No. 737,869. PATENTED SEPT. 1, 1903.

S. A. REED.

SELECTIVE SYSTEM.

APPLICATION FILED AUG. 1, 1901.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

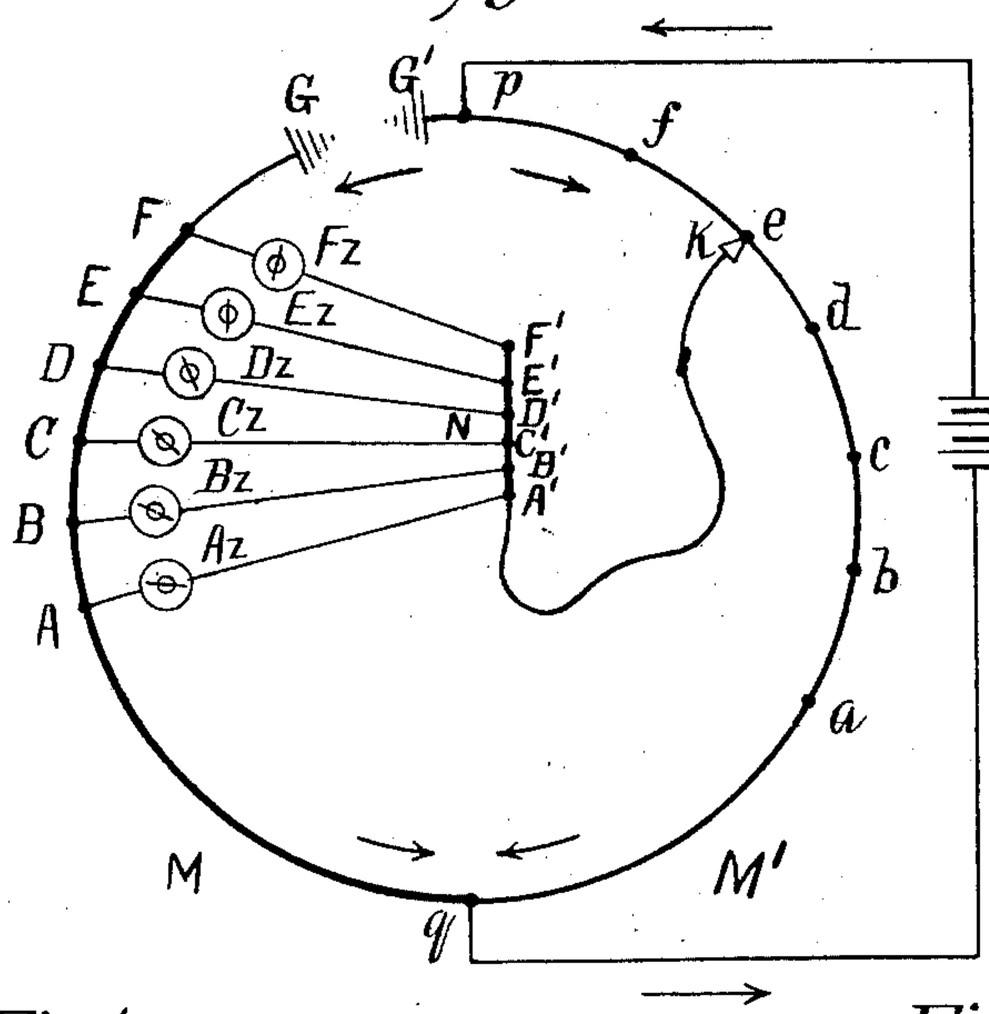
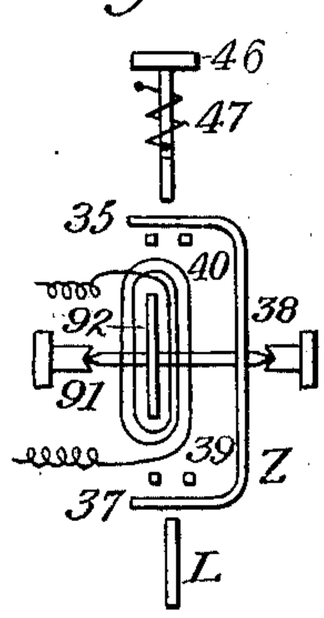


Fig. 6.

Fig. 8.



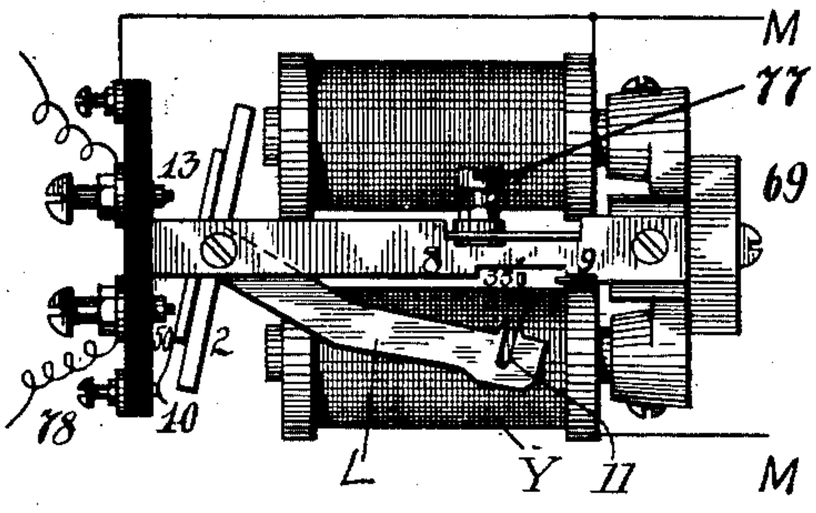
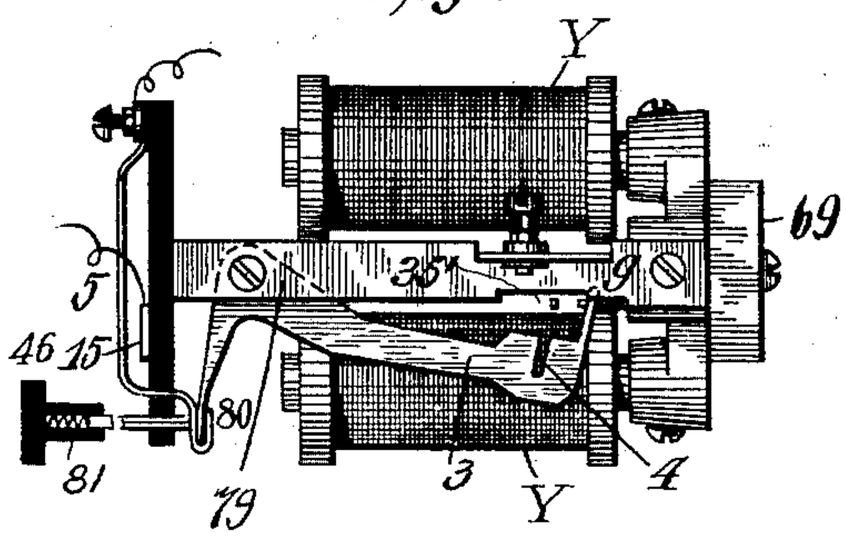
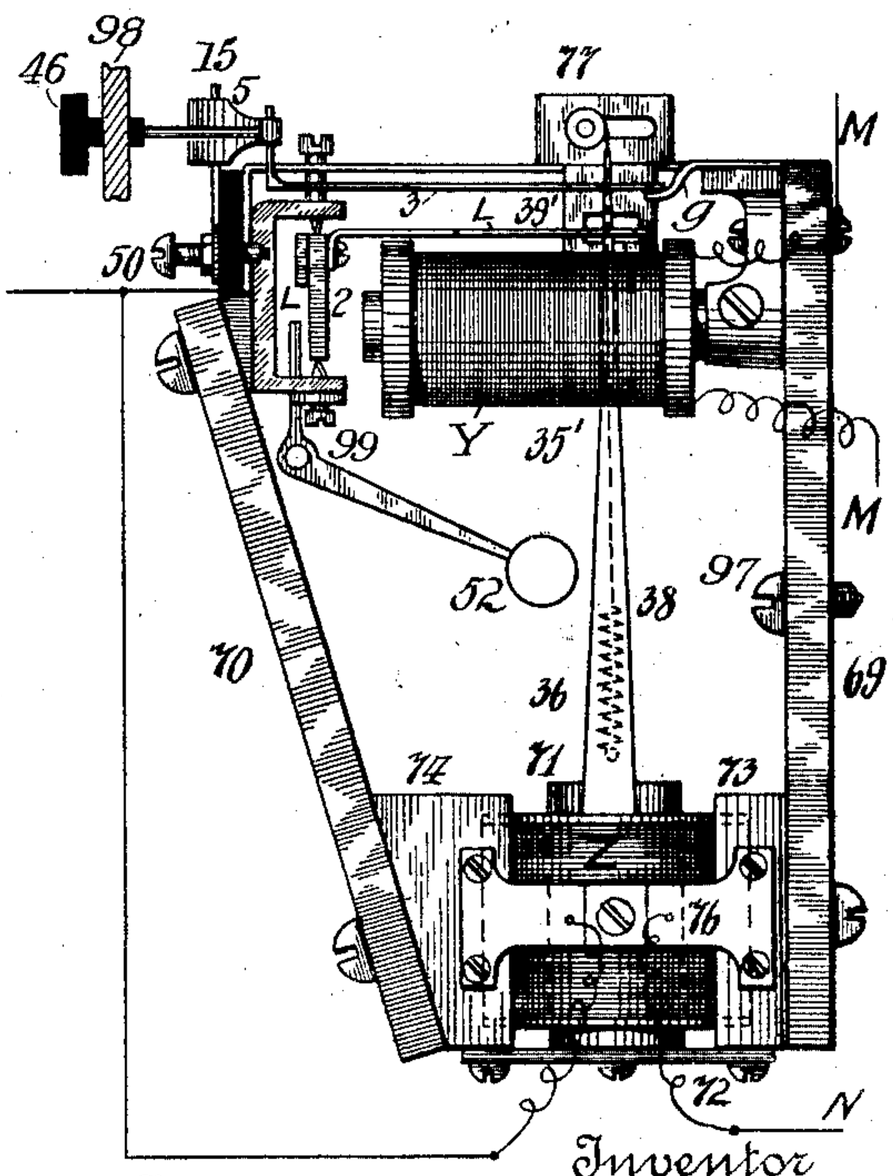


Fig. 7.





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No. 737,869. PATENTED SEPT. 1, 1903.

S. A. REED.

SELECTIVE SYSTEM.

APPLICATION FILED AUG. 1, 1901.

NO MODEL. 2 SHEETS—SHEET 2.

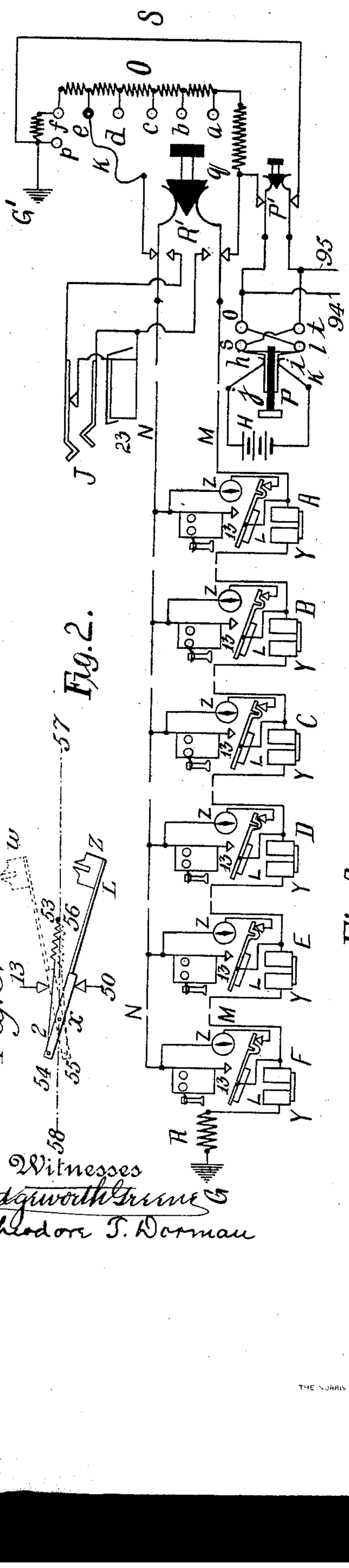

Fig. 2.

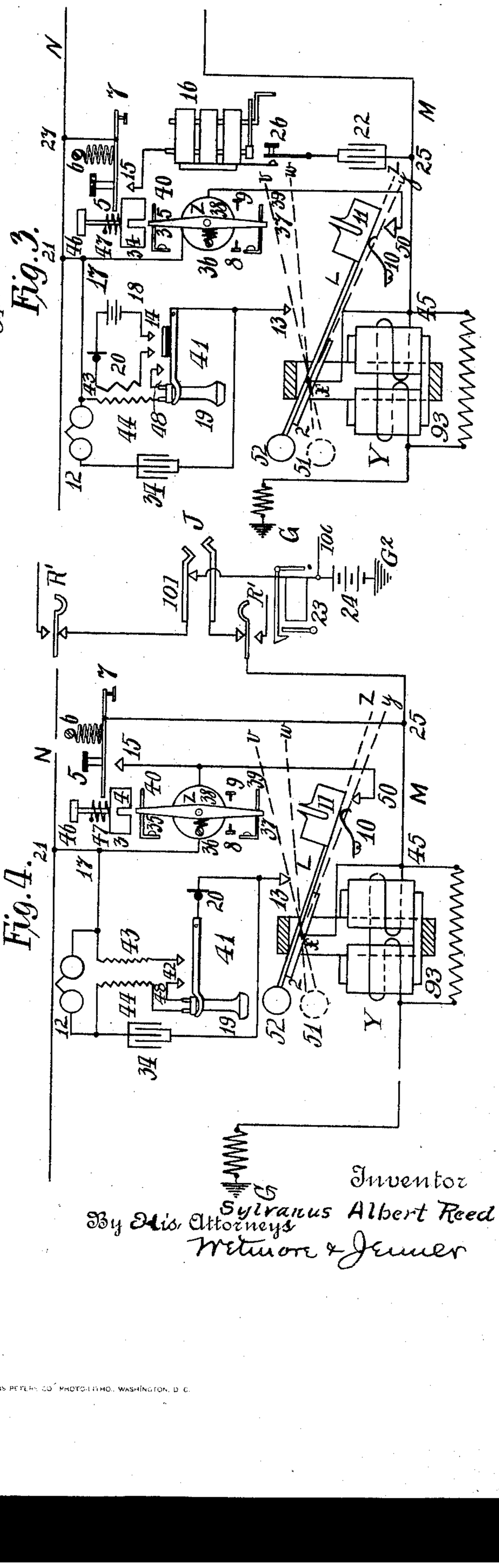

Fig. 3.

Fig. 9.

Fig. 4.

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No. 737,869. Patented September 1, 1903.

UNITED STATES PATENT OFFICE.

SYLVANUS ALBERT REED, OF NEW YORK, N. Y.

SELECTIVE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 737,869, dated September 1, 1903.

Application filed August 1, 1901. Serial No. 70,472. (No model.)

To all whom it may concern:

Be it known that I, SYLVANUS ALBERT REED, a citizen of the United States, residing in the borough of Manhattan, in the city, county, and State of New York, have invented certain new and useful Improvements in Selective Systems, of which the following is a full, clear, and exact description, reference being had to the drawings forming a part hereof.

In my patent dated December 3, 1901, No. 688,118, I described my invention of a system of selective signaling based on an adaptation of the principle of the Wheatstone bridge and gave in detail an application of the same to an intercommunicating party-line telephone system, and I explained its modifications into a central-station system. I also gave under Figure 10 a diagram of a modification of such plan in which battery-contacts were fixed, while one end of each bridge was virtually shiftable, the other ends being fixed to one limb of the loop.

My present invention relates to the detailed adaptation of this system to a two-wire-telephone party-line leading from a central station through a plurality of substations and capable of being operated either under the local-battery or the common-battery system.

Fig. 1 shows an extension of the principle of Fig. 9 of my patent above referred to, in which the loop is broken at G and G′ and grounds substituted and in which also instead of the end of the bridges being united directly at the point T^2, Fig. 10, of my patent they are united indirectly through the common conductor N. Fig. 1 gives a graphical representation of the circuit. Fig. 2 is a working telephone-circuit for six stations on the plan of Fig. 1 with individual keyboard. Fig. 3 is a detailed plan of one of the substations A B C D E F of Fig. 2 when the substations are provided with local batteries. Fig. 4 is a detailed plan of one of the substations A B C D E F of Fig. 2 adapted to the operation of the line on the common-battery system. Figs. 5, 6, and 7 are detailed views of the complete station instrument I prefer to use, Fig. 5 being a vertical elevation thereof, Fig. 6 being a top plan view with the fork-arm 3 omitted in order to afford a better view of the relay-arm L, and Fig. 7 being also a top plan view similar to Fig. 6, but with the relay-arm L omitted, so as to afford a better view of the fork-arm 3. Fig. 8 is a side view of the selective deflecting member or galvanometer Z as it would appear if looked at from the side in Figs. 3 or 4. Fig. 9 shows a modification of the member appearing in Figs. 3 and 4 as the relay-arm L.

Referring to Fig. 1, if a current from the source of current H passes in the direction of the arrows from p to q through the derived branches in multiple p M q and p M′ q, said derived branches forming a loop represented by a circle and having between them a plurality of bridges AA′NK BB′NK CC′NK DD′NK, in which the ends A B C D are permanent as to their position with reference to the branch p M q, while the common end K is shiftable with reference to the branch p M q, then if K be moved from q to p along branch or limb p M′ q the progressive variation of the potential at K will result in a progressive variation of the potential of any particular point, such as A′ on the line N, and a position of K may be found on the limb M′, such as a, which will result in an equalization of the potential between A and A′, which are the extremities of the bridge AA′. Similarly a point, such as b, may be found, to which if K be applied the result will be an equalization of the potentials at the extremities B and B′ of bridge BB′ and similarly as to the points c d e f and the bridges CC′, DD′, EE′, and FF′, respectively. N and K thus become jointly a means for equalizing the falls of potential along the branches M and M′ from the dividing-point p to the extremities AA′, BB′, CC′, DD′, EE′, and FF′ of any selected bridge. The condition of equality of potential between the extremities A and A′ produces the result of zero-current in bridge AA′ and similarly with regard to each bridge, and if each bridge includes a deflecting member, such as a galvanometer, shown by letters AZ, BZ, CZ, DZ, EZ, and FZ, then any such galvanometer may be selectively influenced or actuated by application of the contact K to the contact-point a, resulting in neutrality in the corresponding galvanometer AZ, but deflection—*i. e.*, activity—in all the others. Similarly the application of contact K to the point

b will result in a condition of neutrality in bridge BB′ and activity in the galvanometers of all other bridges. Hence a selective actuation of the galvanometer AZ BZ CZ DZ EZ FZ as to rest or deflection is determined and controlled by the shiftable contact K in connection with the predetermined contact-points *a b c d e f*. In the above illustration I have taken six bridges; but an indefinite number could similarly be selectively controlled.

In Fig. 2, M N are telephone-line wires extending from a central station S through a plurality of substations A B C D E F, of which I have taken for convenience six, although an indefinite number could similarly be connected to the line. O is a keyboard having a series of resistances *qa ab bc cd de ef fp* all in series with the line-wire M through the grounds G G′. These resistances have points *a b c d e f p* arranged so that electrical contact may be made therewith. K is a shiftable contact connected with the line N. R is a resistance which is preferably made equal to the resistance of line M from the central station to the first substation A. H is a source of current having the permanently-located connections *p* and *q* with the circuit through the pole-changer P and the key P′. R′ is a key whereby the line M N may be cut off from normal connection with the switchboard spring-jack J and annunciator 23, and connected with the keyboard O. Y represents polar electromagnets or relays in series in line M at each station. Z is a deflecting member or galvanometer in a bridge between M and N at each station.

The polar electromagnets Y have attached to their armatures 2 the arms L, which are shown in detail in Figs. 3 and 4. These arms are limited in their play by the contacts 13 and 50. For ordinary party-lines I have found a resistance of five to ten ohms preferable for the polar electromagnets Y.

In order that the talking qualities of the circuit shall not be adversely affected by the electromagnets Y, I prefer to place around each the high-resistance non-inductive shunt 93. I have shown Z in Figs. 3, 4, and 8 for convenience as a galvanometer with magnetic needle and stationary coil; but I prefer a galvanometer of the d'Arsonval type and have adopted such type in my regular station instrument. (Illustrated in Figs. 5, 6, and 7.) I have found the most convenient resistance for this coil about five hundred ohms. The needle or index 38 of the galvanometer Z plays between the stops 8 9 and may be restored after deflection to a medial position of stable balance, which I will call the "neutral" position, by the retractile spring 36. The needle 38 may have at either end a flexible extension 35 37, which may be turned at right angles, so that it would be perpendicular to the plane of the figure. Fig. 8 shows a side view of galvanometer Z, in which needle 38 appears mounted on the shaft of a magnetic needle 92, which swings inside the fixed coil 91.

Elastic extension 37 plays in front of a notch or indentation 11 in arm L and between L and a bracket 39, which may be forked or mortised, as shown in Fig. 8. When needle 38 of galvanometer Z is in a neutral position, then 37 is directly opposite notch 11. For convenience I will refer to and characterize the movements of arm L as "ascending" and "descending," respectively, "ascending" referring to movement away from needle 38 and "descending" referring to movement toward needle 38. Similarly, any position of arm L on the side of its medial position away from needle 38 I will characterize as an "elevated" position, and, conversely, any position of arm L on the side of its medial position toward needle 38 I will characterize as a "depressed" position, it being understood that the terms "ascending," "descending," "elevated," and "depressed" are not used in the sense of up and down in which they appear as viewed on the paper in Figs. 3 and 4, but in the special and technical sense which I have just described. Furthermore, a current of direction adapted to elevate arm L, I will characterize as a "reverse" current. When the current passes through relay Y in a definite direction, (say +,) then arm L will descend toward needle 38, and if 38 has not deflected from its neutral position then notch 11 will engage extension 37, and arm L will be able to reach its extreme depressed position. (Shown by dotted lines *x v*, Figs. 3, 4.) If, however, the needle 38 has deflected, then notch 11 will not engage elastic extension 37, but arm L will be blocked in its descent by extension 37, which it will press against the support 39, and it will reach only the intermediate depressed position, (shown at *x w*.) The non-selective arm L may be provided with lugs or points, one on each side of notch 11. These, together with the pressure of L, operate as means to retain the selectively-actuated deflecting member or needle 38 from returning to the neutral position after the current ceases so long as L maintains its blocked position. The armature of relay Y is adjusted so that its bias toward the nearest pole when Y is not energized causes said armature to maintain the last position in which the current has placed it, and the relative positions of arm L and needle 38 are so adjusted that when arm L is in the intermediate blocked position (shown at *x w*) then the armature of Y is a little past its own medial line of unstable balance and has a bias away from said line toward the pole toward which it tends on its descent. Therefore the arm L and needle 38 continue mutually to block each other even after current has been cut off. If the current is applied in the reverse direction, arm L will ascend to position shown by dotted line *x y* and will release needle 38. The elevated position of L may be merely limited by a stop, and said elevated position may have no contact-closing func-

tion, but may be merely a poise, allowing the needle 38 to swing clear, but from which the descending swing may originate.

In Figs. 3 and 4 I have added a circuit-closing function to the extreme elevated position *x y* and have superadded an intermediate elevated position *x z*, in which the arm is placed by the contact-breaking spring 10. These elements and their object will be described farther on.

When the current is again shut off, arm L will retain its elevated position on account of the bias above mentioned; but needle 38 will be brought back to its neutral position by spring 36. The arm L and needle 38 in such relation will serve as a zero-current annunciator.

Instead of relying upon the magnetic bias referred to I may obtain a mechanical bias by the use of a spring or similar means of pressure applied to the armature eccentrically, as illustrated in Fig. 9. In this view, 2 is the armature of polar magnet Y. L is the arm thereto attached. *x* is the pivot of the armature, *x y* is the line of one of its elevated positions, and *x w* the line of one of its depressed positions, the latter being given in dotted lines. 13 and 50 are stops, and the armature 2 is shown in full lines resting against stop 50 in the elevated position and is also shown in dotted lines in the depressed position resting against stop 13. 56 is a tension-spring exercising a pull between a point of attachment 54 on the armature 2 beyond its pivot *x* and a fulcrum 53, which is on a line 57 58, passing through pivot *x* and between the stops 50 and 13, and which fulcrum must be on the side of pivot *x* opposite to 54. It is plain that the positions *x z* and *x w* are positions of stable equilibrium and the position *x* 57 is the position of unstable equilibrium or balance and that there is a resulting bias of the armature toward rest against 13 or 50, respectively, according as the armature may happen to be placed on one side or the other of line *x* 57.

P is a pole-changing switch adapted suddenly to reverse the current in the portion of the circuit to the right of P. It consists, preferably, of an insulating-stem (shown in black) on which are mounted the elastic switch members or springs *h i*, the stem being movable to and fro past the contact members *s l o t*, in which *s l* correspond to a certain current direction and *o t* to a reverse-current direction. During the movement of the stem electrical connection may be maintained between the springs *h i* and the battery H through the medium of the brushes *j k*, adapted to rub against extensions of the springs *h i*. As P is depressed the springs *h i* will first press yieldingly against *s l;* second, will suddenly pass *s l* and snap against *o t*, causing a sudden reversal of current; third, by moving the stem of switch P in a reverse direction the springs *h i* may be brought to the original position against *s l*.

In order to provide effectively for the signaling and calling apparatus hereinafter to be described, means must be provided whereby in the normal or idle condition of the line the bridges between N and M, which contain the selective galvanometers Z, shall have open junction with M at all the substations, but that said junctions shall be automatically closed by an action of the central operator during the period in which a selective signal is to be transmitted from the central to any substation.

The device I prefer, in order that the bridges may be normally open at all substations, but may be closed by the act of selective calling, is illustrated at 10, Figs. 3 and 4. 10 is a contact-breaking spring or other resilient member controlling at the circuit-breaking contact 50 the junction of the galvanometer-bridge with the line M. Spring 10 is adapted in strength and play or range to impel the armature 2, with its arm L, after current has ceased away from contact 50 against the bias, which would otherwise hold it in position *x y* against said contact. The range and strength are, however, not sufficient to throw or impel the arm L so far as to pass the medial line of unstable balance, but only to place it in the position *x z*, intermediate between *x y* and said medial position. While current is passing in relay Y in a direction to elevate the arm L the spring 10 is compressed and arm L reaches the contact 50, closing the bridge-circuit. When current ceases, the arm L moves to position *x z*. The position *x z* of the arm is persistent—that is, when no current passes the arm L will, if up, remain up and resting against the spring 10 in the position *x z*, nearly but not quite in contact with 50; but when a reverse current passes in M the arms at all stations will compress the springs 10, move to positions *x y*, and close the contacts 50, thus uniting the said bridges to M at all stations so long as such reverse current continues.

In order to transmit a selective call from the central station to any station, such as E, the operator applies the shiftable contact K to the keyboard-contact *e*, as shown in Fig. 2, then depresses key R′ to connect the keyboard with the line and disconnect the latter from the jack J and annunciator 23, then depresses P′ to connect pole-changer P with the particular keyboard O rather than with some other keyboard to which the current might be supplied through the leads 94 and 95. Assuming that the springs *h* and *i* of the pole-changing key P have been left normally in contact with the contact members *s* and *l*, respectively, and that the current direction thereby determined is the one that I have characterized as "reverse," then the closing of key P′ will supply said reverse current to the circuit and then during the period while the said reverse current continues all the arms L compress their springs 10 and close the contacts 50, thus bringing all the galvanometer-bridges

into the circuit. All needles 38 except that at station E then deflect. The operator next depresses pole-changing key P, which causes the springs *h i* to slide over *s l*, respectively, and to snap against *o t*, respectively, thus suddenly reversing the current from H. The brushes *j k* maintain contacts respectively with the sliding extensions of the springs *h i* during the depression of the key P. The effect of the sudden reversal of current is to cause all the arms L to descend, instantly breaking the bridge-contacts 50, as a result of which all the deflected needles 38 start to return to the positions of rest or neutrality opposite the notches 11. By original adjustment of the clearance and of the lead furnished by the projecting points or lugs of notch 11 the arms L overtake the deflected needles before they arrive at the neutral or undeflected position and clamp or retain them against the brackets 39, being themselves thereby blocked in the intermediate position *x w* and prevented from descending to the extreme position *x v*, at which the signal and telephone-controlling contact 13 is made. The arm L at station E, however, not being blocked descends to the position *x v* and reaches the contact 13 above mentioned. The operator then opens switch P′, thereby shutting off the battery connection from the keyboard O. The arms L remain, however, as left, inasmuch as the positions *x w* and *x v* are both past the medial line of unstable balance of the armature, and they are retained in such positions by the bias of said armatures away from said line. The operator then may manipulate key R′ to disconnect the lines M N from keyboard O and to connect them with the switchboard for signaling and talking.

When it is desired to restore the line to normal or open condition, the keyboard O is again connected to the lines M N by key R′ and key P′ is operated to connect the battery H with the circuit. The pole-changer P having been previously returned to its original or normal position, with springs *h i* in contact with members *s* and *l*, respectively, the current which passes will be of the direction first applied—namely, the so-called "reverse current"—which will operate to cause all the arms L to ascend and to release all the needles 38, which needles then under the influence of spring 36 tend to return to neutrality. The instant the arms L reach contact 50, compressing spring 10, the bridges are restored and the needles 38 deflect. If contact *k* has been left at *e*, then the deflection will be the original selective deflection. If contact *k* has, however, been removed, then the deflection will be one of a more or less complex character, due to a division of the current between wire M and the bridges. This deflection during the action of restoring the line to normal condition is, however, a matter of indifference, as the operator immediately raises key P′, thereby cutting off the current from the keyboard, whereupon the springs 10 break the contacts 50, the needles 38 all return to the neutral or undeflected positions opposite the notches 11 of arms L. The arms L remain in the positions *x z* against springs 10 on account of the bias previously referred to. The operator then raises key R′, disconnecting the line from the keyboard O and restoring its connection with the jack J and the drop 23.

The arm L only when in its extreme depressed position, but in no other position, closes the normally open operative contact 13, which contact controls the signaling and talking circuit. Such circuits may be arranged in a variety of ways; but I prefer the plan shown in Fig. 4 for a common-battery system and that shown in Fig. 3 for a local-battery system.

In Fig. 3 the closing of the selective contact 13 completes when the hook-switch 41 is down a bridge between 17 and 45, interrupted only by the condenser 34. This bridge may be traced from 45 through *x*, 13, 34, 12, 17 to 21. 12 is a high-resistance polarized ringer and may be actuated by an alternating current propagated through the line-wires M N, the jack J, and the cord-conductors from a magneto-generator connected with the cord-circuit by the usual ringing-key. This alternating current will not affect the low-resistance relays Y.

When the receiver 19 is removed from the hook 41, the contact 48 is closed and the receiver 19, with the induction secondary 44, is brought into the bridge 45 21, shunting the condenser 34 and bell 12. The hook-switch 41 also by means of the insulated block 14 closes the circuit of the local battery 18, which includes the transmitter 20 and the induction primary 43. This station then has its transmitter and receiver in effective relation to the line for talking and listening; but all other stations, having their bridges 45 21 interrupted by the open contact 13, are unable to talk or listen through the line. This arrangement therefore results in a privacy system.

In the circuit represented in Fig. 4, which is what I prefer for adaptation to the conditions of a common-battery system, the effect of closing contact 13 in consequence of a selective call to a particular station is that when the hook-switch 41 is down the condenser and polarized high-resistance ringer 12 are in series in the bridge 45 21, which bridge may be traced from 45 through *x*, 13, 34, 12, 17, to 21. An alternating current propagated through the line from a magneto-generator at the central station will then actuate the bell 12, but will not affect the low-resistance relays Y. When the hook-switch 41 is up, the bridge-circuit 45 21 includes the transmitter 20, the hook-switch 41, the contact 42, and the induction primary 43, while the receiver-circuit

is completed for alternating voice-currents through contact 48, induction secondary 44, and condenser 34.

A battery bridged between the cord strands at the central station will then when the plug of the cord is inserted in the jack J energize the transmitter-circuit and bring this selected station into effective relation with the line for talking and listening, while all other stations on account of having contact 13 open will be unable to talk or listen through the line.

The tip and sleeve-springs of jack J must be connected, respectively, to line-wires N and M in a relation to the common-battery-current direction such that said current direction will when the plug is inserted in the jack tend to depress and not to elevate the arm L at the various stations of the line.

If the operator before applying the reverse current has placed his contact K on *b*, for example, in order to call station B, then during the period while the reverse current continues all the needles are deflected except that at B, which remains at neutral position. The circuit is then in its selective condition so long as said reverse current continues. The instant the operator moves pole-changer switch P with the snap action previously referred to the arms L start to descend and the bridges are instantly broken, the effect of which is to cause all the deflected needles to start to return to the position of rest or neutrality opposite the notches 11. As before referred to, the arms L overtake the deflected needles before they reach their medial positions, clamp them against the brackets 39, and are themselves blocked in the third position *x w*. The arm at the selected station reaches the fourth position *x v* and closes the contact 13, which completes the normally open bridge 45 13 21 between M and N, which is then the only bridge between said lines effective for signaling and talking. The operator then disconnects the keyboard by key R′, which also connects the line with the spring-jack J, whereby signaling and talking currents may be supplied to the line. The ground G is then an open end of the line M and does not affect the circuit.

There are other possible ways consistent with the practice usual in common-battery systems of arranging the transmitter, receiver, and signaling apparatus in the bridge 45 13 21, said bridge being selectively closed through contact 13, and I do not confine myself to the special arrangement of the said transmitter, receiver, and signaling apparatus shown in Fig. 4.

In order that the calling subscriber may have his connection with the line during a call which he requests to be made by the central operator for another subscriber either on this line or some other line, in the case both of the local and common battery systems, I provide the fork or bolt 3, Figs. 3, 4, and 8, having blunt tines or shoulders on each side of its crotch 4. This fork plays up and down opposite the extension 35 of the needle or arm of the galvanometer Z. It is operated by key 46 and retracted by spring 47. The stem of key 46 may comprise a compression-spring (not shown in the drawings) to relieve excessive pressure in operating it manually. The fork or bolt 3 has a crotch 4, which can when the needle is neutral engage an elastic extension 35, which has a position preferably at right angles to its line of motion; but if the needle is deflected the fork is blocked on account of said extension 35 being interposed between one of the shoulders of the fork and the bracket 40, which may be forked. After a subscriber calls the central operator through the agency of switch 5, as will be hereinafter described, he may then release switch 5; but he will continue to hold down key 46 until he receives an answer from the central operator. The central operator effects this object by first operating her key R′ to connect up the keyboard, then placing the contact K at some point, such as *p*, on the keyboard predetermined for the effect of deflecting all the galvanometer-needles without exception.

The caller's needle being locked in medial position by his act in holding down key 46 is the only one not deflected. Therefore when the central operator first elevates and then depresses all the arms L by manipulation of switches P and P′ every arm L is blocked except that of the caller. The arm L at the caller's station reaches the signaling-contact and enables the bell-signal to be made in the manner formerly described. When the caller hears his signal, he takes his receiver off the hook and can talk to the central operator, all other stations being locked out. When he has given the central operator the desired number, he again in case his desired number is on the same party-line holds down key 46, while the central operator first elevates all arms L, including that of the caller, then makes the contact on the keyboard to call the desired station, and then operates the calling-switches P and P′, which operation deflects all needles 38 except that of the called station and that of the calling station, the latter being prevented from deflection by the key 46 and which operation also on reversal of current depresses all arms L, the result of which is that not only is the called station connected up to the line, but also the calling station. In case the call is for some other line the caller may release his key 46 as soon as he is answered. The bolt or fork 3 also operates as a lock-out device for preventing any subscriber from calling the central operator while the line is busy, as will be described farther on.

For calling the central station I prefer in case of a local-battery system the magneto-generator 16, Fig. 3, included serially in the bridge 25 27 between M and N, the bridge being interrupted by the condenser 22, the generator-switch 26, and the switch 5, the latter

making contact at 15 and being restored after depression by the retractile spring 6 and limited by the stop 7. When the line is idle, the key R′ is open and the drop 23, Fig. 2, or other signal-receiving device is bridged between the line-wires M and N. When switch 5 and switch 26 are closed and generator 16 is operated, the drop 23 will be actuated in the usual manner; but the calling-current will not affect the low-resistance relays Y.

In the case of the common-battery system illustrated by Fig. 4 the switch 5 closes, through contact 15, a bridge 25 21 between M and N, which bridge includes the galvanometer Z. At the central station when the key R′ is in normal position, as shown in Fig. 4, the common-line signal-battery 24 includes this particular line M N in multiple with other lines between the common conductor 100 and the ground G^2, the circuit of this particular line being traceable from battery 24 through line-annunciator, drop, or other signal-receiving device 23, jack J, contact 101, line-wire N, 21, 17, Z, 15, 5, 25, line-wire M, grounds G and G^2 back to battery 24. This bridge is normally open at 15; but by closing this contact through the agency of the movable switch member 5 the drop 23 will be effectively operated. When a plug is inserted in jack J, the contact 101 is broken and the battery 24 is out of circuit with this particular line.

The movable switch member or calling-key 5 has an extension which may rest loosely on fork 3, so that fork 3 can be depressed independently of switch 5 for the purposes formerly described; but switch 5 cannot be operated independently of fork 3, but is blocked thereby if fork 3 is blocked by the extension 35 of the selectively-operated deflecting member or needle 38. Therefore if the needle 38 is deflected, which is the condition when the line is busy, the switch member 5 cannot be effectively operated; but it can be effectively operated if the needle extension 35 is in neutral or undeflected position, which is its condition when the line is idle.

It is evident that in both the local-battery and the common-battery systems of calling or signaling to the central exchange the calling-switch 5 can be operated only when the fork 3 is free to move. This arrangement therefore constitutes a lock-out system for calling the central station. I may also provide a visual busy-signal 52, attached to or preferably linked with the arm L and playing in front of a window 51, and therefore only exposed when the arm L is down and the line busy.

In order to produce the proper relation between the resistances on the keyboard and those in the line, either the line may be taken as it is with the interstation resistances, such as result from the accidents of subscribers' location, and the keyboard may be adapted to such line, in which case there will be a separate keyboard for each party-line, or there may be a single standard keyboard for a plurality of party-lines and such lines brought to adaptation to the standard keyboard by the interpolation of resistances in the line and by the substitution of dummy apparatus for stations lacking to make up the standard number. A certain standard will then serve for all lines not having a greater number of stations or any greater interstation resistances on wire M than those of such standard. The former plan I denominate the "individual-keyboard" system and the latter the "common-keyboard" system.

The plan illustrated in Fig. 2 and heretofore described shows the individual-keyboard system, which is the typical plan. In this system the keys R′ and P′ appertain to the keyboard O exclusively. The former, R′, serves to determine the connection of the line with either its line-jack J or its keyboard O, while the latter, P′, serves to control the connection of the calling-key P and battery H with the particular keyboard O, said calling-key P and battery H being common to all keyboards controlled by one operator. The wires 94 95 indicate leads to the keyboard of some other party-line entering the same switchboard. The cord-circuits have no change made from their usual character.

Fig. 5 is a vertical elevation, and Figs. 6 and 7 are top plan views, of the practical station selective instrument I prefer to use. This instrument corresponds to Figs. 3 and 4, omitting the telephone and ringer sets therein shown. In Figs. 5, 6, and 7, Y is the polar electromagnet, polarized by the two bar-magnets 69 and 70. Z is the swinging coil of a galvanometer of the d'Arsonval type. 73 and 74 are pole-pieces attached to the opposite ends of the same bar-magnets 69 and 70, which serve to actuate the polar electromagnet Y. 71 is a soft-iron core supported by the non-magnetizable piece 72, attached to the pole-pieces 73 and 74. The coil Z swings freely in the plane of Fig. 5 in the annular space between 71, 73, and 74. Said coil carries the index arm or needle 38 and is restored to the medial position after deflection by the retractile spring 36, (shown in dotted line,) said spring being adjusted by the screw 77. Arm or needle 38 is rigid as to flexion in the plane of the paper, but is elastically flexible at about its middle portion to movement perpendicular to said plane. The outer end or extension of arm or needle 38 is thickened perpendicular to the plane of the paper, as shown in cross-section at 35′ in Figs. 6 and 7. 39′ is a bracket against which extension 35′ may be elastically pressed and which corresponds to the two brackets 39 and 40, Figs. 3, 4, and 8, whose functions it unites in one. 8 and 9 are shoulders in the frame, which act as limiting-stops to the oscillations of needle 38 and correspond in function to the stops 8 and 9 in Figs. 3 and 4. 2 is the armature of the polarized electromagnet Y. It carries the arm L

and plays between the contacts 13 and 50 in a plane at right angles to that of Fig. 5, but is held normally a short distance away from contact 50 by spring 10, which bears against the adjusting-screw 78. When current of the proper direction passes, armature 2 compresses spring 10 and closes contact 50, which contact connects conductively with one of the leads of coil Z, the other lead of coil Z being connected to line-wire N, as shown at 21 in Figs. 3 and 4.

The armature 2 is in conductive connection, preferably through the frame, with line-wire M, as illustrated at 45 of Figs. 3 and 4. Therefore when armature 2 makes contact with 50 the coil Z is brought into a bridge between M and N, but when said contact is broken the coil Z is out of circuit. The contact-screw of 13 is so adjusted that when arm or needle 38 is undeflected the notch or slot 11 in the end of arm L can engage extension 35′, and said arm L can then pass to a position where armature 2 can reach the contact 13; but the adjustment of 13 is also such that if arm or needle 38 is deflected to either side of its neutral position then one of the shoulders of notch 11 presses 35′ elastically against bracket 39′, and the thickness of 35′ is sufficient to prevent armature 2 from reaching contact 13. In order to allow the projecting points or lugs on either side of notch 11, heretofore described, to pass clear, a slot is made in the bracket 39′, as shown in Fig. 5.

Bracket 39′, in connection with lever 3, Figs. 5 and 7, fulfils the function performed in Figs. 3, 4, and 8 by bracket 40 in connection with fork 3, thereby reducing the multiplicity of parts required in the arrangement illustrated in Figs. 3, 4, and 3.

In Figs. 5 and 7 lever 3, which is pivoted so as to oscillate in a plane at right angles to that of Fig. 5, has the slot 4, which can engage extension 35′ when the latter is in medial position, but which will be blocked by extension 35′ when the latter is deflected. When extension 35′ blocks lever 3, the former is pressed elastically against bracket 39′ just as in the arrangement illustrated in Fig. 8 the extension 35 is pressed elastically against bracket 40 by one of the shoulders of bolt 3. The spring-switch 5, Figs. 5 and 7, is linked to lever 3 at 80, so that normally it retracts lever 3 away from extension 35′; but it may be pressed down by key or button 46 toward the contact 15. Contact 15 is so adjusted as to its distance from spring-switch 5 that when extension 35′ is interposed by deflection between one of the shoulders of lever 3 and the bracket 39′ then contact 15 cannot be reached by spring-switch 5; but that if extension 35′ is in its normal undeflected position then lever 3 can reach contact 15. The tongue *g* slides in a groove in the frame and operates as a guide for lever 3.

In case the common-battery system, such as is shown in Fig. 4, is used then, referring to Fig. 5, contact 15 is in conductive connection with contact 50, and spring-switch 5 being in conductive connection with the frame the line-wire M will be connected with the line-wire N through coil Z when contact 15 is closed, and the line-signal at the central exchange will thereby be operated. In the case of the local-battery system (illustrated in Fig. 3) the contact 15 will be insulated from 50, but will be in conductive connection with line N through the magneto-generator and the condenser. The closing of contact 15 will then complete a bridge between line-wire M via the frame of the instrument, spring-switch 5, contact 15, condenser, magneto-generator switch, and magneto-generator to line N. The subscriber will thus be enabled to generate an alternating current which will operate the line-signal at the central exchange. In the arrangement shown in Fig. 3 the switch-key 5 is for convenience of illustration interposed between the generator 16 and line N, whereas in the arrangement just described (illustrated in Figs. 5 and 7) the switch-key 5 will be electrically between the condenser and the line M. The effect, however, will be the same.

Spring 81 (shown in section in Fig. 7) is a compression member provided in order to relieve excessive pressure against extension 35′ when key 46 is operated manually. The strength of spring 81 is sufficient to allow switch 5 to be pressed to a sufficient contact with 15, when the needle 38 is undeflected. When the switch 5 comes to a bearing on contact 15 or when the needle 38 being deflected the lever 3 comes to a bearing on needle 38, the spring 81 will then yield to further pressure until the button reaches a stop, such as would be afforded by the side of the box, as shown in section at 98, Fig. 5.

In the arrangement shown in Figs. 5 and 7 the fork-lever 3 cannot be operated as a means of locking extension 35′ without at the same time closing the contact 15, whereas in the plan shown in Figs. 3 and 4 the bolt or fork 3 can be operated independently of switch 5, but switch 5 cannot be operated independently of fork 3. The latter arrangement is preferable under some circumstances, but is not necessary in others.

In Fig. 5 the busy signal 52 is shown as attached to the end of a lever pivoted at 99 and adapted to be reached and operated by the movement of armature 2 toward contact 13. This arrangement differs from the plan illustrated in Figs. 3 and 4, where the busy signal is directly attached to armature 2. I do not, however, confine myself to the plan shown in Figs. 3 and 4, but may also use that shown in Fig. 5 or any other equivalent method.

The entire instrument illustrated in Figs. 5, 6, and 7 is self-contained and may be mounted in a separate box and have proper wiring connections with the telephone set and line-wires or may be mounted in the same box or receptacle with the telephone set or

portions thereof. I have shown at 97 a screw for attaching the instrument to the inclosing case or box.

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

1. In a selective system, an electric circuit having derived branches in multiple; a source of current; a common conductor having connection with one of the derived branches; a plurality of bridges extending from another derived branch to the common conductor; and means for equalizing the falls of potential along said derived branches and the said common conductor from the dividing-point of said derived branches to the respective extremities of any selected bridge, substantially as described.

2. In a selective system, an electric circuit having derived branches in multiple; a source of current; a common conductor having connection with one of the derived branches; a plurality of bridges extending from another derived branch to the common conductor; and means for adjusting the ratios of the resistances along the branches respectively and the common conductor from the dividing-point of the said branches to the extremities of any selected bridge, to produce an equality of potential at such extremities, substantially as described.

3. In a selective system, an electric circuit having non-variable derived branches in multiple; a source of current; a common conductor having variable connection with one of the derived branches; a plurality of bridges having non-variable connection with another derived branch and extending from said branch to the common conductor and having non-variable connection with the said conductor; and means for shifting the said variable connection of the common conductor to produce an equality of potential at the extremities of any selected bridge, substantially as described.

4. In a selective system, an electric circuit having derived branches in multiple; a source of current having its points of connection to the loop permanently located on the same; a plurality of bridges between the derived branches; and means for equalizing the falls of potential along said branches respectively from their dividing-point to the extremities of any selected bridge, substantially as described.

5. In a selective system, an electric circuit having derived branches in multiple; a source of current having its points of connection to the loop permanently located on the same; a plurality of bridges between the derived branches; and means for adjusting the ratios of the resistances along said branches respectively from their dividing-point to the extremities of any selected bridge, substantially as described.

6. In a selective system, an electric circuit having two non-variable derived branches in multiple, said derived branches forming a closed loop; a source of current having its points of connection to the loop permanently located on the same; a common conductor having variable connection with one of the derived branches; a plurality of bridges having non-variable connection with the other derived branch and extending from said branch to the common conductor and having non-variable connection with the said conductor; and means for shifting the said variable connection of the said common conductor to produce an equality of potential at the extremities of any selected bridge, substantially as described.

7. In a selective system, an electric circuit having derived branches in multiple; a source of current adapted for location in the circuit; a plurality of bridges between the derived branches and having normally open junction therewith; and means for automatically closing said normally open junctions to establish electrical communication between the branches along each bridge, substantially as described.

8. In a selective system, an electric circuit having derived branches in multiple, said derived branches forming a loop; means for passing an electric current in either direction through the said circuit; a plurality of bridges between the derived branches and having normally open junction therewith; means for closing said normally open junctions, whereby the circuit may be put into condition to transmit a selective call; and means for equalizing the falls of potential along said branches respectively from their dividing-point to the extremities of any selected bridge, substantially as described.

9. In a selective system, an electric circuit having derived branches in multiple, said derived branches forming a loop; means for passing an electric current in either direction through the said circuit; means for suddenly reversing said current; a plurality of bridges between the derived branches and having normally open junction therewith; means for closing said normally open junctions, whereby the circuit may be put into condition to transmit a selective call; and means for equalizing the falls of potential along said branches respectively from their dividing-point to the extremities of any selected bridge, substantially as described.

10. In a selective system, an electric circuit having derived branches in multiple, said derived branches forming a loop; a central station and a plurality of substations in said circuit; means at the central station for passing an electric current in either direction through the said circuit; a plurality of bridges, one at each substation, extending between the derived branches and having normally open junction therewith; means operated from the central station for closing said normally open junctions; and means for equalizing the falls of potential along said branches respectively

from their dividing-point to the extremities of any selected bridge, substantially as described.

11. In a selective system, an electric circuit having derived branches in multiple, said derived branches forming a loop; a central station and a plurality of substations in said circuit; means at the central station for passing an electric current in either direction through the said loop; a plurality of bridges, one at each substation, extending between the derived branches and having normally open junction therewith; a plurality of relays, one at each substation, in one of the derived branches, each relay related to the bridge-junction at its station to close the same during the passage of a current through said branch, whereby the central station may put the circuit in condition to transmit a selective call; and means at the central station for equalizing the falls of potential along said derived branches respectively from their dividing-point to the extremities of any selected bridge, whereby the central station may send a selective call through said circuit, substantially as described.

12. In a selective system, an electric circuit having derived branches in multiple; a source of current capable of being applied at fixed points in the circuit; a plurality of bridges between the derived branches having normally open junction with one of the branches; non-selective means in that branch for automatically making and breaking said junctions, to establish electrical communication between the branches along each bridge; a selectively-actuated deflecting member included in each bridge, adapted to actuate selectively during the period of junction of the bridges, substantially as described.

13. In a selective system, an electric circuit having derived branches in multiple, one an external line, and the other an internal line; a source of current adapted for location in the circuit; a plurality of bridges between the derived branches having normally open junction with one of the branches; non-selective means in that branch for automatically making and breaking said junctions, to establish electrical communication between the branches along each bridge; a selectively-actuated deflecting member included in each bridge, adapted to actuate selectively during the period of junction of the bridges, substantially as described.

14. In a selective system, an electric circuit having derived branches in multiple, said derived branches forming a loop; a plurality of bridges between the derived branches and having normally open junction therewith; a plurality of relays, in one of the derived branches, each relay related to the open junction of one of the bridges to close the same during the passage of a current through the branch containing the relays; and means for passing a current through the branch containing the relays, substantially as described.

15. In a selective system, an electric circuit having derived branches in multiple, one branch being external and composed partly of ground, the other being local and of specific resistance high compared with the external branch; a source of current; a plurality of bridges between the derived branches; and means for equalizing the falls of potential along said branches respectively from their dividing-point to the extremities of any selected bridge, substantially as described.

16. In a selective system, an electric circuit having derived branches in multiple, one branch being external, the other being local and of specific resistance high compared with the external branch; a central station at which the local branch is located; a plurality of substations along the external branch; a source of current; a plurality of bridges, each at a substation, and extending between the derived branches; and means at the central station for equalizing the falls of potential along said branches respectively from their dividing-point to the extremities of any selected bridge, substantially as described.

17. In a selective system, a central station and a plurality of substations; a line-wire extending between the central station and the plurality of substations; a second line-wire extending between said central station and substations and grounded beyond the outermost substation and connected to a keyboard-conductor at the central station; a keyboard with predetermined points at the central station to one end of which is connected the inner end of the grounded line-wire, the other end of said keyboard being grounded; said grounded line-wire and grounded keyboard forming a closed loop; a source of current at the central station transmitting current through the inner and outer limbs of said closed loop in multiple; a common conductor connected to the central-station end of the non-grounded line-wire and having shiftable connection with the predetermined points on the keyboard; a plurality of bridges extending between the line-wires; and signaling and talking devices interposed in said resulting circuit at the substations, substantially as described.

18. In a selective system, a central station and a plurality of substations, a line-wire extending between the central station and the plurality of substations; a second line-wire extending between said central station and substations and grounded beyond the outermost substation and connected to a keyboard at the central station; an electromagnetic motor device in the grounded line-wire at each substation; a keyboard-conductor at the central station to one end of which is connected the inner end of the grounded line-wire, the other end of said keyboard-conduc-

tor being grounded; said grounded line-wire and grounded keyboard forming a closed loop; a source of current at the central station transmitting current through said closed loop; a common conductor connected at the central-station end of the non-grounded line-wire and having shiftable connection with predetermined points on the keyboard; a plurality of bridges extending between the line-wires; signaling and talking devices interposed in said bridges at the substations, substantially as described.

19. A selective system comprising a polarized relay, a pivoted armature therefor, having a range of play across a medial line of unstable balance and a bias away from said line on either side thereof according to the direction of the current last passing through the relay, said line of unstable balance and said bias existing during non-passage of current in the relay, a circuit-closing contact in the path of movement of the pivoted armature, and a resilient member to impel the armature, against its bias, away from the contact when the armature is not impelled toward the contact by current passing in its relay, said resilient member being of range and strength inadequate to impel the armature far enough from the contact to pass the medial line of unstable balance, in combination with a circuit having derived branches and selective devices connected therein between points which may be caused to be at equal potential, a shiftable connection and a source of current, substantially as described.

20. A selective system comprising a polarized relay, a pivoted armature therefor, having a range of play across a medial line of unstable balance and a bias away from said line on either side thereof according to the direction of the current last passing through the relay, said line of unstable balance and said bias existing during non-passage of current in the relay; a circuit-closing contact in the path of movement of the pivoted armature on one side of said medial line; a resilient member to impel the armature, against its bias, away from the contact when the armature is not impelled toward the contact by current passing in its relay, said resilient member being of range and strength inadequate to impel the armature far enough from the contact to pass the medial line of unstable balance; a selectively-actuated deflecting member in circuit with the said circuit-closing contact; said armature having, on the other side of said medial line from the said circuit-closing contact, positions of effective and non-effective relation respectively to said selectively-actuated deflecting member, the armature being moved into said positions by a reverse current, substantially as described.

21. In a selective system, a source of current and a circuit of three main conductors, selective devices included in the circuit between points which may be caused to be at equal potential, relays in said circuit in series relation thereto, and a shiftable connection between a part of the circuit and said source for selectively causing equality of potential to exist at the terminals of any desired selective device, substantially as described.

22. In a selective system, a source of current and circuit of three main conductors, selective devices included in the circuit between points which may be caused to be at equal potential, signal-operating means in series relation to the circuit, said means being controlled by the selective devices, in combination with a shiftable connection between a part of the circuit and said source whereby the potentials at the terminals of any selective device may be caused to be equal, substantially as described.

23. In a selective system, a circuit of three main conductors provided with a plurality of selective devices adapted to be connected between points which may be caused to be at equal potential, relays in series relation to the circuit for effecting the connections of said selective devices and controlling means between the selective devices and the relays whereby the latter may be operated for a different purpose, only when their respective selective devices are not actuated, in combination with a source of current for energizing said relays and a shiftable connection between a part of the circuit and the source for selectively causing equality of potential to exist at the terminals of any selective device, substantially as described.

24. In a selective party-line system, a line-circuit comprising signaling means in normally open bridges, relays in series with the line for closing said bridges and electrical selective devices included in the circuit and adapted when actuated to prevent the closure of said bridges, in combination with a source of current and a shiftable connection at the operating-station for selectively causing equality of potential to exist at the terminals of any desired selective device, whereby one of said bridges may be closed to the exclusion of the others, substantially as described.

25. In a selective party-line system, three main conductors, normally open bridges at the substations between two of said conductors, relays in series with one of said conductors adapted to close said normally open bridges in combination with selective devices connected in the circuit between points which may be caused to be at equal potential and a shiftable connection at the operating-station for causing equality of potential to exist selectively at the terminals of any selective device and means for energizing said relays, substantially as described.

26. A telephone party-line system compris-

ing signaling apparatus in normally open bridges of the line at the substations, circuit-closing means for each bridge, in combination with a plurality of selective devices adapted to be actuated by current in the circuit to block the operation of said circuit-closing means, and means including a source of current at an operating-station for applying current to the circuit and selectively maintaining the non-actuation of any selective device, substantially as described.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

SYLVANUS ALBERT REED.

Witnesses:

THEODORE T. DORMAN,

G. A. TAYLOR.