No. 737,870. PATENTED SEPT. 1, 1903.

S. A. REED.

SELECTIVE SYSTEM.

APPLICATION FILED DEC. 31, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

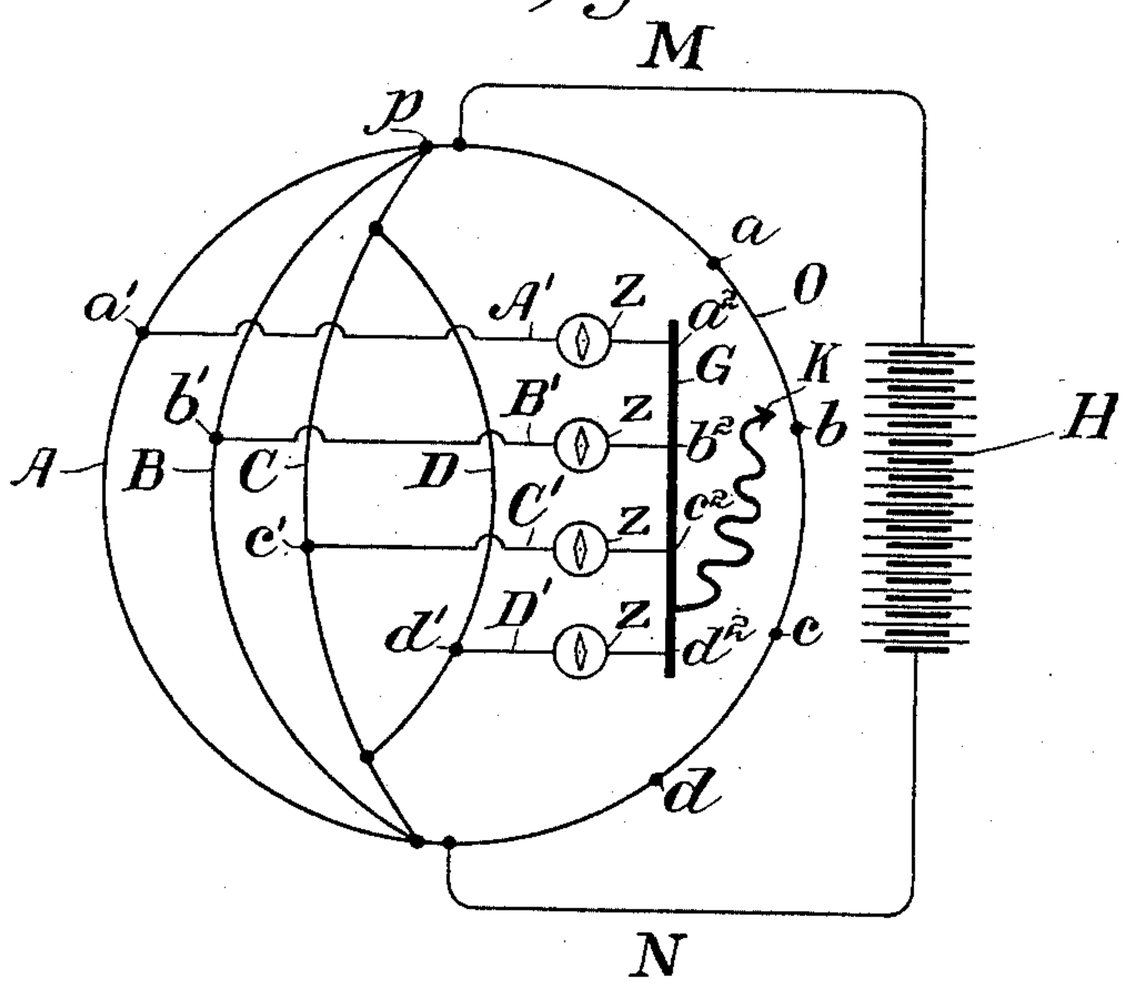
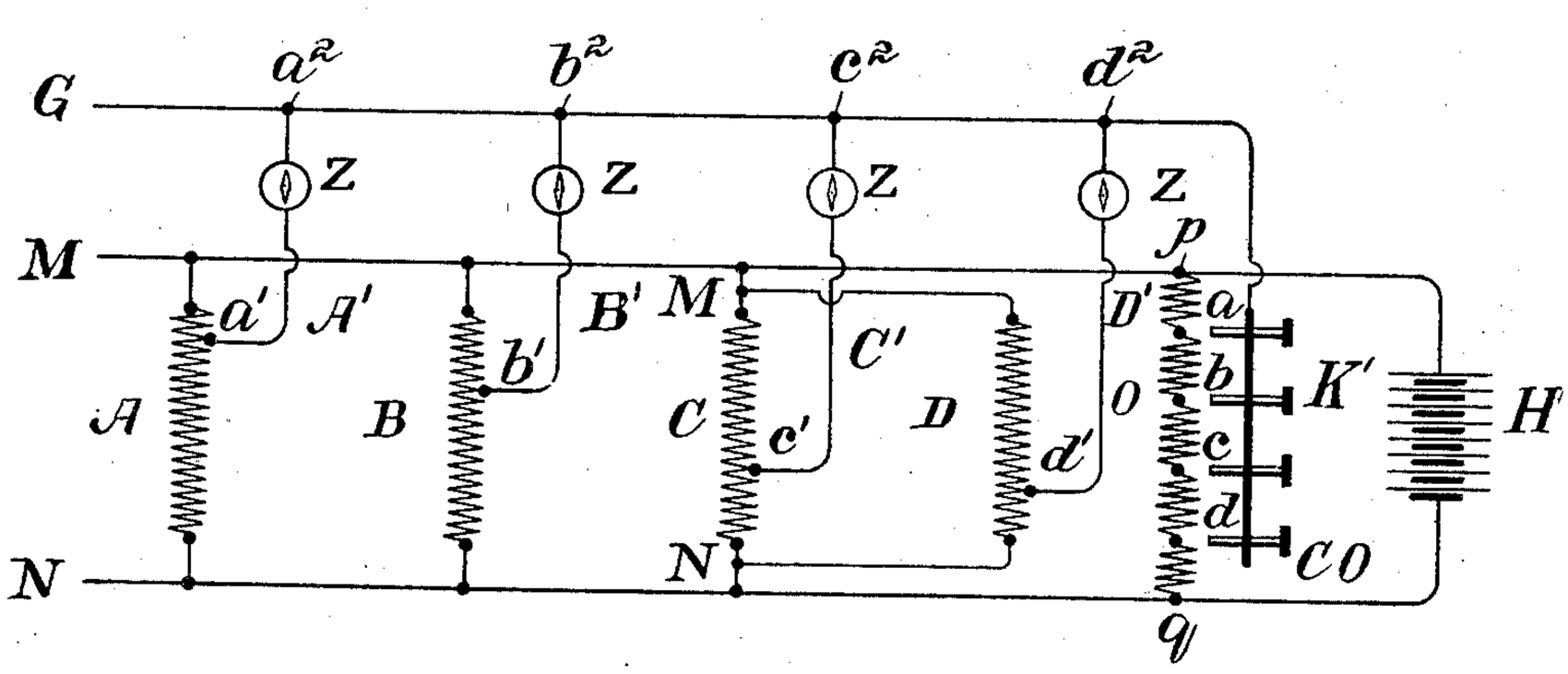


Fig. 2.



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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 5.

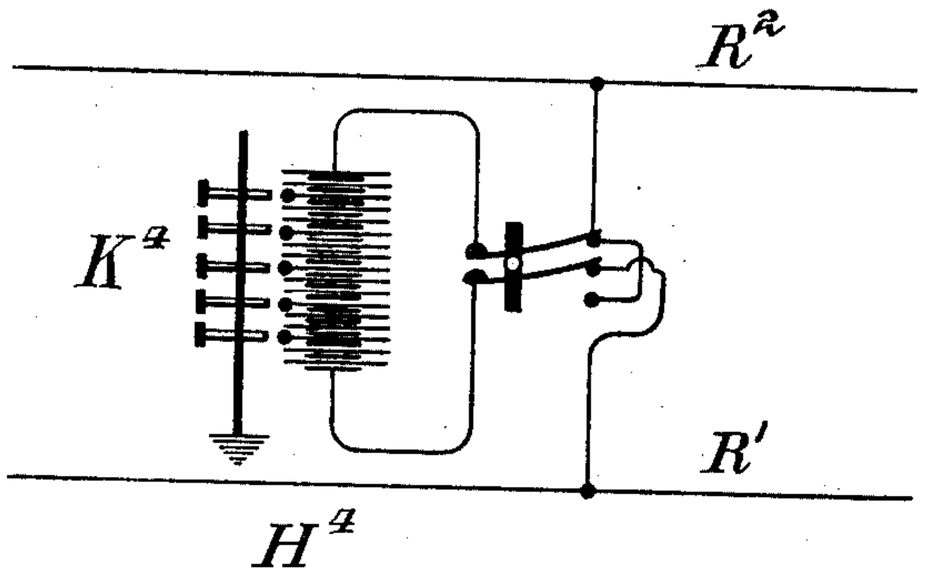
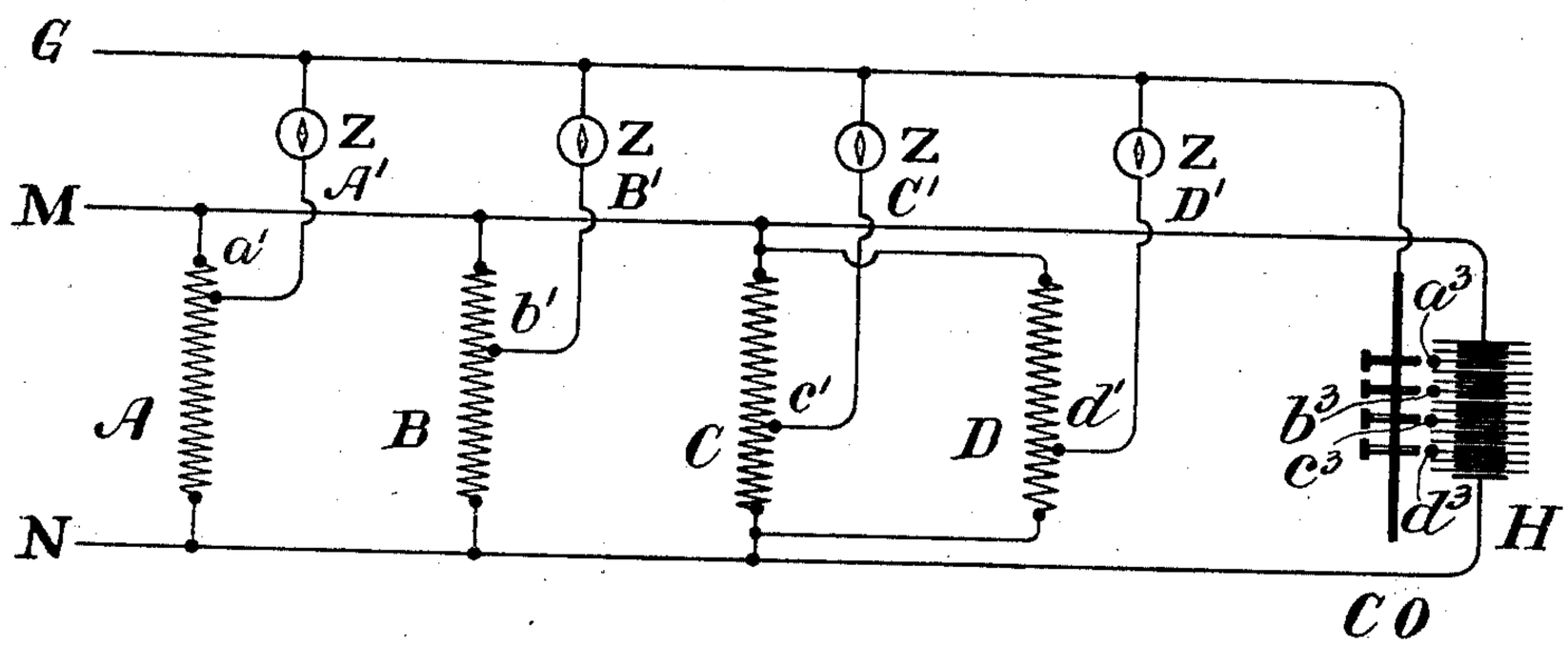


Fig. 3.



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SELECTIVE SYSTEM.

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NO MODEL. 3 SHEETS—SHEET 3.

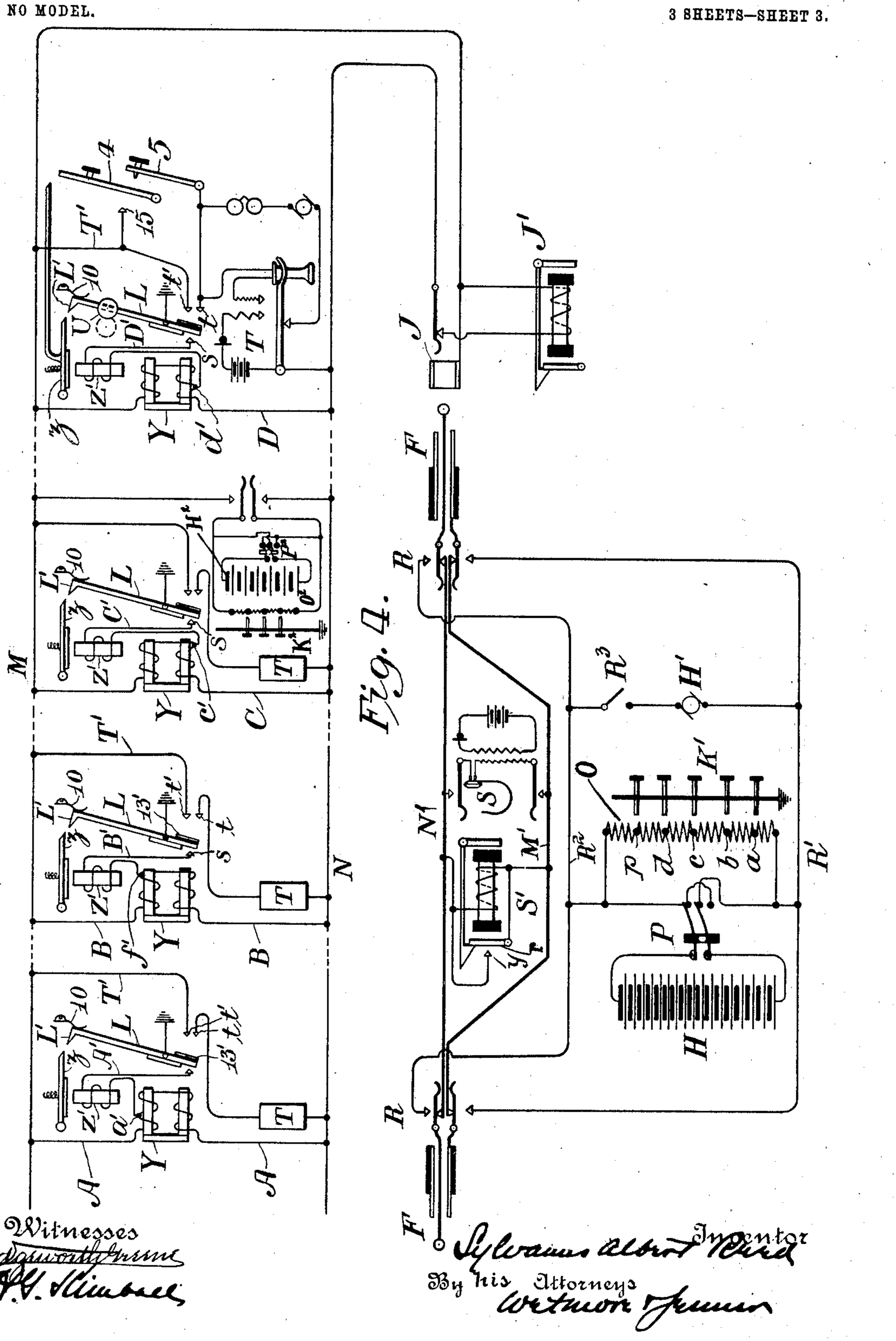

Fig. 4.

No. 737,870. 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. 737,870, dated September 1, 1903.

Application filed December 31, 1902. Serial No. 137,281. (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.

My invention concerns systems of electrical communication, and relates more particularly to improvements in a system described and claimed in Letters Patent No. 688,118, granted to me December 3, 1901. In that patent I disclosed a selective system based upon the principle of the Wheatstone bridge and consisting fundamentally of a circuit having derived branches in multiple, and I specified a practical application of the same, in which the divided circuit consisted of but two branches with selectively-actuated deflecting members or galvanometers in bridges between these branches combined with and controlling non-selectively-actuated signal-operating members or relays in series in one or both of the branches.

A telephone party-line constructed on the bridging or multiple system familiar in the art offers advantages over a series system which are well recognized, and my present invention relates to an improvement in the above-mentioned system whereby the elements which comprise the selective feature of the system are located in multiple relation with respect to the circuit, thus permitting the main line between stations to be as free as possible from objectionable inductance or impedance.

My invention also relates to other features hereinafter pointed out.

Referring to the accompanying three sheets of drawings, which form a part of this specification, Figure 1 is an illustrative diagram of the principle of my system as applied to a circuit having more than two derived branches. Fig. 2 is also an illustrative diagram of the same circuit, but in a form specialized as a "polystation-line," having three main conductors, of which one may conveniently be the ground. Fig. 3 is a modification in which one derived branch is discarded and one of the line conductors is adapted for direct connection with the source of current. Fig. 4 is a diagram of a complete working circuit as applied to an existing party telephone-line of the local-battery or magneto type. Fig. 5 is a modification of the central-station circuit.

Similar reference characters refer to similar parts throughout the various figures.

I will first point out briefly the principle of the present invention with reference to the diagram in Fig. 1 and then proceed to describe the application of the principle to a bridged party-line.

Referring to Fig. 1, A, B, C, D, and O represent derived or multiple branches of the divided circuit M N, carrying current generated by the battery or other source of current H. A′, B′, C′, and D′ are bridges leading from the fixed points *a′ b′ c′ d′* on the branches A B C D, respectively, to a common conductor G, and each bridge contains a galvanometer or other suitable current-indicating device Z. K represents a shiftable contact member flexibly connected with conductor G, whereby it may make contact with any desired point of derived branch O. In this figure relative resistances are represented by relative lengths of the lines of the diagram except the bridges A′, B′, C′, and D′. It is evident that if K is moved or shifted along the branch O a point—such, for example, as *a*—will be found at which current will pass through all the bridges except A′ owing to a difference of potential existing in each between its junction with its derived branch and its junction with the common conductor G and that all the galvanometers Z except that in bridge A′ will therefore show a deflection of their needles. Similarly a point, such as *b*, may be found contact with which will cause neutrality exclusively in the galvanometer in bridge B′ and also points, such as *c* and *d*, which will have a corresponding relation to the galvanometers in C′ and D′. It is thus possible by shifting the contact K to render any desired galvanometer neutral, while all the others are actuated and their indices deflected. Instead of only four derived branches A, B, C, and D there may be an indefinite number having bridges to the common conductor, and contact-points on O may be found bearing a corresponding relation to each of the bridges of the derived

branches respectively. Furthermore, points a', b', c', and d' may be originally so fixed that their corresponding points a, b, c, and d will be at convenient intervals on branch O and such that contact of K therewith at any one point will not cause neutrality in the galvanometer of more than one bridge. It is evident from this figure that the variable connection of contact K with the branch O is a means for equalizing the falls of potential throughout the circuit from one pole of the source of current H to the extremities a' a^2 of the selected bridge A' or to the extremities of any of the other bridges B', C', or D', as may be desired. This result of variable connection may be accomplished by other means than the actual shifting of the contact-point K along the derived branch O. For example, there may be a permanent connection between contact K and O and resistance may be removed from the branch O on one side of K or added to O on the other side of K, or both, or the contact K may take the shape of a conducting-strip lying adjacent to the branch O, and a suitable key or keys may be arranged to connect one to the other at any desired or predetermined point.

In the diagram of Fig. 1 the derived contact branch O is similar to the other derived branches, and any other branch may therefore be used in conjunction with the shiftable contact K as a means of selectively controlling the neutrality and activity of the bridges in the same manner. It is even possible to supply a shiftable contact similarly connected with G for each derived branch, thus combining the functions of the derived contact branch O and the functions of each one of the branches A, B, C, and D.

Passing now to Fig. 2 it will be noted that the same circuit is shown in the more practical form of a polystation-line having substations and a central station designated by C O. A metallic line-circuit M N and a conductor G are common to all stations, and any one of these conductors may be the ground. Connection between the branch O and the conductor G may be made, as before, by an actually-shiftable contact K; but I have shown in this figure a simple form of keyboard by which the conductor G may be connected to branch O at any desired point along its length, as a, b, c, or d, and this constitutes a more ready means for shifting the connection. In order that the greater part of the potential drop throughout the circuit may take place in the derived branches, I make said derived branches of high resistance as compared with the line, and the bridges A', B', C', and D', which contain the current-indicating devices Z, are connected to these branches at points of progressively-lower potential on the potential gradient from one pole of the battery to the other, so that the point of junction of any bridge is of different potential from that at any other junction-point. It will not necessarily be sufficient that the bridges shall be connected to the branches at points of merely different resistance distances from one or both poles of the battery, inasmuch as cases may arise where the various derived branches will have different total resistance, and although the potentials at any two given points may be different the respective resistance distances from said points to the battery may be exactly equal when measured from one pole and different when measured from the other. This consideration will serve to illustrate a fundamental distinction between my system and other systems which depend for selective control solely upon marginal differences of resistance. The derived branch O is located at the central or operating station and also has high resistance as compared to the line, preferably somewhat higher than that of substation derived branches. The contact-points a, b, c, and d are so located along branch O that connection between G and any one of them will cause the current-indicators of all the bridges to show a deflection of their indices except the one which corresponds to the point connected to G. This is precisely the same mode of operation as that explained in connection with Fig. 1.

In Fig. 3 I have shown an obvious modification of the circuit arrangement so far described. The circuit illustrated by this figure is similar in all respects to that of Fig. 2, excepting that the branch O is removed and the keys of the keyboard are adapted to connect the conductor G directly with different internal points of the battery—such as a^3, b^3, c^3, and d^3. It is obvious that the specific manner of securing equality of potential at the terminals of any device Z' is not material to the operation of my selective system, and that branch O and battery H in so far as they are parts of the same circuit having individual potential gradients are equally serviceable for securing non-deflection. The internal points may be so chosen that they will substantially correspond as to degree of potential with the fixed junction-points a', b', c', and d', respectively, and so that connection of G with one of them will cause a deflection in all the current-indicators except the one which corresponds to the point so connected to G. The selective differentiation between the deflecting members Z in respect to deflection or no deflection being under control of the operator at the central station, various methods may be adopted for making such condition selectively effective for the purpose in hand. I prefer to make this selective condition of non-deflection effective in the case of a telephone party-line in the manner shown in Fig. 4, which, it will be noted, embodies the same circuit arrangements and the same principle of selection as that already described in connection with the preceding figures. In this figure I have shown a polystation-line terminating in a line-jack J and line signal or drop J' at the

central office and a plug and cord apparatus for making connection in the usual manner. Four subscribers' stations are shown, each having a derived branch; but it is manifest that the line may be supplied with an indefinite number of stations, as pointed out in connection with Fig. 1, without in any way detracting from its capability of selective differentiation. It should be observed at this point that the features of selective control are not involved in the relative arrangement of the stations with respect to the line and that branches can be taken from the line conductors M and N and other branches from these branches, and so on indefinitely with selective stations on each branch in precisely the same manner as is possible with the familiar bridged line. At each station the derived branches A, B, C, and D include each a relay Y, which is of high resistance as compared with the line. When the sides of the line have about fifty ohms of resistance each, a convenient resistance for the relays is about one thousand ohms, which is sufficient to cause the greater part of the potential drop in the circuit to take place in the coils of the relays. At each station also is the selective current-indicating device, deflecting member, or selector Z′, which operates in connection with the relay Y and is included in bridge A′, B′, C′, or D′, as the case may be, leading from some point, such as a', b', c', or d', on the winding of its associated relay to the third conductor, which is here shown as the ground, or it may of course be connected between any two points which may be selectively caused to be at equal potential. When the relays have each the same resistance, the particular point on the winding of relay Y, chosen as the tap from which to lead off, the selector-bridge will lie at a particular resistance distance from the extremities of the winding, such resistance distance at any one station differing from that at any other station. For example, in practice the winding of one relay may be tapped at, say, a particular turn—for example, the end of the tenth layer of wire of the first spool of the relay, that at another station at the end of the fifteenth layer, that at another station at the end of the twentieth layer, and so on. When one of the plugs F is inserted in the line-jack J, operation of the key R, which may be the regular ringing-key, connects the line conductors M and N, respectively, to the leads R′ and R^2. The battery H, which supplies current for the selection, is adapted to be connected between these leads, so that current from the battery will pass through the resistance O and the substation derived branches in parallel. The connection of the battery-leads to the leads R′ R^2 is controlled by a pole-changing switch P, which may be of any convenient design capable of closing the circuit and then producing a sudden and practically instantaneous reversal of current therein. A suitable keyboard K′ is also provided for connecting any one of the contacts a, b, c, d, or p of said branch to ground. The contacts a, b, c, and d correspond with the fixed junction-points a', b', c' and d' at the substations, but contact p has no corresponding station, and is therefore useful to cause a deflection of all the substation-selectors without exception, as will be explained below. The manner in which these various parts are connected to the line and the keys which control such connections are details of construction which may be varied according to the fancy of the electrical engineer. It is only necessary for the purposes of selective control that the line branches A B, &c., and the resistance O when it is used be in multiple relation with respect to a current which is capable of sudden reversal.

In the diagram I have represented the pole-changing switch as comprising an insulating-yoke and handle thereto and two thin spring-leaves connected, respectively, with the terminal of the battery adapted to bear at their free ends against the crossed terminals of the limbs of the line. Movement of the yoke in one direction causes the springs to move, first, from a normally open-circuit position to engagement with the line-terminals in direct relation; second, to snap from the latter position into engagement with them in reversed relation, and, third, to pass from the latter to open-circuit position. Movement of the yoke in opposite direction causes the reverse of this action. The remainder of the central-station apparatus will be recognized from the drawings to be the usual form of cord-circuit, having an operator's telephone set S and disconnect-signal S′, bridged between the cord-strands M′ and N′, and such other parts as may be necessary, the only addition to the ordinary exchange-switchboard for the purpose of selective control being the keyboard and its resistance, the current source and its pole-changer, with suitable means for connecting them through the cord to the line, and in the form shown in Fig. 5 the keyboard-resistance is omitted. The magneto-generator H′ is adapted to be bridged as usual between the leads R′ and R^2, either by the automatic action of its armature counter-shaft when the latter is rotated in the well-known manner or by the manipulation of a separate switch or key R^3, as shown in the drawings. The pulsating current delivered by it to the ringers of the party-line should be of the same polarity as that which is supplied by the battery when the switch P is in its second position. It is of course to be understood that other magneto-generators may be adapted for bridging between the leads R′ R^2, if desired, to furnish the usual alternating current to operate the ringers of other lines not selective; but such generators are not illustrated in the drawings.

Referring again to the substations, it will be seen that each of the relays Y is provided with a polarized circuit-closing armature L,

which is centrally pivoted with relation to the poles of the relay and is provided with an extension terminating in a spur L′, which cooperates with the selector in blocking the movement of the armature to an extreme position in one direction, as will hereinafter appear in the description of the operation of the subscriber's apparatus. The armature L is permanently connected to ground, as shown in the drawings, and has a normal magnetic bias toward whichever pole of the relay happens to be nearest, so that it tends to remain in its latest position when the relay becomes deënergized. This bias may also be produced by any ordinary mechanical means. An insulated contact-plate 13′, carried by the armature, is adapted to close electrically the gap between the fixed terminals *t t′* of a signaling or telephone circuit T T′, bridged between the sides of the line when the armature is in one of its extreme positions, which position I denominate the "depressed" position, and the selector-bridge leading from a predetermined point of the relay-winding, as above explained, terminates in a normally open contact *s*, which is reached by the armature in its other or extreme "elevated" position, thus connecting one terminal of the selector Z′ to ground. The armature may be prevented from taking the extreme depressed position by the selector Z′, as hereinafter explained, and is normally prevented from taking the extreme elevated position by a light spring 10, located as shown in the drawings, which is strong enough only to counteract the force of the bias of the armature and prevent its reaching the contact unless moved thereto by the energization of the relay with current of the proper direction. The selector Z′, which is thus connected to the ground while the armature is in the extreme position referred to, corresponds with the galvanometers or indicators heretofore mentioned and may be located in the selector or bridge circuit—such, for example, as A′—at each station; but it may also be connected between any two points capable of being selectively caused to be at equal potential. It may consist simply of an electromagnet and an ordinary armature therefor mounted on a pivoted blocking-arm *z*, or a swinging coil of the D'Arsonval type may be used, as shown in my original patent, or any other form of electromotive device may be used which is actuated by difference of potential between two of its terminals. The arm *z*, which I prefer to call a "deflecting" member, extends to a position adjacent the spur L′ of armature L, but normally not in the path of its movement. It is shown in the drawings as yieldingly held in such normal position by a spring; but gravity may obviously be utilized for effecting the same result. When the terminals of the selector are at equal potential, the deflecting member *z* remains motionless in its normal position, so that when armature L descends or moves in a direction to close the circuit T T′ the spur L′ will pass by said deflecting member *z* and permit the armature to descend to its extreme depressed position and bridge contacts *t t′*. If the deflecting member is attracted from its normal position into the path of movement of spur L′ or arm L when the latter descends, it will block said arm from continuing to an extreme depressed position and from bridging contacts *t t′*. The bias of armature L causes it to remain in its latest position and holds the deflecting member locked in blocking position by means of spur L′ after the relay has become deënergized.

The purpose of the selective act at the central station is to place the signaling, talking, or other controlled apparatus T at the selected substation into effective relation with the line, while those of all other stations are in non-effective relation with the line, and this is secured by so proportioning the distribution of the current throughout the various derived branches during the application of current of the elevating direction that the terminals of the selector Z′ at the selected station will be points of equal potential, the deflecting member at that station being therefore in its normal or non-blocking position, and then by suddenly reversing the current to depress the armatures L so that they will descend before *z* has returned to neutral position and close the circuit T T′ at the selected station only, as just explained. This condition will persist on account of the bias of the armature L even when current ceases until by a reverse current the selective condition is terminated and the line is restored to its open or normal condition.

There are various ways in which the signaling or talking apparatus may be connected with the line; but I prefer the arrangement shown in the drawings for a magneto-call-telephone party-line. In this case closure of the circuit T T′ at contacts *t t′* bridges a telephone apparatus into the line. This telephone apparatus is exhibited in detail only at station D. It is of the usual local-battery character; but the magneto-generator it contains is preferably of the pulsating direct-currect type with polarity such that its effect will be to maintain the armatures L in the elevated position and at the same time to actuate the line signal or drop J′. The key 5, Fig. 4, station D, performs manually the same function that arm L performs selectively—that is, it closes the circuit T T′, and thereby connects the calling apparatus with the line. This key 5, however, is adapted to be blocked by the bolt or lock 4, which in turn is adapted to be blocked by encountering the deflecting member *z* when the latter is in its deflected position. The actuation of a selector, therefore, blocks both the automatic and the manual circuit-closing acts, so that if there is a deflection of the deflecting member it is impossible for the subscriber at that station to ring up the central

office or to use his telephone apparatus. For convenience of circuit illustration I have shown the bolt 4 at one side of the arm L and adapted to engage an extension of the member *z*; but it is of course to be understood that no such extension is necessary and that the bolt 4 and arm L may and preferably do both engage directly with the end of the deflecting member.

In operating the system as thus constructed we will suppose that subscriber at substation D wishes to communicate with the central station. We will also suppose that the line is not in use, so that the various selectors Z′ are deënergized and their deflecting members are in their normal or non-blocking positions, as shown in the drawings. The subscriber depresses key 5, which strikes the key 4 and moves it into engagement with contact 15, thus connecting the telephone set with the line. He then turns his generator-crank and delivers a pulsating direct current to line, which operates the line-signal J′ in the usual manner. The line-signal is preferably of low resistance as compared with the station-relays Y, so that very little current will pass through the latter; but such current as does pass through them is of a polarity that tends to continue the arms L in their elevated or normal position. Immediately after ringing the subscriber releases key 5, but continues the depression of the key 4, which holds the deflecting member *z* in its undeflected position and prevents its blocking the arm L during the subsequent operations of the central operator. The depression of key 4 may be effected automatically by the action of the switch-hook when the receiver is taken therefrom, so that all the subscriber is required to do in order to call central is to press 5 and ring, the subsequent removal of his receiver serving to hold the deflecting member *z* in an undeflected position until the central operator answers his call. In the present drawings, however, I have shown the key 4 as separately operated for the purpose of illustrating as simply as possible the operation of my improved system. In order to answer a call from a substation, such as we have assumed to have been sent in from station D, the central operator first makes the usual connections by plugging F into J and operating the key R to connect the leads R′ and R^2 through the cord to the line conductors. She then depresses the key *p* of the keyboard and the pole-changer P. The current supplied by the battery during the first position of the pole-changer is of the direction which moves all the arms L to their extreme elevated position, compressing springs 10, and therefore connecting contacts *s* to the ground through the armatures and their permanent ground connections. The contact which is closed by the key *p* does not correspond to the neutrality of any station-selector; but while key *p* is depressed the current is so proportioned in the various derived branches and the ground that it causes a deflection of all the selectors except that at D, which is mechanically locked in its normal or non-blocking position by the key or lock 4. The further depression of the pole-changer while this condition lasts produces a sudden reversal in the current and change of polarity in the relays Y, whereupon all the arms L descend. The contacts at *s* are broken and the deflecting members *z* start to return to their normal position. They are, however, caught and clamped in the deflected positions by the spurs L′. Still further depression of the pole-changer finally breaks the circuit, and the arms L, on account of their bias, remain in their depressed position blocked, except at station D, by the members *z* of their respective selectors. Only at D does contact-plate 13′ reach the fixed contacts *t t′*, and therefore only at D is the telephone apparatus put in circuit with the line. The key R may then be released to connect the line conductors with cord-strands M′ and N′, so that the operator may ascertain the want of the subscriber and connect him with the desired line. Should any other subscriber on the line attempt to signal the central office, he could not connect his telephone to line by depressing key 5, because key 5 would be blocked by the lock 4, the latter being unable to descend to its extreme position by being blocked by the interposition of the deflected member *z* of his selector Z′. Should any other subscriber on the line attempt to listen, he would find his talking-circuit open at contacts *t t′*, inasmuch as his arm L has not descended to its extreme position, being blocked by the member *z* of his selector Z′. When the conversation is finished, the operator first restores all the arms L to their original position, thereby releasing the deflecting members *z*. This she does through the agency of key R and pole-changer P by sending a reverse current through the line to elevate and unlock the arms L, after which she may withdraw the plug F. If the operator wishes to call up a subscriber, such as B, on the party-line, she proceeds as before in answering a party-call; but she depresses the keyboard-key *b* instead of *p*. This causes a deflection of all the members *z* except that at station B, and the subsequent descent of the arms L connects the telephone to line only at station B and locks out all the others. The operator is then in exclusive communication with B's telephone and may signal him by means of the pulsating current from her generator H. Should any subscriber, such as D, wish to communicate with another subscriber, such as C, on the same line, then after calling the central operator and giving the number desired, as before described, he hangs up his receiver and holds down bolt 4 until his bell again rings, whereupon he may take down his receiver and await the answer of the subscriber desired. To answer this call, the operator upon receiving the desired number from D first puts a reverse current on

the line, restoring all the arms L. Then she depresses keyboard-key *c*, which causes deflection of all arms *z* except that at C and D, the former because of the selection and the latter because of the locking action of bolt 4, held down by subscriber at D. When by reversal of current the arms L descend, both C and D have their contacts *t t'* reached by arms L, and the telephone-sets of both these subscribers are therefore connected with the line. When the operator generates a ringing-current, both bells respond. If D has already taken down his receiver, the bell at C only will respond when the operator rings. The various circuit-closing acts required to be performed by the central operator may be simplified by obvious mechanical means, if desired, so that selection may be effected by the operation of a single key. If a subscriber leaves his receiver off the hook, neither the restoration of the line nor the selective calling of another subscriber by the central operator is interfered with.

The disconnect-signal S', bridged across the cord-circuit, may be provided with short-circuiting switch *y*, closed by the fall of shutter *r*, so that when a disconnect-signal comes in as an alternating current, which will be the case when the selective party-line is connected by the cord with a line using an alternating generator, the immediate fall of the drop will short-circuit the alternating current and prevent it passing into the selective line, where it would tend to operate the relays Y and the ringers.

It may be desirable to provide the substation apparatus with a busy signal in order to apprise the subscriber at a glance whether the line is in use or not. Such a signal may take the form of a target attached to or connected with the relay-arm L or with the deflecting member *z*, or it may be of the electromagnetic variety connected with the line; but I prefer to provide a disk or target upon the arm L, as shown at U in the drawings, which registers with a suitable window or aperture in the inclosing telephone-box when the arm is depressed and the line is busy.

In adjusting the selective instruments at the substations to correspondence, respectively, with the keyboard-stops it is necessary to provide that the taps for the bridges A', B', C', and D' shall be differentiated each from all others as to their positions on the potential-gradient between the two limbs M N of the line. This may be done either by having all the taps at the same point in the relay-winding as supplied by the manufacturer and then by adjusting the virtual position of each tap on its bridge by means of artificial resistances placed in said bridge in series with relay Y on one side or the other thereof; but I prefer the plan wherein the position of said taps may be adjusted by having the instruments as supplied by the manufacturer uniform except as to the positions on the relay-winding at which the taps are taken off, in which particular alone they will differ among each other. For this purpose I prefer to use a set of graded electromagnet-spools, which in case the double-spool relays Y are one thousand ohms each will have five hundred ohms resistance.

Assuming that the central selective keyboard has six selective keys or stops, (numbered, say, from 1 to 6,) thus accommodating party-lines up to six stations, I provide three grades of relays with two relays to each grade, so that by reversing the connections of the relays of the same grade to line I obtain a set of six relays each differently tapped. For example, the upper spools of relays Nos. 1, 2, and 3 may be tapped at the tenth, seventh, and fourth layers, respectively, of their windings, and the lower spools of Nos. 4, 5, and 6 may be tapped, respectively, at exactly the same points. Each relay may be designated by a suitable mark indicating its grade.

The correspondence between the tapped spool at A, for example, and the *a* stop on the keyboard may not be absolute under all circumstances of line and station arrangement. The extension of side branches from the line and each addition of a station may also slightly distort the adjustment of the previous stations, and in order to meet these conditions I prefer to provide each relay with three tappings instead of only one, and thus provide means whereby the preferred tapping may be ascertained when the instrument is installed. Thus an A relay will have the winding tapped not only at, say, the sixth layer, but also at the seventh and fifth. A C relay will have its winding tapped at the third and also at the fourth and second layers. In installing the instrument the particular tapping is chosen which will leave the selector-arm *z* motionless when the corresponding keyboard-stop is depressed at the central exchange.

As heretofore intimated it is possible and within the scope of the present invention to provide an operating-battery or other source of current and a keyboard for each substation for the purpose of rendering the system intercommunicating. The arrangement of the substation apparatus for selective control is indicated in detail at station C, where the battery H^2 is adapted to be connected to line the same as that at the central station by the operation of a suitable key and is provided with a similar pole-changing switch P^2. The keyboard K^2 is also adapted to permit connection of one of a series of contacts in the resistance O^2 to ground, and the contacts are predetermined with respect to the line to cause neutrality at the selectors of the corresponding station. This selective apparatus being normally disconnected from the line does not interfere with the selective operation of the selectors from central or another substation.

The modification illustrated by Fig. 3 may

be applied to the system, as shown by Fig. 5, wherein the keys of keyboard K′ make contact directly with points in the battery instead of with a resistance branch O, as before. As already explained this change in the operating means does not alter the principle of selective control, and the substation, if desired, may be supplied with the same modified form, such modification simply requiring the removal of resistance O and the arrangement of the keyboard-keys to connect with predetermined points of the battery instead.

Having thus described my invention, what I claim is—

1. In a selective system, a source of current and circuit therefor provided with a plurality of derived branches, relays therein and selective devices included in the circuit adapted when actuated, to block the action of said relays, a variable connection between the source and the circuit for selectively causing equality of potential to exist at the terminals of any selective device.

2. In a selective system, two main conductors having a plurality of connections in multiple from one to the other, a third conductor and bridges from respectively different points on said plurality of connections to the third conductor, a source of current, selectors included in the circuit between points which may be caused to be at equal potentials and a variable connection between said source and the circuit for selectively causing an equality of potential at the terminals of any desired selector.

3. In a selective system, two main conductors having a plurality of connections in multiple from one to the other, a third conductor and normally open bridges from respectively different points on said plurality of connections to the third conductor, means for closing said bridges, a source of current, selectors included in the circuit between points which may be caused to be at equal potentials and a variable connection between said source and the circuit for selectively causing an equality of potential at the terminals of any desired selector.

4. In a selective system, two conductors having a plurality of connections in multiple from one to the other, a third conductor, normally open bridges from respectively different points of said plurality of connections to the third conductor, relays connected in the circuit for closing said bridges, a source of current, selective devices included in the circuit between points which may be caused to be at equal potentials, means for operating said relays, a variable connection between said source of current and the circuit for selectively causing an equality of potential at the terminals of any selective device.

5. In a selective system, a source of current and circuit therefor, a plurality of selective devices included in the circuit between points which may be caused to be at equal potentials, a variable connection between the source and the circuit for selectively causing equality of potential to exist at any two of said points, electromagnets for said selective devices in multiple relation to the circuit, armatures for the electromagnets operable upon the non-actuation of their respective selective devices.

6. In a selective system, a source of current and circuit therefor, a plurality of selective devices included in the circuit between points which may be caused to be at equal potentials, a variable connection between the source and the circuit for selectively causing equality of potential to exist at any two of said points, a plurality of signaling-circuits, a plurality of polarized relays therefor in multiple relation with the circuit and armatures for the relays operable to close their respective signaling-circuit only during the non-actuation of their respective selective devices, and means for controlling the polarity of said relays from an operating-station.

7. In a selective system, a source of current and circuit therefor having derived branches, selective bridges leading from said derived branches at respectively different points of the potential-gradient to another part of said circuit, current-actuated devices in said bridges and means for shifting the connection of the bridges with the said part of the circuit to control the potential in said bridges.

8. In a selective system, a source of current and circuit therefor with derived branches, selective bridges from one of said branches to others of said branches, current-actuated devices in the bridges and means for selectively equalizing the current-potentials at the terminals of any current-actuated device.

9. In a selective system, a source of current and circuit therefor provided with derived branches, relays in said branches, bridges from one of said branches to others of said branches, a device in each bridge controlling the operation of a relay, and means for selectively equalizing the current-potentials at the terminals of any controlling device.

10. In a selective system, a source of current and circuit therefor, provided with derived branches, relays in said branches, bridges connecting one of said branches to others of said branches at respectively different points of the potential-gradient, relay-controlling devices in the bridges and means for selectively equalizing the current-potentials at the terminals of any controlling device.

11. In a selective system, a source of current and circuit therefor provided with derived branches, electromagnets in said branches, a common conductor, bridges from said common conductor to the derived branches at respectively different points of the potential-gradient, selective devices in the bridges and a variable connection between the common conductor and a part of the circuit.

12. In a selective system, a source of current and circuit therefor provided with derived

branches, electromagnets in said branches, a common conductor, bridges from said common conductor to the windings of said electromagnets, at respectively different points of the potential-gradient, selectors in the bridges and a variable connection between the common conductor and the circuit, whereby the falls of potential throughout the circuit to the terminals of any desired selector may be made substantially equal.

13. In a selective system, a source of current and circuit therefor provided with derived branches, electromagnets in said branches, a common conductor, bridges adapted to be closed from said common conductor to respectively different turns of the windings of said electromagnets, selective devices in the bridges and a variable connection between the said common conductor and the circuit, whereby current may be caused to pass through all of said selectives devices except the one selected.

14. In a selective system, a source of current and circuit therefor provided with derived branches, a common conductor, bridges between said common conductor and the derived branches at respectively different points of the potential-gradient, current-actuated devices in said bridges provided with deflecting members, in combination with current-controlling means for selectively maintaining the non-deflection of any desired deflecting member when current is applied to said circuit and common conductor.

15. A selective system comprising a plurality of selective stations and an operating-station, a source of energy and a circuit therefor having a derived branch at each station, bridge-circuits between the derived branches at the selective stations and the derived branch at the operating-station, deflecting devices in said bridge-circuits, in combination with means for connecting said bridge-circuits with the derived branch at the operating-station at any desired point along its potential-gradient.

16. A selective system comprising a plurality of selective stations and an operating-station, a source of current and a circuit therefor having a derived branch at each station, a common conductor, electromagnets included in the derived branches at the selective stations, a current-actuated device bridged from each branch containing an electromagnet to the common conductor and adapted to control the operation of its associated electromagnet, a variable connection between the derived branch and the said common conductor at an operating-station, whereby the falls of potential from the source of current throughout the circuit to the terminals of any controlling device may be made substantially equal.

17. A selective system comprising a plurality of selective stations and an operating-station, a source of current and circuit therefor having a derived branch at a selective station, a current-actuated device in a normally open bridge connection, said connection leading from a distinctive point on the potential-gradient of the circuit to another part of said circuit, a signaling apparatus normally disconnected from said circuit, in combination with a relay controlled from an operating-station for closing at will either of the normally open connections.

18. A selective system comprising a plurality of substations and a line-circuit, a derived branch of said circuit and a signaling apparatus at each substation, a common conductor, electromagnets in said derived branches for rendering operative the signaling apparatus, in combination with controlling devices bridged between said derived branches and the common conductor and means for supplying current to the derived branches and common conductor in such proportions as to balance the current-potentials at the terminals of any selected controlling device.

19. In a selective system, a plurality of substations and a line-circuit, a derived branch of said circuit at each such station, a relay in each derived branch, a common conductor, signaling apparatus rendered operative by the said relay when the latter is energized by current of one character, a controlling device associated with each relay adapted when energized, to prevent the operation of the signaling apparatus, said controlling devices being adapted to be bridged between their respective derived branches and the common conductor by the action of the relays when the latter are energized by current of a different character, in combination with means for supplying current to the derived branches and to the common conductor in such proportions as to balance the current-potentials at the terminals of any selected controlling device.

20. In a selective system, a plurality of stations and a line-circuit, a derived branch of said circuit at each station, a relay in each derived branch and a polarized circuit-controlling armature therefor, a common conductor, a normally inoperative circuit including signaling apparatus at each station rendered operative by the movement of the armature in one direction, a controlling device associated with each relay and derived branch, adapted when energized to prevent the operation of the signaling apparatus, said circuit-controlling devices being adapted to be bridged between appropriate points on their respective derived branches and a common conductor by the movement of the armature in an opposite direction, and means for supplying current to the line-circuit and to the common conductor in such proportions as to balance the current-potentials at the terminals of any selected controlling device.

21. In a selective system, a plurality of substations and a line-circuit, a derived branch of said circuit at each substation, and a common conductor, a relay in each derived branch

and signaling apparatus in a normally open shunt thereto, said relay operating when energized by current of one direction to close the shunt in combination with a controlling device associated with each relay adapted when energized to prevent the closure of the shunt, and also adapted to be connected in bridge relation between a predetermined point on its respective derived branch and the common conductor by the action of the relay when energized by current of a different direction, a source of current and means at an operating-station for supplying current to the line in either direction, whereby the selective devices may be connected to the common conductor and become selectively deflected and the relays operated to close the shunts before such deflection ceases.

22. A selective system comprising a plurality of selective stations and an operating-station, a source of current and a circuit having derived branches at the selective stations, signaling apparatus at the selective stations in normally open circuits, movable arms for closing said normally open circuits, current-actuated devices adapted to block the movement of said arms, bridge-circuits leading from respectively different points of the potential-gradient to an operating-station and including said actuated devices, in combination with a variable connection at the operating-station for controlling the potential in said bridge-circuits.

23. In a selective system, a plurality of stations, a source of current and a circuit therefor having a derived branch at each station, a common conductor and a plurality of normally open electrical connections between the derived branches and the common conductor, means for closing said connections whereby the line may be put in condition for a selective act, in combination with means at any station for causing an equality of current-potential at the extremities of any of said connections.

24. In a selective system, a plurality of subscribers' stations, a source of current and a line-circuit of three conductors therefor having a derived branch at each station, signaling apparatus in a normally open bridge to two of said conductors of said line-circuit, a relay by which said bridge may be closed by a distant operator, and a circuit-closing mechanism whereby the subscriber may close said bridge, in combination with a selective controlling device adapted when energized to prevent the closure of the bridge by either means, said controlling device being in bridge relation between a derived branch and the other conductor and means for supplying current to the line and said other conductor in such proportions as to balance the current-potentials at the terminals of any controlling device.

25. A selective system comprising a plurality of substations, a source of current and circuit therefor having a derived branch at each substation, a common conductor, relays in the derived branches, normally open connections between the common conductor and the external circuit at respectively different points of the potential-gradient, selectors in said connections and means at an operating-station to actuate the relays to close said normally open connections, in combination with a variable connection between said common conductor and the source of current.

26. A polystation telephone system comprising a source of current and circuit therefor having derived branches, a telephone apparatus in normally open bridge relation to said circuit, a common conductor, normally open connections between said common conductor and respectively different points of the potential-gradient, polarized relays in the derived branches controlling said normally open circuits, in combination with a pole-changer and a variable connection between the common conductor and the source of current.

27. A polystation telephone system comprising a line-circuit having derived branches and a telephone apparatus in normally open bridge relation to the line at each substation, a relay in the derived branch for closing said bridge, a common conductor, and a selector bridged between said common conductor and a distinctive point on the potential-gradient, in combination with a source of current and a connection therefrom to the line including the usual ringing-key leads, a pole-changer controlling said connection, and a variable connection between said common conductor and the source of current.

28. A polystation telephone-circuit comprising derived branches at the subscribers' stations, a common conductor, a high-resistance relay in each branch, and a selectively-actuated deflecting device connected to the winding of each relay at a predetermined resistance distance from a side of the line, an armature for said relay adapted when the relay is properly energized to complete a circuit through said deflecting device to the common conductor, a central-office apparatus comprising leads for connection with said line, a source of current between said leads and circuit-closing apparatus whereby current may be supplied to the line to cause the armatures to complete the circuits of the deflecting devices and whereby current may be simultaneously supplied to the common conductor in such proportion as will cause the actuation of the deflecting devices at all or all but one of said stations.

29. A polystation telephone-circuit comprising a derived branch at each station, a high-resistance relay in each such branch provided with a centrally-pivoted armature, said armature having a normal bias toward the nearest pole of the relay, a spring opposing the movement of the armature to an extreme position in one direction and a selectively-actuated deflective member for mechanically

blocking the movement of the armature to an extreme position in the other direction, fixed contacts engaged by said armature in its extreme positions and means at the central station for causing said armature to close one contact in opposition to the spring to put the line in condition for a selective call and means for selectively controlling said deflecting members so that the reverse movement of the armature to an extreme position will not be blocked at the selected station.

30. A polystation telephone-circuit comprising polarized relays at the substations, selectors connected from each station at respectively different points of the potential-gradient to the central station and means for controlling the potential at the terminals of said selectors, in combination with a cord-circuit at the central station and a disconnect-signal therein provided with an automatically-closed short circuit.

31. A polystation telephone-circuit comprising relays and telephone apparatus at the substations and a common conductor, selector-bridges from respectively different points of the potential-gradient to said common conductor, and means for controlling the current therein, in combination with a plug and leads connected thereby to the telephone-circuit and a pulsating-current generator adapted for connection with said leads.

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

SYLVANUS ALBERT REED.

Witnesses:

G. A. TAYLOR,

H. G. KIMBALL.