No. 688,118. Patented Dec. 3, 1901.

S. A. REED.

SELECTIVE SYSTEM.

(Application filed Feb. 27, 1901.)

(No Model.) 3 Sheets—Sheet 1.

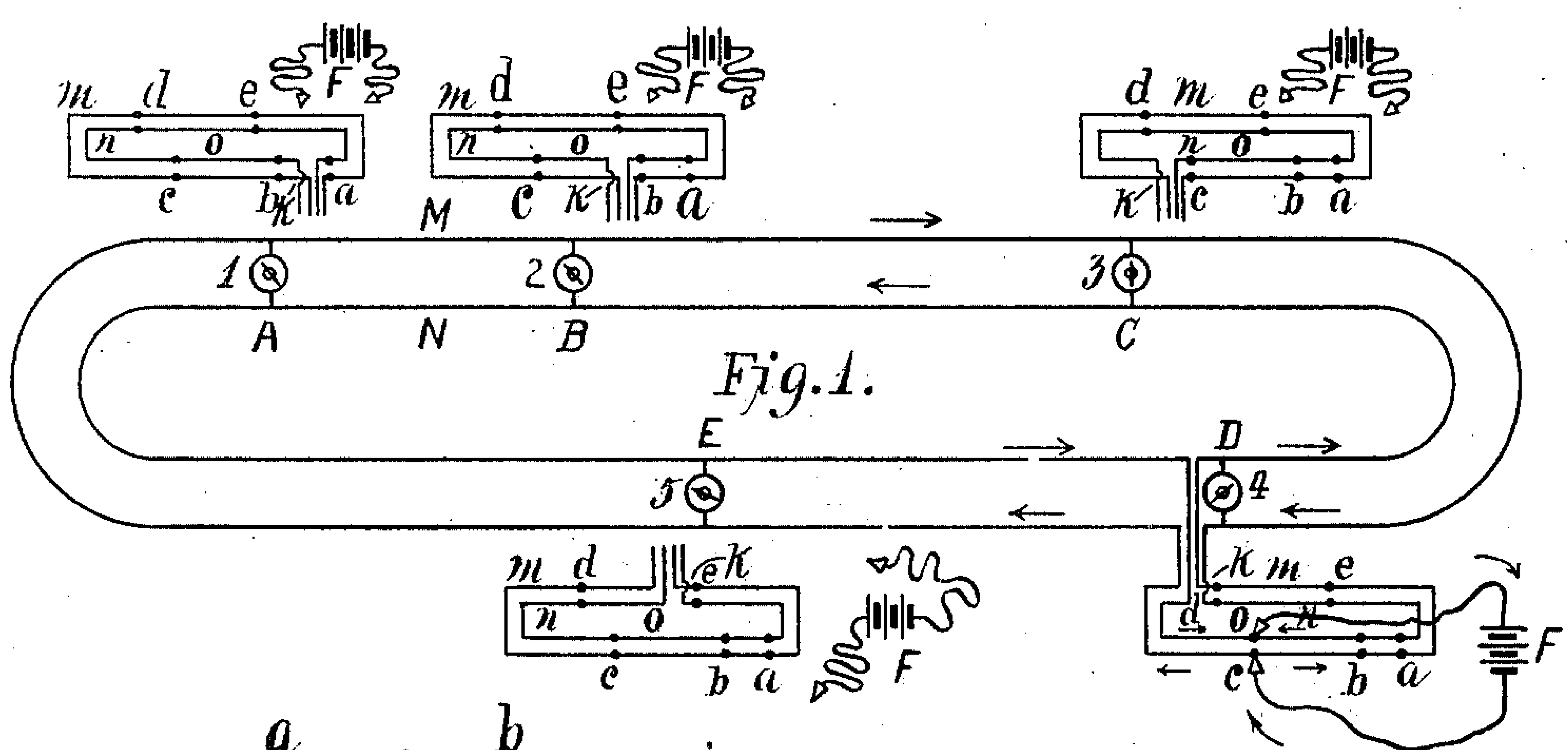

Fig. 1.

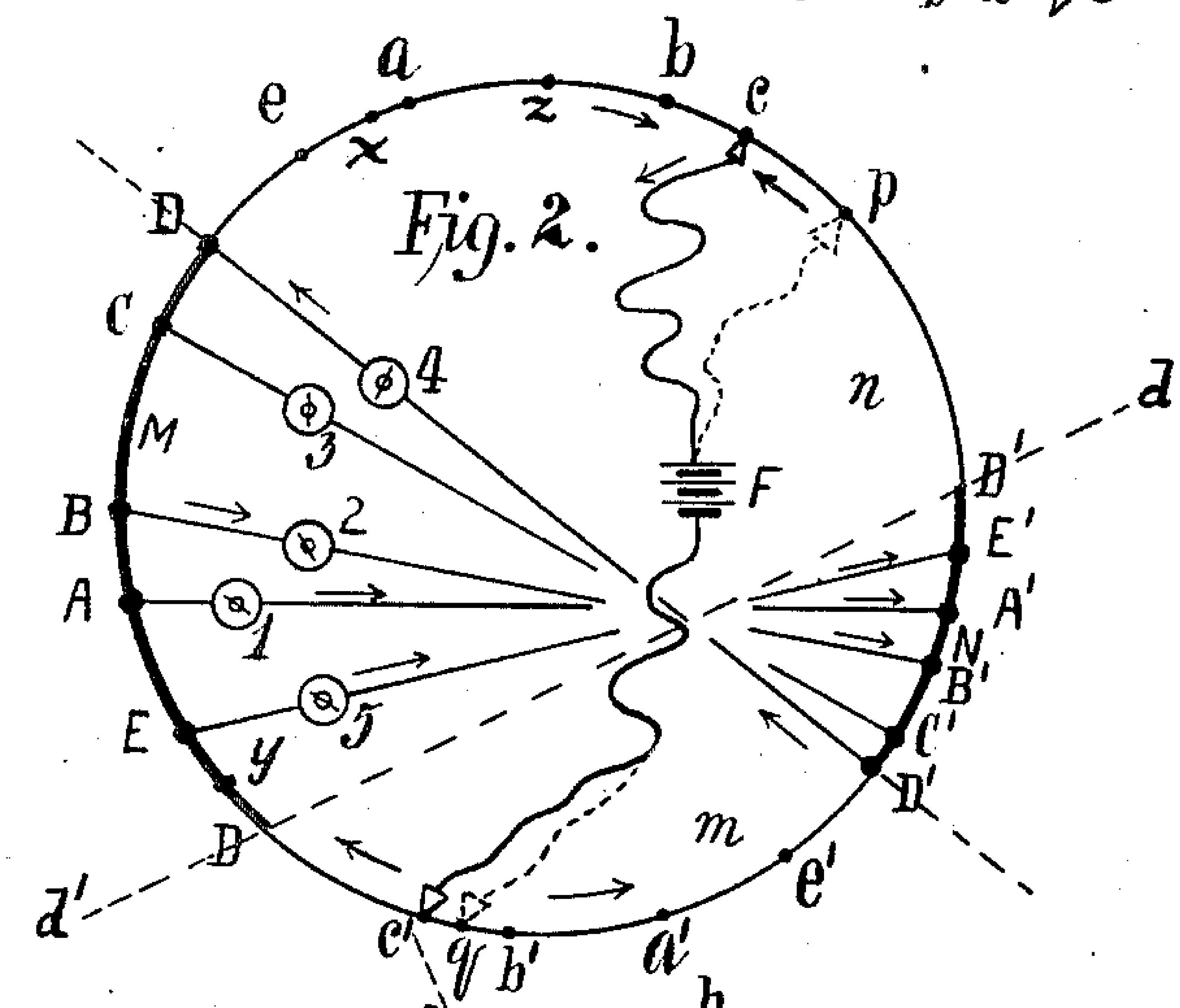

Fig. 2.

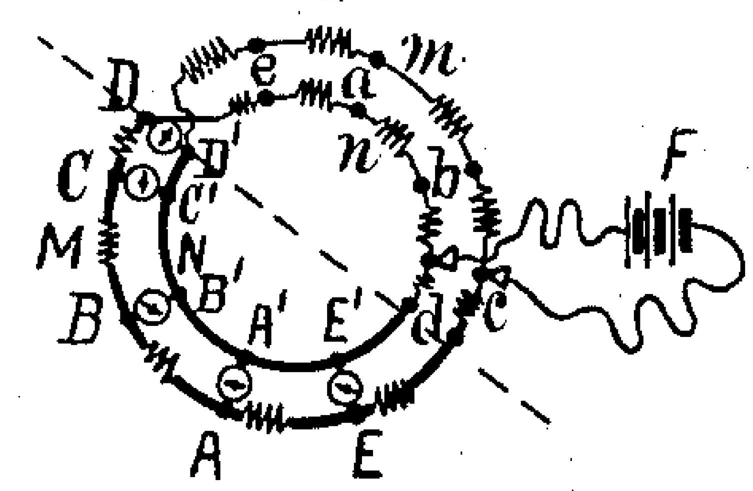

Fig. 2 a.

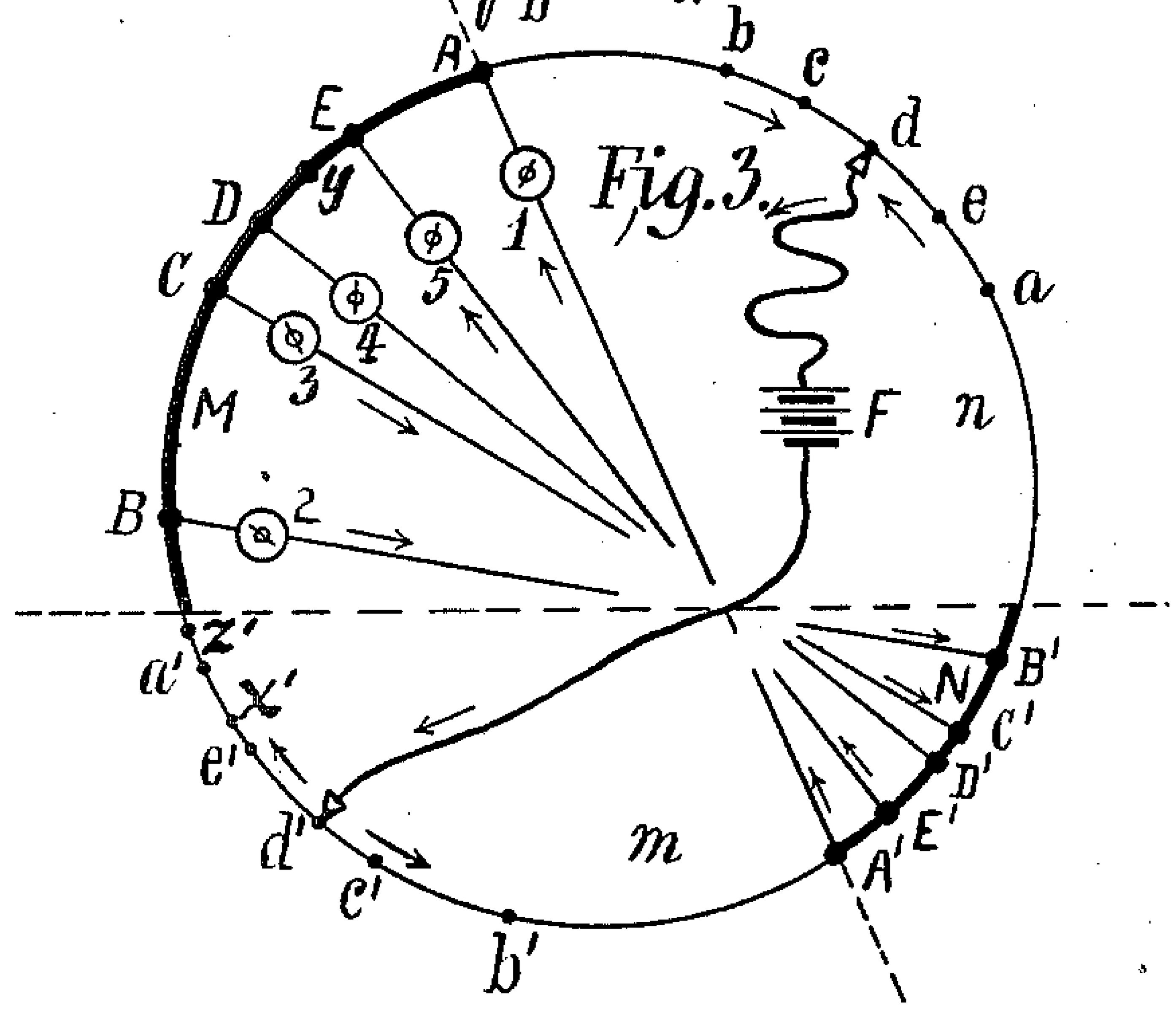

Fig. 3.

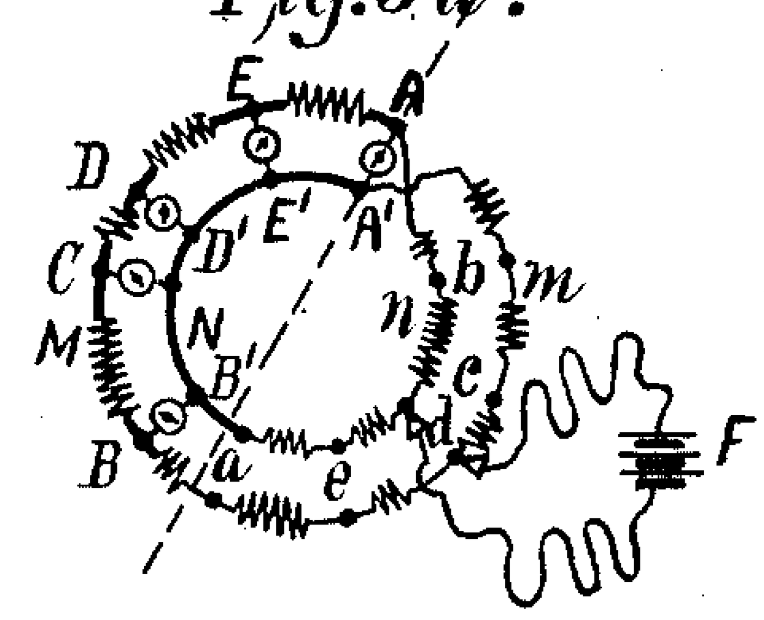

Fig. 3 a.

Witnesses
Edgeworth Greene
Theodore T. Dorman

Inventor
Sylvanus Albert Reed
By His Attorneys
Wetmore & Jenner

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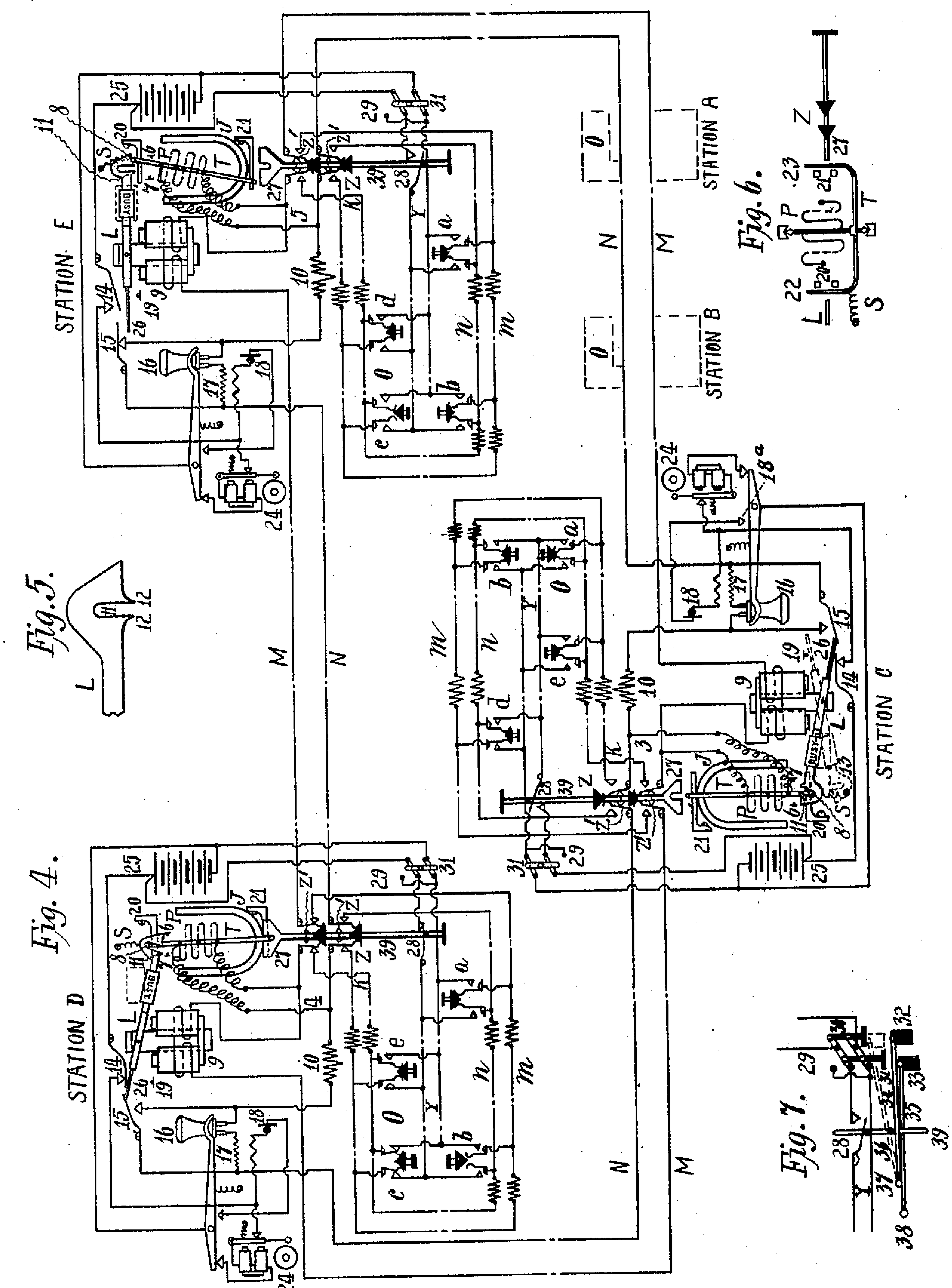
(No Model.) 3 Sheets—Sheet 2.



Witnesses
Edgeworth Greene
Theodore T. Dorman

Inventor
Sylvanus Albert Reed
By His Attorneys
Wetmore & Jenner

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(No Model.) 3 Sheets—Sheet 3.

Fig. 8.

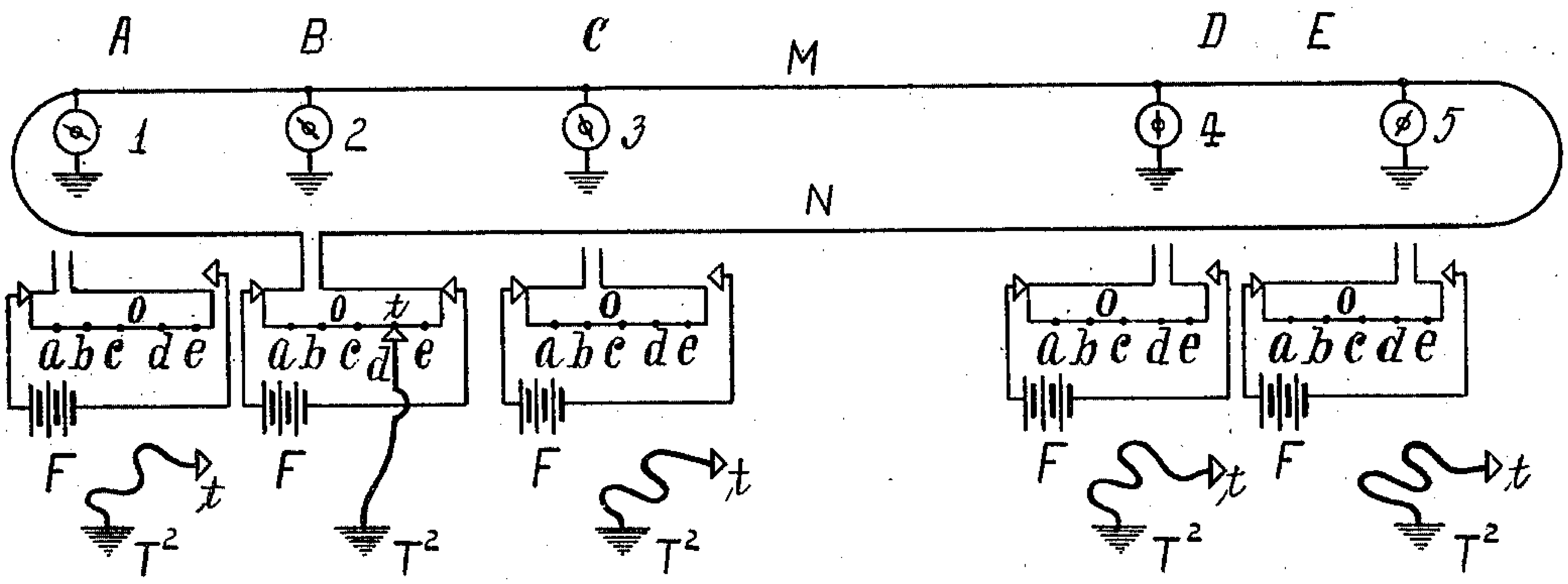


Fig. 9.

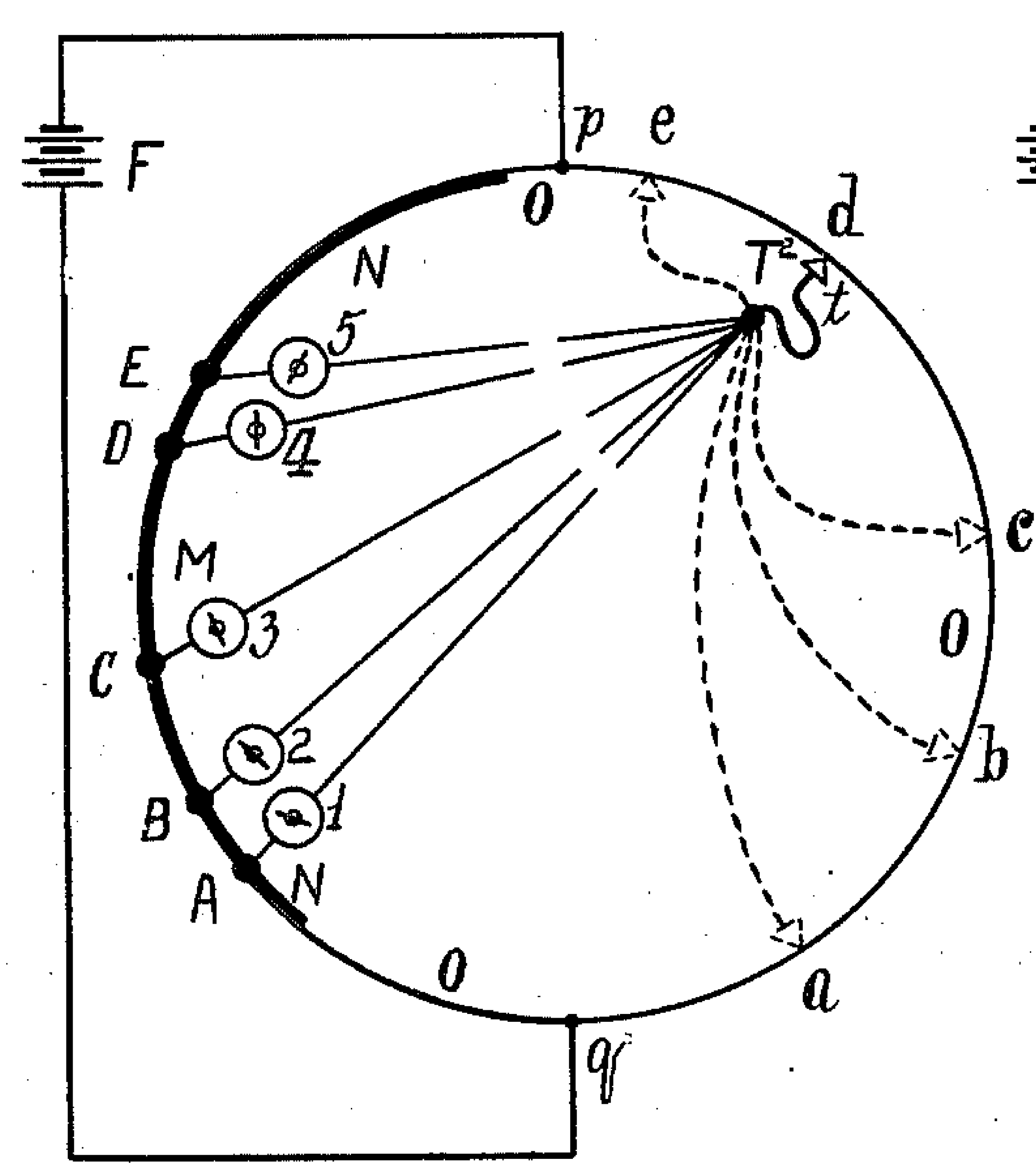
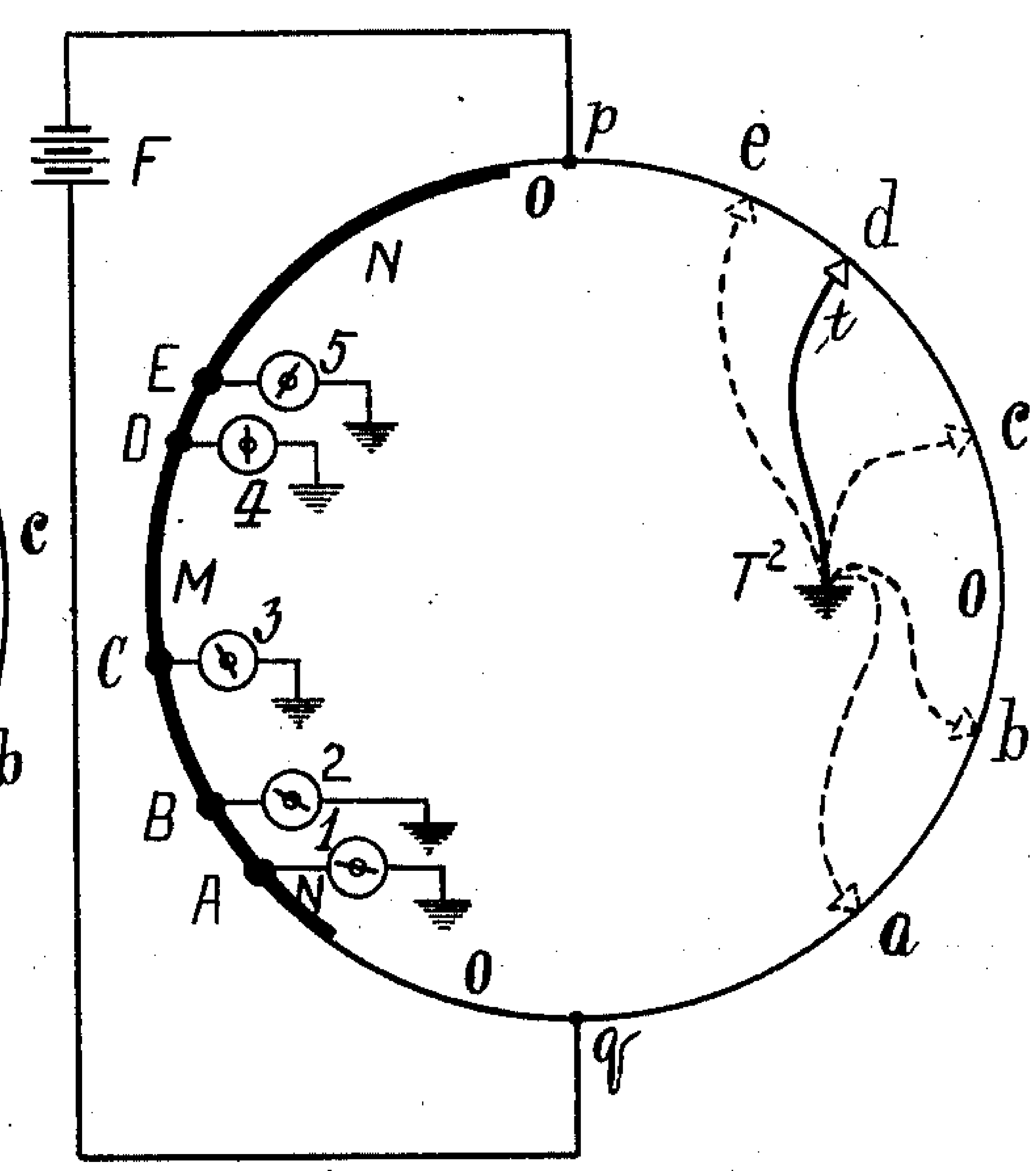


Fig. 10.



Witnesses
Edgeworth Greene
Theodore T. Dorman

Inventor
Sylvanus Albert Reed
By His Attorneys
Witmore & Jenner

UNITED STATES PATENT OFFICE.

SYLVANUS ALBERT REED, OF MIDDLETOWN, NEW JERSEY.

SELECTIVE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 688,118, dated December 3, 1901.

Application filed February 27, 1901. Serial No. 49,024. (No model.)

To all whom it may concern:

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

My invention relates to systems of selective electrical communication wherein an operation may be performed at a predetermined distant point, such as the display of a signal or the throwing of a switch.

The object of the invention is generally to provide a system of selective electrical communication between distant points which will permit of adding to or subtracting from the number of such points as desired, the system being capable of operation between an indefinite number of such points, and especially to provide a selective intercommunicating privacy system for telephone party-lines which is characterized by simplicity of plan and structure, is easily and speedily operated, perfectly efficient in operation, and absolutely trustworthy in result.

The systems for selective signaling heretofore known and used are classed under three heads—first, those known as the "step-by-step" systems, in which step-by-step mechanisms at the subscribers' stations are controlled from the central station in such a manner as to enable the operator to pick out or select the desired station and ring its bell to the exclusion of all others on the same line; second, those known as the "strength" and "polarity" systems or that class of selective calling devices which depend for their operation on changes in the strength or in the direction of a current or on changes in both; third, those known as the "harmonic" systems, in which a vibrating reed is made to take up its vibration by the action of a succession of impulses of force occurring in the same period as that peculiar to the reed which it is desired to operate. With all of these systems various well-known fundamental objections are associated, of which it may suffice to mention the limitation in the number of stations in the strength and polarity systems and the excessive number of moving parts and delicate adjustment in the receiving apparatus of the other two systems. My invention does not fall properly in any of these classes, but is based upon a distinctively new and original application of the principle of the well-known Wheatstone bridge. This principle is commonly used in electrical measurements of resistance, and is also applied in the location of faults or changes on telegraph, telephone, alarm, and signal lines, and is also applied in multiplex telegraphy; but it has not been applied in a selective system. In the application of this principle to a selective system and to fit such application to the practical conditions of telephone service I have devised novel arrangements of circuit, novel designs, and novel apparatus, and in these I believe myself to be the pioneer. My invention applies the principle named to telephone party-line operation, with the effect that on a two-wire loop common to an indefinite number of stations, limited only by convenience, any station may appropriate the line, may call up any other station exclusively, and may maintain exclusive telephone communication with said other station, and may afterward restore the line to a normal condition ready for similar use by other stations. During the use by one pair of stations, as above described, no other station can cut in or hear the conversation, except that a supervising-station may be provided with the means of so doing, if this is desired. The system operates either on a strictly metallic circuit or on a partially-grounded circuit, and it may be operated either with local or common sources of current or batteries and may utilize the telephone instruments in current use.

To illustrate my invention, I have appended drawings, in which—

Figure 1 is a diagrammatic view of a circuit with five stations according to my system. Fig. 2 is a graphical diagram showing the circuit of Fig. 1 expanded, with station D having its keyboard looped into the line. Fig. 2ª illustrates graphically the intermediate step in the expansion of the actual circuit of Fig. 1 to the diagrammatic graphical representation of Fig. 2. Fig. 3 is a view similar to Fig. 2, showing the station A looped into the line. Fig. 3ª represents the intermediate step in the expansion of Fig. 1 to the graphical representation of Fig. 3. Fig 4 is a detailed plan of a complete system similar to that of Fig. 1, showing the five stations, three being developed into the complete apparatus. Figs. 5, 6, and 7 are detailed views of various parts on a larger scale than Fig. 4. Fig. 8 is a diagrammatic view of a modification of my five-station circuit shown in Fig. 1, with station B having its keyboard looped into the line. Fig. 9 illustrates graphically the conditions of Fig. 10, but with direct instead of earth connections between the bridges and the keyboard. Fig. 10 is a graphical diagram showing the circuit of Fig. 8 expanded.

Similar letters and numerals indicate corresponding parts throughout the several views.

In order to explain the principle utilized in my invention, I have given in Figs. 2 and 3 graphical diagrams of the electrical circuit employed. In these diagrams relative resistances are represented by relative lengths. Considering Figs. 2 and 3, the circuit is seen to consist of a loop M *m* N *n*, represented as a circle, and a source of current F, which may be connected to the loop by conductors with shiftable contacts, represented in Figs. 2 and 3 by the small pointed heads. Connection being thus established, current will pass into the loop at *c′*, let us say, and in so doing will divide, following the direction of the arrows, part of it passing around the loop on the branch *c′* M *c* and the rest passing around in the opposite direction on the branch *c′* N *c*. The current reunites at *c*, where it leaves the loop. The loop thus constitutes two derived branches in multiple in the circuit. Now if the bridges be extended across the loop between the branches thereof, as at A A′, B B′, C C′, D D′, E E′, it is readily understood from the principle of the Wheatstone bridge that these bridges will permit a portion of the current to pass from one branch of the circuit to the other, depending upon the differences in potential at the respective extremities of each bridge. If one bridge (let us say C C′) be so related to the point of entrance of the current into the loop that its respective extremities are at points of equal potential, no current will pass and that bridge will be neutral, while all the other bridges will pass current and be active. By interposing a current-indicating device, such as a galvanometer, in each bridge it may be seen which bridge is neutral and which are active. In the drawings these galvanometers are represented by the numerals 1 to 5. Now if the current-supplying contact-points are shifted along the loop from the points *c′ c*, to the points *d′ d*, let us say, and if the location of the points *d′ d* with respect to the bridge D D′ has been predetermined to produce an equality of potential at the extremities of such bridge, then upon the passage of current into the loop at the point *d′* and its division about the respective branches thereof (see Fig. 3) the bridge D D′ will now become neutral, while the previously neutral bridge C C′, together with the other bridges, will become active, the conditions in the respective bridges as to activity or neutrality being indicated by the galvanometers, as before. By ascertaining throughout the loop the location of pairs of points, each pair having the special definite relation to one of the bridges that current from it will cause the related bridge to remain neutral, while all the other bridges become active, it follows that the operator is given the power absolutely to select and to control the electrical condition of any desired bridge as to neutrality or activity by simply applying current at the appropriate contact-points. The contacts represented on Figs. 2 and 3 by *a a′*, *b b′*, *c c′*, *d d′*, *e e′* have been thus determined with this special relation to the respective bridges A A′, B B′, C C′, D D′, E E′.

The plan just described (illustrated in Figs. 1 to 4) is one where the bridge connections are fixed and the current connections or contacts are shiftable. There is another way in which any desired bridge may be brought to a condition of neutrality, and this is illustrated in Figs. 8 to 10. In this plan the current connections or contacts with the loop are fixed, and one of the connections of each bridge with the loop is shiftable. I have explained this at length farther on and for the present will return to the situation disclosed in Figs. 1 to 4.

In order to adapt the circuit above described to practical conditions, I have devised the special doubling or folding of the loop on itself exhibited in Figs. 2ª and 3ª, in which the same lettering is adopted as in Figs. 2 and 3. By this plan of folding it is seen that a resultant endless coil of two turns is formed, in which the bridge extremities and the contacts for the source of current instead of being remote from each other become adjacent and assume the proper and convenient sequence. If in Figs. 2 and 3 we confine the bridges to the two segments (indicated by the heavy lines) and the contacts to the other segments, (indicated by the light lines,) then after folding the loop into the special form of double coil shown in Figs. 2ª and 3ª the heavy segments will be brought together and the light segments will also be brought together, and the coil will consist of the defined bridge region M N and the contact region *m n*. If now we draw together or constrict the opposite sides of the double coil of Fig. 2ª at the points cut by the dotted line, the double coil will assume a sort of hour-glass or "dumb-bell" contour instead of the circular form there shown. If next we make the region shown in light lines in Fig. 2ª of material whose specific resistance is high compared to that of the region shown in heavy lines, we shall obtain a construction which may be developed into the form shown in Fig. 1.

It will be remembered that I have already stated Figs. 2 and 3 to be drawn to represent relative resistances by relative lengths. It must be borne in mind that this is no longer true of the showing in Fig. 1. This figure is a general diagram of the practical working selective circuit I prefer to adopt. In this figure the neck of the dumb-bell is shown at K, the loops M N and *m n* being the respective bulbs of the hour-glass or dumb-bell and representing the parts indicated by the same letters in Figs. 2 and 2ª. The circuit consists of an external line M N with stations A B C D E, it being understood that instead of five stations an indefinite number, limited only by convenience, may exist. By the term "station" I mean a location on a circuit at which an operation is performed by selective actuation from another location on said circuit, said latter location being also included under the term. This practical working line consists of two distinct adjacent limbs or wires M N, each forming in the normal or idle condition of the line a closed loop. At each station is a bridge connecting the two wires M N in multiple. Each bridge includes serially an electrically-operated signal or motor device of some kind, preferably a high-resistance galvanometer or electromagnet, (indicated by the numerals 1 to 5.) At each station is also a pair of local conductors O, which are normally disconnected from the line, and at each station there is also a source of current, such as a local battery or a magneto-generator, preferably adapted for direct instead of alternating currents. The local conductors O correspond to the regions *m n* of the graphical diagrams, Figs. 2 and 2ª. They constitute the selective calling or signal-transmitting apparatus and are made up, preferably, of high-resistance material, each being usually of total resistance somewhat greater than one of the wires M or N of the external line. The local conductors form each in a certain sense a miniature reproduction of the external line. Each set of local conductors has a sequence of pairs of predetermined contacts *a b c d e*, brought into a convenient position on a keyboard to facilitate the making of electrical connections therewith, and the intermediate portions of said keyboard-conductors are coiled into a compact space. The pairs of contacts on the various keyboards are carefully located with a definite relation to the various bridges across the line, so that for each bridge in the line there is a related pair of contacts on each keyboard. The keyboard-conductors are arranged so that they may be looped into the external circuit according to some one of several different methods, all of which accomplish in different ways a similar result—namely, the result of producing jointly with the external line a single resultant combined circuit, in which by adjustments and connections selectively made at the predetermined keyboard-contacts a current of electricity when applied will so divide that at every station except the one selected there will be set up at the junctions of its bridge with the line-wires a difference of potential, whereas at the selected station such difference of potential will be zero. Considering any one pair of contacts as the points of entrance and egress, respectively, of an electric current into and out of the loop, it will be found that during the passage of a current through them their related bridge joins points on the loop which are of equal potential, and such bridge is therefore neutral, while every other bridge joins points on the loop of different potential and is therefore active.

Returning to a consideration of Fig. 2, it should be noted that the segments there indicated by heavy lines M N correspond to the two limbs M N of the external line of Fig. 1 and that the segments *m n* of Fig. 2 (indicated by light lines) correspond to the keyboard-conductors *m n* of Fig. 1. These keyboard-segments are seen to be located around the loop in alternation with the external-line segments. The dimensions in Fig. 2 are purposely made unsymmetrical—that is, line M is made longer than line N to indicate the more general case where relays or resistances are added to one line and not balanced to the other. It is, however, preferable that there should be a balance between the two lines, and in that case the graphical diagram would be symmetrical and the bridges would be represented by diameters. Considering Fig. 2, if the battery-terminals be applied at points *q p*, selected at random, one on each conductor *m n*, the current passing into the loop, say, at *q* will divide at *q* and the two branch or derived currents will reunite at *p*. If the bridges across the loop are of resistance high compared with that of the loop, their own shunting action will not greatly disturb the uniform potential gradient between *q* and *p* by either of the routes, and every normal to a straight line joining the terminals will be approximately the graphical representation of one of the equipotential lines; but in any case the total fall of the potential from *q* to *p* must be the same by either of the routes, although said fall need not be uniform in the two routes. If any one of the bridges happens to connect points respectively on the two branches which are of equal potential, then that bridge will be neutral and its galvanometer will indicate no current. In order to produce the condition of neutrality in any one selected bridge, such as A A′, a means must be supplied of equalizing the fall of potential from *q* along the route *q* A *p* to the extremity A of the bridge A A′ with the fall of potential *q* A′ *p* to the extremity A′ of the bridge A A′. Such means of equalizing the fall of potential must be to vary the resistance ratios along the two routes. If the bridge is permanent, as in the cases of Figs. 1 to 4—that is, if its connections with the loop are not shifted for the purpose of selective action—such variation must be either by the manipulation of artificial resistances or rheostats or by the shifting of one or both of the current-dividing points *q p* or by a combination of both the processes named. If, however, as in the cases illustrated in Figs. 8 to 10, the bridges are not permanent—that is, if one or both of the connections A A′ with the loop are capable of being shifted—the act of equalization may be performed either by the manipulation of artificial resistances or rheostats or by shifting the connection until A and A′ are of equal potential or by a combination of both processes named. By the use of the term "permanent" to indicate a bridge with a fixed connection or one in which the location of the connection is invariable, while its actual contact may be made or broken, I do not mean to be understood as excluding a bridge with an adjustable connection adapted to be shifted from time to time as the exigencies of the circuit may demand, such as for readjustment when a new station is added, for I consider a bridge with such an adjustable connection to be included under the term "permanent." If the keyboard-conductors are made of sufficient length, it will be found that for every possible bridge between M and N there may be found at least one pair of points—one point on one of the keyboard-conductors and the other on the other keyboard-conductor—to which if the terminals of a source of current be connected that bridge will be a neutral bridge, while all others will be active bridges. Thus for the bridges A A′, B B′, C C′, D D′, E E′ the pairs of points *a a′*, *b b′*, *c c′*, *d d′*, *e e′* are predetermined, respectively, for connection with the battery-terminals in order to make bridges A A′, B B′, C C′, D D′, or E E′ selectively neutral.

As stated before, Fig. 2ª shows the conductor M *m* N *n* of Fig. 2 doubled or folded into an endless coil of two turns, M N occupying one region and *m n* occupying the other region, the points of bridge connection A A′, which in Figs. 2 and 3 are distantly separated, being caused to become adjacent in consequence of the peculiar manner of doubling or folding. Similarly the contact-points *a a′*, which in Fig. 2 are distantly separated, are also caused to become adjacent. The same will be true with regard to bridge B B′ and its specially-related pair of contacts *b b′*, also with regard to all other bridges and contact pairs. The bridges connect adjacent points in the respective turns of the endless coil, while the points of each pair of contacts are adjacent, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point. Now returning to Fig. 1, the conductors *m n* occupy the position of being cross-looped into the two previously-independent limbs M N of the external line, the crossover being at K. In order to so cross-loop *m n* into the line, the loops M N are opened and the conductors so connected therewith that *m* joins the incoming end of M with the outgoing end of N and *n* joins the incoming end of N with the outgoing end of M. If instead of the subscriber at station D having cross-looped his keyboard O into the line the subscriber at station A had so looped in his keyboard O, a resultant circuit would have been formed which could be unfolded or expanded into that shown in the graphical diagram, Fig. 3, passing through the intermediate stage. (Illustrated in Fig. 3ª.) Conversely the graphical circuit-loop shown in Fig. 3 may pass through a sequence of stages—namely, the double-coil stage and the dumb-bell stage—similar to those described in the cases of Figs. 2 and 2ª for development into the working circuit which Fig. 1 would exhibit had it been drawn with the keyboard at station A, looped into the line instead of station D.

The description of my system thus far has related only to the principle upon which the subscriber at any station may selectively cause a bridge at any other station to become neutral, the resultant effect at the selected station thus being one of inactivity, while at all other stations it is the one of activity. Now under certain conditions a signaling system might be practicable where a negative indication should be interpreted as a positive signal and a positive indication as a negative signal, the positive indication being in either case the deflection of an index or the lighting of an incandescent lamp, yet for the purposes of practical working it is desirable to invert the resultant effect at each station, so that neutral bridges will operate a signal or switch positively, while active bridges will do the same negatively. To do this, I may cause the needles themselves to act as relays in a local circuit, said circuit controlling the connection of a telephone with the circuit. Under this arrangement the current must be continued so long as the selective state is to be maintained, and the instant such current ceases the selective state will terminate. I therefore prefer to provide a means whereby coincidently with the selective deflection there is produced a clamping effect at the various stations, which effect will persist without the continuous action of a current until such clamped condition is terminated by a reversing or unclamping effect transmitted from the calling station. To accomplish the desired object, I therefore prefer to introduce at each station a relay or motor electromagnet 9, Fig. 4, which is free to operate when the galvanometer-needle is in its neutral position, but is blocked by such needle when it is deflected. This relay must be non-selective—that is, it must operate simultaneously at all stations—both the selected and the non-selected. It therefore must be actuated by a current external to the bridge-current. I prefer to place such relays in series in one or both of the line-wires M N. This relay or motor electromagnet may be neutral or polarized and may act either simply to clamp the needles in the position in which the selective current has placed them, the needles then operating upon the signaling device directly, or this relay or motor electromagnet 9 may, besides clamping its needles, also itself operate upon signals or switches in its own circuit or in auxiliary circuits or in local circuits; but I prefer and have chosen for further specification at this stage a system in which at each station is a polarized relay operating upon a signal in a local circuit and also upon a normally short-circuited telephone set in series in one of the main-line wires M N. The apparatus referred to is shown in more complete and detailed plan in Fig. 4. In this plan the lettering and numbering of the skeleton diagrams of Figs. 1 to 3 refer to corresponding details.

M N are the two wires of a metallic circuit forming a loop passing through five stations in this illustration; but there may be an indefinite number of stations and they may be placed at any points on the line. At stations C D E is shown the complete apparatus. At the other stations A B, I have merely indicated the apparatus by a dotted line. The keyboard sets are indicated by O, and Z indicates movable switch members for looping the sets O into the main line.

3 4 5 are the bridges at stations C D E, respectively, there being similar bridges 1 2 at stations A B.

The numeral 9 indicates polarized relays in series in line M, and the numeral 10 non-inductive resistances in line N to balance relays 9.

16 indicates telephone-receivers, and 17 the secondary windings of the induction-coils of microphone-transmitters 18. 16 and 17 are in series in branch or derived circuits of line N in multiple with the normally closed shunting-switches 15.

When the line is idle, all keyboards O are disconnected and the switches at Z are closed, so as to leave the main lines unbroken. The main lines M and N then form, respectively, two closed independent loops, united only by the bridges 1 2 3 4 5 in multiple at the stations. Line M contains in series only the switches Z and a relay 9 at each station. Line N contains in series only the switches Z' and the non-inductive resistances 10 and the normally-shunted derived branch containing serially the telephone-receiver 16 and the transmitter-secondary 17 at each station, respectively. In series in each bridge is placed a high-resistance helix P, pivoted in the field of a permanent horseshoe-magnet J. I have generally used a resistance of five hundred ohms in the helices for a five-station line such as is illustrated. This apparatus corresponds to the galvanometers shown in the skeleton diagram Figs. 1, 2, 3, 2a, and 3a and is constructed, preferably, on the principle of the D'Arsonval galvanometer. The helix P carries a light arm T, which plays between stops 6 7 and is restored to rest when not energized preferably by the retractile spring S. The polarized relay 9, whose resistance I have usually made low, (about five ohms,) has a rocking arm L attached to its pivoted armature, which is limited in its play in one direction by the stop 19. Arm T has at either end a flexible and elastic extension 22 23. (Shown in Fig. 6, this figure being taken in a plane longitudinally through T at right angles to the plane of Fig. 4.) Elastic extension 22 plays in front of arm L in a relation such that it will block the descent of arm L if 22 has deflected, but will allow L to descend if 22 has not deflected. This may be accomplished by a variety of mechanical expedients; but I pr[illegible] L with a notch 11, so that elastic extension 22 plays in front of the notch or indentation 11 in L (shown more in detail in Fig. 5) and between L and a forked or mortised bracket 20. When arm T is in a neutral position, then 22 is directly opposite notch 11. When the current passes through relay 9 in a definite direction—say plus—then arm L will move toward arm T, which direction I will refer to as "descending," and the opposite motion away from T, I will characterize as "ascending," and if T has not deflected from its neutral position then notch 11 will engage extension 22 and arm L will be able to reach its extreme position, (shown at stations C and D.) If, however, the arm T has deflected, then notch 11 will not engage elastic extension 22, but arm L will be blocked in its descent by extension 22, which it presses against the forked support 20, and it will reach only the intermediate position, as shown at station E. The non-selective arm L is provided with lugs 12, Fig. 5, 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 arm T from returning to the neutral position after the current ceases so long as L maintains its blocked position. The bias of the armature of relay 9 toward the nearest pole when 9 is not energized insures its armature maintaining the last position in which the current has placed it, and the relative positions of L and T are so adjusted that when L is in the intermediate blocked position (shown at station E) then the armature of 9 is a little past its own line of unstable equilibrium and has a bias toward the pole toward which it tends on its descent. Therefore the arms L and T continue to mutually block each other, as shown at station E, even after current has been cut off. If the current is applied in the reverse direction, rocking arm L will ascend to position shown by dotted line 13 at station C, Fig. 4, and will release arm T. When the current is again shut off, arm L will retain its elevated position on account of the bias above mentioned, but arm T will be brought back to its neutral position by spring S. It will be seen by an examination of the diagram in Fig. 1 and by tracing out the currents denoted by arrows that no matter at what station the keyboard is connected to the line a current in a stated direction from the local battery at that station applied in the described manner will cause the arms L at all stations to simultaneously ascend and for a current in the reverse direction to simultaneously descend. Furthermore, as the arms L all descend they will all be blocked by the arms T, which simultaneously deflect, except at the station corresponding to the pair of contacts selected on the keyboard. At the selected station the arm L not being blocked will descend to its extreme position. In Fig. 4 I have shown station D calling station C. The descent of arm L to its extreme position may be caused to operate mechanically by striking a bell; but I prefer to have it operate as a switch at each station upon a vibrating electric bell 24 whose electromagnet is preferably in a branch circuit of the local battery 25, this branch circuit also embracing in series the spring-contact switch 14 and the hook-switch of receiver 16. Normally switch 14 is open and the hook-switch is closed; but 26, a non-conducting extension of arm L, when in its extreme depressed position reaches and closes switch 14, causing the bell 24 to ring until the circuit is broken by the removal of the receiver from its hook. The shunting-switch 15 is also reached and opened by extension 26, but only when arm L is in its extreme depressed position. When the shunting-switch 15 is open, the receiver 16 and secondary coil 17 are in series in the wire N of the main line. The removal of receiver 16 from the hook, which opens the bell-circuit, also operates through contact 18^a to substitute the transmitter 18 and its primary coil in that circuit. The subscriber at station C is therefore in the non-inductive line N for talking and listening. In order that the calling-station D may also have its telephone set in circuit, I provide the lock 27. This is a fork which moves with its crotch opposite elastic extension 23 of arm T when the latter is in its neutral position, and in such case the depression of the fork—that is, its movement toward T—will cause the crotch to engage extension 23, and the fork may be pushed down between the tines of the forked bracket 21. Thus the caller at D before applying the current and while his own arm T is in neutral position may lock the said arm T in such position and prevent its deflection when he applies the calling-current. Arm T being locked at calling-station D, the arm L at that station will not be blocked in its descent when the caller applies current, but will be free to reach its extreme position and to operate the caller's own switches 14 15, upon which his own call-bell rings until he removes the receiver from the hook. His telephone-receiver and the secondary of his transmitter are now in series in wire N, together with those of the called station, exclusively, those of all other stations remaining short-circuited. It thus occurs that the selectively-actuated deflecting member T and its associated deflecting member—the arm L—are so disposed toward one another that the selectively-actuated deflecting member in non-deflected position relates itself to the other member to permit the latter on deflection to assume its effective relation with respect to the local operating device, such effective relation being in this case to operate the signal-bell and bring the telephone apparatus into operative condition in the line, but in deflected position relates itself to the other member to prevent the latter on deflection from assuming its effective relation. Lock 27 also operates in connection with arm T as a lock-out apparatus in the following manner: After D has called C the selectively-actuated deflecting members or arms T are deflected at all stations except D and C. No other station except that called can depress the lock 27, as the deflection of arms T at such other stations has caused the elastic extension 23, Figs. 4 and 6, to move from its neutral position opposite the notch in the fork of the lock 27 to a position opposite one of the blunt tines of said fork, so that when lock 27 descends it will be blocked by extension 23, supported by the forked bracket 21, against which the extension 23 bears elastically when pressed down by the fork of the lock 27. This situation is shown in station E, Fig. 4. Lock 27 is attached directly or indirectly to the stem 39 of the movable switch member Z, which switch member controls the looping of the keyboard O into the main line. Therefore when lock 27 is blocked the subscriber cannot effectively operate switch Z, and therefore he can not loop his keyboard into the line.

Y is a branch circuit from the local battery, with plug-switches, whereby the current may be applied at the pairs of predetermined contacts *a b c d e* on keyboard O for selectively calling the desired stations. Circuit Y has in series a battery-switch 28 and a pole-changing switch 29. Switch 28 is a self-restoring switch operated by the stem 39 of switch Z, so that it can be closed or effectively operated by the movable stem 39 only when lock 27 is not blocked. If 27 is not blocked, the adjustment is such that said switch 28 will be closed by the operation of said stem 39 an instant later than the looping in of the keyboard by switch Z.

Z is a wedge-switch which, when elevated, as at stations E and C, closes the main lines M and N through the contacts Z', but which when depressed cross-loops the keyboard-conductors *m n* into the line-wires M N in the special manner shown, having the single crossover K, the plan of connection being more clearly shown in Fig. 1 at D and being also illustrated in Figs. 2^a and 3^a.

There is also provided a busy sign, preferably attached to arm L at each station. This sign plays in front of a window which is so adjusted that the sign is displayed only when the arm L is in the intermediate position it occupies when blocked by arm T, as seen at station E, Fig. 4.

In practice the holes or openings for the keyboard-plugs are brought together in a row or series, each marked with the number or designation of the station which it calls. The resistances forming the keyboard-conductors are preferably coiled into a compact space below the keyboard. A single insulating-plug may be used for all the calls. This plug may be left with safety in the last hole used, as the battery-current is controlled by switch 28 and the connection of the keyboard with the line occurs only during the depression of switch Z. By having only one plug I insure its removal from the last hole used before a new call is made. The stem 39 of switch Z is retracted after depression by a spring. I have shown in Fig. 4 an arrangement whereby the spring of the self-restoring switch 28 operates to so retract the stem 39.

In Fig. 7 I show a device whereby the pole-changing switch 29 is interlinked with switches Z and 28, so that all three switches are operated jointly in proper sequence by a single operation for calling or disconnecting, respectively. In this figure the pole-changing switch 29 is seen to have an extension provided with a non-conducting link 30, extending to and terminating in a button. The non-conducting link 31 of the main part of the switch 29 is also similarly extended and terminates in a button. The button on the upper end of stem 39 of switch Z, as shown in Fig. 4, is omitted, and the two-spring push-buttons 32 33 are provided, each linked to the end of an elastic rocking lever 34 35, pivoted at 37 38, respectively, and each bearing loosely on an insulating cross-bar 36, attached to the stem 39 of switch Z. When button 33 is depressed, it also depresses stem 39, operates switch 28 and switch Z, and throws pole-changing switch 31 down, reversing the current. When button 33 is released, stem 39, being a spring-switch, rises and pushes up button 33 and restores switches 28 and Z to their normal position. Pole-changing switch 29, however, remains in the position in which it was just placed. When button 32 is depressed, as shown by the dotted line, Fig. 7, switches Z and 28 are again operated as just described, but 29 is reversed and is so left when button 32 is released. The adjustments are so made that the operations described occur in the proper sequence, as will be described farther on.

The apparatus having now been described in detail, I will proceed to describe its operation in practice.

First. Suppose the line is idle, all keyboards are disconnected and all batteries cut off, all telephone sets are short-circuited, and the calling-bell circuits are open. Rocking arms L at all stations are in the elevated position in which they were left by the last disconnecting call by a subscriber. All bridge-arms T are in their neutral positions. The two loops M N of the main line are each complete and unbroken, except that they are united in multiple by the high-resistance bridges at each station and all the busy signs are concealed.

Second. Suppose station D wishes to call and communicate with station C. The calling subscriber first takes his plug from the keyboard-hole in which it was left at the last call made by him and inserts it into the hole marked *c*. (See Fig. 4, station D, hole *c*.) This connects the battery-conductors with the keyboard-conductors at the predetermined contacts *c* for making neutral the bridge at station C. He then depresses button 33, which will be marked "Call." His lock 27 not being blocked, as his arm T is not deflected, he is able to so depress 33. The depression of button 33 operates the switches in the following sequence: first, closes Z, looping his keyboard into the main line and by the depression of lock 27 locking his own arm T in its neutral position; second, closes switch 28, which applies the current in the direction for keeping arms L in their elevated positions and which causes the deflection of all the bridge-arms T except at station C, and, third, throws switch 29, thereby reversing the current and causing arms L at all stations to descend. At the same time the currents are reversed in all the active bridges and the arms T start to reverse their deflection. By original adjustment, however, of the relative distances between the elements concerned the arms L in their descent strike the arms T before the latter come opposite the notches 11 and the further descent of arms L is blocked except at calling-station D and called station C, where the arms L reach their extreme depressed position and close switches 14, causing the signal-bells to ring at stations D and C and open the shunts 15 at those stations. The calling subscriber then releases button 33, which rises, pushed up by stem 39, opening switch 28, shutting off the current, and operating switch Z, so that the keyboard is cut out from the main line and the latter closed through the contact Z'. Pole-changing switch 29, however, remains depressed. All arms L remain depressed. Each subscriber then removes his receiver from its hook, which removal in each case causes the bell to cease ringing, puts his telephone set in series in the non-inductive circuit of wire N, and closes his local microphone-circuit. Conversation can now be carried on. If now the subscriber at any other station—such as, for example, E, Fig. 4—attempts to connect with the line, the blocking of lock 27 by arm T at his station locks him out and prevents him from operating any of his switches. Should any subscriber, as at station E, attempt to listen, he would find it impossible, as his telephone is short-circuited by switch 15. When D and C have ceased talking, each restores his receiver to the hook, which again starts his call-bell ringing, and this continues until one or the other has pushed the button 32, which will be marked "Off," the keyboard-plug being still in some one of the holes. This operates the switches in the following sequence: first, operates switch Z, looping keyboard into line; second, operates switch 28, applying the current to the line in the direction to keep the arms L depressed, and, third, pushes down link 30, reversing the pole-changer 29, and thereby raising the arms L at all stations. The button 32 is then released, switches Z and 28 open, the current is cut off, and the main line closes. Pole-changer 29 remains in its position as left. All arms L remain in the elevated position and the line is restored to its normal condition ready for use by any subscriber. Should either of the subscribers who have been talking leave the receiver off the hook, it would still be possible for the other to operate the "off" switch and restore the circuit to normal, inasmuch as the additional resistance of the receiver in the line N would not suffice to prevent the response of all the relays 9 to the reverse current.

My invention as embodied in apparatus is susceptible of many modifications, some of which I will now proceed to mention. I reserve the right to make these the subject-matter of subsequent applications with specific claims as distinguished from the generic invention herein covered.

The modification known as the "bridge-connection-shifting system," so called to distinguish it from the current-contact-shifting system heretofore described and hereinafter specifically claimed, is shown in Figs. 8 to 10, and I will now describe the same.

Figs. 8, 9, and 10 illustrate the manner of equalizing potential fall by shifting one of the connections of the selected bridge with the loop. Fig. 8 is a view of a working line planned on this principle—namely, an external line M N and keyboard-conductors O and a source of current F, one at each station A B C D E. At station B the keyboard-conductor is shown looped into the line, while at the other stations the keyboard-conductor is not so looped in. Station B is shown in the condition of calling-station D by connecting contact-point *d* to earth after making his battery connection with the keyboard-conductor, as shown in the diagram. Fig. 10 is a graphical exhibit of the circuit of Fig. 8 as it exists after B has looped in his keyboard. Fig. 9 illustrates a circuit of the same kind, but using a common conductor T^2 instead of the earth as a return for the bridge-currents. Fig. 9 therefore is an intermediate step in the graphical development from Fig. 2 of the circuits of Figs. 8 and 10, and the principle involved can more easily be shown thereby than in Figs. 8 and 10. It will be seen in Fig. 9 that the ends of the bridges A B C D E, which join wire M, are fixed and permanent. Therefore for any given fall of potential from *p* to *q* by the route *p* O N M N O *q* the actual potentials at the bridge-junctions A B C D E are constant. The potentials of the other ends—that is, of the non-permanent ends of the bridges which unite in T^2—can be varied by shifting the contact *t*—that is, by applying contact *t* to various points on the limb *p t q*, such as *a b c d e*. In this case the control of potential equalization is effected by shifting one of the virtual connections with the loop of the non-permanent bridges, the current connections being permanent at *p q* for that station, whereas in the plan illustrated in Figs. 1, 2, and 3 the control of such potential equalization is effected by shifting the virtual current connections on a loop having permanent bridges. It will now be apparent that whereas the equalization of potential must be accomplished at the respective extremities of any selected bridge it does not necessarily follow that equalization of potential exists in the points of the loop connected by such bridge. While it is true that in an arrangement such as is shown in Fig. 2, for example, the equality of potential is simultaneously present at the extremities of the selected bridge and at the points of the loop joined by such bridge, this is not the case in a structure such as is shown in Fig. 9. Were the common locus or meeting point T^2 of the bridges to be capable of coincidence successively with selected points on the loop the statement made of the structure of Fig. 2 would be likewise applicable. Where, as in Fig. 9, a common conductor from the point T^2 to the loop is employed it will be found that T^2 is the point to be placed at equality with any of the points A B C D E. For the purposes of equalizing the potential at the extremities of any bridge in such case the common conductor T^2 *t* must be considered as a part of the loop or an extension from the loop to the bridges rather than a prolongation of the bridges to the loop. In either aspect, however, it is none the less true that the bridges are extended across the loop between the branches thereof, and in speaking of the bridges as being "between" the branches of the loop I wish to be understood as indicating both the situation where the extremities of the bridge are coincident with the branches of the loop and that where either or both extremities are not coincident with the branches proper of the loop, but are connected to the same by prolongations either of the bridges or of the loop branches.

Should it be desired to make one station a supervising-station, such station may be so arranged by disconnecting the lock 27 from the switch-stem 39 and operating 39 by an independent button. The supervisor can then switch off all telephones at any time and can also connect in his own telephone set at any time or leave his lock so that all calls put him on the line. The supervising-station may be a central station, through which connection may be made with other lines. In operating the line as a central-station party-line system the substations will omit their keyboards and will have a direct call to the central station, care being taken that the current used for such call shall have a direction such that it will tend to elevate and not to depress the arms L.

I have alluded to other possible plans than that described in full of establishing through the instrumentality of a local conductor or conductors having predetermined contacts and looped into the line at will together with either a local source of current or a distant grounded battery such a division of the current as will cause a selected bridge to be neutral; and I do not confine myself to the special plan described at length, but may utilize any of such combinations for the purpose specified. To illustrate the variations which may be made, it may be seen by a reference to Fig. 2 that bridge B B′, for example, could be made neutral by applying the current at the points *x y* instead of *b b′*, one of which points *x* is in the region occupied by the local keyboard-conductors and the other at a distant point in the region occupied by the line-wires; also, that C C′ could be made neutral by applying the current at *z y*, *y* being the same point as before. In the practical operation of this plan there would be a common battery at *y*, with one pole connected permanently to the line either directly or to a permanent high-resistance loop in said line and with the other pole grounded. Then the subscriber at D whose keyboard is looped in (in the case shown in Fig. 2) could call station B or C, for example, by connecting predetermined contacts *x* or *z*, respectively, to earth. Referring to Fig. 3, the subscriber B, whose keyboard is looped in, could call A or B, respectively, by connecting *x′* or *z′* to earth. In adapting this common battery plan to intercommunicating lines having certain intervals between stations it may be found best to shorten one of the keyboard-conductors, such as *n*, to zero resistance and to have all the predetermined calling-contacts on conductor *m* of the keyboard.

I do not confine myself to the use of local batteries for selective transmission, but may use also a common battery.

I do not limit the application of this system of selective control of distant signals, switches, or operating devices to telephony, but may extend it to use in connection with telegraph-lines, fire, messenger, or burglar-alarm lines or annunciator-lines, electric-light lines, or other like uses.

The selective effects herein specified are not based expressly upon the establishment in the bridge at the selected station of a current strength different from that in the bridges at the other stations, but are based upon the establishment at the selected station of zero-current in contrast to finite current in the bridges at the other stations—that is to say, they depend theoretically upon the entire extinguishment of current in the bridge at the selected station. Nevertheless, although under absolutely perfect adjustment of the specified conditions there will be absolutely zero-current in the selected bridge, there will be in practice a liberal margin for inaccurate original adjustment and for subsequent inconstancy of conditions. The differentiation between the conditions resulting in the giving of a signal at a selectively-called station and no signal at the next adjoining station depends not upon an absolute non-deflection of the needle at the selected station in contrast to a deflection of the needle at the next adjoining station, but upon the needle at the selected station not deflecting sufficiently to carry it beyond the range of the notch 11, whereas at the adjoining non-selected station the needle does deflect beyond the range of the notch 11, even if by only a minute distance. It is plain that for a given difference of potential selectively established at the extremities of any bridge the question whether its needle will or will not deflect beyond the range of the notch 11 depends upon the electromagnetic efficiency of the galvanometer, the tension of its retractile spring, the width of the notch 11, and the width of the portion of the needle which is engaged by said notch. An adjustment of these factors may be made such that a finite current of a given strength may pass in the selected bridge without causing the needle at that bridge to deflect beyond the range of notch 11 and yet that any greater current—such, for example, as will exist at the next adjoining bridge—will cause a deflection beyond the range of the said notch 11. If such given current strength represents a marginal provision large enough to embrace a certain range of possible variations growing out of the probable irregularities of ordinary telephone-line working—such as leakage, difference of earth-potential, and variation of resistance in the line or in the instruments—then the positive and correct selective action of the system will not be prevented by the existence of such irregularities, provided the latter do not exceed the definite range of variation for which a definite marginal provision has been made in the manner described. I have found that marginal provision of the above character may be made which will meet variations of line conditions affecting the balance of the system to an extent of twenty per cent. The fact, however, that under such abnormal circumstances the current in the selected bridge is not absolute zero, but is a finite quantity, does not affect the validity of the principle embodied in my specification as to the selective action being based upon zero-current in the selected bridge contrasted with finite current in the non-selected bridges.

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 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.

2. In a selective system, an electric circuit having two derived branches in multiple, said derived branches forming a loop, a source of current, a plurality of permanent bridges across the loop, and means for adjusting the ratios of the resistances along the branches respectively from their dividing-point to the extremities of any selected bridge, to produce an equality of potential at such extremities, substantially as described.

3. In a selective system, the combination of a loop, a plurality of pairs of current-supplying contact-points at intervals along said loop, a plurality of bridges across the loop, said bridges having the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge is connected to said loop at points of equal potential respecting its said related pair of contacts considered respectively as the points of entrance and egress of an electric current, said connecting-points being located around the loop in alternation with the individual points of said related pair of contacts, substantially as described.

4. In a selective system, a loop, a plurality of bridges across the loop, a plurality of pairs of contact-points along said loop, means for applying current to any such pair of contact-points, the bridges having the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins the loop at points where the current from its related pair of contacts is of equal potential, said joining points being located around the loop in alternation with the individual points of said related pair of contacts, substantially as described.

5. In a selective system, a loop comprising four segments; a plurality of bridges connecting two non-consecutive segments; a plurality of pairs of contact-points, one point of each pair located on one of the non-bridge-connected segments and the other point on the other non-bridge-connected segment; the bridges being specially related to the pairs of contact-points, each individual bridge to a different pair; means for applying electric current to any desired pair of contact-points; each bridge with respect to its specially-related pair of contact-points being in the definite relation of joining points on the loop which are of equal potential during the passage of a current between its said specially-related pair of contact-points, substantially as described.

6. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, each individual bridge connecting different adjacent points; a plurality of pairs of contact-points, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of a current between its related pair of contact-points, substantially as described.

7. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, throughout a defined region thereof, each individual bridge connecting different adjacent points; a plurality of pairs of contact-points in the remaining region of the endless coil, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of a current between its related pair of contact-points, substantially as described.

8. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, throughout a defined region thereof, each individual bridge connecting different adjacent points; a plurality of pairs of contact-points in the remaining region of the endless coil, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; the said remaining region being constructed of material of a resistance high compared to that composing the bridge-connected region; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of current between its related pair of contact-points, substantially as described.

9. In a selective system, an external line consisting of a conductor in an endless coil of two turns; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the respective turns of the endless coil; a pair of

local conductors at one or more of said stations, of specific resistance high compared with the external line; means for looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the looped-in pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge, substantially as described.

10. In a selective system, an external line consisting of two limbs or wires, each forming normally a closed loop; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the line-wires; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means for cross-looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the cross-looped pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge, substantially as described.

11. In a selective system, an electric circuit having derived branches in multiple, a source of current, a plurality of bridges between the derived branches, an electrically-operated signaling device included serially in each bridge, 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.

12. In a selective system, an electric circuit having two derived branches in multiple, said derived branches forming a loop, a source of current, a plurality of permanent bridges across the loop, an electrically-operated signaling device included serially in each bridge, and means for adjusting the ratios of the resistances along the branches respectively from their dividing-point to the extremities of any selected bridge, to produce an equality of potential at such extremities, substantially as described.

13. In a selective system, the combination of a loop, a plurality of pairs of current-supplying contact-points at intervals along said loop, a plurality of bridges across the loop, an electrically-operated signaling device included serially in each bridge, said bridges having the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge is connected to said loop at points of equal potential respecting its said related pair of contacts considered respectively as the points of entrance and egress of an electric current, said connecting-points being located around the loop in alternation with the individual points of said related pair of contacts, substantially as described.

14. In a selective system, a loop, a plurality of bridges across the loop, an electrically-operated signaling device included serially in each bridge, a plurality of pairs of contact-points along said loop, means for applying current to any such pair of contact-points, the bridges having the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins the loop at points where the current from its related pair of contacts is of equal potential, said joining points being located around the loop in alternation with the individual points of said related pair of contacts, substantially as described.

15. In a selective system, a loop comprising four segments; a plurality of bridges connecting two non-consecutive segments; an electrically-operated signaling device included serially in each bridge; a plurality of pairs of contact-points, one point of each pair located on one of the non-bridge-connected segments and the other point on the other non-bridge-connected segment; the bridges being specially related to the pairs of contact-points, each individual bridge to a different pair; means for applying electric current to any desired pair of contact-points; each bridge with respect to its specially-related pair of contact-points being in the definite relation of joining points on the loop which are of equal potential during the passage of a current between its said specially-related pair of contact-points, substantially as described.

16. In a selective system, a single loop dou-

bled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, each individual bridge connecting different adjacent points; an electrically-operated signaling device included serially in each bridge; a plurality of pairs of contact-points, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of a current between its related pair of contact-points, substantially as described.

17. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, throughout a defined region thereof, each individual bridge connecting different adjacent points; an electrically-operated signaling device included serially in each bridge; a plurality of pairs of contact-points in the remaining region of the endless coil, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of a current between its related pair of contact-points, substantially as described.

18. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, throughout a defined region thereof, each individual bridge connecting different adjacent points; an electrically-operated signaling device included serially in each bridge; a plurality of pairs of contact-points in the remaining region of the endless coil, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; the said remaining region being constructed of material of a resistance high compared to that composing the bridge-connected region; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of current between its related pair of contact-points, substantially as described.

19. In a selective system, an external line consisting of a conductor in an endless coil of two turns; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the respective turns of the endless coil; an electrically-operated signaling device included serially in each bridge; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means for looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the looped-in pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge, substantially as described.

20. In a selective system, an external line consisting of two limbs or wires, each forming normally a closed loop; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the line-wires; an electrically-operated signaling device included serially in each bridge; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means for cross-looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the cross-looped pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal po-

tential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge, substantially as described.

21. In a selective system, an electric circuit having derived branches in multiple, a source of current, a plurality of bridges between the derived branches, an electrically-operated motor device included serially in each bridge, 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.

22. In a selective system, an electric circuit having two derived branches in multiple, said derived branches forming a loop, a source of current, a plurality of permanent bridges across the loop, an electrically-operated motor device included serially in each bridge, and means for adjusting the ratios of the resistances along the branches respectively from their dividing-point to the extremities of any selected bridge, to produce an equality of potential at such extremities, substantially as described.

23. In a selective system, the combination of a loop, a plurality of pairs of current-supplying contact-points at intervals along said loop, a plurality of bridges across the loop, an electrically-operated motor device included serially in each bridge, said bridges having the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge is connected to said loop at points of equal potential respecting its said related pair of contacts considered respectively as the points of entrance and egress of an electric current, said connecting-points being located around the loop in alternation with the individual points of said related pair of contacts, substantially as described.

24. In a selective system, a loop, a plurality of bridges across the loop, an electrically-operated motor device included serially in each bridge, a plurality of pairs of contact-points along said loop, means for applying current to any such pair of contact-points, the bridges having the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins the loop at points where the current from its related pair of contacts is of equal potential, said joining points being located around the loop in alternation with the individual points of said related pair of contacts, substantially as described.

25. In a selective system, a loop comprising four segments; a plurality of bridges connecting two non-consecutive segments; an electrically-operated motor device included serially in each bridge; a plurality of pairs of contact-points, one point of each pair located on one of the non-bridge-connected segments and the other point on the other non-bridge-connected segment; the bridges being specially related to the pairs of contact-points, each individual bridge to a different pair; means for applying electric current to any desired pair of contact-points; each bridge with respect to its specially-related pair of contact-points being in the definite relation of joining points on the loop which are of equal potential during the passage of a current between its said specially-related pair of contact-points, substantially as described.

26. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, each individual bridge connecting different adjacent points; an electrically-operated motor device included serially in each bridge; a plurality of pairs of contact-points, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of a current between its related pair of contact-points, substantially as described.

27. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, throughout a defined region thereof, each individual bridge connecting different adjacent points; an electrically-operated motor device included serially in each bridge; a plurality of pairs of contact-points in the remaining region of the endless coil, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of a current between its related pair of contact-points, substantially as described.

28. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, throughout a defined region thereof, each individual bridge connecting different adjacent points; an electrically-operated motor device included serially in each bridge; a plurality of pairs of contact-points in the remaining region of the endless coil, one point of each pair being on one of the

turns of the endless coil and the other point on the other turn and adjacent to the first point; the said remaining region being constructed of material of a resistance high compared to that composing the bridge-connected region; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of current between its related pair of contact-points, substantially as described.

29. In a selective system, an external line consisting of a conductor in an endless coil of two turns; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the respective turns of the endless coil; an electrically-operated motor device included serially in each bridge; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means for looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the looped-in pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge, substantially as described.

30. In a selective system, an external line consisting of two limbs or wires, each forming normally a closed loop; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the line-wires; an electrically-operated motor device included serially in each bridge; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means for cross-looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the cross-looped pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge, substantially as described.

31. In a selective system, an electric circuit having derived branches in multiple, a source of current, a plurality of bridges between the derived branches, an electromagnet included serially in each bridge, 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.

32. In a selective system, an electric circuit having two derived branches in multiple, said derived branches forming a loop, a source of current, a plurality of permanent bridges across the loop, an electromagnet included serially in each bridge, and means for adjusting the ratios of the resistances along the branches respectively from their dividing-point to the extremities of any selected bridge, to produce an equality of potential at such extremities, substantially as described.

33. In a selective system, the combination of a loop, a plurality of pairs of current-supplying contact-points at intervals along said loop, a plurality of bridges across the loop, an electromagnet included serially in each bridge, said bridges having the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge is connected to said loop at points of equal potential respecting its said related pair of contacts considered respectively as the points of entrance and egress of an electric current, said connecting-points being located around the loop in alternation with the individual points of said related pair of contacts, substantially as described.

34. In a selective system, a loop, a plurality of bridges across the loop, an electromagnet included serially in each bridge, a plurality of pairs of contact-points along said loop, means for applying current to any such pair of contact-points, the bridges having the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins the loop at points where the current from its related pair of contacts is of equal potential, said joining-points being located around the loop in alternation with the individual points of said related pair of contacts, substantially as described.

35. In a selective system, a loop comprising four segments; a plurality of bridges connect-

ing two non-consecutive segments; an electromagnet included serially in each bridge; a plurality of pairs of contact-points, one point of each pair located on one of the non-bridge-connected segments and the other point on the other non-bridge-connected segment; the bridges being specially related to the pairs of contact-points, each individual bridge to a different pair; means for applying electric current to any desired pair of contact-points; each bridge with respect to its specially-related pair of contact-points being in the definite relation of joining points on the loop which are of equal potential during the passage of a current between its said specially-related pair of contact-points, substantially as described.

36. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, each individual bridge connecting different adjacent points; an electromagnet included serially in each bridge; a plurality of pairs of contact-points, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of a current between its related pair of contact-points, substantially as described.

37. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, throughout a defined region thereof, each individual bridge connecting different adjacent points; an electromagnet included serially in each bridge; a plurality of pairs of contact-points in the remaining region of the endless coil, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of a current between its related pair of contact-points, substantially as described.

38. In a selective system, a single loop doubled into an endless coil of two turns, adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple; a plurality of bridges connecting adjacent points in the respective turns of the endless coil, throughout a defined region thereof, each individual bridge connecting different adjacent points; an electromagnet included serially in each bridge; a plurality of pairs of contact-points in the remaining region of the endless coil, one point of each pair being on one of the turns of the endless coil and the other point on the other turn and adjacent to the first point; the said remaining region being constructed of material of a resistance high compared to that composing the bridge-connected region; means for applying electric current to any one pair of contact-points; the bridges being in the definite relation to the pairs of contact-points, each individual bridge to a different pair, that each bridge joins points on the loop which are of equal potential during the passage of current between its related pair of contact-points, substantially as described.

39. In a selective system, an external line consisting of a conductor in an endless coil of two turns; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the respective turns of the endless coil; an electromagnet included serially in each bridge; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means for looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the looped-in pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loops which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge, substantially as described.

40. In a selective system, an external line consisting of two limbs or wires, each forming normally a closed loop; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the line-wires; an electromagnet included serially in each bridge; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means for cross-looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having

the respective turns of the external line located alternately with the respective local conductors of the cross-looped pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge, substantially as described.

41. In a selective system, a selectively-actuated deflecting member, electrical means for selectively actuating said deflecting member, a movable switch member, the said members having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position prevents the effective operation of said movable switch member, substantially as described.

42. In a selective system, a selectively-actuated deflecting member, electrical means for selectively actuating said deflecting member, a movable switch member, the said members having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position mechanically blocks the effective operation of said movable switch member, substantially as described.

43. In a selective system, a selectively-actuated deflecting member, electrical means for selectively actuating said deflecting member, a non-selective means for retaining the selectively-actuated deflecting member in deflected position, a movable switch member, the said members having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position prevents the effective operation of said movable switch member, substantially as described.

44. In a selective system, a selectively-actuated deflecting member, electrical means for selectively actuating said deflecting member, a non-selective means for retaining the selectively-actuated deflecting member in deflected position, a movable switch member, the said members having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position mechanically blocks the effective operation of said movable switch member, substantially as described.

45. In a selective system, two deflecting members, one of which is selectively actuated, the other being capable of assuming an effective relation with respect to a local operating device, electrical means for actuating said selectively-actuated member, electrical means for controlling the actuation of the other member, the said members being so disposed that the selectively-actuated deflecting member in non-deflected position relates itself to the other member to permit the latter on deflection to assume its effective relation, but in deflected position relates itself to the other member to prevent the latter on deflection from assuming its effective relation, substantially as described.

46. In a selective system, two deflecting members, one of which is selectively actuated, the other being capable of assuming an effective relation with respect to a local operating device, electrical means for actuating said selectively-actuated member, electrical means for controlling the actuation of the other member, the said members being so disposed that the selectively-actuated deflecting member in non-deflected position relates itself to the other member to permit the latter on deflection to assume its effective relation, but in deflected position mechanically blocks the latter on deflection from assuming its effective relation, substantially as described.

47. In a selective system, the combination of a loop adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple, a plurality of pairs of current-supplying contact-points at intervals along said loop, a bridge across the loop intermediate of the respective points of each pair of contact-points, said bridge having the definite relation to one of said pairs of contact-points, that said bridge is connected to said loop at points of equal potential with respect to its said related pair of contact-points considered respectively as the points of entrance and exit of an electrical current, whereby it is neutral on the passage through the loop of current from its related pair of contact-points, but is active on the passage of current from every other pair of contact-points, an electrically-operated motor device included serially in said bridge, a motor-electromagnet external to said bridge and controlled by said motor device, being non-effective when the bridge is active, but being effective when said bridge is neutral, substantially as described.

48. In a selective system, the combination of a loop adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple, a plurality of pairs of current-supplying contact-points at intervals along said loop, a bridge across the loop intermediate of the respective points of each pair of contact-points, said bridge having the

definite relation to one of said pairs of contact-points, that said bridge is connected to said loop at points of equal potential with respect to its said related pair of contact-points considered respectively as the points of entrance and exit of an electrical current, whereby it is neutral on the passage through the loop of current from its related pair of contact-points, but is active on the passage of current from every other pair of contact-points; an electrically-operated motor device included serially in said bridge; a motor-electromagnet external to said bridge, in series in the loop, and controlled by said motor device, being non-effective when the bridge is active, but being effective when said bridge is neutral, substantially as described.

49. In a selective system, a selectively-actuated deflecting member, electrical means for selectively actuating said deflecting member, a non-selective means capable of successive actuation to retain the selectively-actuated deflecting member in deflected position, and to release it from deflected position, a movable switch member, the said members having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position prevents the effective operation of said movable switch member, substantially as described.

50. In a selective system, a seclectively-actuated deflecting member, electrical means for selectively actuating said deflecting member, a non-selective means capable of successive actuation to retain the selectively-actuated deflecting member in deflected position, and to release it from deflected position, a movable switch member, the said members having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position mechanically blocks the effective operation of said movable switch member, substantially as described.

51. In a selective system, two deflecting members, one of which is selectively actuated, the other being capable of actuation to an effective relation with respect to a local operating device, and of further actuation to terminate such effective relation, electrical means for actuating said selectively-actuated member, electrical means for controlling the actuation of the other member, the said members being so disposed that the selectively-actuated deflecting member in non-deflected position relates itself to the other member to permit the latter on deflection to assume its effective relation, but in deflected position relates itself to the other member to prevent the latter on deflection from assuming its effective relation, substantially as described.

52. In a selective system, two deflecting members, one of which is selectively actuated, the other being capable of actuation to an effective relation with respect to a local operating device, and of further actuation to terminate such effective relation, electrical means for actuating said selectively-actuated member, electrical means for controlling the actuation of the other member, the said members being so disposed that the selectively-actuated deflecting member in non-deflected position relates itself to the other member to permit the latter on deflection to assume its effective relation, but in deflected position mechanically blocks the latter on deflection from assuming its effective relation, substantially as described.

53. In a selective system, an external line consisting of a conductor in an endless coil of two turns; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the respective turns of the endless coil; a motor device comprising a selectively-actuated deflecting member included serially in each bridge; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means including a movable switch member for looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the looped-in pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge; the selectively-actuated deflecting member and the movable switch member at any one station having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position prevents the effective operation of said movable switch member, substantially as described.

54. In a selective system, an external line consisting of a conductor in an endless coil of two turns; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the respective turns of the endless coil; a motor device comprising a selectively-actuated deflecting member included serially in each bridge; a non-selective means for retaining the selectively-actuated deflecting member in

deflected position; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means including a movable switch member for looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the looped-in pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge; the selectively-actuated deflecting member and the movable switch member at any one station having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position prevents the effective operation of said movable switch member, substantially as described.

55. In a selective system, an external line consisting of a conductor in an endless coil of two turns; a plurality of stations on said external line; a permanent bridge at one or more of said stations in multiple between the respective turns of the endless coil; a motor device comprising a selectively-actuated deflecting member included serially in each bridge; a non-selective means capable of successive actuation to retain the selectively-operated deflecting member in deflected position, and to release it from deflected position; a pair of local conductors at one or more of said stations, of specific resistance high compared with the external line; means including a movable switch member for looping any one pair of said local conductors into the external line to form a resultant single loop arranged in an endless coil of two turns having the respective turns of the external line located alternately with the respective local conductors of the looped-in pair; each pair of local conductors carrying a plurality of pairs of contact-points, one contact-point of each pair of contacts being on one of the said local conductors and the other point on the corresponding local conductor; a source of current at each station respectively with terminals adapted to be connected selectively with any pair of the contacts located on the local conductors at that station; the location of the pairs of contacts being predetermined, each pair respectively with the special relation exclusively to the bridge at a selected station, that said bridge joins points on the loop which are of equal potential under the conditions of the passage of a current between the contact-points of the pair specially related to said bridge; the selectively-actuated deflecting member and the movable switch member at any one station having the relation that the selectively-actuated deflecting member in non-deflected position permits the effective operation of the movable switch member, but in deflected position prevents the effective operation of said movable switch member, substantially as described.

56. In a selective system, the combination of a loop adapted to be interposed in an electric circuit and to constitute derived branches thereof in multiple, a plurality of pairs of current-supplying contact-points at intervals along said loop, a bridge across the loop intermediate of the respective points of each pair of contact-points, said bridge having the definite relation to one of said pairs of contact-points, that said bridge is connected to said loop at points of equal potential with respect to its said related pair of contact-points considered respectively as the points of entrance and exit of an electrical current, whereby it is neutral on the passage through the loop of current from its related pair of contact-points, but is active on the passage of current from every other pair of contact-points; means for applying electric current to any one pair of contact-points; a motor device comprising a selectively-actuated deflecting member included serially in said bridge; a second deflecting member external to said bridge, capable of actuation to an effective relation with respect to a local operating device, and of further actuation to terminate such effective relation; electrical means for controlling the actuation of such second deflecting member; the said deflecting members being so disposed that the selectively-actuated deflecting member in non-deflected position relates itself to the other member to permit the latter on deflection to assume its effective relation, but in deflected position relates itself to the other member to prevent the latter on deflection from assuming its effective relation, 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.