

(No Model.)

2 Sheets—Sheet 1.

J. A. BARRETT.
MULTIPLE STATION TELEPHONE CIRCUIT.

No. 569,401.

Patented Oct. 13, 1896.

Fig. 1.

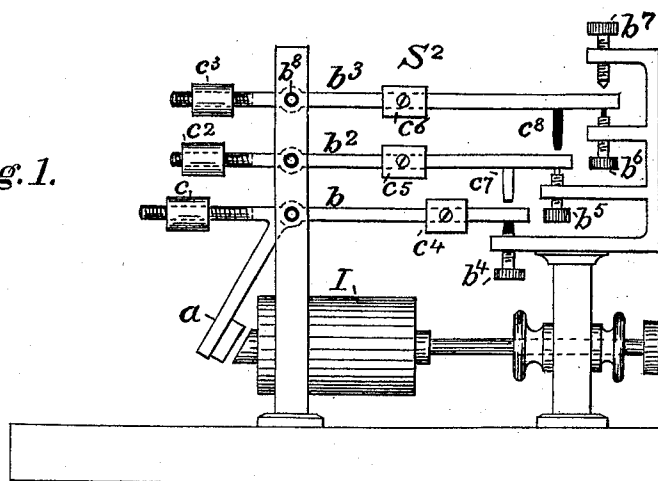


Fig. 3.

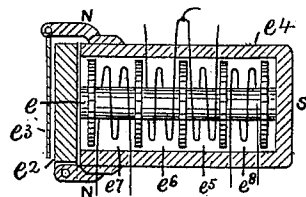
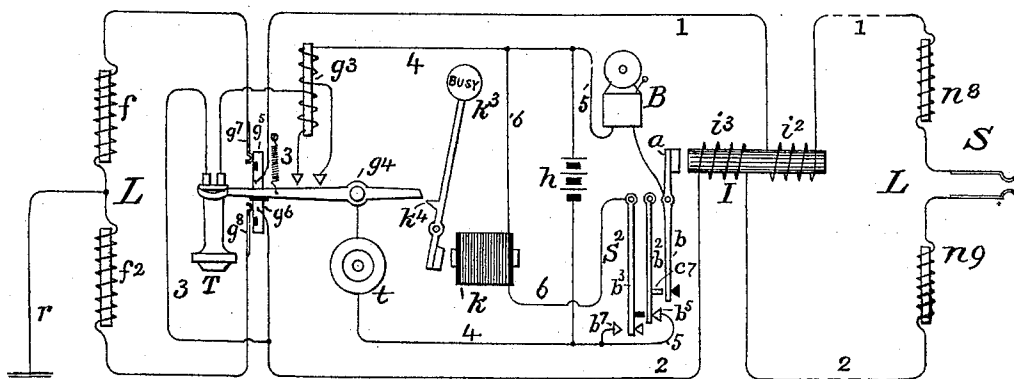


Fig. 2.



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his attorney.

(No Model.)

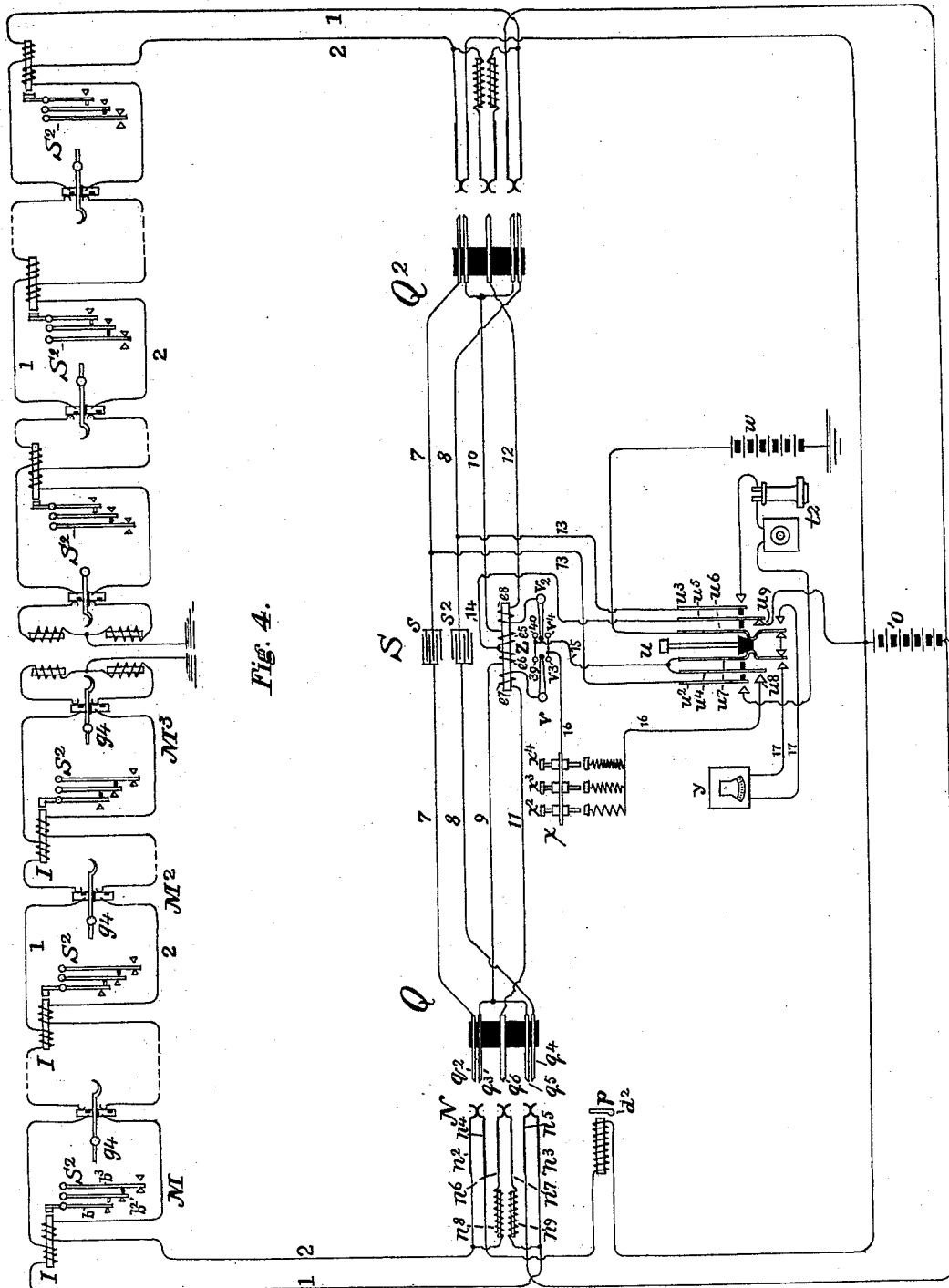
2 Sheets—Sheet 2.

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MULTIPLE STATION TELEPHONE CIRCUIT.

No. 569,401.

Patented Oct. 13, 1896.



Attest.
Jesse Lewis
W. R. Edelen

Inventor,
John A. Barrett
by Tallok & Mauro
his attorneys.

UNITED STATES PATENT OFFICE.

JOHN A. BARRETT, OF RUTLAND, VERMONT, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

MULTIPLE-STATION TELEPHONE-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 569,401, dated October 13, 1896.

Application filed January 27, 1896. Serial No. 577,049. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. BARRETT, residing at Rutland, in the county of Rutland and State of Vermont, have invented certain Improvements in Multiple-Station Telephone-Circuits, of which the following is a specification.

This invention relates to telephone-exchange circuits and apparatus, and more particularly to circuits of that class which connect a number of subscribers' stations with the central office and which are known in exchanges as "party lines." Its objects are as follows: to ring the call-bells of the several subscribers' stations selectively; that is, to sound the call-signal from the central office at the desired substation only, the others being excluded; to set a signal indicating to the eye that the line is occupied when such is the case, and at the same time to prevent the telephones from being switched into the circuit at all substations on the line or lines concerned in a communication except the stations making or responding to the call; to provide for the operation of these selective and other signals without introducing the impedance of electromagnets into the talking-circuit, and to provide a disconnecting or clearing-out signal operative by either of the two stations which have been communicating with each other, also without introducing impedance into the talking-circuit.

Each multiple-station subscriber's circuit is a metallic circuit, and at each station I place the usual telephones, a call-bell, the busy-line indicator and telephone connection controlling or locking device, a single electromagnet for actuating both of them, the ordinary automatic telephone-switch and a special electromagnetic switch or circuit-changing relay controlling the selective operation of the call-bells, and the collective operation of the busy-indicators and the locking devices.

When at rest, the metallic telephone-circuit is led at each substation through a circuit-breaker carried by the automatic telephone-switch and at the central station is provided with a suitable call-receiving annunciator and a generator, which may be common to a number of circuits, maintain-

ing a normal current on the circuit. Calls, therefore, are sent inwardly from the substation to the central station by simply removing the receiving-telephone from its supporting-switch, for while the said switch is passing from one position to the other the circuit-breaker it carries momentarily opens the circuit, whereupon the current from the central-office generator ceases to flow and the annunciator at the central office gives its call-signal.

The substation-telephones are in a normally open bridge between the main-line conductors, and by the action of removing the receiving-telephone from the switch-support this bridge is closed and the telephones are brought into the metallic talking-circuit. The transmitter induction-coil primary and secondary circuits are arranged in the usual manner, a local transmitter-battery being employed whose circuit through the transmitter and primary is controlled by the automatic switch, so that it is closed when the telephones are brought into the main metallic circuit and opened again when by replacing the telephone upon its support it is withdrawn from the talking-circuit.

The call and busy signal and the telephone-lock device are controlled at each substation by the special selective switch or relay before mentioned. In sending call-signals the relays at the several stations are adjusted each to respond to a definite strength of calling-current and to be irresponsive when a stronger or weaker current passes through their coils, and the calls are made selective by adjusting each of the several relays differently, whereby each is enabled to respond as a call-signal to its own predetermined current and to no other; but the said relays are also all constructed and adjusted to respond collectively to a current of considerably greater strength than any which are employed in sending call-signals, and thereupon to set a busy-signal, showing at all stations that the line is occupied in the transmission of intelligence, and to lock the automatic switch-levers at all stations except those actually engaged in such transmission.

The selective relay at each substation actuates these appliances by controlling two

normally open local circuits, supplied with current when closed, from a suitable battery, which conveniently may be the same as that which supplies current for the transmitter.

5 The first local circuit contains the electromagnetic call-bell, and the second contains an electromagnet whose armature-lever actuates the busy-indicating signal and carries a bolt which on the attraction of the armature moves into the path of the automatic
10 telephone-switch lever, preventing it from moving when the telephone is taken therefrom.

The electromagnetic coils of the several selective relays of a party-line metallic circuit
15 are not included in the metallic talking-circuit, but are connected in a distinct signaling-circuit composed of the two conductors of the metallic circuit joined in parallel to constitute a single-line conductor and having
20 a ground or independent return. The said coils are connected half in one of the two parallel line-wires and half in the other, as shown, this arrangement being symmetrical and conducing to a maintenance of an
25 electrical balance between the said two conductors in their functions when serving as the two sides of the metallic talking-circuit. Thus while the telephone-currents and inward
30 call-signals traverse the metallic circuit the outgoing signal-currents are transmitted in a ground return-circuit whose line conductor is formed of the two sides of the metallic circuit bunched to form a single wire
35 of greater size.

To prevent the diversion of the voice-currents from the metallic telephone-circuit into other portions of the system of main-line conductors, where their presence is undesirable,
40 or from being in any way short-circuited between earth terminal connections, a choking or impedance coil is placed in circuit with each line conductor between the automatic switch connections and the earth branch at
45 the last substation of the circuit, and two others (one for each conductor) are similarly placed at the central station.

When two circuits are united at the central station to permit the exchange of conversation
50 between any of their respective substations, a double conductor connection joins the two wires of one to those of the other through interposed condensers. A steady current of appropriate strength is thrown upon
55 the two wires in parallel of both of the said circuits to maintain the display of the busy-indicating signal, and the locked disconnection of the telephones at all disengaged substations, and a disconnecting-signal annunciator
60 is associated with both circuits in such a way that it is made responsive to the replacement of the receiving-telephone upon the automatic switch-lever serving as its support. This disconnecting-annunciator has
65 four windings, and although two of them are associated with one of the united substation-circuits and the remaining two with the

other, and although, as stated, the said disconnecting-signal is under the control of the
70 telephone-switch at the substations of both circuits, so as to be responsive to the replacement of the telephone at either station, none of the said windings are in the talking-circuit, two being placed as long as the two
75 lines are united for conversation in short circuits of the normal signal-current generator formed by electrically uniting the ends of the central-station terminal loops of the two main
80 circuits which are severed from the substation portions of the said main circuits by the insertion of the connecting-plug, and the other two being placed in the selective-relay grounded circuits of the two lines.

The plan of dividing the exciting-coils of the selective-relay magnet at each substation
85 into two portions and of placing one portion in each conductor of the talking-circuit, together with the above-mentioned arrangement of the disconnecting-annunciator at the central station, whereby electromagnetic helices
90 in one case are so connected with the talking-circuit that their adverse action is neutralized by the equal opposed action of others and in the other case are excluded altogether from the talking-circuit, enables me
95 to provide a talking-circuit composed of two multiple-station lines in which the voice-currents circulate without material impedance from the electromagnets at intermediate stations or elsewhere. I provide also at the
100 central station a key or switch which when operated introduces the operators' telephones into a bridge between the two conductors, uniting the two circuits for conversation, which introduces a meter to indicate the
105 strength of the current passing over the circuit for outgoing signals formed of the two conductors in parallel, and which establishes a branch connection between the generator producing the said current and a group of
110 keys controlling the different strengths of current required to operate the selective relays which govern the signaling and locking devices at the substations.

In the drawings accompanying this specification, Figure 1 is a view in elevation of my
115 new selective switching-relay. Fig. 2 is a diagram representing the appliances and their circuit connections of a substation apparatus embodying my invention, including
120 the selective switch and the local circuits and devices which it controls. Fig. 3 is a similar view of the disconnecting-signal and its circuits. Fig. 4 is a diagram of two substation-circuits which may be united at a central
125 station for reciprocal conversation, together with their normal signaling connections, their switchboard connections, and their accessory apparatus. Fig. 2 represents the electrical arrangement of the terminal substation of a
130 multiple station telephone-circuit L and the plug-socket connection at the central station S. The said circuit has two main-line conductors 1 and 2 extending from the cen-

tral station S through any suitable number of way or intermediate stations (not shown) to the said terminal substation, where they are grounded after passing, respectively, through choking or impedance coils f and f^2 . All of the other substations have similar apparatus and connections, but the terminal one is chosen for description, since, necessarily, it alone has the terminal ground.

T is the receiving-telephone; t , the transmitter; g^3 , the transmitter induction-coil, and g^4 the automatic telephone-switch. The said receiver and the secondary winding of the induction-coil are in a normally open bridge or branch 3 of the metallic talking-circuit and the transmitter and primary in a local circuit 4, including a local battery h , all being controlled in the usual manner by the automatic switch.

S^3 is the selective switching-relay, and I its actuating-electromagnet. The helices of the said magnet are in a grounded circuit which has for its main conductor the two lines 1 and 2, bunched in parallel to form a single conductor, over which the currents to operate such magnet are sent, and united at the last substation to a terminal ground connection r . One half, i^2 , of the coils of the said magnet are connected up in the conductor 1 and the other half, i^3 , in the conductor 2 in such manner that the signaling-current passing in the same direction through both conductors shall coöperate in the two coils to produce a magnetized condition of the cores.

Obviously when the telephones are in use and voice-currents are traversing the metallic circuit the said currents circulate in opposite directions in the two line conductors 1 and 2, and the coils i^2 and i^3 therefore oppose to them no appreciable impedance, since such magnetism as the current in one line-wire tends to excite in the magnet-core is neutralized by an equal but opposed magnetism which the current in the other line tends to set up.

B is the call-bell; k^3 , the visual busy-signal indicator; k^4 , the telephone-switch lock or bolt, and k the actuating-electromagnet for the said indicator and bolt, the call-bell being contained in a normally open local circuit 5 of the battery h , having two points at which it may be controlled or opened and closed by the relay S^3 , while the electromagnet k is included in a second normally open local circuit 6 of the same battery, having one point where it may be closed or opened by the said relay.

To adapt the automatic telephone-switch g^4 in my system for the automatic transmission of the call and disconnecting signals to the central station, it is arranged as follows: The switch-lever carries two contact-pieces g^5 and g^6 , and has contact-springs g^7 g^8 , which bear upon the contact-surfaces of these pieces g^5 g^6 , the said contact-surfaces being interrupted by inlaid sections of insulating material. The contact-piece g^5 and its spring g^7 and piece g^6 and its spring g^8 are interposed in the line

conductors 1 and 2, respectively. In both normal and alternate position of the switch the circuits through the contact-pieces and their springs are complete; but as the switch-hook rises from its normal position to its alternate position the circuit is momentarily interrupted, owing to the passage of the non-conducting sections under the contact-springs, so that if there be a current normally on the circuit it ceases for an instant to flow, and a signal can thus be produced on an annunciator in the normal central-office connections. Manifestly the circuit is also momentarily interrupted when the receiving-telephone is replaced, and I utilize this circumstance, as hereinafter detailed, to produce a clearing-out signal.

The selective circuit-controlling-switch relay of my invention may be described in a general manner as comprising an electromagnet and its armature, means for opposing the movement of the armature by progressively-increasing forces throughout its range of travel, whereby its travel is divided into several stages, local-circuit contacts controlled by the armature to be closed at the end of its initial stage of travel, other local-circuit contacts adapted to be opened in its subsequent travel, and still others to be closed or other mechanism to be operated in its final movement. The first and second mentioned contacts are included serially in the same circuit, which may contain any suitable responsive instrument, so that by means of a current of predetermined strength in the magnet the relay may be caused to close the circuit through the instrument, while with a weaker current it will remain inert, or with a stronger current it will close and instantly thereafter interrupt the said circuit. The last-mentioned contacts or mechanism may control any desired device or instrument, and may be caused to close or open the electric circuits or to operate the said devices in response to currents sufficient to throw the armatures to the extreme positions of their travel. The principles and preferred style of construction of this selective relay are indicated by Fig. 1, and such a relay (differently adjusted) is located at each substation.

The selective relay S^3 (shown in Fig. 1) comprises an electromagnet I and three pivoted levers b b^2 b^3 , which impinge upon one another successively. Lever b carries the armature of the electromagnet. Its longer arm rests normally upon an adjustable stop b^4 , which has an insulating-tip. Levers b^2 and b^3 rest on other stops b^5 and b^6 , the former of which forms a conductive contact with the lever and the latter of which has an insulating-tip. Lever b^3 has also an alternate contact b^7 in electrical connection with the frame carrying the stops. All the levers are journaled in insulating-bushings b^8 in the frame. These levers are balanced upon their pivots by counterweights c c^2 c^3 , respectively, and carry other movable weights

c^4 c^5 c^6 , by which they may be adjusted to require different forces to lift them. Lever b^2 carries a downwardly-projecting stud c^7 , of metal, upon which lever b impinges when the latter is raised and through which lever b communicates motion to lever b^2 . Lever b^3 is furnished with a similarly-disposed stud c^8 , of insulating material, placed to engage with lever b^2 . In adjusting this instrument the weight c^4 should be so placed that the lever will be raised into contact with stud c^7 by a predetermined current—say ten milliamperes. Weight c^5 on lever b^2 should then be placed to permit the lifting of the latter lever by any current in excess of ten milliamperes, while weight c^6 will permit the raising of its lever only by a greatly-increased current.

The lever b of relay S^2 is united to one terminal of the bell B, whose other terminal is united to one pole of battery h . The resting-contact b^5 of lever b^2 connects with the other pole of the same battery. Hence when the lever b is raised into contact with the stud c^7 , carried on lever b^2 , the local circuit 5 of the battery h containing the bell B is closed. When the lever b is moved through a further stage of its travel, it lifts lever b^2 and the contact between the latter and its stop b^5 is severed, breaking the local bell-circuit.

The busy-circuit indicator k^3 and telephone connection-lock k^4 are likewise operated by the switching-relay S^2 by means of the local circuit 6 of the battery h and the actuating-magnet k contained therein, and are responsive to such movements of its armature a as result in raising the third lever b^3 thereof. Lever b^3 and its contact-stop b^7 are the normally-separated terminals of the said local circuit, so that when the lever moves into contact with the stop the circuit 6 is closed, its magnet is excited, the armature thereof attracted, and the indicator moves to a position of display, showing that the line is occupied or in use at some other station. The detent or bolt k^4 at the same time is moved into the path of the switch-lever g^4 , and projecting under the end thereof prevents it from being moved to bring the telephones into circuit, and by this means all stations are prevented from heedlessly interrupting any communication which may be in progress.

When the magnet I is traversed by a current of appropriate strength, the local circuit 5 of the bell is closed and the bell is rung to give the call. When a moderately-increased current passes through the magnet-coils, the levers b and b^2 , acting together, as described, again open the local circuit 5, so that the station-bell will not ring, and it should be stated that if the increased current be initially sent the said local circuit will open at b^5 so promptly after it closes at c^7 that the bell will not have time to ring. With a still stronger current through the relay-coils and a correspondingly greater excitement of the magnet the lever b is moved through its final stage and lifts both

of the other levers, causing the lever b^3 to close upon its contact-stop b^7 , and thus to complete circuit 6, setting the indicator and locking the telephone-switch to prevent the connection of the telephone-bridge.

The use of the apparatus described, in a complete telephone-line equipped with several stations and terminating in a central office, may now be considered. The complete apparatus is represented in Fig. 4. The line conductors 1 and 2 are shown as forming a circuit of three stations, (designated M, M², and M³.) At each station they include the two helices of the magnet I and contact-points of the switch g^4 . The signal-bell, indicator, and telephone at the substations are not here shown, having been sufficiently described.

For permitting the selective signaling of any of the stations M, M², and M³ the levers b are differently weighted, so as to respond to currents of different strengths in the line conductors. Thus lever b at station M may respond to ten milliamperes, the same lever at station M² to twenty milliamperes, and the lever at station M³ to thirty milliamperes. The lever b^2 at each station should be so weighted that it will be lifted by a current a little in excess of that to which the corresponding lever b will respond. All the levers b^3 are so heavily weighted that they require for their movement a current considerably in excess of that required to lift the lever b at station M³. It will be apparent that with such an adjustment of the different switching-relays a current of ten milliamperes through the conductors 1 and 2 jointly or in parallel will bring lever b at station M into contact with lever b^2 at the same station and will thus close the local circuit at that station and ring the bell B. The selective relays at the other stations will remain inert. A current of twenty milliamperes in the line-circuit will move the lever b at station M through the second stage of its travel, and will thus interrupt the circuit 5, including the bell, before the latter has responded; but the same current will bring lever b at station M² into position to close the circuit 5 at that station and ring the bell there and will not be sufficiently strong to affect the relay at station M³ at all. In the same way a current of thirty milliamperes will cause the interruption of the bell-circuits 5 at stations M and M², but will bring about the closing of the bell-circuit at station M³ and will thus give the call-signal at that station.

A greater current—say forty milliamperes—will lift the entire series of levers at all stations, and thus will close the local circuits at the different substations, displaying the annunciators and locking the telephone-switches at all the stations where the telephones have not already been taken from the switch-hooks. Thus any of the stations on the party line may be signaled independently of the others, and after the sending of the signal the instruments at all stations not signaled may be

locked, so as to prevent their use, and indicators may be displayed to show the occupied condition of the line.

Line conductors 1 and 2 are led at the central station S to the springs $n^2 n^3$ of the spring-jack N. These springs are normally in contact with other springs $n^4 n^5$, by which the conductors 1 and 2 are continued to the two poles of the battery o or other source of current, the line-annunciator p , of any suitable type, being included in either conductor, as shown. The spring-jack N has also other switch-springs $n^6 n^7$, which are connected with line conductors 1 and 2, respectively, through small impedance-coils $n^8 n^9$. With this spring-jack a plug Q is employed having two pairs q^2, q^3, q^4 , and q^5 , respectively, of contact-strips entering between and registering with the two pairs $n^2 n^4$ and $n^3 n^5$ of switch-springs in the spring-jack and also a piece q^6 , which makes contact with the two springs n^6 and n^7 when the plug is inserted into the spring-jack. Two plugs Q and Q² of this type are employed in making connection between two lines. The two like contact-strips q^2 of the plugs Q and Q² are united through a conductor 7 of the plug-circuit. The two other contacts q^4 are likewise united through a conductor 8. These conductors 7 and 8 both include condensers, (designated as s and s^2 , respectively.) The contacts q^3 and q^5 of each plug are connected together and constitute the terminals of conductors 9 and 10, respectively. The contact-pieces q^6 form the terminals of two conductors 11 and 12.

The operator at the switchboard has the usual telephones t^2 and a key u for connecting the telephones with the plug-circuit. She has also a pair of switches or keys v and v^2 , either of which is adapted to connect the source w of signaling-current to one of the lines, a set of keys x for varying the strength of the current from battery w , and an indicator or meter y for showing the strength of current flowing to the line.

The key u has the usual pair of switch-springs $u^2 u^3$, with their anvils, which are adapted when the plunger of the key is depressed to complete the bridge 13 of the plug-circuit 7 8. The same key has also other switch-springs u^4 and u^5, u^6 and u^7 . The spring u^4 is thrust against an anvil u^8 when it is forced outward. Spring u^5 rests normally on the contact-anvil u^9 , from which it is separated when the plunger of the key is depressed. Springs u^6 and u^7 have normal resting-anvils, which are connected together, and alternate anvils with which they engage when the springs are thrust apart. A clearing-out annunciator z of the type shown in Fig. 3 is also furnished with each pair of cords. This clearing-out annunciator, as represented in Fig. 3, has a magnet e^1 , a pivoted armature e^2 , and a light shield e^3 hung before the armature.

A permanent polarity is imparted to the

core e by a permanent magnet e^1 , whose poles of like sign are presented to the armature and, in coöperation with the core, serve to retain the armature normally in its vertical concealed position. For use in the plug-circuit adapted to the mode of selective signaling of the present invention this magnet has four windings, (designated in the drawings e^5, e^6, e^7 , and e^8 .) Two of these windings, e^5 and e^6 , tend when traversed by current of appropriate direction to oppose or neutralize the permanent magnetism of the device and thus to release the armature and permit the display of its face. The other two helices, e^7 and e^8 , act to magnetize the core in the same direction as its permanent polarity. When the armature is released, it must fall away to such a distance that the attraction of the permanent magnet alone shall be insufficient to cause its return, but that such attraction assisted by the magnetism evoked by coils e^7 and e^8 shall draw it back or reset it.

The conductors 9 and 10 are united after traversing the helices e^6 and e^5 , which tend to oppose the magnetism of the permanent magnet, and thence are led through a conductor 14, including the spring u^5 and its anvil u^9 of key u , to one terminal of battery o . The other coils, e^7 and e^8 , which tend to assist the magnetism of the permanent magnet, are connected in the two conductors 11 and 12, respectively, which then extend to the switches v and v^2 . Through these switches the circuits of these two conductors are united and are thence led through a wire 15 to the springs u^4 and u^7 of key u . In the normal position of this key the circuit is continued through springs u^7 and u^6 to battery w . The alternate contacts v^3 and v^4 of switches v and v^2 are led by wire 16 through the normally open contacts x^2, x^3 , and x^4 of the composite key x and thence, still by wire 16, to the anvil u^8 of key u . The contact-anvils of buttons x^2, x^3 , and x^4 are connected in multiple with conductor 16 through resistance-coils of different magnitude, so that by depressing button x^2 a certain predetermined current—for example, ten milliamperes—may be permitted to flow through the line-circuit, or by depressing button x^3 or button x^4 a current of twenty milliamperes or thirty milliamperes will flow to line. The meter y is included in the wire 17, whose terminals are the external contact-pieces of springs u^6 and u^7 .

In each substation-circuit when at rest current flows continually from battery o through line conductors 1 and 2, circulating in opposite directions in the magnet-coils i at the different stations, and the effect of this current flowing through the coils of annunciator p holds the armature d^2 thereof in its quiescent position.

The entire series of operations of signaling from a substation, giving the order to the attendant at the central station, and signaling to the required station of the party line may

be described with relation to the single party line shown, since no operation of the process is different in connecting two different lines.

A subscriber requiring connection between his station and another simply removes his telephone from its switch-hook. The switch-hook g^4 in rising momentarily opens each of the line conductors 1 and 2, interrupting the current through the annunciator p and thus permitting it to display its indicator. In response to this signal the operator inserts plug Q into the spring-jack N. This operation effects a rearrangement of the circuits as follows: The line conductors 1 and 2 are extended to the conductors 8 and 7, respectively, of the plug-circuit, while the springs n^2 and n^3 are disconnected from their normal contact-springs n^4 and n^5 and from the continuations of line conductors 1 and 2, extending to battery o . These last springs are short-circuited through contact-pieces q^3 and q^5 of the plug, thus forming a closed circuit of low resistance, including the annunciator p and battery o . The increased current in this circuit effects the restoration or resetting of the annunciator p . The operator next depresses the plunger of key u , whereby the bridge-conductor 13, including the telephones t^2 , is completed and the telephones are brought into connection with the plug-circuit. The subscriber may now address the operator and state with what station connection is required.

It will be observed that the line conductors 1 and 2 have at this moment a connection through the two impedance-coils n^8 and n^9 and the two springs n^6 and n^7 in parallel, through the contact-piece q^6 of the plug, and thence through wire 11, coil e^7 , switch v , wire 15, spring u^i , indicator y , spring u^6 , and battery w to ground. Through this circuit when the switch v is turned to its contact 39 a current flows which tends to increase the magnetism in the core of clearing out annunciator z , and which hence holds in place the indicator of that annunciator. Another circuit exists normally from battery o through contact u^9 and spring u^5 , wire 14, coil e^6 , conductor 9, thence through contact-piece q^5 of plug Q and spring n^5 to battery o , which, when it is complete, permits a current to circulate through coil e^6 in the direction and of proper strength to neutralize this current through coil e^7 ; but the latter circuit is at this moment interrupted at the contact between the spring u^5 and the point u^9 of the key u .

Suppose that station M has transmitted the initial call-signal, and that the station with which connection is required is M^3 . If the switch v is not already in contact with point v^3 , it is so placed, whereby a circuit is formed to wire 16. The button x^2 is then depressed, whereby a current of thirty milliamperes is permitted to flow to the line-circuit. This current is sufficient to lift the levers b and b^2 at station M and M^2 , interrupting the bell-circuits at these stations and to lift the lever b at station M^3 , so as to close the bell-circuit

at this last station. The call-signal is thus transmitted to station M^3 , the instruments at the other stations remaining unaffected.

When the subscriber at the signaled station has responded and addressed the operator, the latter may turn the switch v to its point 39, whereby a direct circuit will be completed from battery w through conductor 11 and through the line-wires 1 and 2, permitting a sufficiently heavy current to flow through this circuit to raise the three levers at station M^3 . This movement of these levers closes the local circuit 6, (see Fig. 2,) displays the busy-signal, and locks the telephone-switch at that station. Subscribers at stations M and M^3 may then converse without interruption from the subscriber at the intermediate station. Having finished the process of completing connection between subscribers, the operator releases the key u , whereby the telephone is cut off from the plug-circuit and the indicator y is disconnected from the other apparatus, a direct circuit being completed through springs u^6 and u^7 . At the same time the circuit from battery o through wire 14 and coil e^6 is closed and the current for neutralizing the magnetism arising from coil e^7 is permitted to flow. The core of the clearing-out annunciator has then only what magnetism may be produced from the permanent magnet, which is sufficient to maintain its indicator in position. When, after the completion of the conversation, either subscriber replaces his telephone on its switch-hook, the line conductors are again momentarily interrupted and the current through coil e^7 of the clearing-out annunciator is broken. The coil e^6 , which tends to demagnetize the core of the magnet, now remains alone active, and hence causes the indicator of the annunciator to fall. The signal for disconnection is thus given.

When the plug Q is removed from the spring-jack, the apparatus is returned to its normal position.

If desired, the operator may place the key u again in position to connect her telephone with the plug-circuit for the purpose of assuring herself that the conversation is finished. If this be done, the circuit of coil e^6 is again interrupted while that of e^7 is closed, and the indicator of the clearing-out annunciator is returned to its concealed position. This arrangement of the clearing-out annunciator dispenses with the necessity of having its coils in the talking-circuit, and therefore relieves the said circuit from the impedance they would introduce.

When connection is to be made between two different lines, the operator, after the reception of the order, will insert plug Q into the spring-jack of the required line, will bring the switch v^2 into contact with v^1 , and operate the proper button of call-key x to transmit the desired selective signal. The circuits thus formed are the counterparts of those described and the mode of operation

does not differ. If the call-initiating line be a party line with several stations, the insertion of plug Q into the spring-jack *n* in answering the initial call will permit current to flow through wires 15 and conductor 11 to the line sufficient to lock the switches of all those telephones which are not in use at the different stations and to set the indicators at the same stations.

In cases where the visible signal denoting an occupied line and the telephone-switch lock are not desired the third lever of the electromagnetic switch or relay can be dispensed with without interfering with the other features of the invention in any way whatsoever.

Having thus described my invention, I claim—

1. A multiple-station metallic telephone-circuit, and a telephone at each station in a normally open bridge or branch thereof, controlled by an automatic telephone-switch, in combination with an independent signaling-circuit having a line conductor formed of the two wires of the said metallic circuit joined in parallel, a selective relay at each station in the said signaling-circuit; and an associated call-signal instrument controlled thereby, each station-relay being adjusted to actuate its call instrument on the passage through its coils of a definite and different strength of calling-current, and to maintain the irresponsiveness of the said call instrument on the passage of stronger or weaker call-currents.

2. The combination in a telephone system, of the two wires of a telephone party line, forming in series the direct and return conductors of a metallic telephone-circuit, and in parallel the single conductor of a ground return-signaling circuit, and a telephone at each subscriber's station connected or adapted for connection in the said metallic circuit, or in a normally discontinuous bridge or branch thereof, with a selective switch or relay connected in the said signaling-circuit at each substation, and independent call and busy signals, and a telephone connection-lock, associated with said relay and controlled thereby; the several station-relays being adjusted to actuate their associated call-signals selectively, with a definite strength of calling-current different for each, and to actuate their associated busy-signals, and telephone-locking devices collectively, when excited by an actuating-current of strength greater than that of the strongest calling-current, substantially as described.

3. A grounded signaling-circuit extending from a central station to a number of subscribers' stations, having a line conductor formed by connecting in parallel the two wires of a metallic telephone-circuit, in combination with a substation call-bell connected with a current-generator in a local circuit, and a selective relay with its electromagnet in the said signaling-circuit, provided with circuit-

controlling devices for progressively and successively closing and opening the said local bell-circuit, the said relay being adjusted to close the said local circuit and operate the bell with a current of definite and predetermined strength flowing in the signaling-circuit, and to close and instantly reopen the said circuit and thereby prevent the signal from being given, on the passage of a stronger current, substantially as described.

4. In a telephone system, the two wires of a telephone party line, forming in series the two line conductors of the metallic telephone-circuit, and in parallel, the single conductor of a ground return-signal circuit, in combination at each subscriber's station with a telephone in the said metallic circuit or in a bridge or branch thereof, and an electromagnetic signal instrument in the said grounded circuit, the electromagnetic coils of the said instrument being connected half in circuit with one line conductor and half in circuit with the other, in such manner that the two said halves may cooperate magnetically in the signaling-circuit, and oppose each other magnetically in the talking-circuit, whereby a number of signaling-magnets may be connected with a telephone-circuit without introducing impedance.

5. In combination with the two wires of a multiple-station telephone-line forming severally the outgoing and return conductors of a metallic talking-circuit, and jointly when connected in parallel the single conductor of a ground return-signaling circuit; a subscriber's station apparatus comprising a telephone, and an automatic lever-switch controlling the connections thereof, two local circuits containing respectively the station call-bell, and the actuating-electromagnet of a visual busy-signal and a locking device for the said telephone switch-lever; and a selective electromagnetic switch or relay in the main signaling-circuit, provided with a series of armature-actuated circuit-changing levers controlling the said local circuits, and adapted to close the local bell-circuit; to hold it open; and to close the busy-signal and switch-lock circuit, according to the strength of current flowing in the main signaling-circuit, substantially as described.

6. In a telephone subscriber's station apparatus the combination of a relay or electromagnetic switch comprising an electromagnet connected in the main signaling-circuit, a lever attached to the armature thereof, a second lever hung in the path of the first to be actuated thereby, and carrying a front contact-stop therefor, and a third lever hung in the path of the second to be operated thereby, with two normally open local circuits, one containing the station call-bell and leading through the first and second levers, the front contact of the first, and the resting-contact of the second, and the other containing the electromagnet of a busy-signal indicator and telephone-switch lock, and leading through

the third lever and its front contact, whereby the first local circuit may be closed, or closed and immediately opened, and the second local circuit closed, as the relay-armature is by
5 different main-line currents partially or fully attracted, and moves one, two or all of the said levers; substantially as described.

7. In a telephone-station apparatus, a selective relay comprising an electromagnet, a
10 pivoted lever mounted on the armature thereof, another pivoted lever lying in the path of movement of the said armature-lever, and a third pivoted lever mounted in the path of the second, the third lever being adapted to
15 be operated by the second, and the second by the first, as the armature-lever completes successive portions of its stroke, and independent circuit-changers controlled by the said levers respectively, substantially as described.

20 8. The combination in a telephone signaling-circuit, of a series of selective relays or switches one at each station, each comprising an electromagnet, an armature therefor and a pivoted lever mounted thereon and carrying
25 a circuit-closer, a second pivoted lever mounted in the path of the armature-lever and carrying a circuit-breaker, and a third pivoted lever mounted in the path of the second and carrying a circuit-closer, the third
30 lever being adapted to be actuated by the second, and that by the first, each after its actuating-lever has begun its stroke, and two local circuits for each relay, one containing a call-bell, the circuit-closer of the first lever
35 and the circuit-breaker of the second, and the other containing the electromagnet of a busy-indicator, and telephone-lock; and the circuit of the third lever, the said relays being selectively adjusted to initially respond
40 by moving their first lever only to a definite strength of current different for each station, and to respond collectively by moving all of their levers, to a current stronger than the strongest calling-current, substantially as described.
45

9. In a selective switch, the combination

with an electromagnet and a lever actuated thereby, means for opposing the movement of the lever by forces increasing progressively
50 through successive stages of travel, a pair of contact-points adapted to be closed in its first stage of movement, another pair adapted to be separated in its second stage, and a third pair adapted to be closed in its third stage, as described.
55

10. The combination in a selective switch, of an electromagnet and pivoted lever carrying the armature thereof, another pivoted lever lying in the path of movement of the armature-lever, and a third pivoted lever in the
60 path of the second-mentioned lever, adjustable weights upon each of the levers, and switch-contacts controlled by each lever, as described.

11. In combination with a telephone-line
65 having at its subscribers' stations a telephone-switch adapted when operated to interrupt the line-circuit, a disconnecting or clearing-out annunciator having an indicator and a permanently-polarized electromagnet normally retaining the indicator in its dormant
70 or concealed position, the said indicator having two equal and oppositely-acting helices, one of these, that tending to reinforce the permanent magnetism being in the main signaling-circuit formed by connecting the two
75 wires of the talking-circuit in parallel, together with a source of current, and the other in an independent circuit together with a similar source of current, whereby the said
80 annunciator is maintained inert while the telephone-circuit remains unbroken at the substation, but is responsive to the interruption thereof, as described.

In testimony whereof I have signed my
85 name to this specification, in the presence of two subscribing witnesses, this 20th day of January, 1896.

JOHN A. BARRETT.

Witnesses:

THOMAS D. LOCKWOOD,
G. LAWRENCE BETTS.