H. G. WEBSTER.

TELEPHONE SYSTEM.

APPLICATION FILED DEC. 19, 1902.

941,666. Patented Nov. 30, 1909.

3 SHEETS—SHEET 1.

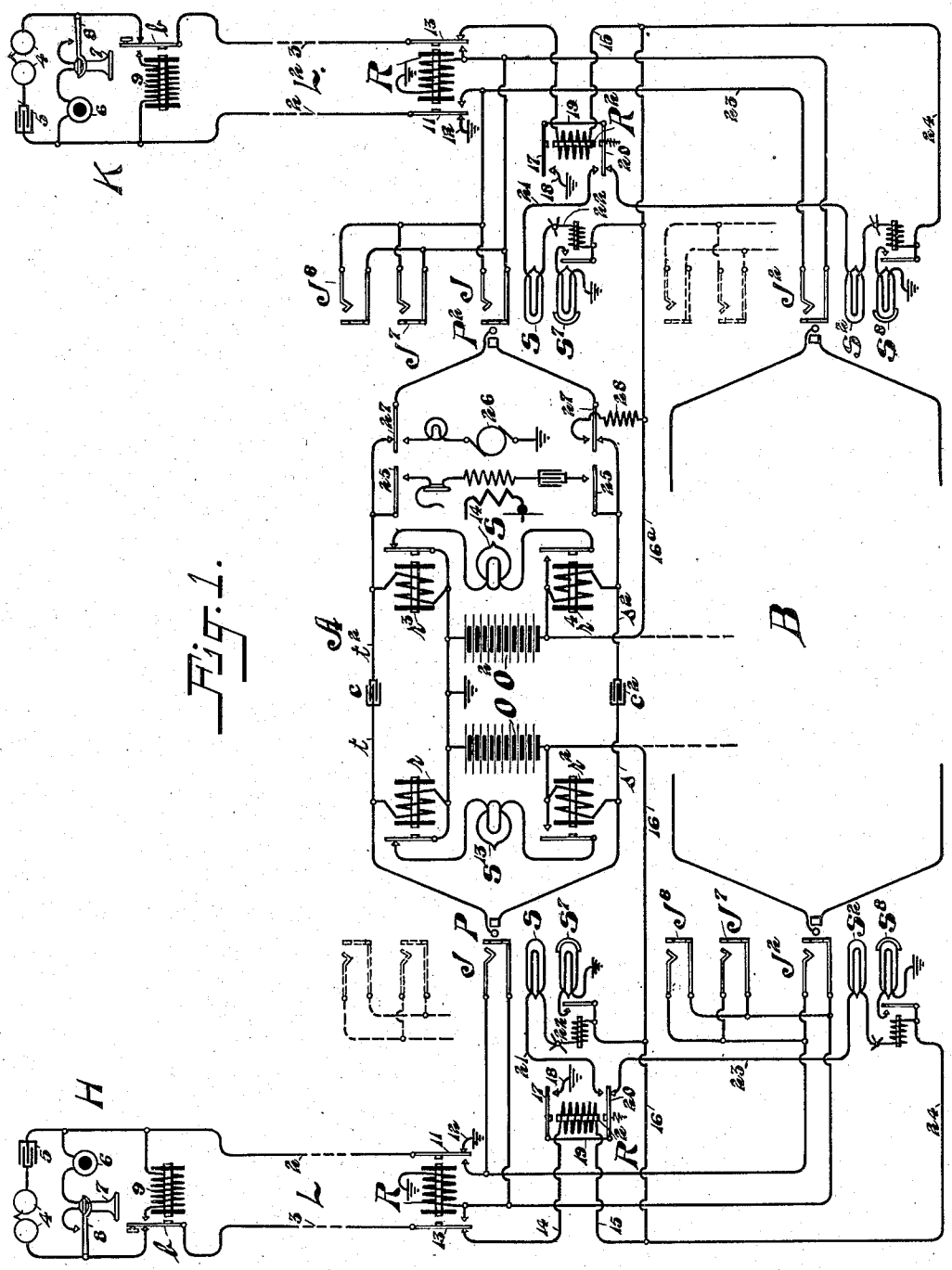

Fig. 1.

Witnesses.

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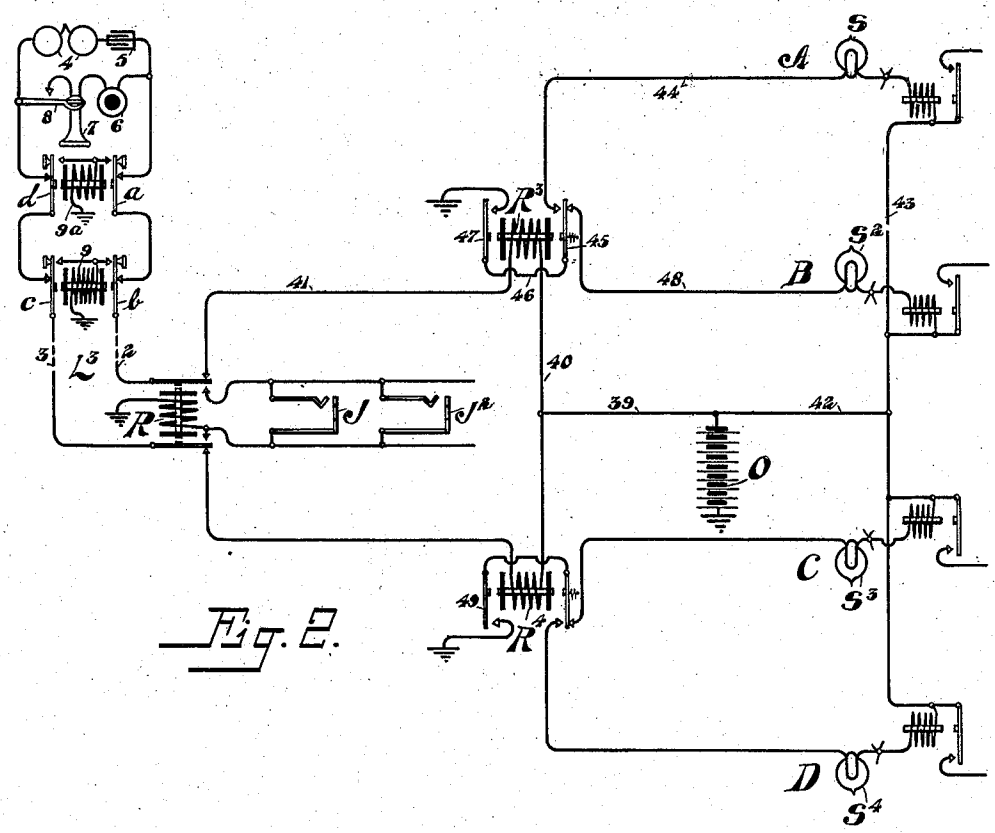

Fig. 2.

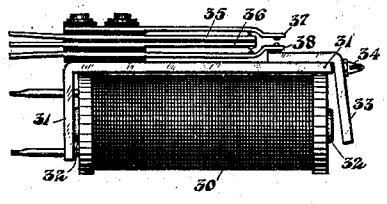

Fig. 3.

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3 SHEETS—SHEET 3.

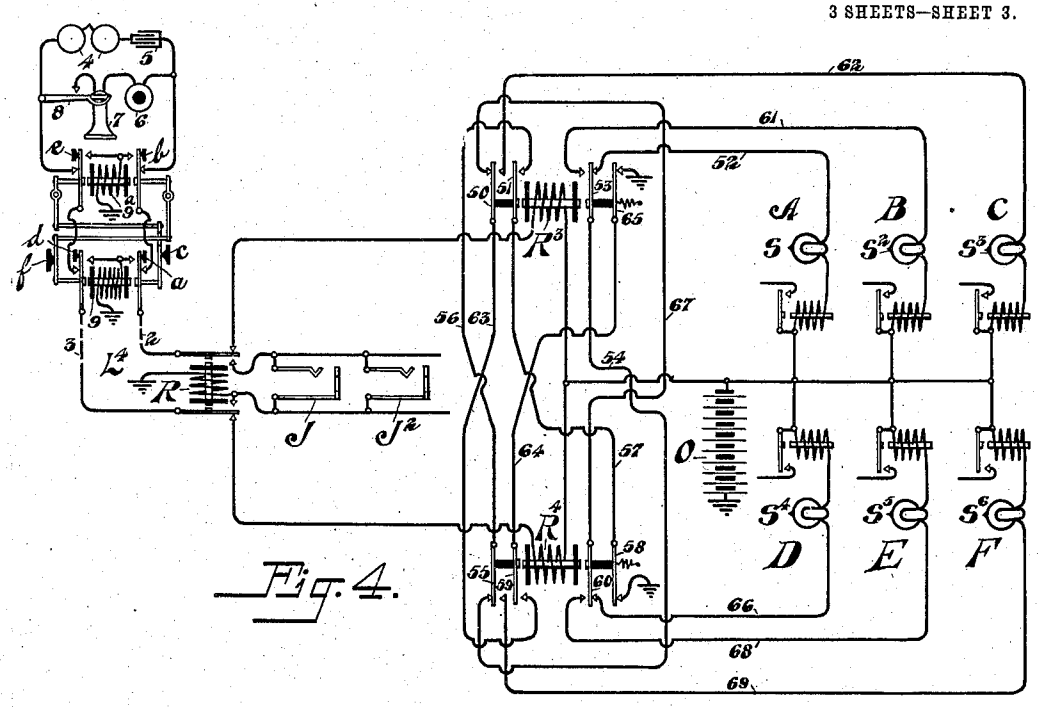

Fig. 4.

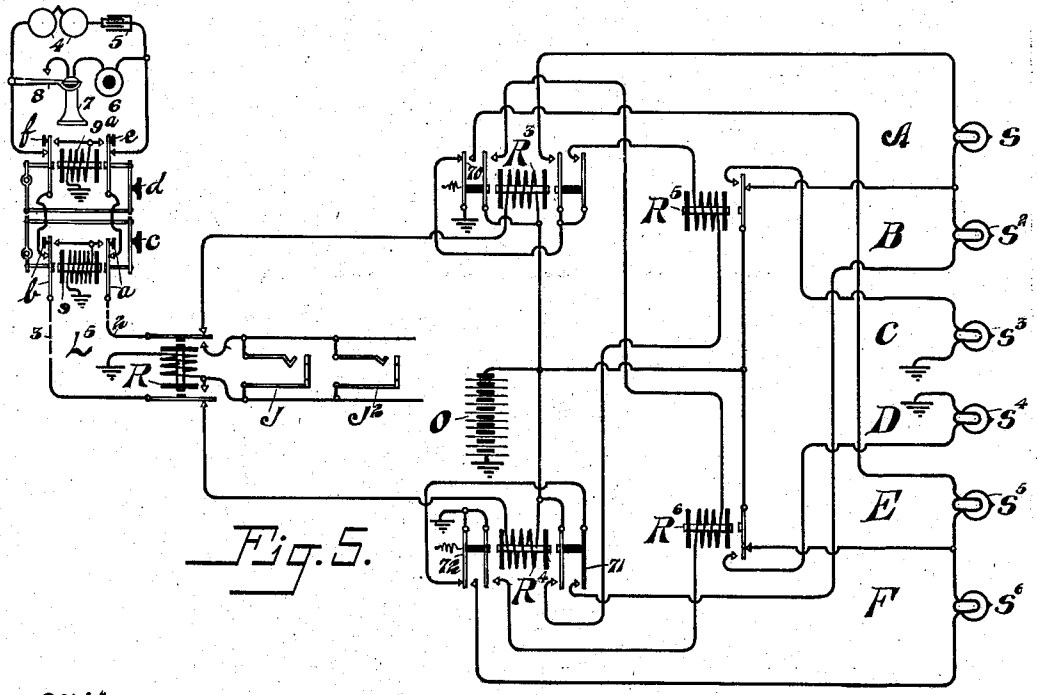

Fig. 5.

Witnesses.

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UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

941,666. Specification of Letters Patent. Patented Nov. 30, 1909.

Application filed December 19, 1902. Serial No. 135,891.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, and resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems, and more particularly of the divided central type. In this class of systems the lines are each provided with signals upon the different divisions of the switchboard and the subscriber is furnished with means for selectively operating the said signals. By thus being able to call the different sections of the switchboard, the multiple jacks for each line need not be as many as where the straight multiple board system is used. A considerable reduction in the expense of the installation thus results.

My invention has for its objects to provide a system of this type, which shall be comparatively simple, and which is sufficiently elastic to permit its application to two-division, four-division, six division and even eight division switchboards, I preferably accomplish these results by providing central office call responsive devices, that are responsive to signaling currents of different strengths and by providing the subscriber with means at his disposal for sending over the line the proper currents to suitably actuate said devices.

In the accompanying drawing in which the same reference characters are used throughout to designate like parts, Figure 1 is a diagram of the telephone system embodying my invention as applied to a two-division system; Fig. 2 is a similar view showing the improvements in their application to a four-division system; Fig. 3 is a view of the relay that I prefer to use in these systems; Fig. 4 is a diagrammatic view of a six-division system, and Fig. 5 is a modification of the six-division system of Fig. 4.

Referring to Fig. 1, L and L^2 indicate two subscribers' lines extending from their respective sub-stations H and K to the central office. At the substation the said conductors 2 and 3 are normally and preferably permanently bridged by a call bell 4 and condenser 5, while the transmitter 6 and receiver 7 are adapted to be connected in a bridge of the line conductors when the said receiver is removed from the switch-hook 8. This bridge is designed to be of comparatively low resistance. A high resistance magnet 9 is shown permanently connected with one line conductor and to have its circuit completed across the line by the key *b* when depressed, which also opens the other line conductor. Pressure upon the key *b* serves therefore to close a high resistance path across the line, which is maintained closed by the magnet 9 until current is removed from the line. The talking instruments here shown are intended to typify any suitable common battery outfit.

The switchboard at the central office is divided into two divisions which may be designated as the A division and the B division. The line is provided with a signal S in one division and a similar signal S^2 in the other division, suitable pilot signals S^7 and S^8 being also provided for each operator's position. Adjacent each line signal an answering jack such as J or J^2 is provided and a suitable number of multiple jacks, such as J^7 and J^8 are provided upon one of the divisions. The tip line conductor terminates in a spring 11 of the cut-off relay R, and is normally grounded through branch 12, while its forward contact is connected with the tip contacts of the several jacks. The forward contact of the spring 13 of said cut-off relay is connected with the sleeve conductors of the said jacks, the spring itself being permanently connected with the line conductor 3. The cut-off relay has its winding legged to ground from said jack sleeve conductor. The normal contact of spring 13 is connected by conductor 14 with the winding of the line relay R^2 which is in turn connected by conductor 15 with a bus bar 16 leading to the live pole of the battery O, which is preferably common to the exchange. The relay R^2 is provided with a spring 17 which responds to the magnetization caused by a weak current only. The forward contact of this spring is grounded by branch 18, while the spring itself is conductively joined by conductor 19 with another spring 20 of the said relay which is adjusted to respond only to a strong magnetization of the said relay. The forward contact of this spring is joined by conductor 21 with the individual signal S in the A division of the switchboard, the other terminal of which is connected by conductor 22 through a suitable pilot relay with a battery lead 16. The normal contact of said spring 20 is joined by branch 23 with

the other individual signal S^2, and the opposite terminal of which is conductively linked by conductor 24 with the said battery lead 16, a suitable pilot relay being included in the conductor 24 and serving to control the local circuit of the pilot signal S^8.

While the operator's connective means may be of any desired type, that which I have shown and prefer to employ consists of the plugs P and P^2 having their tip contacts inductively united through the strands t and t^2 and the interposed condenser c, while the sleeve contacts thereof are similarly joined by the strands s and s^2 connected with the opposite plates of the condenser c^2. The battery O is bridged across the answering end of the cord circuit and is provided upon either side with the supervisory relays r and r^2 the former controlling through its normally closed contacts and the latter through its normally open contacts the local circuit of the supervisory lamp S^{13} which is preferably charged from the same battery O. A similar battery O^2 is bridged across the calling end of the cord circuit and includes at either end supervisory relays r^3 and r^4, which similarly control the local circuit of the supervisory signal S^{14}. The operator's outfit is adapted to be bridged across the calling end of the cord circuit by means of the springs 25 of any suitable listening key, while a ringing generator 26 is arranged to be connected with the tip strand t^2 of the cord circuit by means of the springs 27 of any suitable ringing key, while at the same time the sleeve side of the cord circuit is connected through a suitable resistance coil 28 over a suitable lead 16^a to the live pole of battery O^2. This ringing outfit is intended to indicate merely any suitable ringing apparatus and may be replaced by many other styles or arranged for party line ringing. It will be understood that each operator in the A division is provided with any suitable number of cord circuits, while the operators in the B division are likewise supplied with such cord circuits and connective apparatus.

In establishing connections the subscriber H may operate his signal in the B division by pressing the key b. This completes a path for current from the battery O through the high resistance magnet 9, the path for which may be traced as follows: from the live pole of battery O over bar 16, conductor 15, through relay R^2, conductor 14, line conductor 3, through the magnet 9, back to the central office over conductor 2 and ground through 12. Owing to the high resistance of the magnet 9, the line relay R^2 is only slightly energized and only the spring 17 is attracted. This closes a circuit from the battery lead 16, over the said conductor 24, through the pilot relay and the line lamp S^2, conductor 23, spring 20 of relay R^2, conductor 19 leading to the spring 17 and thence to ground through conductor 18. Assuming, however, that subscriber H wishes to connect with another subscriber whose multiple jacks are located upon the A division, he takes up his receiver and thereby closes a low resistance path for current from the battery O through the line relay R^2 and thence through the sub-station apparatus. This increased flow of current causes both armatures of the said relay R^2 to be attracted thereby effecting a closure of the local circuit of the signal S located upon the A division. This circuit may be traced from the live pole of battery O, over conductor 16, conductor 22, through lamp S, conductor 21, spring 20, conductor 19, spring 17 and conductor 18 to ground. The lamp is thus lighted, and the operator responds by inserting the answering plug of her cord circuit in the answering jack J. The subscriber may, for the sake of uniformity, be provided with a separate key to close the low resistance path at his station. The insertion of the plug P directs current from the battery O over the sleeve strand and the sleeve conductor of a jack, through the cut-off relay R to energize the same, and thereby disconnect the relay R^2 to render the line signals inoperative and to connect the jacks with the external line circuit for conversation. Upon learning the order the wanted line is tested by touching the tip of the calling plug P^2 to the test ring of the jack of the wanted line, and if the line is busy a click will be received by the operator, and if not busy no click will be received, all in the ordinary and well understood manner. Upon finding a line idle, the plug P^2 is inserted and the ringing key operated to call the subscriber. As is also well understood by those skilled in the art, the sleeve spring of the ringing key closes an auxiliary path for current from the battery O^2 through the cut-off relay of the called line to maintain the same actuated during conversation, and also to provide a low resistance return path for the ringing current. The operation of ringing and the path for the ringing current varies, of course, according to the apparatus used and the arrangement of the call bells upon the line. After ringing and before the subscriber's response, only the supervisory relay r^4 is operated, so that the supervisory signal S^{14} is lighted, and is only deënergized when the subscriber responds by the actuation of the relay r^3. It should be mentioned that the insertion of the calling plug actuates the cut-off relay for the called line and thereby renders the line signals of that line inoperative during the remainder of the connection. At the termination of the conversation, the opening of the line circuits by the return of the receivers to their hooks cuts off current from supervisory relays r and r^3 with the result that the lamps S^{13} and S^{14}

are lighted. Upon observing this the operator withdraws the plugs and restores all parts to normal condition. During conversation the batteries O and O^2 furnish current over the telephone lines for transmission, as well as for the operation of the various relays associated therewith. It will be understood that the several grounds mentioned are preferably one and the same, or they may be the common office return.

The relay which I prefer to employ is shown in Fig. 3, in which 30 indicates the usual magnet coil, 31 a bar of magnetic material extending alongside of the coil and secured at its rear end to the core 32 of the magnet coil, and carrying at its forward end the bent armature 33 which is adapted to rock upon the edge of said bar 31 as a fulcrum when actuated by the magnetism of the front end of the core 32. A bolt and nut 34 passes loosely through the armature 33 to prevent its getting out of place. A bunched set of springs is secured to the bar 31 and are insulated therefrom and from each other. The two central springs 35 and 36 are comparatively rigid, but the upper spring 37 is flexible and tends normally to engage a spring 35 while the lower spring 38 is normally free from the others. When a weak current traverses the magnet coil, the armature 33 moves only far enough to cause the spring 38 to engage spring 37 but without disengaging the latter from spring 35. Upon the passage of a stronger current, the armature 33 is moved a greater distance and causes the spring 38 to engage spring 36 and to also lift the upper spring 37 out of contact with spring 35. It is thought that this description will fully convey the idea of how the device is to be employed.

Fig. 2 indicates how the invention may be applied to a four-division circuit. The line L^3 is shown terminating in a subscriber's station at one end at which four calling keys *a*, *b*, *c*, *d* are located and at the other end in a four division switchboard upon which the line signals S, S^2, S^3 and S^4 are provided. These signals are controlled through line relays R^3 and R^4 of the type just described with reference to Fig. 1, and as shown in Fig. 3. Any suitable number of jacks, such as J and J^2 are provided for the line, one being located adjacent each signal and the multiple jacks being placed upon one of the divisions. The cut-off relay R is adapted when operated to disconnect said signals and to connect the jacks with the external line circuit. The operation of the key *a* at the sub-station closes a path for current from the battery O, over conductors 39 and 40, through the line relay R^3 and thence by conductor 41 and the tip line conductor through the key *a* and the low resistance magnet 9^a at the sub-station. The key *a* is locked down by the magnet 9^a and owing to its low resistance a comparatively strong current flows over the line, causing both armatures of the relay R^3 to be attracted with the result that a path for current is provided from the battery O over conductor 42, conductor 43, through the pilot relay and the lamp S upon the A division, conductor 44, forward contact and spring 45 of relay R^3, conductor 46, spring 47 and forward contact of said relay and thence to ground, thus lighting the said signal in operating the pilot relay to actuate its signal. The operation of the key *b* at the sub-station closes the same path for current from the battery O, except that it now flows through the high resistance winding of the magnet 9. The current flow is now insufficient to more than pull up the spring 47 of the relay R^3 which serves to close a circuit from the live pole of battery O, over conductors 42 and 43, through the pilot relay and the lamp S^2 and thence by conductor 48, spring 45, branch 46, spring 47, through its forward contact to ground. The insertion of the answering plug of the cord circuit in response to any of these calls serves to actuate the cut-off relay R, thereby momentarily cutting off current from the battery O and allowing the switch at the sub-station to be restored to normal position. Likewise the depression of key *c* at the sub-station closes a high resistance path for current through the line relay R^4, from the battery O, which relay attracts only its armature 49 with the result that the pilot relay and the line signal S^3 are operated. The actuation of key *d* at the subscriber's station, serves to close a low resistance path through the said line relay R^4, which owing to the increased current through its winding, attracts both armatures and closes the local circuit of the line signal S^4 and its associated pilot relay located upon the D division of the switchboard. The keys *a*, *b*, *c*, and *d* are arranged to be irresponsive to the attraction of the magnets 9 and 9^a until manually brought into their forward positions whereby the actuation of one of the keys does not result in the attraction of the opposite key. It will be understood that the central office apparatus may be the same as that described for Fig. 1 and that the arrangement of the pilot lamps and the connecting jacks may also be similar to those shown in Fig. 1 but are not shown in detail in this figure to prevent complication.

Fig. 4 shows how this system may be arranged to selectively operate individual line signals located upon the several divisions of a six-division switchboard. For this purpose the keys *a* and *b* are arranged to connect the tip conductor 2 of the line with either the high resistance coil 9 or low resistance coil 9^a; keys *d* and *e* are arranged to similarly connect the sleeve conductor 3 of the line with the said coils; key *c* is arranged as

shown to connect the tip conductor through the high resistance coil and the sleeve conductor through the low resistance coil when it is depressed, and the key *f* serves similarly to connect the sleeve conductor through the high resistance and the tip conductor through the low resistance. The two line relays R^3 and R^4 are provided with additional sets of contacts, those on the right side requiring a stronger current through the magnet for their operation as is intended to be indicated by the coiled tension springs affixed thereto. A depression of key *a* connects the tip conductor through the high resistance coil 9 and thereby serves to operate only the contacts 50 and 51 of the line relay R^3. This closes a path for current from the battery O through the pilot relay and line signal S, conductor 52, spring 53 of relay R^3, conductor 54, spring 55 of relay R^4, conductor 56, spring 51 of relay R^3, conductor 57, spring 58 of relay R^4 and thence to ground. The lamp upon the B-division is not operated because its circuit is open at spring 53 of relay R^3; the circuit of lamp S^3 upon the C division is not operated because its circuit is open at spring 59 of relay R^4; the lamp S^4 is not lighted for the reason that its path for current is open at spring 50 of relay R^3; signal S^5 fails to operate because its circuit is broken at spring 60 of relay R^4, and lamp S^6 has its circuit severed at spring 55 of relay R^4. The depression of key *b* connects the tip conductor through the low resistance coil 9^a thereby operating both sets of contacts upon the relay R^3, which results in actuating lamp S^2 by current from the battery O through said lamp, conductor 61, spring 53, conductor 54, spring 55, conductor 56, spring 51, conductor 57, spring 58 and thence to ground. The circuit of lamp S will now be found open at spring 53 of relay R^3, the circuit of lamp S^3 is open at relay R^4, lamp S^4 is prevented from operation by relay R^3, the E lamp has its current path severed also by relay R^4, while the F lamp circuit is also broken at relay R^4. Key *c* when depressed connects the tip conductor through the high coil 9 and the sleeve conductor through a low coil 9^a with the result that only one set of contacts of relay R^3 is operated, while relay R^4 is completely actuated. This actuates the lamp S^3 over conductor 62, spring 50, conductor 63, spring 59, conductor 64, spring 65 and thence to ground. The circuits of all of the other lamps are now open at the springs of said relays R^3 and R^4 as may readily be traced. When push button *d* is operated the sleeve conductor is connected through the high coil to ground and the lamp upon the D section is operated over conductor 66, spring 60, conductor 67, spring 50, conductor 63, spring 59, conductor 64, spring 65 and thence to ground. The other lamps at this time remain dark. Key *e* closes the sleeve conductor of the line through the low coil 9^a, thereby fully actuating relay R^4 and operating the E lamp over conductor 68, spring 60, conductor 67, spring 50, conductor 63, spring 59, conductor 64 and spring 65 to ground. The operation of key *f* at the substation closes the sleeve conductor 3 over the high coil and the tip conductor over the low coil with the result that the F signal operates over conductor 69, spring 55, conductor 56, spring 51, conductor 57 and spring 58 to ground. It will thus be observed that the operation of the keys at the substation selectively operates the signals located upon the six divisions of the switchboard. The remainder of the operation of the system, as well as the arrangement and location of its parts is the same as in the previous figures.

Fig. 5 shows an alternative scheme for operating the signals upon a six-division switchboard, the main difference between this system and that shown in Fig. 4 being that the springs or keys *c* and *d* at the substation are arranged to close both line conductors through the same coil. Key *c* for example, closes both line conductors through the high coil 9, while key *d* closes them through the low coil 9^a. At the central office additional relays R^5 and R^6 are provided, and the sets of contacts upon the left hand side of relays R^3 and R^4 are the ones that require the strong energization of the magnets for their attraction. The operation of push button *a* closes the tip line conductor through the high coil 9 to ground, thus actuating relay R^3. This places the signal to ground through spring 70 thereof. The B lamp is now prevented from operation by relay R^4, the C lamp has its circuit opened at relay R^5, the D lamp circuit is open at relay R^6, the E lamp circuit at spring 70 of relay R^3 and the F lamp circuit at relay R^4. The depression of key *b* closes the sleeve conductor through the same high coil, thus operating only the right hand contacts of relay R^4 which serves to close the contacts of the B lamp through springs 71 and 72 of relay R^4. The operation of key *c* closes both line conductors through the high coil 9 and therefore only partially operates both relays R^3 and R^4. This serves to close the circuit of relay R^5 which in turn closes the break in the circuit of the C lamp which is lighted to indicate a call at this division. The other lamps at this time are prevented from lighting. The operation of key *d* closes both line conductors through the low coil 9^a to completely operate both relays R^3 and R^4. The D lamp is now lighted through the forward contacts of relay R^6 whose circuit is in turn completed by the relays R^3 and R^4. Key *e* closes the tip conductor of the line through the low coil to ground,

thereby completely operating relay R^3 which closes the circuit of the E lamp through spring 70. Key *f* at the sub-station serves when depressed to ground the sleeve conductor through the low coil thereby completely operating relay R^4 and establishing a path for current through lamp S^6 and spring 72 of said relay. The operation otherwise is the same as that previously described. Relays R^3 and R^4 may be the same as that shown in Fig. 3 but with an additional set of springs.

It is obvious that by carrying forward the method above described with reference to switchboards having a different number of divisions my improvements may be adapted to switchboards of a greater or different number than those specifically above described, without departing in any way from the spirit of my invention.

I claim:

1. In a telephone system, the combination with a telephone line, of three or more signals therefor at the central office, a source of current therefor at the central office, electro-magnets at the substation having different resistances, means associated therewith for closing the circuit of said source so as to form paths of different resistances through said electro-magnets, and means for causing signals to selectively respond to the currents through said electro-magnets and remain actuated until said electro-magnets are deënergized, substantially as described.

2. In a telephone system, the combination with a telephone line, of a condenser in the line to prevent the passage of direct current therethrough, a magnet at the substation, two armatures therefor each normally out of the range of its magnetic field, means for bringing either or both of said armatures within the range of the magnetic field and simultaneously closing the circuit through the electro-magnet whereby it is energized to attract and hold either or both of said armatures, and signaling means at the central office differently controlled by the different conditions of said armatures, substantially as described.

3. In a telephone system, the combination with a telephone line, of an electro-magnet at the substation, two switches associated with said magnet, means for maintaining either or both of said switches actuated by current flowing in the line, signals at the central office, and means for selectively operating said signals by each of the said actuations of the switches, and a cut-off relay for the line actuated when connection is established therewith to momentarily open a line circuit and thereby break the circuit through said electro-magnet and release either or both switches then depressed and extinguish the signal then displayed, substantially as described.

4. In a telephone system, the combination with a telephone line, of an electro-magnet at the substation, switches associated with said electro-magnet; signals for said line at the central office selectively operated by the actuation of one or more of said switches, means for maintaining one or more of said switches actuated by current flowing through said magnet and a cut-off relay for the line actuated when connection is established therewith at the central office to momentarily open a line circuit and thereby break the circuit through said electro-magnet, simultaneously effacing the signal and releasing any or all switches then depressed, substantially as described.

5. In a telephone system, the combination with a telephone line, of a condenser in the line to prevent the passage of direct current therethrough, line signals therefor located upon the different sections of a divided central switchboard, a source of direct current associated therewith at the central office, switches at the substation adapted to be operated singly or in pairs to complete the circuit of said source to selectively operate said signals, a magnet in the path of said current to lock the switches in actuated position and means for rendering said signals inoperative when a connection is established with the line and for unlocking said switches, substantially as described.

6. In a telephone system, the combination with a telephone line, of three or more signals therefor located upon the different divisions of a switchboard, a central source of current, magnet windings of different resistances at the substation, means associated therewith for including said different magnet windings in the line circuit from said source, and means to cause said signals to selectively respond to currents through said different windings, substantially as described.

7. In a telephone system, the combination with a telephone line, of a plurality of signals therefor located upon the different divisions of a switchboard, a central source of current, electro-magnets of different resistances at the substation, means associated therewith for closing the line circuit through the windings of said magnets, means to cause said signals to selectively respond to the currents through said windings, and a cut-off relay for the line actuated when a connection is established therewith at any of said divisions to render said signals inoperative, substantially as described.

8. In a telephone system, the combination with a telephone line for which talking current is furnished from a central office, of a plurality of switches at the substation, a relay associated with the line at the central office, and means whereby with the selective operation of said switches said relay may be

caused to either partially or fully operate to differently alter the circuit connections controlled thereby, substantially as described.

9. In a telephone system, the combination with a telephone line, of a plurality of signals for said line distributed upon the different sections of a divided central switchboard, a single line relay normally in each limb of said telephone line, said relays each having a single winding and two degrees of actuation, means at the substantion for controlling the flow of current through said relays, and means to selectively actuate said signals according to the degree of actuation of said relays, substantially as described.

10. In a telephone system, the combination with a telephone line, of a source of current for said line located at a central office, a single line relay serially connected between one terminal of said source and each of the limbs of said telephone line, said relays each having two degrees of actuation, and means at the substation to cause the proper amount of current from said source to flow through either of said electro-magnets to actuate it in either of its degrees of actuation, and a plurality of signals adapted to be selectively displayed by the actuation of said relays, substantially as described.

11. In a telephone system, the combination with a telephone line, of a plurality of signals for said line at the central office, a central source of current, a relay normally included between said source and one limb of said telephone line, said relay having a single actuating coil and two degrees of actuation depending upon the current flow through said coil, means at the sub-station to control the current flow through said coil, and means to selectively actuate said signals according to the degree of actuation of said line relay, substantially as described.

12. In a telephone system, the combination with a relay at the central office of the system, of a plurality of springs for said relay and a movable armature for the actuation of said springs, telephone circuits adapted to be controlled by the actuation of said springs, a suitable source of current, and means whereby current from said source may be caused to partially actuate said relay to control said telephone circuits in one manner, and to completely actuate said relay to control said circuits in another manner, substantially as described.

13. In a telephone system, the combination with auxiliary telephone circuits at the central office of the system, of a relay to control said circuits, a plurality of springs for said relay disposed substantially parallel with the coil of said relay and insulated one from another, an armature adapted by its movement to control said springs, means whereby said armature when slightly attracted will overcome the tension of only a portion of said springs to control said auxiliary circuits in one manner, and when more strongly attracted will overcome the tension of additional springs to control said auxiliary circuits in another manner, a source of current and means to control the flow of current from said source through the coil of said relay, whereby the degree of attraction of its armature is controlled, substantially as described.

14. In a telephone system, the combination with a telephone line, of signals therefor at the central office, a source of direct current at the central office, means for closing the circuit of said source so as to form paths of different resistance, and a relay having two degrees of actuation included in each of said paths and adapted by its different degrees of actuation to control the circuits of said signals, substantially as described.

Signed by me at Chicago, county of Cook, State of Illinois, this 10th day of December 1902.

HARRY G. WEBSTER.

Witnesses:

GAZELLE BEDER,

ROBERT LEWIS AMES.