in branch to main exchange calls, means for operating the switch as a connector in main to branch exchange calls, and means controlled over a branch exchange subscriber's line for restoring the switch to normal responsive to the termination of a call of either class.

10. In a telephone system, a main exchange and a branch exchange, an attendant's switchboard at the branch exchange, a trunk line extending from the main exchange through said switchboard to a switch in the branch exchange, means for operating said switch as a finder in branch to main exchange calls, and means at said switchboard for directively operating the switch as a connector in main to branch exchange calls.

11. In a telephone system, a main exchange and a branch exchange, an attendant's switchboard at the branch exchange, a trunk line extending from the main exchange through said switchboard to a switch in the branch exchange, a local two-conductor trunk line extending from the switchboard to the branch exchange, a calling device including a pair of impulse contacts at the switchboard, means for connecting said calling device to either said local trunk line or to said switch, and means for adapting the calling device to transmit impulses over a single conductor to operate said switch or to transmit impulses over the two conductors of said local trunk line in series to operate switches associated with said trunk line.

12. In a telephone system, two exchanges connected by a trunk line, a switch terminating the trunk line at one exchange, an attendant's switchboard at said one exchange, means at the switchboard for directively operating said switch to extend a call incoming over the trunk line to a called subscriber's line in said one exchange, means in the switch for testing the called line for its idle or busy condition, a relay in the switch operated responsive to the called line testing idle for applying signalling current to the line, a second relay in the switch operated responsive to the called line testing busy for preventing the operation of said first relay, a third relay for preventing the release of the switch when the attendant withdraws from the connection, means controlled by the attendant for operat-

ing said third relay, and means controlled by said third relay for locking operated under control of said second relay.

13. A telephone system as claimed in claim 12 in which the second and third relays release upon the busy called line becoming idle and the first relay operates to apply signalling current to the line.

14. In a telephone system comprising a main exchange and a branch exchange, subscriber's lines in the branch exchange, a two-way trunk line connecting the exchanges, a switch terminating said trunk line at the branch exchange and having access to said lines, means for operating said switch to connect with a calling line or with an idle or busy called line, means in the switch for immediately connecting a calling or busy called line with said trunk, and means in the switch for delaying the connection of an idle called line with the trunk until the called subscriber answers the call.

15. In a telephone system comprising a main exchange and a branch exchange, subscriber's lines in the branch exchange, a two-way trunk line connecting the exchanges, a switch terminating the trunk line at the branch exchange, means for operating said switch to connect with a calling or called line, means in the switch for connecting the line with said trunk line, means for signalling the line prior to the operation of said connecting means when a call is extended to an idle called line, and means for delaying the operation of said signalling means until the line becomes idle when a call is extended to a busy called line.

In testimony whereof we affix our signatures.

CHARLES EDMUND BEALE.
HERBERT STANLEY DEYES.