(No Model.)

G. F. DURANT.

TELEPHONE EXCHANGE SYSTEM.

No. 286,595. Patented Oct. 16, 1883.

Fig. 1.

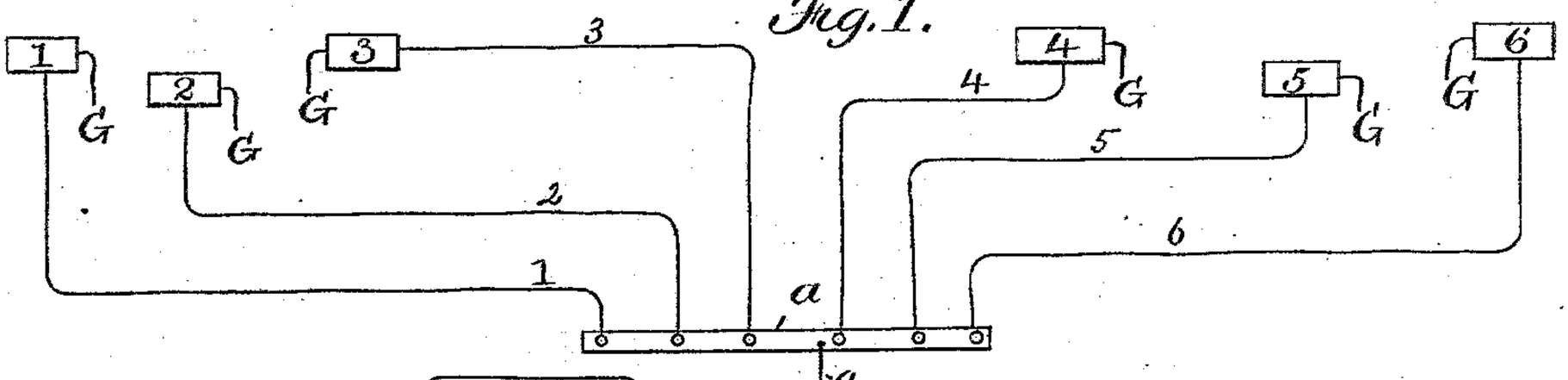


Fig. 2.

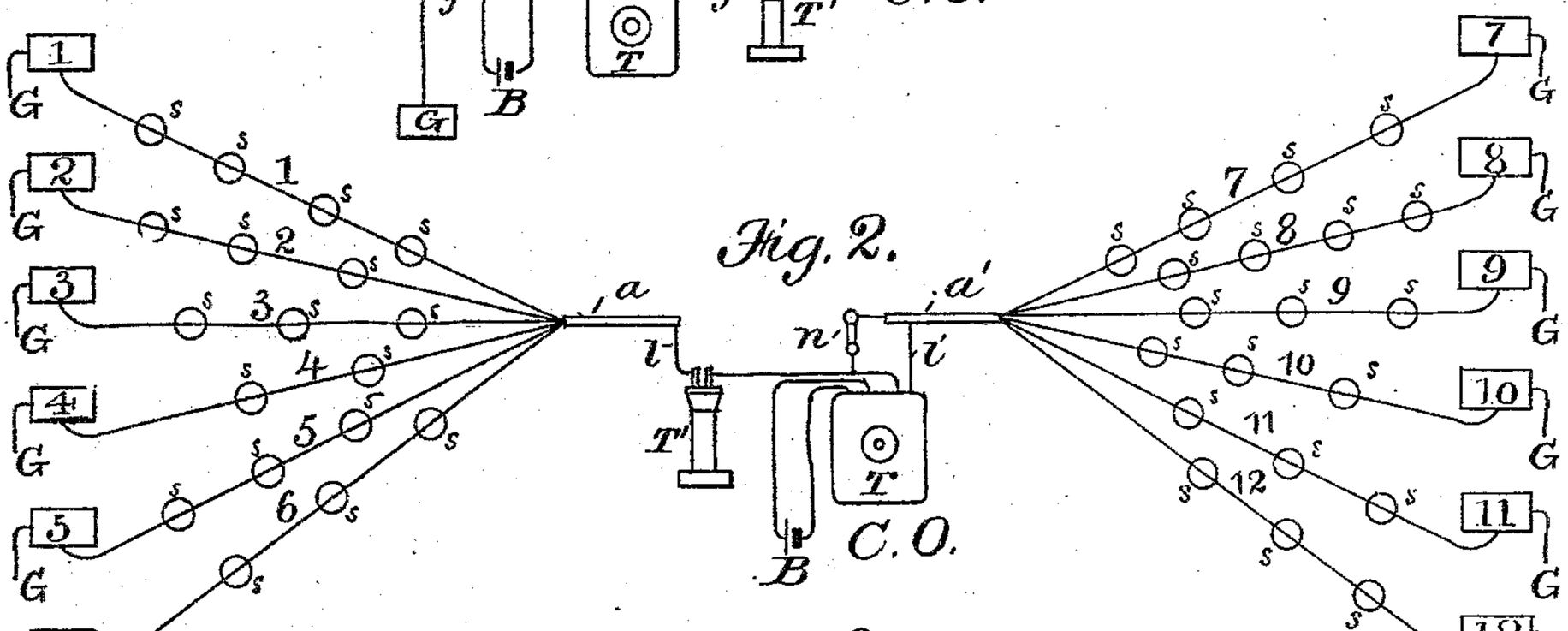
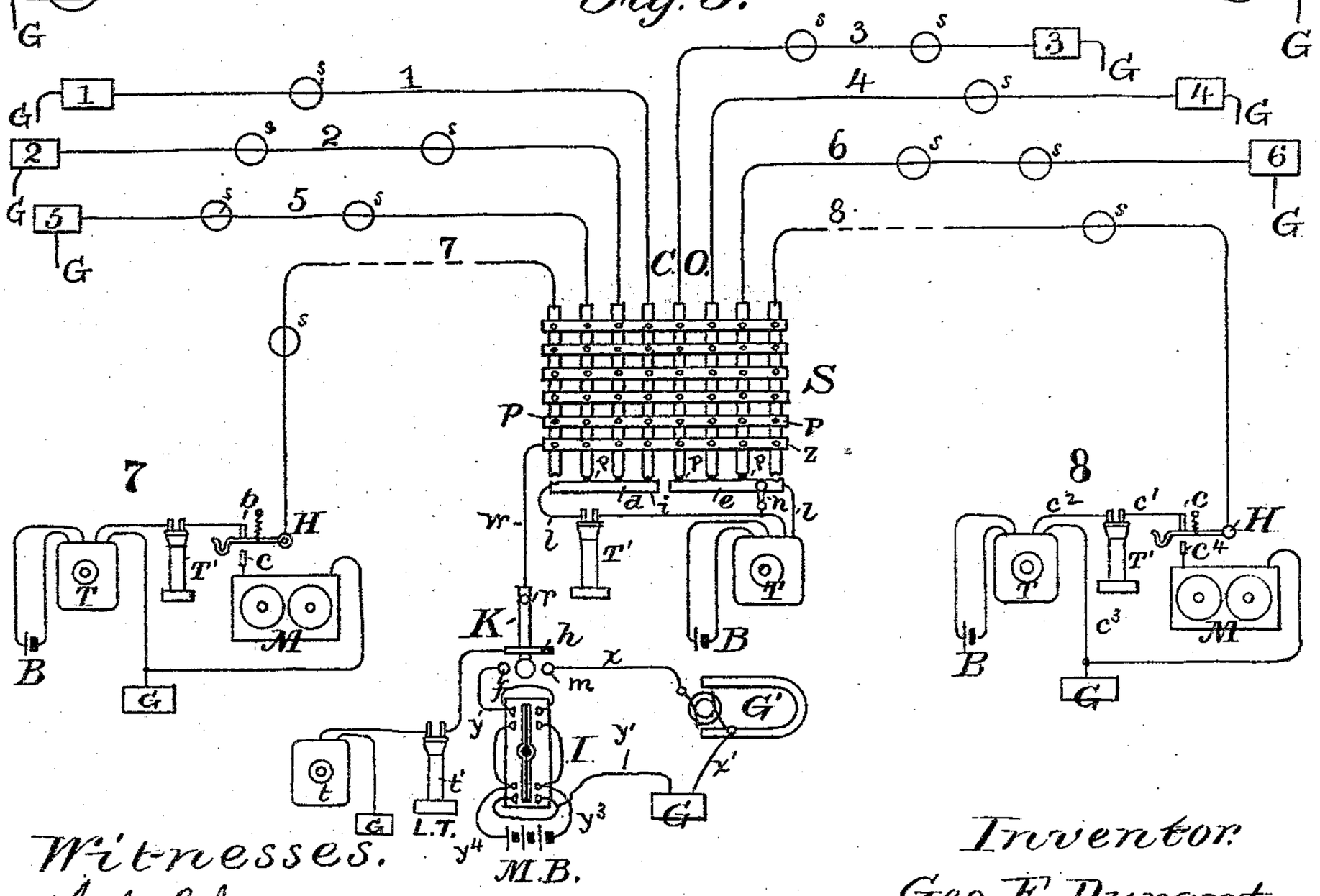


Fig. 3.



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UNITED STATES PATENT OFFICE.

GEORGE F. DURANT, OF ST. LOUIS, MISSOURI.

TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 286,595, dated October 16, 1883.

Application filed August 18, 1883. (No model.)

To all whom it may concern:

Be it known that I, GEORGE F. DURANT, of St. Louis, in the county of St. Louis and State of Missouri, have invented certain Improvements in Telephone-Exchange Systems, of which the following is a specification.

My present invention relates to an organization of electric circuits and apparatus for direct intercommunication by means of speaking-telephones, in which a central station is connected, by means of wires radiating therefrom, to a number of sub-stations situated at various points within the surrounding district. The organization and arrangements of the lines and instrumentalities in the central station are such that any two sub-stations within the district may at any moment's notice be placed in direct telephonic communication with one another. My invention relates more particularly to a special arrangement of the several circuits at the central station, whereby annunciators or other apparatus adapted to receive call-signals from sub-stations may be entirely dispensed with; and its object is to provide a simple and efficient system of circuit construction, whereby a single listener placed at the central station can keep watch over a large number of lines connecting with such a station.

It consists, in a general way, in dispensing with a main central-office ground-wire, in grouping a suitable number of lines together, and in looping a receiving-telephone or receiving and transmitting telephones between each pair of groups, so that, as hereinafter more particularly described, a large proportion of the articulating electrical undulations produced by speaking in the transmitter at any of the sub-stations must necessarily pass through the receiver at the central office which is common to that group.

Heretofore, and prior to this invention, several methods for effecting communication between the various sub-stations whose lines converge to the central station have been adopted. As a recognition of the prior state of the art I will here briefly describe them. By the first method a bell or enunciator is placed in the circuit of each converging line at the central station, and any subscriber desirous of being put into communication with any other subscriber is required to give a signal by transmitting an electrical pulsation and actuating the said bell or drop, whereupon the attending operator connects a telephone to the line of the subscriber signaling and takes his order. The desired sub-station is then signaled, and electrical connection between the two is effected, in the usual manner, by means of a switch-board. The second method, while avoiding the use of the annunciator or signal-bell at the central station, involves an additional or "signal" wire extending from the central office to a number of the sub-stations with which the telephones of the subscriber may be connected, and which, at the central station, is connected with a receiving-telephone, at which an operator is always listening. When this method is adopted, a subscriber desiring to converse with any other switches his telephone from his direct wire to the signal-wire, and, without any preliminary signaling, repeats his order, which is heard and attended to by the listening operator at the central station. The subscriber required is rung up and the two direct lines connected together. A third system groups a series of converging lines to a common ground-wire at the central station, and inserts the operator's receiving and transmitting telephones in the circuit of the said common ground-wire, as shown and described in Letters Patent granted to Geo. B. Scott, February 7, 1882, No. 253,316. In this system it was found necessary to insert resistances in each of the converging circuits, so as to prevent the greater part of the electrical current from being diverted from the central-office ground terminal and the telephones included therein into the remaining circuits of the converging series. Each of the methods thus described have disadvantages which I aim to overcome. The first method involves a large amount of expensive and complicated signaling apparatus, and is not so economical in the element of time as is desirable. The second is objectionable from the necessity of the additional wire, which, besides adding greatly to the cost of construction, is open to the serious objection that it makes the telephonic facilities of a great number of sub-stations dependent upon the good order and efficiency of a single wire inasmuch as, if the signal-wire is

in any way disabled, the sub-stations connected therewith have no means of communicating with the central station.

In the drawings which accompany and form a part of this specification, Figure 1 is a diagram representing the third method, hereinbefore described, and upon which, more than any other, my present invention is an improvement. Fig. 2 is a similar diagram, representing the circuit-connections utilized in my invention. Fig. 3 is also a diagram illustrating the invention, in which the instrument-connections at the central and sub stations are more fully elaborated.

In Fig. 1 the several subscribers' lines 1, 2, 3, 4, 5, and 6 are shown as converging from their terminal stations, where they are each united to a ground-wire, to a central station, C O, where they are all normally united to the metal bar *a*, the said bar, furthermore, being connected by a wire, *g*, through a receiving-telephone, T', and transmitter T to the ground. The object of so placing the central-office telephones in the common ground-wire is to enable the listening operator there to hear any words uttered at any of the sub-stations of the group. Experience has, however, demonstrated that when the several line-circuits are grouped in this way only a small proportion of the electrical currents pass through the central-office telephone to earth, the greater part dividing itself between the remaining line-circuits in direct proportion to their respective conductivities, the telephonic articulations in the central-office instruments being thus rendered very faint and indistinct. To remedy this it has been proposed to insert resistances in each of the several line-circuits, so that a less proportion of the telephonic currents will be diverted over them, a greater proportion thus taking the route through the central-office instrument, causing a corresponding increase in the loudness of the speech reproduced therein. By my invention, however, a much more satisfactory result is obtained, and the resistances may, moreover, be dispensed with. Its principle is exemplified in the diagram Fig. 2. Two groups of lines, each constituted of as many lines as may be desirable, are attached at the central station, respectively, to the conducting-bars *a* and *a'*, which form the terminals of a conducting-loop, *l l'*, the said loop including the transmitter T and receiver T', the former being energized in the usual manner by the battery B. The lines radiating from the central station, C O, after passing through one or more way-stations, *s*, ultimately terminate in an earth-wire at the terminal stations 1 2 3 4 5 6, and so on. By this arrangement a much greater portion of a working-current generated at any of the sub-stations passes through the central-office instruments, whereby the speech transmitted at any of the way-stations is reproduced with much greater loudness and distinctness than in the method delineated in Fig. 1.

It is well known that any electrical current having a choice of routes divides at the point of junction, the amount passing over each being directly proportionate to its relative conductivity, or inversely proportionate to its relative resistance. Therefore words spoken to the transmitter at any of the sub-stations on any of the lines (for example, line No. 1) will generate currents which, reaching the central station, will divide, a portion thereof being diverted through the other lines, 2, 3, 4, 5, and 6, on the same side of the central-office telephones, while the remaining portion, after passing as a whole through the telephones T T' at the central station, divides between the lines 7, 8, 9, 10, 11, and 12 on the other side of the said telephones. A button-switch, *n*, is provided, by which, if desired, the resistance of the transmitter T may be short-circuited, and ordinarily this would be done. In many cases it is not necessary to hold conversation with the subscriber, and in such cases the transmitter T may be dispensed with altogether, the receiver being then the only instrument included in the loop between the two groups of circuits.

Fig. 3 shows one way of embodying my invention in a practical form. In it 1, 2, 5, and 7 represent the line-circuits on one side of the central-office telephones, and 3, 4, 6, and 8 an equal number of lines on the other side. These numbers are also assigned to the terminal stations of the several lines, the intermediate or way stations being designated by the letter *s*. Each of the lines is grounded at G at the terminal station. Entering the central office C O, the several lines connect with the switch-board S, which may be of any desired character. When the form shown in the drawings is used, half of the lines are, as shown, united by metal plugs *p* with the metal bar *d*, and the remainder with the corresponding bar, *e*. A wire, *l*, fastened to the bar *d*, leads to the receiving-telephone T', passes thence to the transmitter T, and from thence continues to the bar *e*, to which it is united. A metallic loop containing the receiving and transmitting telephones, or, if preferred, the former only, is thus formed, of which the bars *d* and *e* are the terminals. The lowest switch-board cross-bar, *z*, is attached to a wire, *w*, leading to a spring-key, K, capable of being depressed, and also capable of being moved horizontally round the pivot *r*. By its own resiliency the key presses upward against the bridge or back contact *h*, and a wire is led from thence through receiving and transmitting telephones *t t'* to the ground. When the key K is turned on its pivot to the right, it may be depressed upon the stud *m*, which, by wire *x*, leads to the magneto-generator G, the said generator being also connected with the ground by the wire *x'*. Similarly, when the key K is turned to the left, it may be depressed upon the stud *f*, which leads, by wire *y*, to a pole-changer, I, the said pole-changer also connecting with the ground by the wire *y'*, and with the battery M B by the wires y^3 and y^4. By connecting any of the sub-

scribers' lines with the switch-bar *z*, when the key is undepressed, any conversation passing on that line may be heard by the telephone L T, and, under the same conditions, when the key is depressed and makes contact with the right-hand button *m*, call-signals due to currents generated by the magneto-machine G′ may be sent to line. If the key is depressed onto the left-hand button *f*, battery-currents constantly reversed by the pole-changer are sent to line. It is not necessary that both of these forms of signaling apparatus shall be used; but it is convenient to have them, in order that one can be used during any temporary disablement of the other. As in Fig. 2, the transmitter T′ may be short-circuited by the button-switch *n*. In Fig. 3 the lines 7 and 8 are carried out to show the sub-station apparatus at the stations 7 and 8. The said lines are represented as being connected with one another through the central-office switch-board. The line entering the sub-station is attached, first, to the hook-switch H, and while the lines are in use continues thence by the contact point or spring *c*, wire *c′*, receiver T′, wire c^2, and transmitter T, to the ground. When the lines are not in use, the receiver hangs on the hook, and the line is thus directed, by the contact of the hook-lever with the point c^4, through the signal-bell M, to the ground. B represents the transmitter-battery.

In the operation of this system it is supposed that an operator at the central station is constantly listening for orders at the operator's telephone, which is normally connected with both groups of lines. Suppose, now, station 7 desires to speak with station 8. The operation is as follows: 7 removes his telephone from the hook and at once speaks to the central station, stating his desire. The operator, listening at telephone T′, hears the order and removes the plug of 8 from its regular hole, inserting it at the same time into a hole on the same vertical plane on the lowest cross-bar, *z*. The desired line is thus placed in connection with the key K, which, being pressed, sends electrical currents to line and signals the required sub-station, 8. The plugs of lines 7 and 8 are then placed, as shown, on the same horizontal switch-bar, any bar except the lowest bar, *z*, serving for that purpose, and the lines 7 and 8 are then in connection with one another. To ascertain when the conversation is finished, an additional plug may be placed in the hole at the intersection of the line-bar with the cross-bar *z*, thus attaching a ground branch to the united lines. By now listening at the test-telephone *t′*, the state of the conversation may be ascertained; or, in a manner well understood, I may insert a "ringing-off" annunciator in the circuit of two connected lines, which shall be adapted to give a disconnecting-signal upon the discontinuance of conversation, the said signal being sent by one of the two sub-stations concerned.

I do not confine myself to any specific form of switch-board or signaling device, since it is obvious that my invention is not dependent upon the form of apparatus employed. Moreover, although I have shown and described but one pair of groups of sub-station lines connected with one another through the central-office telephones, it is evident that I do not limit myself to that or any other number, since any number of pairs of groups may be arranged in a single central station without departing from the spirit of my invention. In the arrangement which I have described I prefer to connect the same number of line-circuits with each group of a pair, as the resultant effect is thereby improved. Such a construction is not absolutely necessary, and one or more circuits, as occasion may demand, may be taken from or added to either group without material disadvantage.

I claim—

1. The combination, in a telephone-exchange system, of one or more pairs of groups of telephone-line circuits, the lines of each group converging to a single central-office terminal, with a receiving and transmitting telephone connected between the two groups of each pair, substantially as hereinbefore described.

2. In a telephone-exchange system, the combination, substantially as hereinbefore described, of a pair of groups of telephone-line circuits, each of the said circuits converging from one or more sub-stations to a central station, a common conducting-terminal for each group of lines, and a conducting-loop including the central-station telephone or telephones, uniting the terminal of one group with the terminal of the other, whereby each of the line-circuits of both groups of a pair has a normal ground-terminal at the distant end of each of the other lines.

3. In a telephone-exchange system, a pair of groups of sub-station telephone-lines, all the lines of both groups converging at the central station, a terminal wire for each group at the central station, to which all the line-wires of each group are united, a conducting-loop including a receiving and transmitting telephone, and constituting a connecting-link whereby the terminal of one of the groups is united with the terminal of the other group, and a short-circuiting switch adapted to shunt the transmitting-telephone, all in combination, substantially as specified.

4. The combination, in a telephone-exchange system, of a pair of groups of line-circuits, each group concentrating into a single terminal at the central station, the terminals of the two groups being united together to form the pair, a receiving and transmitting telephone included in the circuit of the said united terminals, and means for disconnecting any of the several line-circuits of either group from the said common or single terminal, and for connecting any two of the line-circuits together, substantially as and for the purposes set forth.

5. In a telephone central-office system, the combination of a conducting-loop line including a telephone or telephones located at the

central station, with a series of telephone-line circuits connected with and radiating from one of the terminals of the said loop, and with a second series of line-circuits similarly connected with and radiating from the other terminal of the said loop, so that the joint resistance of the circuits on one side is approximately equal to that of the circuits on the other side, whereby a large proportion of the electrical undulations produced in any of the sub-station transmitters is caused to pass through the central-station instruments, substantially as and for the purposes described.

6. The combination, substantially as hereinbefore described, of a pair of groups of line-circuits, each group concentrating into a single terminal at the central station, the terminals of the two groups being united together to form the pair, a receiving and transmitting telephone included in the circuit of the said united terminals, means, as indicated, for disconnecting any of the several line-circuits from the common united terminal, and for connecting any two of the said line-circuits together, and other means for sending call-signals over any of the several lines.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses.

GEO. F. DURANT.

Witnesses:
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C. H. BURTON.