

No. 641,743.

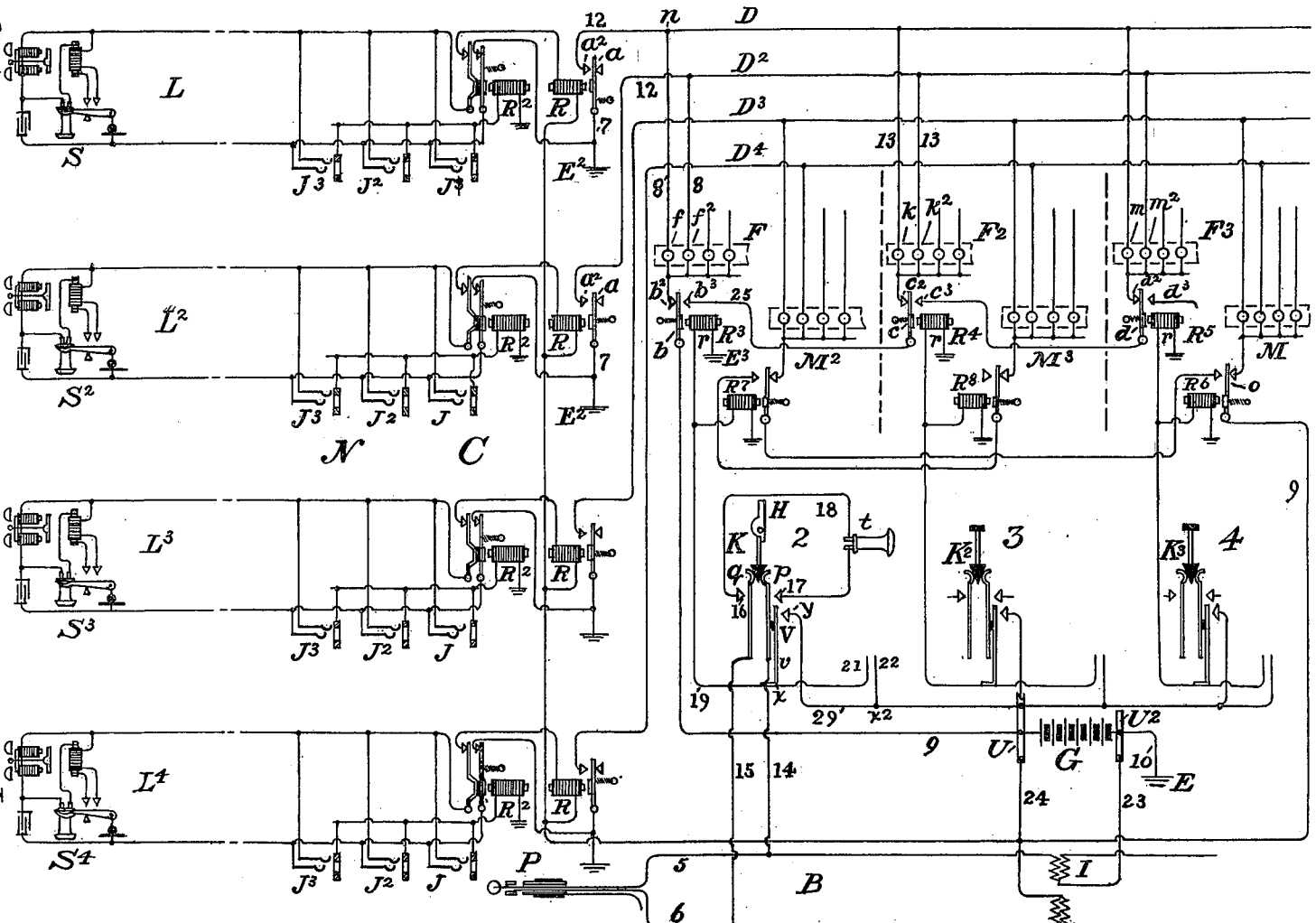
Patented Jan. 23, 1900.

T. C. WALES, JR.

TELEPHONE SWITCHBOARD APPARATUS AND APPLIANCE.

(Application filed July 5, 1899.)

(No Model.)



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TELEPHONE-SWITCHBOARD APPARATUS AND APPLIANCE.

SPECIFICATION forming part of Letters Patent No. 641,743, dated January 23, 1900.

Application filed July 5, 1899. Serial No. 722,838. (No model.)

To all whom it may concern:

Be it known that I, THOMAS C. WALES, JR., residing at Newton, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Telephone-Switchboard Apparatus and Appliances, of which the following is a specification.

This invention relates to the switchboard apparatus and appliances of telephone-exchange central stations, and with greater particularity concerns the structure and arrangement, in association with the switchboard, of the call-signal devices with which the several convergent subscribers' lines or substation-lines are provided for the purpose of calling the attention of the central-station operators preparatory to a request that the calling line shall be switched to some other substation-line for through telephonic communication.

It has been customary to divide up the switchboard (and more especially the multiple switchboard) into any required number of sections or operators' positions, placing at each such position the call-signal devices and answering-jacks or like switch devices of a definite portion of the whole number of entering lines, the lines answered at each position being, however, provided with switch devices at the other positions, so that when called for by any other line at any position it shall be accessible there. By this plan it will be seen that the call receiving and answering devices are divided between the switchboard-sections or operators' positions.

It is highly desirable that the work of the central station in making the required manipulations of the substation-lines shall be equitably distributed between the several operators' positions, as otherwise some of the operators are overworked, while others have relatively little to do; but it has been found that even when the lines are divided equally or evenly between the operators' positions, the business originated by them runs so irregularly that it is difficult, and, indeed, well nigh impossible, to properly or satisfactorily equalize the work, and in consequence of this there is frequently at some of the positions considerable delay or lag, attributable to the circumstance that the calls received

from the substations whose lines are answered at such positions are temporarily in excess of the operator's facilities for or capabilities of answering.

The objects of this invention are to provide that call-signals which otherwise would be answered at a given position of the switchboard shall, if the operator there be already engaged in answering a previous call, be automatically transferred to another position where the operator is disengaged, to insure that no second call-signal shall be received at any operator's position until a prior one shall have been disposed of and until the operator there is ready to devote to it her exclusive attention, and consequently to automatically effectuate an equal and equitable distribution of the incoming call-signals between the operators or operators' positions. To this end the substation-lines connected with the switchboard are provided not only with their regular and ordinary call-signal device, placed at some one of the switchboard-sections or operators' positions, but also with one or more additional signal-receiving devices placed at other operators' positions, and a circuit-controlling relay or electromagnetic switch controlled by a circuit-closer comprised in the telephone connecting or listening key or keys at each position constitutes means for making the requisite withdrawal of the signaling-current from the set of signals at an operator's position which is already occupied and for its transfer to the first position which for the moment is disengaged.

The invention comprises, moreover, certain detailed arrangements of the several circuits and instrumentalities involved, whereby it is enabled the more practically and certainly to carry out the purposes for which it is designed, these being pointed out and particularly specified in the claims which follow at the close of this specification.

To facilitate definition and reference I characterize the more ordinary and regular call-signal device by the term "primary," and I employ the various terms "auxiliary," "supplementary," "alternative," and "secondary" to characterize the additional signal devices in their various relations to the signals of the primary sets.

The drawing accompanying this specification is a diagram illustrating the application of the invention at the central station of a telephone-exchange to a multiple switchboard, four substation-circuits only being indicated.

In the drawing, $L^1 L^2 L^3 L^4$ are subscribers' or substation circuits or lines converging from substations S, S^2, S^3 , and S^4 , respectively, to a multiple switchboard N at a central station C , each circuit being provided at its substation with the standard outfit of telephones and signal appliances.

$J J^2 J^3$ are the switch-sockets or like switch devices of the several circuits, arranged on the multiple switchboard N at the several operators' positions or sections 2 3 4, &c., thereof. The said operators' positions are, however, shown as being separately placed at the right of the drawing in order that the appliances and circuit arrangements more strictly characteristic of my present invention may be indicated with greater clearness and perspicuity than otherwise would be possible. It is to be understood, therefore, that 2, 3, and 4 represent different sections or operators' positions of the switchboard N , that the switch-sockets J of the several substation-circuits are in practice located at the said positions, and that the call-signals of the circuits $L L^2$ are primarily answered at position 2, while those of L^3 and L^4 are primarily answered at position 4. The call-signal-actuating relays of the substation-circuits are indicated by the reference-letter R and their cut-off relays by R^2 , both being arranged in the usual and well-known way.

F is the group or series of primary call-signals (glow-lamps being preferred) at the position 2 of the switchboard, one for each of any desired number of lines— f , for example, being the call-signal of the line L and f^2 that of the line L^2 . These signals depend for their operation on the action of the corresponding signal-relays R and are placed in local circuits $D D^2$, &c., of a source of electricity G , such as a battery.

The circuit D of signal device f , starting from the earth connection E , connects by wire 10 with one pole of the said current-generator G and, passing from the other pole thereof, continues by conductor 9 through the armature and back contacts $b b^2$ of a relay-switch R^3 , to be hereinafter described, to the signal device f , thence by the conductor 8, junction-point n , and conductor 12 to the fixed and movable contacts a^2 and a of the call-relay R of main line L , and, finally, by conductor 7 to the complementary earth or return connection E^2 . The call-signal local circuits of the other main lines having their primary call-signal devices located at position 2, as shown, up to their connection with the group of signals follow the same route, employing the same current-supply conductor 9, leading through the contact-points of relay R^3 ; but each after reaching its particular signal, as

f^2 , then passes by its own separate conductors 8, 12, and 7 and the contact $a^2 a$ of its own call-relay R to the return connection E^2 ; but in addition to the primary call-signal of the series F the substation-line has several alternative or secondary call-signal devices placed at other operators' positions. In the drawing the lines $L L^2$ are shown as being provided with two such secondary signals, placed at the operator's position 3 in a group F^2 and at position 4 in a similar group F^3 . The letters k and k^2 indicate the secondary call devices of lines L and L^2 in the series or group F^2 , and $m m^2$ indicate the secondary call devices of the same lines in the group F^3 at section 4. The secondary signal devices of each substation-circuit are connected in branches 13 from the conductor 12 of their local circuits $D D^2$, &c., and thus sustain the same relation to the contacts of relay R as do the primary signals $f f^2$; but, as will presently be explained, they are not normally in connection with the source of current G or with the current-supply conductor 9 thereof. Hence under normal conditions should a substation S or S^2 transmit a call to the central station C the primary signal devices of the group F only will be operated, and the said call will be manifested at switchboard section 2 alone.

Each operator's position of the switchboard is provided with a number of switchcords, each fitted at both ends with suitable switch-plugs adapted for insertion in the switch-socket devices J of the several lines and for engagement with the switch-conductors thereof, there being, as usual, three cord-and-plug conductors, two of which (represented by the two forward conducting-surfaces of the plug) are for main-conductor connections and one (represented by the hindermost plug-conductor) for connection with the test ring or frame of the switch-sockets, whereby in a multiple switchboard the busy-test is established and the cut-off relay R^2 vitalized.

B represents a portion of one of the group of switch-cords located at the section 2. P is the answering switch-plug thereof, and 5 and 6 the main-line cord-conductors. The local cord-conductor having no relation to the present invention is merely indicated.

$K K^2 K^3$ are appliances known in the art as "listening" or telephone keys, one listening-key being associated with each switch-cord at each operator's position. In the drawing the listening-keys K, K^2 , and K^3 are assumed to be placed at the operators' positions 2, 3, and 4, respectively. Each has conductors 14 and 15, extending from the respective main conductors 5 and 6 of the cord and terminating within the key in contact-springs p and q , which normally have no conductive connection with each other.

t is a receiver representing the usual telephone instruments of the operator and is placed in a loop 18, having terminal points 17 and 16 within the range of the key-springs p and q . When the cam or button H of the

key K is depressed, the springs p and q are forced into contact with the said points 17 and 16, and the telephones are thus brought into a closed bridge connection between the conductors 5 and 6 of the switch-cord. A special circuit-closer V, shown as consisting of a contact-spring v or other movable element and a normally-severed contact-point y or fixed element, is associated with the listening-key K, acting, when the same is depressed, to bring the said severed element into contact to close a circuit within which they are included, and when the cam is again elevated to permit the said elements once more to separate. The springs v may be mechanically and rigidly attached to the key-springs, but insulated therefrom, as shown, and the point y may be suitably supported in any preferred way in the frame of the listening-key. The circuit-closer spring v is attached to conductor 19, and the point y is directly united to conductor 29, and by way of the bus-bar U with the current source G.

It is obvious that I am not in any way restricted to any special form of listening-key, and that any preferred form of key or switch capable of switching the operators' telephones into and out of connection with the switch-conductors and which is capable of having associated with it any such circuit-closing device as that described may be employed.

U and U² are bus-bars for the two poles of the current source G, and, if desired, the same source by means of conductors 23 and 24 may be utilized to supply current through the regular repeating-coil I to the switch-cord conductors 5 and 6, and thereby to the usual main-circuit transmitters and supervisory signals.

R³, R⁴, and R⁵ are circuit-controlling relays or electromagnetic switches, whereby under appropriate conditions the signaling-current may be withdrawn from the primary signal devices and transferred to the secondary signal devices of the same group of lines at a disengaged operator's position, and whereby therefore an incoming call-signal may be transferred from the primary signal device to some one of the supplementary signals of the same line at the position of a different operator, so that by means of the said circuit-controllers it becomes feasible to automatically distribute the call-signals received from the subscribers' lines with substantial equality between the operators' positions, where their several signal devices are respectively placed. The said circuit-controlling relays each comprise an electromagnet r , forming the actuating member thereof, an armature therefor forming the active or switching member, and the front and back limit-stops of the said armature, serving as switch-contacts.

It will be observed that the magnet r of the circuit-controlling relay R³ is in the local circuit 19, extending from the bus-bar U of the current source G, through the circuit-closer V of the listening-key K at the operator's po-

sition 2, and through the said magnet to the earth or return connection E³. The magnets r of the other circuit-controlling relays R⁴ and R⁵ are similarly connected in other local circuits 19, leading through their circuit-closers associated with their respective listening-keys K² K³. The said magnets therefore become excited only when the listening-keys at their respective operators' positions are depressed.

The armature b of the relay R³ rests normally against its back contact b^2 , thus supplying current to the primary signal devices F to be made available for the manifestation of a signal when the line-relay R of any of the said devices is operated. The front contact b^3 is united by conductor 25 to the armature c of the relay-switch R⁴ next in succession, so that when attracted by its magnet the armature b of the first relay swings over, the supply-conductor 9 is switched from the primary signals F to the first series of secondary signals F², the armature c being connected with these, as in the first instance, through its back contact connection c^2 . If a call-signal should now come in, the primary signal F could not operate, since no current would be supplied to it; but the corresponding signal device of the group F² would take its place and the call would be received and answered by the operator at position 3. In the same way the armature d^3 of the circuit-controlling relay R⁵ has a permanent connection with the forward contact of relay R⁴, its rear contact d^2 connects with the secondary signals F³, and its forward contact makes connection with the armature of a fourth relay, if the series is continued further.

The incomplete branch conductors 21 and 22, extending from points x of conductor 19 and x^2 of conductor 29, respectively, at each operator's position, are intended to indicate that at each such position there is a plurality of listening-keys, each having its special circuit-closer V, and that the several circuit-closers of the keys at each position are in parallel with one another and all adapted to determine the action of the circuit-controlling relay of the position.

It will now be apparent that the several substation-circuits are provided with signal devices at a definite operator's position, where primarily the calls of the circuit are answered, with a succession of one, two, or more secondary and alternative signal devices at other positions, each designed to be brought into operation when the operator in charge of the preceding signal of the series is busy, so that any call thus transferred may invariably be received by an operator who is at leisure and thus be answered with promptness, with automatic electromagnet-actuated switches associated with the said primary and several secondary sets of signal devices for the purpose of automatically effectuating the said transfers as they become necessary, and means actuated by the use of the listening-key at any

operator's position for operating the said automatic switch. In the operation of these instrumentalities we may suppose that substation S of circuit L has sent a call to the central station C and that the operator at the position 2 is not busy—that is, none of the listening-keys at such position are in operation. The call in this case is manifested by the signal device *f* of the primary set F in the usual way, because current is supplied to all the signals of said set by the supply-conductor 9 through the contact of the switch-armature *b* with its back stop, and because the call-relay R when excited is thus enabled to complete the circuit of the source G through the said signal device *f*; but the alternative or secondary signals *k* and *m* of the same substation-circuit do not operate, because though they are equally with *f* under the control of the said relay they have no completed connection with the source of current. Consequently the operator at the switchboard position 2 answers the call by plugging into the switch-socket of the calling-line, depressing her listening-key, and taking charge of the desired connection, as usual; but if a call be sent in over any line-circuit of the group while any listening-key at position 2 is depressed no signal can appear at F. For instance, while the call of S is being answered and the key K is in operation the circuit-closer V of such key is actuated and its points *v* and *y* are brought together. This closes a circuit of the source G or of any prearranged generator through the electromagnet *r* of relay R³, which becoming excited moves its armature from its back stop to its front stop, and thus switches the current connection from the signals F of the primary set to the signals F² of the secondary set at position 3, and if a listening-key there is also in operation the current connection is further switched to the signals F³ of the position 4, and so on. If now substation S² of line L² should send a call, it will appear before the operator at the first switchboard position having one of its secondary signals, where no telephone-key is in operation, and will be answered and attended to by the operator there. It is obvious that by multiplying these secondary signals the calls of a definite group of lines may be distributed among as many operators as are desired. It is also evident that should the primary sets of signal devices be all at the same position, or, in other words, should the line-signals all have their direct current connection at the same operator's position—as, for example, has the primary signals F at position 2—by means of the switch-armature *b* the operator at such position will invariably receive the call at all times when there are no listening-keys depressed at such position, and this operator is therefore liable to be worked at a higher rate than the others. To obviate this difficulty, the primary signals of the entering lines may be divided among any desired number of positions. This is indicated

in the drawing, where a portion of the said primary signals are shown as being placed at section 4, the said set of primary signal devices M of this group and the sets of secondary signals M² and M³, placed at sections 2 and 3, respectively, being arranged in a second bank or row and organized to be under the control of another set of circuit-controlling relays R⁶, R⁷, and R⁸, whose magnets are connected in parallel with those of the relay-switches of the first group in the same circuits and governed by the same listening-key-circuit closers at their respective positions. In this case the armature *o* of the relay R⁶ has the direct current connection 9, relays R⁷ and R⁸ following in the order named. It will be seen that for this portion of the lines (represented by substation-circuits L³ L⁴) the tendency is to give the larger portion of the work to the operator at position 4. Manifestly, then, if still other portions of the total number of lines have their primary signal devices placed at position 3 and other portions placed at such other positions as may in practice compose the switchboard it becomes possible to obtain an extremely even distribution of the central-station work.

An incidental advantage accruing from my system of transferring calls is that by such an arrangement it becomes possible to concentrate the entire work of the central station upon two or three adjacent sections, for by keeping depressed the listening-keys at any desired number of the switchboard-sections the incoming calls are forced to manifest themselves at the sections where the said listening-keys are not depressed or operated, and the calls coming in may thus be distributed between a very few operators. A convenient and satisfactory mode of handling the business of the station during the hours when little is going, as during the night and on Sundays and holidays, is thus afforded.

I claim—

1. The combination substantially as set forth, in a telephone-exchange, of a multiple switchboard; a substation-circuit provided with a switch device at a plurality of the sections or operators' positions of the said switchboard; and the ordinary or primary call-signal-receiving device at one of the said positions; an auxiliary or supplementary signal-receiving device for the said substation-circuit at another of the said positions; and means for the automatic transfer of an incoming call-signal from the said primary to the said supplementary signal device, when the operator at the position of the former is busy.

2. In a telephone-exchange, the combination of a switchboard; and a number of subscribers' lines connected with, and represented by switch devices at the several operators' positions of the said switchboard; with a plurality of call-signal-receiving devices for each of the said subscribers' lines, associated with the said switchboard, the said signal devices

being located at different operators' positions; and means for automatically distributing the call-signals received from the said subscribers' lines with substantial equality between the operators' positions at which their signal devices are respectively placed; substantially as set forth.

3. The combination in the switchboard apparatus of a telephone-exchange, of a series of main substation-circuits having switch devices at each of a number of sections or operators' positions of the said switchboard; a listening or telephone-connecting key at each section, adapted for temporary connection with any main circuit by means of the switch devices thereof; and a series of regular or primary call-signal-receiving devices for the said main circuits respectively, at some one of the switchboard-sections; with an alternative series of call-receiving devices for the same main circuits; a current-supply conductor with alternative branches to the said two series of signals respectively; an automatic electromagnetic switch adapted to transfer the said conductor from either of the said branches to the other, but normally maintaining the connection thereof with the branch leading to the signals of the primary series; and a circuit-closer associated with and actuated by the said listening-key and controlling the circuit of the said electromagnetic switch; substantially as and for the purposes specified.

4. The combination in a telephone-exchange call-transfer system, of a multiple switchboard; a series of substation-circuits respectively provided with switch devices at the several sections of said switchboard; a listening or telephone-connecting key at each section, and a local-circuit closer associated therewith, and actuated by the operation thereof; a primary group of call-signal devices for a portion of the said substation-circuits, placed at some one section of the said switchboard; alternative groups of call-signals for the same lines at other sections of the said switchboard; a conductor normally connecting a source of current-supply with the signal devices of the first group; a normally discontinuous extension thereof leading to the signals of the several alternative groups successively; a series of automatic switches for the primary and alternative groups of signals respectively, each normally in a position to unite the supply-conductor or its extension with the signals of its group, and each adapted when operated, to move to a second position, and thereby to render the said supply-conductor continuous to the switch and group of signals next in succession; and an electromagnet for each of the said switches, each in the local circuit controlled by the circuit-closer of the listening-key of its own section; substantially as and for the purposes described.

5. In a telephone-exchange, a switchboard comprising several operators' positions; substation-circuits divided into groups, each group having for each of its members a pri-

mary call-signal device at a different one of the said operators' positions, a secondary call-signal device at each of the several other operators' positions at which are placed the primary call-signals of the other groups, and a switch device at all of the said positions; and a source of signaling-current in normal conductive relation at each position with the primary signal devices thereof; combined with a telephone-key adapted for connection with any substation-circuit by means of the switch devices thereof; and having a special circuit-closer attached thereto and actuated thereby at each position; a circuit-controlling relay having its armature directly connected with the said source, associated with the primary signals of each group; and a succession of normally-disconnected subordinate circuit-controlling relays, one for each set of secondary signals of the said group, each relay having its actuating-magnet in circuit with and responsive to the operation of the special circuit-closer of the telephone-key at its particular operator's position, each subordinate relay having its armature connected with said source, only through, and after the operation of all preceding relays of the series, and each of the said relays being adapted on and by means of the attraction of its armature, to transfer such connection with the said source from its own set of signals, to the circuit-controlling-relay armature of the next set; whereby the incoming calls of any substation-circuit may be automatically transferred to the first switchboard position of any series having no telephone-key in use; and whereby the calls from the substation-circuits may be evenly distributed between the operators' positions.

6. The combination substantially as hereinbefore described, of a switchboard comprising several operators' positions; substation-circuits divided into groups, each group having for each of its members a primary call-signal device at a different one of the said operators' positions, and a switch device at all of the said positions; a source of signaling-current for the operation of said signal devices; and a telephone or listening key adapted for connection with any substation-circuit by means of the switch devices thereof; with a set of secondary signal devices for each group, one for each member thereof at each of the several other operators' positions at which the primary call-signals of the other groups are located; a special circuit-closer attached to the telephone-key at each operator's position and actuated to close a local circuit by the operation thereof; and a series or succession of circuit-controlling relays for each group, one for each set of primary and secondary signals thereof, the armature of the primary signal-relay being in direct connection with the source of current, the armature of each of the others being united with the front armature-contact of the one preceding it; the back contact of the ar-

matures of each being in connection with the associated set of signals; and the electro-magnet of each being in the local circuit controlled by the special circuit-closer of the
5 telephone-key at the same operator's position; substantially as, and for the purposes set forth.

In testimony whereof I have signed my

name to this specification, in the presence of two subscribing witnesses, this 29th day of 10 June, 1899.

THOMAS C. WALES, JR.

Witnesses:

GEO. WILLIS PIERCE,
KATHARINE DUFEE.