H. W. MUNSELL.

SEMI-AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED SEPT. 25, 1915.

1,296,104.

Patented Mar. 4, 1919.

2 SHEETS—SHEET 1.

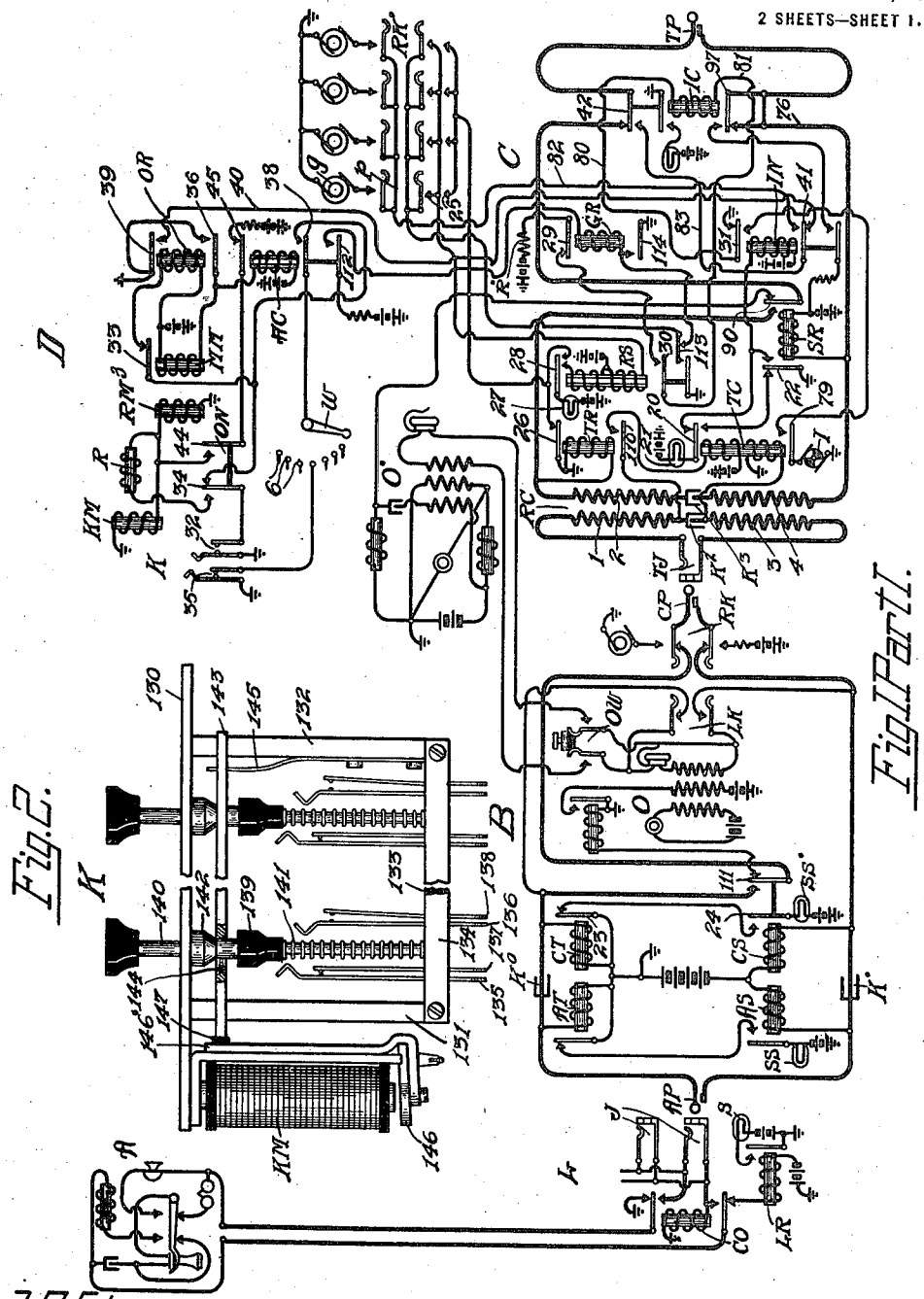

Fig. 1.

Witnesses:

G. A. Janochowski.

W. Berghaln

Inventor:

Harry W. Munsell.

By Curtis B. Comp.

Attorney.

H. W. MUNSELL.

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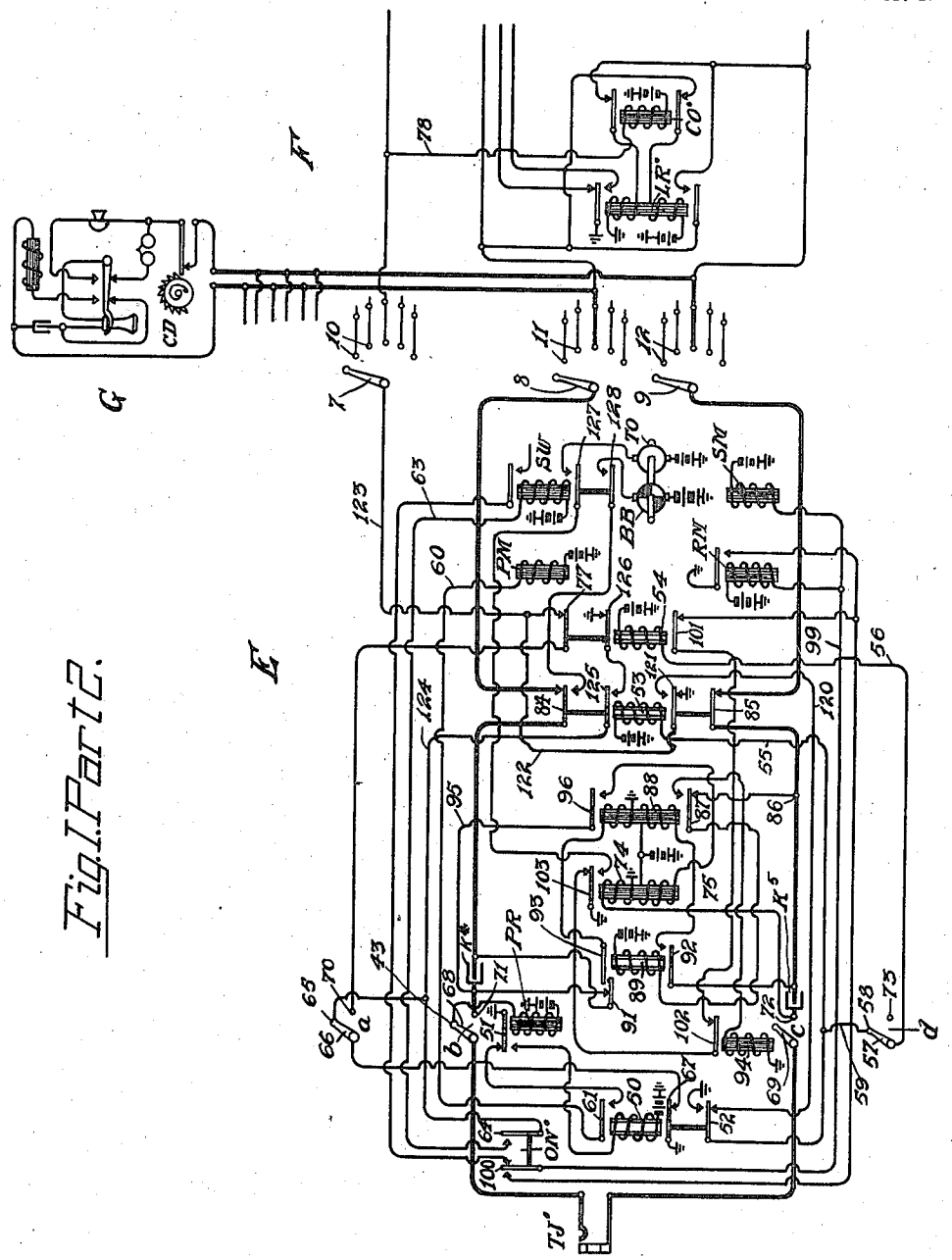

Fig. 1. Part 2.

Witnesses

G. A. Ganochowski.

W. J. Berghalyn.

Inventor:

Harry W. Munsell.

By Curtis B. Camp.

Attorney.

UNITED STATES PATENT OFFICE.

HARRY W. MUNSELL, OF INDIANAPOLIS, INDIANA, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

SEMI-AUTOMATIC TELEPHONE SYSTEM.

1,296,104. Specification of Letters Patent. Patented Mar. 4, 1919.

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To all whom it may concern:

Be it known that I, HARRY W. MUNSELL, a citizen of the United States of America, residing in Indianapolis, county of Marion, and State of Indiana, have invented certain new and useful Improvements in Semi-Automatic Telephone Systems, of which the following is a specification.

My invention relates to telephone systems and has to do more particularly with systems of the semi-automatic type in which an operator is employed to transmit impulses to operate switches to select the contacts of a called line in an automatic exchange. In systems of this character a great many connections are put through by an operator, so it is desirable to have a device which is easy of manipulation and quick in operation. To this end I employ a series of impulse control keys equal in number to the number of subscribers that the final selector or connector switch has access to. By this arrangement it is only necessary to operate one key to call any subscriber in the exchange.

One of the features of my invention is the provision of a calling device of the character above described, that may readily be associated with any trunk of a plurality of trunks extending to the final selectors or connectors that are used to establish connection with called subscribers' lines, and the provision of means for preventing the impulse lead of the calling device from being operatively associated with more than one of said connectors at a time.

In general, the object of my invention is the provision of an impulse sender of the character above described which is simple of construction, easy of manipulation and operation and compact in form. In the ensuing description and claims I shall more particularly point out the features thereof.

I preferably arrange the subscribers' lines in groups of any desirable size. A plurality of final selectors or connectors are associated with each group of lines and the trunk lines connected to these connectors terminate in their opposite ends, in multiple jacks upon an operator's board, each of the trunk lines being accessible to a plurality of operators. Each operator thus has a plurality of groups of jacks appearing before her equal in number to the number of groups of subscribers' lines.

For a more complete understanding of my invention reference may be had to the accompanying drawings which consist of Figure 1, Part 1, and Fig. 1, Part 2. When Fig. 1 Part 1 is placed to the left of Fig. 1 Part 2, the two parts thus placed illustrate a complete circuit arrangement between a calling and a called subscriber. Fig. 2 is a view of a strip of impulse keys associated with the impulse machine of my invention.

Referring now more in general to my invention, as illustrated in the accompanying drawings, and referring to Fig. 1, Part 1, at the left of said drawing I show a well-known substation A terminating at the exchange in a line circuit L comprising a line relay LR, a cut-off relay CO, a line lamp S and the multiple jacks J. The cord circuit B comprises an answering plug AP and a calling plug CP, the said plugs being connected by the heavily marked conductors and having the condensers K^0 and K^1 interposed. I show the usual answering tip and answering sleeve supervisory relays AT and AS, the two said relays controlling an answering supervisory signal SS. Calling tip and calling sleeve supervisory relays CT and CS are associated with the calling end of the cord circuit B, the two said relays controlling a calling supervisory signal SS^1. I also show a listening key LK, which, when operated, connects the operator's set O to the cord conductors and a ringing key RK which when thrown connects ringing current to signal a called local subscriber, when the cord circuit B is used for interconnecting two local subscribers. An order-wire key OW is associated with cord circuits B which when depressed connects the operator's set O of the cord circuit B with the operator's set O^1 which is associated with the trunk circuit C.

The trunk circuit C at its incoming end terminates in a trunk jack TJ and at its outgoing end in a trunk plug TP the said plug and jack being connected through a repeating coil RC by the heavily marked conductors, which have condensers K^2 and K^3, interposed between the windings 1, 3 and 2, 4 of the repeating coil RC. The trunk circuit C is provided with a trunk calling sleeve supervisory relay TC energized when the operator of cord circuit B plugs into the assigned trunk jack TJ. A ringing signal relay RS is provided which is energized when any one of the plungers of the ringing key RK^1 is depressed. A combined interrupter

and impulse connecting relay IC is provided which is energized when the relay RS is operated. An impulse guard relay GR is also provided to guard against interference on the impulse wire when a connection is being set up while the impulse machine is running. The operation of this relay will be more fully described in the following description of the operation of the system. A sleeve relay SR is provided which is operated when the connector E has seized the called line as does also the interrupter connector relay IN which connects the interrupter I, to intermittently energize and deenergize the relay IC to connect the ringing lead to supply ringing current to the called line. A tip relay TR is provided which is energized when the called subscriber answers to disconnect ringing current and also efface the supervisory signal 27.

The circuit of the impulse machine as illustrated at D in Fig. 1, Part 1, comprises a plurality of keys K diagrammatically illustrated at D and shown in detail in Fig. 2. These keys K are mounted in the key shelf of the switchboard before an operator. I provide one key for each bank contact 6 on the impulse machine. When any one of a plurality of these keys is depressed, an energizing circuit for the operating relay OR is established which in turn operates motor magnet MM. Motor magnet MM steps the wiper W of the impulse machine over the contacts 6 associated with the said impulse machine until the contact associated with the depressed key is engaged when the impulse machine comes to rest. The impulses are thus transmitted to operate the connector switch E at the automatic exchange to select the contacts of the called line. A release magnet RM^3 and a key release magnet KM are provided, the magnet RM^3 upon energizing releases the actuated wiper of the impulse machine and the magnet KM upon energizing, releases any one of the keys which has been depressed. The construction of the key K as illustrated in Fig. 2 will be more fully described in the ensuing specification. Off-normal contacts ON are provided which assume their alternate position upon the first step of the wiper W from normal position.

The connector switch E is of the well-known type and terminates at one end in a trunk jack TJ^1 before a trunk operator and at its other end at the automatic exchange in wipers 7, 8, and 9, said wipers being associated with the connector contacts 10, 11, 12. The connector switch as shown is preferably a one motion switch, that is, it has rotary motion only. The switch is provided with the usual switch shaft (not shown) carrying the wipers 7, 8 and 9. I also show the side switches *a*, *b*, *c* and *d* which assume their second position when the contacts of the called line have been seized by the connector switch E. A primary relay PR and a primary magnet PM supply the motive power to step the wipers 7, 8, and 9 over the bank contacts 10, 11 and 12, into engagement with the contacts of the called line. A side switch relay SW is provided to control the said switch wipers in a well-known manner. A release magnet RM and a side switch release magnet SM are provided, which control the release of the wipers 7, 8, and 9 of the connector switch and also the side switches *a*, *b*, *c* and *d*. A busy-back tone BB is provided which operates when a busy line is encountered, to notify the calling subscriber and also the trunk operator of the busy condition of the called line. Off-normal contacts ON^1 are also associated with the connector switch E and assume their alternate position upon the first step of the wipers 7, 8, 9 from normal.

To the right of Fig. 1, Part 2, I show a calling substation G provided with the usual apparatus and also including a calling device CD. The station G terminates in an automatic line circuit F which includes a line relay LR^1 and a cut-off relay CO^1.

Having described in general the apparatus embodying my invention, I will now describe in detail the operation of my system as illustrated.

Assuming now that the subscriber at the substation A wishes to initiate a call, the subscriber thereat removes his receiver, which act closes an energizing circuit for the relay LR of the line circuit L, to light the line signal S. The operator associated with the cord circuit B, noting the lighted signal S inserts the answering plug AP of cord B into the jack J of the calling line and throws her listening key LK to connect her operator's set O to the cord conductors to inquire the wants of the calling subscriber. Upon the insertion of the answering plug AP into the jack J, a series energizing circuit for the cut-off relay CO and the sleeve supervisory relay AS is established traced from battery through the winding of the relay AS, the sleeve contacts of the connected plug and jack and through the winding of the relay CO to ground. The relay CO operating opens the circuit of the line relay LR; the said line relay restoring, brings about the effacement of the line signal S. The answering tip supervisory relay AT is also energized through the now closed contacts of the cut-off relay CO, and through the substation back to battery. The operation of the relay AT prevents the premature lighting of the supervisory signal SS. Assuming that the subscriber at substation A wishes to converse with the subscriber at a distant automatic exchange, and assuming further that it is the substation G that is wanted, the operator at B now depresses

the order-wire key OW so that she may communicate with the trunk operator O[1]. The operator after depressing key OW, repeats the number of the called subscriber to the operator of trunk circuit C and the operator at the trunk circuit C then assigns the trunk to be used.

The operator at the cord circuit B now inserts the plug CP into the trunk jack TJ closing a series energizing circuit for the relay CS of B and the relay TC of the trunk circuit extending from battery through the winding of the relay CS, the sleeve contacts of the connected plug and jack, the winding 3 of the repeating coil RC and through the lower winding of the relay TC to ground. The closing of alternate contact 20 of relay TC establishes a circuit for the signal 21, traced from battery through the said lamp 21, the alternate contact 20 of relay TC to ground at normal contact 22 of relay SR. The lighted signal 21 notifies the operator at the trunk circuit C that the operator at B has plugged into the assigned trunk jack. The lamp remains glowing until the called subscriber is signaled when it is effaced. The operation of the relay CS of the cord circuit B closes a circuit through the signal SS[1] traced from ground through normal contact 23 of relay CT, alternate contact 24 of relay CS and through the said supervisory signal SS[1] to battery, the lamp remaining glowing until the called subscriber answers.

Returning to the operator at C, she first tests the trunk jack TJ[1] by placing the tip of the trunk plug TP to the sleeve of the trunk jack TJ[1] and tests it as to its idle or busy condition. If the trunk jack tested is busy, the operator will receive the customary click signifying the busy condition of that particular connector. Assuming that the connector E connected to the trunk jack TJ[1] is idle, the operator inserts the plug TP into the jack TJ[1] and depresses one of the plungers of the ringing key RK[1] to connect the proper frequency of ringing current to ring the call bell of the called subscriber, and then depresses the proper impulse key K of the impulse machine D, to transmit impulses from the said impulse machine to operate the connector E to extend the connection to the called subscriber at the substation G. The operator at C having depressed the plunger of the ringing key to its fully depressed position, an energizing circuit for the relay RS is established, the circuit extending from battery through the lower winding of the relay RS, the alternate contact 25 of the depressed ringing key plunger p to ground at normal contact 26 of relay TR. Upon the energization of the relay RS, the circuit for the supervisory signal 27 is established traced from battery through the said signal, alternate contact 28 of relay RS to ground at normal contact 26 of relay TR, the signal remains lighted until the called subscriber has answered. A circuit for the relay IC is also established upon the energization of the relay RS, the circuit being traced from battery, normal contact 29 of relay GR, alternate contact 30 of relay RS and through the winding of relay IC to ground at normal contact 31 of relay IN. The operator at trunk circuit C having depressed the impulse key K corresponding to the number of the wanted substation, brings about the momentary closure of the contact spring 32 of the depressed key plunger establishing an energizing circuit for the operating relay OR of the impulse machine D, said circuit being traced from battery through the relay OR, normal contact 33 of the motor magnet MM, normal contact 34 of the off-normal springs ON to ground at the momentarily closed contact 32 of the depressed key plunger K. When the depressed impulse key K is released, it assumes its indicating position, the circuit 32 again opening. The contact 35 associated with the depressed impulse key K remains open removing ground from the bank contacts associated with the depressed key. The relay OR, upon energizing, closes an energizing circuit for the motor magnet MM traced from battery through the winding of the magnet MM, through alternate contact 36 of relay OR to ground. The slow acting relay AC is also energized over a circuit traced from battery through the winding of said relay, the alternate contact 36 of relay OR to ground. The relay OR has its circuit interrupted when the contact 32 of K is opened, when the key assumes its indicating position after pressure is released. The relay OR deënergizing, opens the circuit of the motor magnet MM, which upon deënergization moves the wiper W of the impulse machine to the first bank contact 6. The wiper engaging the first contact, which is grounded, establishes a second energizing circuit for the relay OR traced from the first engaged grounded contact 6 through the alternate contact 38 of relay AC (which being a slow acting relay has not as yet released), normal contact 33 of magnet MM and through the winding of relay OR to battery. The motor magnet MM is thus alternately energized and deënergized, stepping the wiper W of the impulse mechanism over the bank contacts 6 by means of a suitable ratchet and pawl mechanism as is well-known. Wiper W is therefore stepped around until it encounters the ungrounded contact associated with the depressed impulse key K. The impulses transmitted by the opening and closing of contact 39 of relay OR are transmitted from ground at contact 39 of relay OR, over conductor 40, normal contact 41 of relay IN,

the alternate contact 42 of relay IC, the tip contacts of the connected trunk plug TP and jack TJ¹, side switch wiper 68, contact 43, through the winding of the primary relay PR of the connector switch E to battery. A resistance R is provided in the impulse circuit D which is cut in when the wiper W takes its first step and as the off-normal contacts assume their alternate position upon the first step of the wiper, so that should an operator be slow in removing her finger from the depressed impulse key K, when a low number is being called, the switch will not be released and stepped forward again causing the transmission of false impulses, but will remain in its operated position until the shunt resistance R is cut out of circuit.

Upon the first energization of the relay PR, an energizing circuit for slow acting relay 50 is established, extending from battery through the winding of relay 50 to ground at alternate contact 51 of relay PR. The closing of alternate contact 52 of relay 50 establishes an energizing circuit for the relays 53 and 54. The circuit for relay 53 being traced from battery through the winding of relay 53, conductor 55 to ground at alternate contact 52 of relay 50. The circuit for relay 54 being traced from battery through windings of the said relay 54, conductor 56, the side switch wiper 57, contact 58, and conductor 59 to ground at alternate contact 52 of relay 50. Upon the first deënergization of the relay PR an energizing circuit for primary magnet PM is established extending from battery through the winding of the magnet PM, conductor 60 and the alternate contact 61 of relay 50 to ground at normal contact 51 of relay PR. The relay 50 being slow to release, its contact 61 is held energized during the transmission of impulses to the primary magnet PM. The impulses, from the impulse machine transmitted to the connecter E, as before described, causes the relay PR to energize and deënergize and, due to the opening and closing of its normal contact 51 the said magnet PM is likewise energized and deënergized stepping the wipers 7, 8, and 9 of connector switch E into engagement with the contacts 10, 11, and 12 of the called line. The relay 50, as before described, being slow acting, is not affected by the rapid interruptions of relay PR and therefore the relays 53, 54 remain energized during the transmission of said impulses. Upon the first step of the wipers the off-normal contacts ON¹ assume their alternate position. When the wiper W of the impulse machine D engages the ungrounded contact 6, the ground having been removed when its associated key K was depressed by the trunk operator, the circuit for relay OR is interrupted thereby interrupting the circuit of the magnet MM at contact 36 of OR. The wiper W comes to rest and the impulses cease. The relay AC being a slow acting relay is not affected by the rapid interruptions of relay OR but has its circuit permanently interrupted when relay OR is deënergized, thereby closing an energizing circuit for the release magnet RM³ and the key release magnet KM. The circuit for magnet RM³ being traced from ground through the winding of RM³, alternate contact 44 of off-normal contacts ON, the normal contact 45 of relay AC to battery. The circuit for magnet KM being traced from ground through the winding of KM, alternate contact 44 and normal contact 45 to battery. The magnet RM³ releases the wiper W and allows it to restore and the magnet KM restores the depressed key K rendering available the impulse machine for sending another set of impulses.

The impulses having ceased, the relay PR remains deënergized thereby opening the energizing circuit for the relay 50. The relay 50 restoring opens the circuits of relays 53, 54 at contact 52. The relay 50 deënergizing closes a circuit for the side switch magnet SW, extending from battery through the winding of said relay SW, conductor 63, alternate contact 64 of off-normal contacts ON¹, contact 65 and the wiper 66 to ground at normal contact 67 of relay 50. Upon the energization of the magnet SW the side switch wipers 57, 66, 68 and 69 are stepped to their sectond position into engagement with contacts 73, 70, 71 and 72. When the side switch wiper 66 leaves its contact 65 and engages the contact 70 the circuit for the magnet SW is opened. The said magnet deënergizing, permits the side switch to remain in its second position. As soon as the side switch has assumed its second position, a series circuit for the relay 74 of the connector E and the sleeve relay SR of the trunk circuit C at the manual exchange is established, said series circuit being traced from ground through the upper winding of the relay 74, conductor 75, contact 72, wiper 69, the sleeve contacts of the connected jack and plug TJ¹ and TP, conductor 76 and through the winding of the relay SR to battery. The opening of the normal contact 22 of relay SR effaces the signal 21 of the trunk circuit C notifying the operator that the called party is now being rung. The cut-off relay CO¹ of the line circuit F associated with the called subscriber G is also energized, over a circuit traced from ground at normal contact 67 of relay 50, wiper 66, contact 70, the normal contact 77 of relay 54, wiper 7, contact 10, conductor 78 and through the winding of the cut-off relay CO¹ to battery. The cut-off relay CO¹, upon energizing removes the substation control of the line circuit L¹ when the called subscriber answers in response to the call.

Upon the energization of the relay SR

of the trunk circuit C, an energizing circuit for relay IN is established being traced from battery through the winding of said relay to ground at alternate contact 22 of relay SR. The closing of contact 31 of relay IN connects the interrupter I to the relay IC to intermittently energize and deënergize the said relay IC. The circuit being traced from ground through the interrupter I, the alternate contact 79 of relay TC, alternate contact 31 of relay IN, conductor 80 through the winding of relay IC, conductor 81, alternate contact 30 of relay RS, normal contact 29 of relay GR and through the protective resistance R^1 to battery. The relay IC is intermittently energized and deenergized by interrupter I and operates to connect the ringing lead 82 to the tip side of the line. The path for the ringing current extending from the ungrounded pole of generator *g* closed contact of the plunger of the ringing key RK^1, ringing lead 82, alternate contact 41 of relay IN, conductor 83, alternate contact 42 of relay IC, tip contacts of the connected plug and jack, the wiper 68, contact 71, the normal contact 84 of relay 53, wiper 8, contact 11, condenser and call bell of called substation G, contact 12 and wiper 9, normal contact 85 of relay 53, the ringing current dividing at 86 part of it going through the normal contact 87 of relay 88 and through the winding of the relay 89 to battery, part extending through the condenser K^5 contact 72 of side switch *c* upper winding of the relay 74 to ground, and a part extending through the wiper 69 of side switch *c*, sleeve contacts of connected plug and jack, conductor 76, through winding of relay SR of trunk circuit C to battery. The bell of called substation G is thus intermittently operated and when the subscriber at called substation G answers the tip relay TR of trunk circuit C and relay 89 of the connector switch E are energized in series, said energizing circuit being traced from ground through the winding of said relay TR of trunk circuit C alternate contact 90 of relay SR, normal contact 42 of relay IC, tip contacts of the connected plug and jack, wiper 68, contact 71, contact 91 of relay 89, normal contact 84 of relay 53, wiper 8, contact 11, through the now closed contacts of the switch-hook of the called substation G, returning through contact 12, wiper 9, normal contact 85 of relay 53, normal contact 87 of relay 88 and through the winding of the relay 89 to battery. Upon the energization of TR of trunk C the circuit for signal 27 is effaced, notifying the operator that the subscriber has answered. The closure of alternate contact 110 of relay TR closes a circuit for relay CT of cord B, circuit being traced from ground through the winding of relay CT, closed contact 111 of relay CS, tip contacts of the plug CP and jack TJ, winding 1 of repeating coil RC, alternate contact 110 of relay TR and through the upper winding of relay TC to battery. Relay CT upon energizing opens the circuit of signal SS^1 of cord B. Upon the energization of relay TR the circuit for relay RS is interrupted at contact 26 of relay TR. The relay RS restoring opens contact 30 which opens the circuit for relay IC, which deënergizes and disconnects the ringing current. Upon the energization of the relay 89 the circuit for relay 88 is closed, traced from battery through the lower winding of the relay 88, alternate contact 92 of relay 89 to the sleeve conductor, through the normal contact 85 of relay 53, wiper 9, contact 12, through the closed contacts of the switch-hook of the station G, contact 11 of the wiper 8, normal contact 84, alternate contact 93 of relay 89, and through the upper winding of relay 88 to ground. The relay 88, furnishes battery for talking purposes to the called subscriber's telephone. The relay 88, upon energizing, closes a substitute circuit for relay 89 said substitute circuit being traced from battery through the winding of the said relay 89, alternate contact 87 and through the winding of relay 94 to ground. The relay 94 upon energizing opens the release circuit for the connector switch E and prevents the connector switch from releasing until the called subscriber has replaced his receiver upon the switch-hook and the operator has removed the plug from the trunk jack which leads to the connector switch E. The energization of relay 88 also closes a substitute circuit for relay TR of cord circuit C extending from ground through the winding of the said relay TR, alternate contact 90, normal contact 42, tip contacts of the connected plug TP and trunk jack TJ^1, wiper 68, contact 71, the conductor 95, alternate contact 96 of relay 88 and through the lower winding of relay 74 to battery. The subscribers may now carry on conversation over the heavily marked circuit.

Assuming now that the subscribers have finished conversation, they replace their receivers upon their respective switch-hooks. The replacing of the receiver at the called substation G opens the energizing circuit for relay 88. The said relay restoring opens the energizing circuit of the relays 94 and 89 at contact 87 of relay 88. The tip relay TR of the trunk circuit C is also deënergized due to the replacing of the receiver at called substation G. The opening of contact 110 of relay TR opens the energizing circuit of relay CT of cord B which again brings about the lighting of the supervisory signal SS^1, notifying the operator at B that the conversation has been terminated. The circuit for

the release magnet RM and the side switch release magnet SM, is not as yet closed due to the fact that relay 74 is still held energized from battery through the sleeve relay SR at the trunk circuit C. The operator noting the lighted supervisory signal, removes the plug TP from trunk jack TJ¹.

The removal of the plug from the trunk jack opens the circuit of the relay 74. The said relay 74 deënergizing closes the circuits of the release magnet RM and the side switch release magnet SM. The circuit of the release magnet RM extends from battery through the winding of the said magnet RM, conductor 99, alternate contact 100 of off-normal contact ON¹, normal contact 101 of relay 54, and normal contact 102 of relay 94 to ground at normal contact 103 of relay 74. The circuit of magnet SM extends from battery through the winding of said magnet, conductor 99, following the same path as that of magnet RM. The magnet RM, upon energizing, releases the wipers 7, 8, 9, allowing them to restore to normal and the magnet SM upon energizing, releases the side switch to normal or first position. The off-normal contacts ON¹ are also restored to normal thus opening the circuit of the release magnet RM and side switch release magnet SM, the two magnets restoring to normal. The apparatus at the connector E is now at normal and is available for establishing other connections.

Upon the removal of the plug TP from the jack TJ¹, the circuit of the relay SR of the trunk circuit C is opened bringing about the deënergization of the relay IN. The operator at B having received the disconnect signal from the subscriber at A, due to the deënergization of the relay AT, removes plugs AP and CP from their respective jacks, the removal of plug AP opens the circuit of relay CO of L and AS of the the cord circuit B and the removal of the plug CP from the jack TJ deënergizes the relay CS of the cord circuit B and also the relay TC of the trunk circuit C. The apparatus now returns to normal and the cord circuit B, trunk C, impulse machine D and connector E are now available for other connections.

Referring now to the guard relay GR, of the trunk C. This relay is used as a guard against interference on the impulse wire when a connection is being set up while the impulse machine is still running. In this event should the impulse machine be still running while the trunk plug TP of a trunk circuit as C be inserted into a trunk jack as TJ¹ leading to a connector E, a circuit for the guard relay GR will be immediately established, the circuit being traced from battery through the alternate contact 112 of relay AC of circuit D, (the said relay AC being held energized during the operation of the impulse mechanism due to its being a slow-acting relay), the winding of relay GR, the make-before-break contact 113 of relay RS, the closed contacts of the depressed ringing plunger of the ringing key RK¹, (which is depressed by the operator after the plug TP is inserted into the jack TJ¹), to ground at normal contact 26. The relay GR upon energizing closes a locking circuit for itself traced from battery through the alternate contact 112 of relay AC, through the winding of relay GR, its alternate contact 114, to ground. The relay is thus locked up until the relay AC deënergizes which is after the cessation of impulses. It is thus seen that the relay GR holds its normal contact 29 open preventing the relay IC from energizing, and the connection of the impulse lead through the alternate contact 42 of the relay IC to the tip conductor of the trunk circuit C. With this relay GR provided, it is impossible to interfere with the impulses while they are being transmitted to a connector E.

Now let us assume that the called automatic subscriber's line is busy, the operation of the circuit is the same as previously described up to and including the time that the side switch is stepped to second position to engage the contacts 70, 71, 72 and 73. The called subscriber's line being busy, a ground will be encountered by the private wiper 7 in engaging the private contact 10 of the called line contacts, the said ground being furnished by another switch already in use. The relay PR deënergizes as before after the group of impulses have been transmitted and opens the contact 51 bringing about the restoration of the relay 50. The side switch relay SW is energized as before through the normal contact 67 of relay 50 to ground, the relay SW stepping the side switches *a*, *b*, *c*, and *d*, into their second or final position. The switch wiper 57 having stepped to its second or final position opens the energizing circuit for the slightly slow-acting relay 54. The relay 53 has its circuit interrupted due to the opening of the contact 52 of relay 50, the relay 53 also being slightly slow-acting, and a substitute circuit for the said relay is established before it restores. The said circuit being traced from battery through the winding of the relay 53, conductor 55, normal contact 52 of relay 50, conductor 120, alternate contact 121 of said relay 53, conductor 122, conductor 123 to the ground encountered by the private wiper 7. The side switch relay SW is therefore held energized, the circuit being traced from battery through the winding of the said relay, conductor 63, alternate contact 64, conductor 124, alternate contact 125 of relay 53 to ground at normal contact 126 of relay 54. The relay 74 is energized as soon as the side switch has moved to its second position, the

circuit extending from ground through the upper winding of the relay 74, contact 72, wiper 69 of side switch *c*, sleeve contacts of the connected plug and jack, normal contact 77 through winding of relay SR of trunk circuit C to battery. Upon the energization of the relay 74 the tone generator TO is started, the circuit being traced from battery through tone generator TO, alternate contact 127, of relay SW to ground at alternate contact 103 of relay 74. The busy back machine is now connected to the calling line over a circuit traced from battery through busy back BB, alternate contact 128 of relay SW, alternate contact 84 of relay 53, make before break contact 91 of relay 89, contact 71, wiper 68, the tip contacts of the connected plug and jack, normal contact 42 of relay IC, alternate contact 90 of relay SR, through the winding of relay TR to ground, the busy signal also being transmitted to the calling subscriber notifying him that the called line is busy. The relay TR of the trunk circuit C is thus intermittently operated due to the busy back machine. The intermittent operation of relay TR causes the supervisory relay CT to flash the supervisory signal SS^1.

The operator noting the flashing supervisory signal knows that the called line is busy and removes the plug CP from the trunk jack TJ. The removal of the plug CP from the jack TJ causes the supervisory signal 20 to be operated. The operator at C noting the glowing of the supervisory signal 20 removes the trunk plug TP from the trunk jack TJ^1. The removal of the trunk plug from the trunk jack opens the energizing circuit of relay 74, the relay 74 deënergizes and closes a circuit for the release magnet RM and the side switch release magnet SM as before described. The two relays upon energizing bring about the restoration of wipers 7, 8 and 9 of connector switch E, and the side switches *a*, *b*, *c* and *d*. The restoration of the other connected apparatus is the same as before described.

Referring now to Fig. 2, I here show the construction of the strip of keys K which are associated with the impulse machine D, the key-board comprises an escutcheon 130 to which, by suitable means the studs 131 and 132, an insulating plate 133 is held in place by means of the plate 134. The insulation plate carries suitable spring combinations, comprising normally closed contacts 135 and 137 and normally open contacts 136 and 138, which are adapted to be actuated by means of the insulating buttons 139 carried by a plunger rod 140. The plunger rod is mounted at one end in the escutcheon plate 130 and at the other end in the insulation plate 134. A suitable spring 141 tends to hold the plunger in its upper position. The plunger is provided with a cam 142 preferably integral with the said plunger, the said cam serving to hold the plunger in its indicating position after it is depressed, and to this end I provide a sliding plate 143 which slides transversely of the frame work, the said plate being suitably supported between the studs 131 and 132. The plate has a plurality of cam openings 144 with which the cams 142 coöperate.

Assuming now that a plunger is depressed to its fully depressed position, in its downward movement the cam 142 engages the cam surface of the opening 144 of the plate 143. The plate 143 is forced to the right against the tension of the leaf spring 145, when the upper surface of the cam 142 passes below the bottom surface of the plate 143, the said plate is forced back to its normal position by means of the leaf spring 145. When fully depressed, the insulating button 139 engages the contact springs 135 and 136 opening normally closed contacts 135 and 137 and closing normally open contacts 136 and 138. When pressure is released from the depressed key plunger the spring 141 forces the plunger up until the cam engages the bottom surface of the plate 143. In this position the contact springs 135 and 137 are held open due to the said spring 135 still engaging the angular surface of the button 139. The spring 136 being shorter than the spring 135 restores after the key is moved to its indicating position again engaging its spring contacts 138. Thus in indicating position, the contact springs 135 and 137 are open and springs 136 and 138 are allowed to restore to again close their contacts. To release a depressed key plunger from indicating position, I provide a key release magnet KM suitably connected to the escutcheon plate 130. The said magnet, upon energizing attracts its armature 146 and through the medium of its extension 146^1 which carries a rubber buffer 147 that engages the plate 143 moves the plate 143 to the right until the opening 144 of the plate 143 allows the plunger to restore to normal. The leaf spring 145 moving the plate 143 to the left to normal after the magnet has deënergized.

In practising my invention, it will be apparent that many alterations and modifications may be made not only in the mechanical construction of the various elements entering into the system, but also in many of the circuit arrangements, without departing from the spirit and scope of my invention. Therefore I have sought to use such terms in the appended claims as will fully cover all changes and modifications.

Having described my invention, what I claim as new and desire to secure by United States Letters Patent, is:

1. A telephone system comprising subscribers' lines divided into groups, an auto-

matic switch having access to the lines in one of said groups of lines, a step-by-step motor magnet for said automatic switch, link circuits, an operator's calling device associated with said link circuits, keys for said calling device equal in number to the number of subscribers' lines in one of said groups of lines, means for operatively connecting said calling device with said automatic switch through the medium of one of said link circuits, and impulse generating means included in said calling device and controlled by one of said keys for transmitting impulses to the said step-by-step motor magnet of said automatic switch to extend a connection to a called one of said lines.

2. A telephone system comprising subscribers' lines divided into groups, automatic switches for connection with said lines, operators' link circuits provided with frequency selecting devices, a calling device associated with said link circuits, means responsive to the operation of one of said frequency selecting devices for connecting said calling device to one of said link circuits, and means responsive to the operation of said calling device for operating one of said automatic switches to extend a connection to one of said lines.

3. A telephone system comprising subscribers' lines divided into groups, an automatic switch having access to only the lines in one of said groups of lines, a step-by-step motor device for said automatic switch, a plurality of trunk circuits, an operator's calling device associated with said trunk circuits, means for connecting said calling device to said automatic switch through one of said trunk circuits, keys for said calling device equal in number to the number of steps said automatic switch is adapted to take, and impulse generating means included in said calling device and controllable by one of said keys for transmitting impulses to the said motor device of said automatic switch to operate the same, to extend the connection to the subscriber's line corresponding to the operated key.

4. A telephone system comprising subscribers' lines divided into groups, automatic switches for extending connections to said lines, motor devices for said automatic switches, a plurality of trunk circuits, an operator's calling device associated with said trunk circuits, means for connecting said calling device to one of said automatic switches through one of said trunk circuits, keys for said calling device equal in number to the number of subscriber's lines in a group and to the number of steps said automatic switches are adapted to operate, and means controlled by the operation of any one of said keys to transmit operating impulses to the motor device of said connected switch to move the wipers of said connected switch into engagement with any one of the lines in one of the said groups of lines.

5. An impulse-sending device for controlling a step-by-step automatic switch, keys for said device equal in number to the number of steps that said switch is adapted to operate, bank contacts equal in number to the number of said keys, normally closed connections extending from said keys to the said bank contacts, and means controlled by the depression of one of said keys for opening one of said normally closed connections thereby controlling the number of steps that said switch will operate.

6. An impulse-sending device comprising bank contacts and a wiper for coöperation therewith, an automatic switch adapted to be controlled by said impulse-sending device, keys equal in number to the maximum number of steps that said switch may operate, connections from the said keys to the said bank contacts, means controlled by the said keys for affecting the said connections thereby controlling said automatic switch.

7. A step-by-step impulse-sending device provided with a single group of keys, a step-by-step automatic switch adapted to be connected to said impulse sending device, a driving magnet for said step-by-step automatic switch, means controlled by the operation of one of said keys for causing said impulse sending device to step forward, and means for transmitting impulses to said motor magnet to cause said automatic switch to take a number of steps equal in number to the steps taken by said impulse sending device, and means for releasing said impulse sending device without affecting the operative position of said automatic switch.

8. A step-by-step impulse-sending device provided with a single group of controlling keys, an automatic connector switch adapted to be connected to said device, the keys of said device being equal in number to the maximum number of steps that said device is adapted to operate, means controlled by said keys for stepping the said device ahead, and means for operating said connector switch a corresponding number of steps.

9. In a telephone system, subscribers' lines divided into groups, a step-by-step connector switch for connection to any one of the lines in one of said groups of lines and to no other lines, a step-by-step impulse-sending device for controlling said connector switch, keys for said impulse-sending device equal in number to the number of lines in one of said groups and to the number of steps said connected switch is adapted to take, and means controlled by said keys for simultaneously operating said impulse-sending device and said connector

switch, said impulse sending device and said connector switch being provided with step-by-step motor devices.

10. A calling device comprising a plurality of bank contacts and a wiper for cooperation therewith, keys equal in number to the number of bank contacts, motor mechanism for driving the said wiper, means controlled by the operation of one of said keys for affecting the potential of its corresponding bank contact and for initiating the operation of said motor mechanism, and means controlled by the engagement of said wiper with the said bank contact to prevent further operations of the said motor mechanism and for restoring the said wiper to normal.

11. A calling device comprising a plurality of bank contacts and a wiper for cooperation therewith, a motor mechanism for driving said wiper over said bank contacts, a plurality of keys equal in number to the number of bank contacts, connections between said keys and said bank contacts, means controlled by the operation of one of said keys for affecting the electrical condition of its corresponding bank contact, and means controlled by the engagement of said wiper with said bank contact for preventing further operation of said motor mechanism and for restoring said key to normal.

12. A calling device comprising a plurality of bank contacts and a wiper for cooperation therewith, motor mechanism for driving said wiper over said bank contacts, a plurality of keys equal in number to the number of bank contacts, connections between said keys and said bank contacts, means controlled by the operation of one of said keys for affecting the electrical condition of its corresponding bank contact, and means controlled by the engagement of said wiper with said bank contact for restoring the electrical condition of said contact.

13. In a telephone system, an operator's link circuit provided with a calling device and a frequency selecting device, an automatic switch for extending connections to called subscribers' lines, means controlled by said frequency selecting device for selecting the desired frequency to signal the called subscriber and for connecting said calling device to said automatic switch, means for operating said calling device whereby said switch is operated to extend connection to a called subscriber's line, and means operated upon the connection of said switch to said called line for applying the selected ringing current to the said called line.

14. In a telephone system, a plurality of operators' link circuits provided with frequency selecting devices, a calling device associated with said link circuits, automatic means for extending connections to called subscribers' lines, means for operating said frequency selecting device to select the desired ringing current to signal a called subscriber and for connecting the said calling device to said automatic means, and means for delaying the application of said selected ringing current to the called line until said automatic means has extended connection to the said called subscriber's line.

15. In a telephone system a plurality of operators' link circuits, a calling device associated with said link circuits, a relay in each of said link circuits, means for connecting said calling device to one of said link circuits, means for operating said calling device, and means controlled by the operation of said calling device for energizing the relay of a second of said link circuits to prevent its connection to said calling device.

16. A telephone system comprising a calling subscriber's and a called subscriber's line, means including an A-operator's link circuit, a B-operator's link circuit and an automatic switch for connecting said lines, an automatic machine-controlled impulse sending device for controlling said switch, a supervisory signal for said A-operator's link circuit operated upon completion of the connection to the called subscriber's line, and means for intermittently operating said supervisory signal upon the completion of said connection, if said called subscriber's line tests busy.

17. In a telephone system, a plurality of subscribers' lines arranged in a group, a step-by-step switch for connection to only the lines in said group of lines, a step-by-step impulse sending device provided with a plurality of keys substantially equal in number to the number of steps said switch is adapted to operate, means controlled by the operation of one of said keys for operating said impulse sending device and said automatic switch, and means for synchronizing the operations of said impulse sending device and said automatic switch.

18. In a telephone system, a plurality of operators' link circuits, a calling device associated with said link circuits, key controlled means for connecting said calling device to one of said link circuits, and means for preventing the said calling device from being connected to another of said link circuits while connected to the said first link circuit.

19. A telephone system including subscribers' lines divided into groups, an operator's impulse-sending device provided with keys substantially equal in number to the number of subscribers' lines in any one group, automatic switches for each group of said subscribers' lines, trunk lines associated with said impulse sending device and

terminating in said automatic switches, and means for connecting said impulse-sending device to one of said trunk circuits and for operating a single one of said keys whereby one of said automatic switches is operated to extend a connection to a called one of said lines.

20. A telephone system including subscribers' lines divided into groups, automatic switches divided into groups corresponding to the number of groups of subscribers' lines, an A operator's board and a B operator's board, trunk lines extending from said B operator's board to said automatic switches, an impulse-sending device at said B operator's board provided with keys, means for extending a call from a calling line of one of said groups to said B operator's board, and means controlled by the B operator for extending a call via one of said trunks to one of said automatic switches and for operating one of said keys whereby said automatic switch is operated to extend a connection to a called line in one of said groups.

21. A telephone system including subscribers' lines divided into groups, automatic switches divided into groups corresponding to the number of groups of subscribers' lines, an A operator's board and a B operator's board, trunk lines extending from said B operator's board to said automatic switches, an impulse-sending device at said B operator's board provided with keys, one for each subscriber's line in a group, means for extending a call from a calling line of one of said groups to said B operator's board, and means controlled by the B operator for extending a call via one of said trunks to one of said automatic switches and for operating one of said keys whereby said automatic switch is operated to extend a connection to a called line in one of said groups.

22. A telephone system including a group of subscribers' lines, a step-by-step automatic connector switch adapted to make connection with any one of said lines, a step-by-step calling device for controlling said automatic switch, said calling device being provided with as many keys as subscribers' lines in the group and adapted to operate as many steps as the automatic switch is adapted to operate, and means controlled by one of said keys for operating said calling device and said switch to complete a connection with the desired one of said lines.

23. A telephone system including a group of subscribers' lines, a step-by-step automatic connector switch adapted to make connection with any one of said lines, a step-by-step calling device for controlling said automatic switch, said calling device being provided with as many keys as subscribers' lines in the group and adapted to operate as many steps as the automatic switch is adapted to operate, a link circuit, a selective ringing key, means including said link circuit and said selective ringing key for operatively associating said calling device with said automatic switch, and means controlled by one of said keys for operating said calling device and said switch to complete a connection with the desired one of said lines.

Signed by me at Indianapolis in the county of Marion and State of Indiana, in the presence of two witnesses.

HARRY W. MUNSELL.

Witnesses:
A. OTTO ABEL,
JAMES E. BROWN.