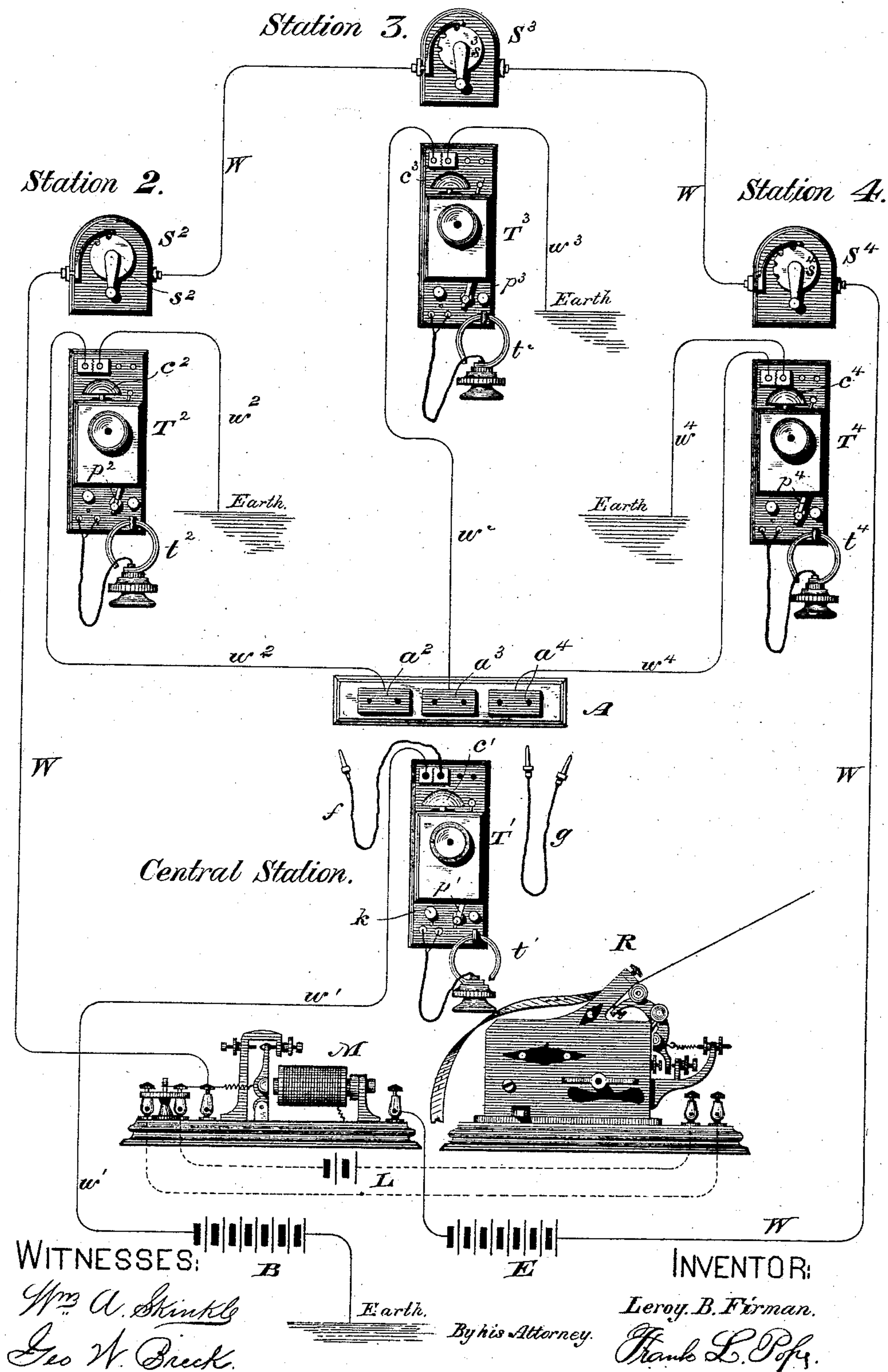


L. B. FIRMAN.

TELEPHONE EXCHANGE SYSTEM AND APPARATUS.

No. 328,305.

Patented Oct. 13, 1885.



UNITED STATES PATENT OFFICE.

LEROY BROWN FIRMAN, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC MANUFACTURING COMPANY, OF SAME PLACE.

TELEPHONE-EXCHANGE SYSTEM AND APPARATUS.

SPECIFICATION forming part of Letters Patent No. 328,305, dated October 13, 1885.

Application filed January 16, 1880. Serial No. 877.

To all whom it may concern:

Be it known that I, LEROY BROWN FIRMAN, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful
5 Improvements in Telephone-Exchange Systems and Apparatus, of which the following is a specification.

My invention relates to that method of intercommunication known as the "district-
10 telephone" system, which consists of a central station or stations connected by means of radiating telegraph-lines with a number of sub-stations, the organization being such that any two of the sub-stations may be placed in
15 direct telephonic communication with each other at a moment's notice by the attendant at the central station, who, upon being notified to do so, connects the two lines leading to the respective sub-stations with each other.

20 Prior to the date of my invention, so far as my knowledge extends, it was customary to attach to each separate line at the central station an electro-magnetic alarm or call bell, and also an annunciator having a separate
25 drop operated by a special electro-magnet for designating the line with which it was connected. It was also necessary to provide each separate line with a battery for the purpose of transmitting signals from the sub-stations
30 to the central station, or else to provide a single battery at the central station of sufficient power to supply all the sub-station lines. When the number of lines entering the central station is very large, the multiplication of signaling-instruments and batteries necessitated
35 by this system becomes a source of great inconvenience and expense.

The objects of my invention, speaking generally, are to obviate the objections incident
40 to such systems as heretofore worked, to simplify the operation thereof, and to enable signals designating the respective stations and conversation between any two of such stations simultaneously to be communicated
45 through the system.

My invention relates to the organization of instrumentalities for carrying out the objects of my invention; and it consists of certain novel combinations and arrangements of old
50 elements, which combinations are specifically

stated in the claims at the end of this specification.

The object of the first part of my invention is to enable any one of a series of sub-stations to transmit its designating-signal to the central office, and to receive a return-signal without interfering with the transmission to the central office of other designating-signals from other stations, which end I attain by combining upon one circuit a series of signal-transmitting instruments at different stations and a common signal-receiving instrument at the central station with a signal-transmitting instrument at said station and signal-receiving instruments at different sub-stations upon independent circuits radiating from the central station.

The object of the next part of my invention is to enable any one of a series of sub-stations to transmit its designating-signal to the central office without interfering with conversation between different stations of the system, which end I attain by combining a series of signal-transmitting instruments at the different stations and a common receiving-instrument at the central station upon a telegraphic circuit, with a telephone at each sub-station upon an independent wire extending thence to the central station.

The objects of the next part of my invention are to enable an operator at any one of a series of sub-stations to transmit his designating-signal to the central station to call the attention of the operator there, then to signify the other station with which he desires to communicate, and to enable the operator at the central station to connect the sub-stations desiring communication, which ends I attain by combining one or more signal-transmitting instruments at different sub-stations and a common receiving-instrument at the central station upon one circuit with a telephone at each sub-station upon independent circuits extending thence to the central station, a telephone at the central station, and connecting wires or switches by which said telephones may be connected at will with any one of said sub-station circuits.

The object of the next part of my invention is to enable the operator at the central station

readily to connect his signal-transmitting apparatus with the signal-receiving apparatus of any sub-station of the system, which end I attain by combining a series of signal-receiving instruments at different sub-stations, each instrument being in an independent circuit extending from the central station to said sub-station, which circuit is grounded at the sub-station and open at the central station, with a signal-transmitting instrument at the central station in a normally-open earth-circuit, and connecting wires or switches by which said earth-wire may be connected at will with either of said independent open circuits, so as to form a closed circuit.

The object of the next part of my invention is to enable the operator at the central station to put any two sub-stations of a system in direct telephonic connection, which end I attain by combining a series of telephones at different sub-stations, each in an independent circuit extending from the central station to said sub-station, which circuit is grounded at the sub-station and open at the central station, with a telephone at the central station in a normally-open earth-circuit, and connecting wires or switches by which said open earth-circuit may be connected at will with either or both of the said independent wires, so as to form a closed circuit.

The object of the next part of my invention is to transmit and repeat or record at the central station the designating number of any one of a series of sub-stations without interrupting telephonic communication between said stations, which end I attain by combining a series of automatic signaling instruments (upon one circuit at different sub-stations) capable of transmitting determinate and different signals, and a sounding or recording instrument at the central station in said circuit with a telephone at each sub-station upon an independent wire extending thence to the central station.

The accompanying drawing represents a district-telephone system embodying my improvements. I have shown therein a central station and three sub-stations, which is a sufficient number to illustrate the principle of my invention. The central station is supposed to be situated at some convenient point at or near the geographical center of the system, while the sub-stations 2, 3, &c., are distributed throughout the whole area of the district, as circumstances or convenience may determine.

In carrying out my system of intercommunication I connect each sub-station with the central station by two separate and independent lines. One of these lines, W, is common to all the sub-stations in a system, or to a considerable number of them, and is employed exclusively for the transmission of signals from the several sub-stations to the central station. I prefer that this circuit should be a metallic circuit extending from one pole of the battery E at the central station through

all the sub-stations in succession, and thence back to the central station, and through the receiving-instrument M to the other pole of the battery; but it may be connected with the earth, say at station 4, and also at the plus-pole of the battery E, in which case that portion of the line between the battery and station 4 might be dispensed with.

The construction and arrangement of the signaling-circuit W and the apparatus immediately connected therewith which I ordinarily prefer to employ, is the same as that which is made use of in what are known as "district" and "fire-alarm" telegraph systems. At each sub-station I place an automatic signal-box, as at S², which is provided with a circuit-breaking wheel, s², so constructed that when the box is operated—as, for instance, by turning a crank—the circuit will automatically be interrupted a certain number of times corresponding to the designating number of the station. The construction and arrangement of such a signal-box being well known, it is unnecessary here to enter into a minute description of it; but I will remark that where a large number of sub-stations are placed upon a single circuit it may be preferable to employ a non-interfering signal-box—such, for example, as that described in Letters Patent No. 113,649, granted to J. N. Gamewell, April 11, 1871—by which means any confusion that might be liable to arise from an attempt to transmit signals simultaneously from two different sub-stations at the same time would be avoided.

In connection with the signaling-circuit at the central station is placed a receiving apparatus, preferably consisting of an ordinary Morse relay, M, and a Morse register, R, operated by a local battery, L, the contact-points of the relay being so arranged as to close the local circuit when the main circuit is broken, and vice versa. I prefer to employ for this purpose the well-known self-starting register, and this may often with advantage be operated directly by the main-line current without the intervention of a relay and local battery.

An electro-magnetic call-bell or alarm may be placed either in the main or the local circuit at the central station, but this will ordinarily be unnecessary, as the sound of the armature of the recording-instrument will usually be sufficient to serve the purpose of a call or alarm. In systems of moderate extent it may even be sufficient to employ a simple call-bell or sounder without any recording apparatus whatever, and in such a system the signal-boxes might in some cases be replaced by ordinary push-buttons or break-keys, by which a person at any sub-station might signal to the central station by tapping upon his key or button in such a manner and at such intervals as to transmit the required signal. Telephonic transmitters might even be employed with advantage in many instances in connection with a telephonic receiver at the

central station, at which an attendant is constantly stationed. These details may be varied in many ways, the essential point being that any sub-station shall be able to transmit at pleasure to the central station a signal which shall designate the particular sub-station at which it originates, and that such signal shall be instantly communicated to the attendant at the central station by means of a signal-receiving instrument kept constantly in circuit at that point.

Instead of a closed metallic circuit with a constant current, as shown in the drawing, it may be more convenient in some cases to arrange the signal-wire as an open-earth circuit by connecting one pole of the battery E to the earth, and leaving the line W open or disconnected at the most distant sub-station. In this case the signal-transmitting instruments must be arranged so as to close instead of break the circuit when operated, and must be placed in branch circuits or tap-wires leading from the signal-circuit to the earth. This amounts to the substitution of an open for a closed signal-circuit, and the arrangement of the details of such a system will be understood by reference to Letters Patent No. 186,548, granted T. A. Edison, January 23, 1877.

At each sub-station—at station 2, for example—in addition to the signal-transmitting instrument hereinbefore described, there is a telephone, T^2 , (which may have an additional hand-telephone, t^2 , connected therewith, if desired,) a signal-bell, c^2 , and a switch, p^2 , by means of which either the telephone or the signal-bell may be placed in connection with the central station. I have shown a hand-switch in the drawing; but it is obvious that an automatic switch may be employed, if desirable, which may be operated by the act of removing the hand-telephone from its rest, or of replacing it therein, as the case may be. These telephones and switches may be of any usual well-known construction. This telephone and signal-bell are placed in a telegraphic line or circuit wholly distinct from and independent of the signaling-circuit W , and which is connected to the earth at the sub-station, but is normally disconnected or open at the central station, as will hereinafter appear.

I prefer to make use of a special circuit arranged in the manner just described from the telephone at each sub-station directly to the central station; but in many cases two or more of these sub-station telephones may be placed upon one and the same circuit for the purpose of saving the expense of separate circuits without departing from the general principle of my invention.

At the central station the separate lines converging from the several sub-stations are brought to a switch-board or commutator, A , which may be of any convenient form. I prefer in ordinary cases to use the simple and well-known arrangement shown in the drawing, which consists of a base board of wood,

or other non-conducting material, to which are secured a number of metallic strips or plates, $a^2 a^3 a^4$, one of which is appropriated to each line entering the office, and which forms the terminal of such line.

In addition to the apparatus hereinbefore described I provide at the central station a telephone, T' , and signal-bell c' , arranged in precisely the same manner as those at the sub-stations. This telephone and signal-bell are placed in a wire which forms what is technically known as an "open earth-circuit"—that is to say, a wire or line connected at one end to the earth and the other end terminating preferably in a flexible conductor, f , having a metallic tip, so that it may be inserted into a corresponding hole in each of the line terminals $a^2 a^3$, &c. Of course, any other well-known arrangement for connecting one wire with either of several others will serve the same purpose. The open earth-circuit w' is provided with a battery or other generator of electricity, B . Suitable detached flexible conductors, one of which is shown at g , are provided at the central station for connecting or coupling up the lines $w^2 w^3$, &c.

The method of operating the system is as follows: Suppose a person at station 2 desires to communicate directly with a person at station 4. He first notifies the central station by operating the signal-transmitting instrument S^2 , which sets the receiving-instrument R at the central station in action, which attracts the attention of the attendant there, at the same time informing him that station 2 desires to communicate. The attendant then attaches the flexible conductor f to the terminal a^2 of the switch A , and a closed circuit is formed consisting of the lines w' and w^2 , including the battery B and the signal-bells c' and c^2 . He then taps the signal-bell c^2 at station 2 by means of the break-key k , thus notifying the person there that he is ready to attend to him, and immediately switches his telephone T' into circuit by means of the switch p' . The person at station 2 does the same, and by means of the telephone informs the attendant of his desires, who thereupon changes his conductor f to the terminal a^4 and signal station 4 in the same manner as he had before signaled station 2, and upon receiving a response connects the two lines together by attaching one end of the cord g to the terminal a^2 and the other end to the terminal a^4 . By attaching his own telephone to either one of the terminals the attendant can listen to the conversation and ascertain when the parties have finished using the combined circuit, so as to disconnect it, as experience shows that an earth connection at the central station does not materially interfere with telephonic conversation between the sub-stations thus connected, especially if a considerable resistance is inserted in the wire w' .

Thus it will be understood that by the use of my improved system a large number of sub-stations may be served by means of two bat-

teries of moderate power, one of which is used in a closed circuit and the other in an open circuit, while the apparatus at the central station is of a very simple and inexpensive character.

In a large city, where the character and distribution of the business is such as to necessitate the use of two or more central stations, each central station is made, as it were, a sub-station on the signaling-circuit of the other station, and special trunk-wires are run from terminals in the switch of one central station to terminals in the switches of each of the other central stations, by which means communication may be easily and quickly established directly between sub-stations connected with different central stations.

By the use of circuit-breaking wheels in the automatic transmitters capable of producing groups of breaks or dots upon the receiving-instrument at the central station, as in the well-known systems of fire-alarm and district telegraphs, a great number of different numerical signals may be formed. The use of a particular numerical designation for each sub-station removes the difficulty which might otherwise arise in an extensive system from the confusion of names having more or less resemblance to each other.

I do not claim herein the art, method, or system hereinbefore specified; neither do I claim the combination, substantially as hereinbefore set forth, of a signal-transmitting instrument at a sub-station, and a signal-receiving instrument at the central station in one circuit, and a telephonic transmitting and receiving instrument at each of the sub-stations connected with each other by an independent circuit, as these constitute the subject-matter of another division of this application; but I limit the claims to the specific combinations and organization of instrumentalities therein specified.

I claim as of my own invention—

1. The combination, substantially as hereinbefore set forth, of signal-transmitting instruments at different stations and a common signal-receiving instrument at a central station upon one circuit with a signal-transmitting instrument at the central station and signal-receiving instruments at different sub-stations upon independent circuits radiating from the central station.

2. The combination, substantially as hereinbefore set forth, of signal-transmitting instruments at different stations and a common

signal-receiving instrument at a central station upon a telegraphic circuit with a telephone at each sub-station upon an independent wire extending thence to the central station.

3. The combination, substantially as hereinbefore set forth, of signal-transmitting instruments at different sub-stations and a common receiving-instrument at a central station upon one circuit with a telephone at each sub-station upon an independent circuit extending thence to the central station, a telephone at the central station, and connecting wires or switches by which said telephones may be connected at will with any one of said independent sub-station circuits.

4. The combination, substantially as hereinbefore set forth, of signal-receiving instruments at different sub-stations (each in an independent circuit extending from the central station to said sub-station, which circuit is grounded at the sub-station and open at the central station) with a signal-transmitting instrument at the central station in a normally-open earth-circuit and connecting wires or switches by which said earth-wire may be connected at will with either of the said independent open circuits, so as to form a closed circuit.

5. The combination, substantially as hereinbefore set forth, of telephones at different sub-stations (each in an independent circuit extending from the central station to the said sub-stations, which circuit is grounded at the sub-station and open at the central station) with a telephone at the central station in a normally-open earth-circuit and connecting wires or switches by which said open earth-wire may be connected at will with either or both of the said independent wires, so as to form a closed circuit.

6. The combination, substantially as hereinbefore set forth, of automatic signaling-instruments upon one circuit (at different sub-stations) capable of transmitting determinate and different signals and a sounding or recording instrument at the central station with a telephone at each sub-station upon an independent wire extending thence to the central station.

In testimony whereof I have hereunto signed my name.

LEROY BROWN FIRMAN.

Witnesses:

L. B. WIGHT,
WM. A. SKINKLE.