(No Model.) 2 Sheets—Sheet 1.

R. M. BAILEY.

TELEPHONIC CIRCUIT.

No. 392,301. Patented Nov. 6, 1888.

Fig. 1.

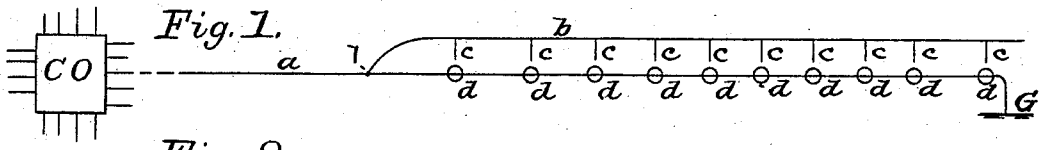


Fig. 2.

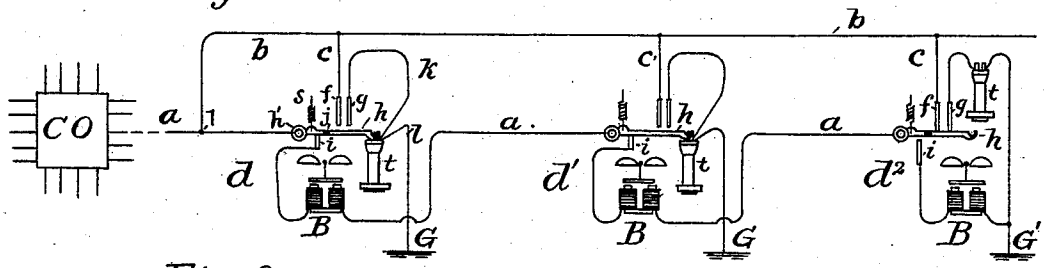


Fig. 3.

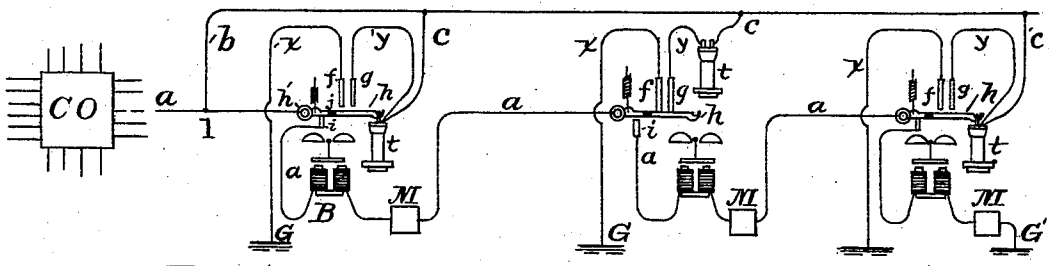


Fig. 4.

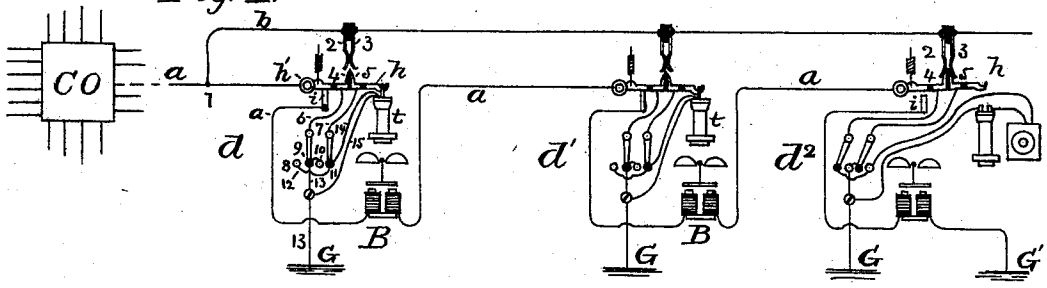
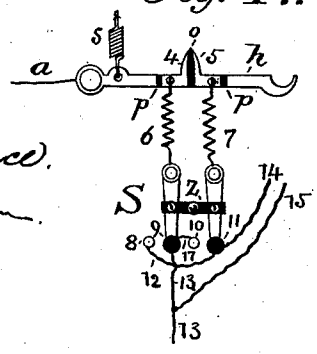


Fig. 4ª.



Witnesses.
Geo. Willis Pierce.
Jas. K. McCathran.

Inventor:
Robert M. Bailey.
by A. Pollok.
his attorney.

(No Model.) 2 Sheets—Sheet 2.

R. M. BAILEY.

TELEPHONIC CIRCUIT.

No. 392,301. Patented Nov. 6, 1888.

Fig. 5.

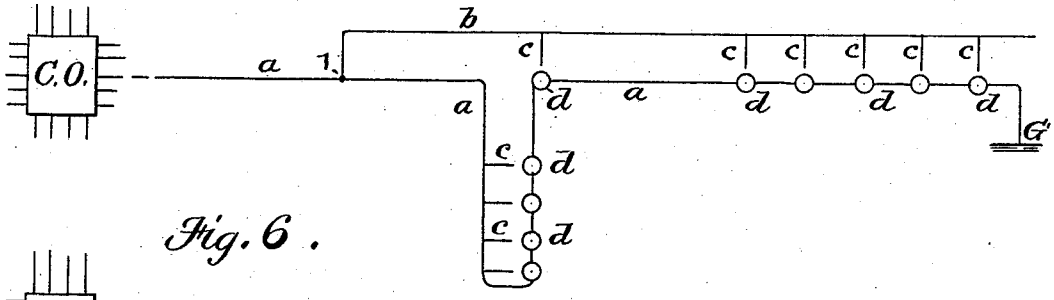


Fig. 6.

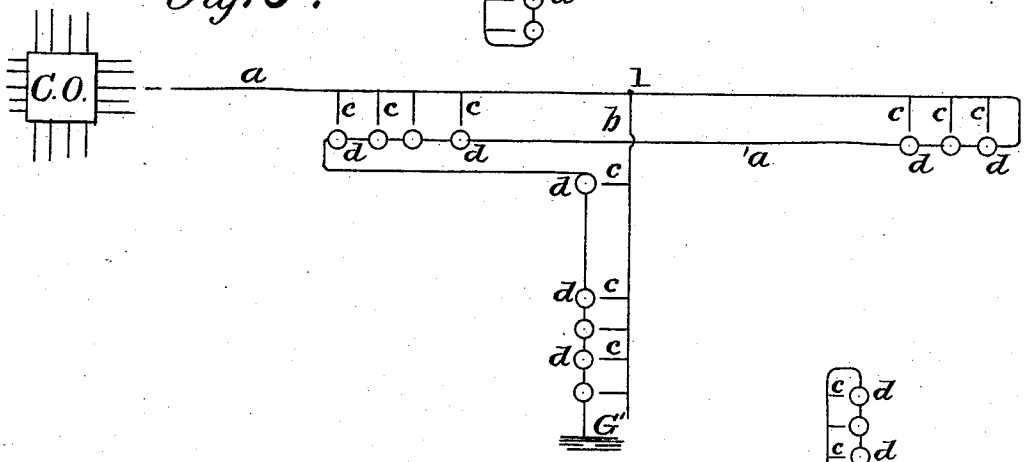


Fig. 7.

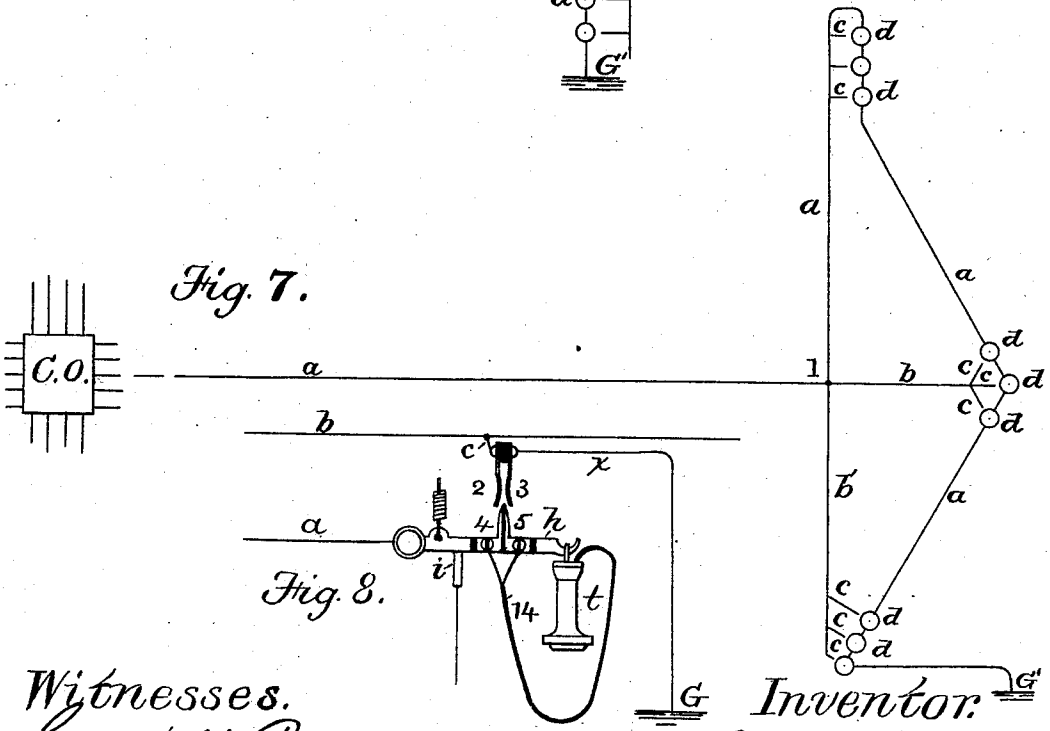


Fig. 8.

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UNITED STATES PATENT OFFICE.

ROBERT M. BAILEY, OF WILLIAMSPORT, PENNSYLVANIA, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

TELEPHONIC CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 392,301, dated November 6, 1888.

Application filed August 2, 1888. Serial No. 281,717. (No model.)

To all whom it may concern:

Be it known that I, ROBERT M. BAILEY, of Williamsport, in the county of Lycoming and State of Pennsylvania, have invented certain Improvements in Telephonic Circuits, of which the following is a specification.

This invention relates to the construction and arrangement of telephone-circuits; and its object is to place a number of telephone-stations in serial circuit with one another without subjecting the telephones of any of the stations to the retarding influence of magneto-electric counter-currents, which influence necessarily is exerted when electro-magnets are interposed in the line at way-stations, and to accomplish this by simple devices which require no expertness or skill on the part of the user.

Heretofore and prior to my invention it has been well known that electrical currents of a rhythmical character, or which have a rapid rate of change, whether in direction or strength, (such, for example, as the voice-currents employed in speaking telephony,) find much difficulty in passing through circuits or portions of circuits which have a high coefficient of self-induction. This condition is found where a number of electro-magnets are included in the circuit, and the accruing self-induction and consequent impedence is especially accentuated where the cores of the said electro-magnets are normally magnetized by proximity to or contact with a permanent magnet.

It is essential in a telephone-circuit that some device should be normally in circuit at each station for the purpose of producing a call-signal when the station is wanted, and a polarized bell operated by magneto-electric currents has been found most universally convenient. In a line having a number of stations it is evident that there will be an equal number of call-bell magnets; and it is also evident that the voice-currents transmitted from any given station and received at another for the purpose of reproducing the speech must necessarily pass through the coils of the call-bell magnets of all intervening stations and experience the impeding effect due to the combined action of the whole. This effect is due to the fact that the magnetism of the cores of the call-bell magnets varies with every change of the main current which traverses the helices surrounding the said cores, and that the magnetic variations thus set up react upon the said helices and develop magneto-electric currents therein. Now, inasmuch as these helices are a portion of the main circuit, it follows that these magneto-electric reactionary currents flow through the said main circuit sometimes in opposition to and sometimes in accord with the legitimate voice-currents as to direction, but almost invariably differing therefrom in rate of change per unit of time. Even when their direction is harmonious their time is not in unison; and this phenomenon has proved to be a serious hinderance to the otherwise convenient and economical practice of connecting several telephones in serial circuit with one another.

I am well aware that various remedies have been proposed to counteract the practical evil which I have described. For example, it has been proposed to shunt the several bell-magnets by a condenser or a resistance-coil, and also to connect the two helices of each bell-magnet in multiple arc with a view to the decrease of resistance. These remedies, however, appear to but partially meet the disadvantage, as the telephonic currents are still obliged to pass through the bell-magnets of the stations where the telephone is not in use. It has also been proposed to arrange a number of stations in series on loop-circuits, the original magnet of each station being in a normally-disconnected branch adapted to be closed by a relay-magnet in one portion of the loop, switches being provided for the purpose of grounding the station and opening the portion of the loop containing said relay-magnets, so that by the manipulation of said switches the user may establish a talking-circuit unincumbered by the signal-bell magnets.

The present invention likewise has for its object to arrange the circuits and connections so that each telephone-station (irrespective of the number that may be connected with the circuit) shall or may during the transmission of speech have at its disposal an individual, clear, and unincumbered telephone-line with absolutely no electro-magnets intervening be-

tween the station itself and the central station, or between any two sub-stations of the same line which may be carrying on conversation. This is accomplished in the best manner, first, by attaching to the main line at a point between the central station and the first sub-station a branch wire or a number of branch wires, as may be required, which branch or one of which branches is led to each sub-station, entering the same preferably as a single, wire (although it may be looped) for the purpose of furnishing the clear talking-circuit, this branch being left open or ungrounded at its outer terminal, while the bell-magnets at all stations are all included in the normally-closed main-line circuit; and, second, by so combining the automatic telephone-switch with the said branch that a removal of the telephone shall automatically open the bell or main line portion of the circuit, thus preventing interference, and shall connect the station-telephones with the branch of the talking-circuit, whereby the clear telephone-circuit free from bell-magnets is secured. Thus any one in conversation talks over or around all intermediate stations, or any two stations on the line talk from each round all intermediate offices, and when the telephone is replaced the integrity of the ringing-circuit is again restored while the shunt or talking-branch is reopened. The telephone portion of the branch circuit at the sub-station may have one of its terminals permanently connected with the earth while the other terminal stands open or insulated until the raising of the automatic switch connects it with the main branch; or, conversely, it may be normally connected with the main branch and the other terminal united with the station-ground, the junction, as before, being automatically effected by the removal or replacement of the telephone; or, again, it may be arranged in such a manner that both terminals of the way-station telephone are disconnected and open when not in use.

The invention extends generally to the combination with or use in a telephone-circuit which extends from a central office to two or more sub-stations, or between any three or more stations, and which includes in series the calling-magnets of said stations, of a derived branch or system of branches which extends from between stations around the calling-magnets at any two or more stations and passes through said stations, so that said branch or system of branches forms a shunt or shunts by which said stations may talk around the bell-magnets of two or more stations and over a remaining portion of the main line. By having the shunt or shunts around all the sub-stations, as before explained, there will be a line from each of the sub-stations to the central office without any bell-magnets in it, and this arrangement is specially included in the invention.

The invention also extends to the combination, with a telephone-circuit provided with a talking branch or system of branches, as explained above, of switches in general, whereby the said branch or system of branches (or a suitable portion thereof) is or may be closed for talking and opened at other times, and whereby the shunted portion of the main line is or may be opened for talking and closed at other times; but it covers this combination as a special feature of invention when automatic switches are employed at the different stations with contacts properly arranged to close the shunt and break the shunted or signaling portion of the main circuit in the act of switching in the telephone and to close the signal portion of the main line in switching out the telephone.

The invention also covers the arrangements, constructions, or dispositions of the circuit and its appliances, as hereinafter pointed out.

In the drawings which illustrate and form a part of this specification, Figure 1 is a diagram indicating in its simplest form the principle of the invention. Figs. 2, 3, and 4 are diagrams of the circuit and apparatus illustrative of different modifications in the method of connecting the several devices. Fig. 4^a is a detail of the switch mechanism employed in Fig. 4. Figs. 5, 6, and 7 represent different plans of construction capable of being alternatively employed in the line-circuits. Fig. 8 is a modified arrangement of the switch mechanism shown in Fig. 4^a.

In all of the figures, except 4^a and 8, C O represents a central station.

In Fig. 1, *a* is a main telephone-line extending from the said central station to earth, G′, at the most distant station. *b* is an auxiliary wire diverging from the main line *a* at the point 1, and extending by a branch, *c*, into each sub-station *d*.

Fig. 2 embodies the principle indicated in Fig. 1, and shows in detail the circuit arrangements of the sub-stations. The main-circuit line *a*, entering station *d*, passes, as shown, (the telephone *t* being in place upon the switch-support *h*,) to one portion, *h*′, of the switch, thence by the lower contact, *i*, thereof to the bell-magnet B, and through the said magnet out to station *d*′, and so on until, after passing the bell-magnet of the last station, it terminates at the earth G′. The branch or talking wire *b* is at 1 permanently connected with the main line, and passes successively all of the sub-stations *d*; but is open or disconnected at its most distant point. From this main branch *b* a sub-branch, *c*, leads into each sub-station and terminates in the contact-piece *f*. One of the terminals of the telephone *t* (which may be understood to symbolize the entire telephone outfit, including both receiving and transmitting instruments) is attached to a ground-wire, *l*, while the other is united to a conductor, *k*, leading to a second contact-piece, *g*, fixed side by side with the first and adapted therewith to make contact with the switch-bar *h*, when the telephone being removed, the said bar, impelled by the spring *s* or similar

means, flies upward. It should be stated that the two parts *h* and *h'* of the switch are insulated from one another in this instance by the interposed piece *j* of non-conducting material. Although this construction would in most cases be adopted, it is not essential, and circumstances are conceivable in which it would be advantageous to dispense with the insulation, as shown at the second station *d'*.

The advantage attending the absence of the insulation would be that in the event of a break on the talking-branch conversation could still be carried on over the main or bell line, albeit with decreased efficiency.

The arrangement delineated in Fig. 3 does not vary from the above in any material feature. It is differentiated in the following particulars only. The permanent sub-branch *c* connects with one terminal of the telephone *t*, and from the remaining terminal of the telephone a wire, *y*, leads to one of the upper switch-contacts *g*. The remaining switch-contact *f* is connected with the earth G through an earth-wire, *x*. The connections at all of the sub-stations may be identically arranged, the wire from the last bell leading directly to the main terminal ground-wire G'.

The plan shown in Figs. 4 and 4ª is one in which both terminals of the speaking-instruments are normally disconnected, and in which by the addition of a manual switch the direction of communication can be determined. As in the prior cases the main-line circuit *a* entering connects with one part, *h'*, of the switch-lever, and continues in the resting position thereof to the resting-contact *i*, and thence through the bell-magnet B out to the next station, or to the terminal ground, as the case may be.

The divergent talking-branch circuit *b* loops into the stations and may be connected with the two sides 2 and 3 of a spring-jack. These two sides in this instance must be normally in contact with one another, so that the branch circuit shall be continuous to the last station. The said branch joins the main line, as before, at a point, 1, between the central station and the first station therefrom. A spring-jack double wedge is carried by the hook *h*, and, in a manner well understood, is constructed of two separate conducting-plates, 4 and 5, insulated from each other by a non-conducting partition, *o*, each forming one terminal of the telephone-loop, and each adapted to connect with one side of the spring-jack. The wedge appliance is preferably insulated from the hook-switch *h* by the interposition of a non-conducting-plate, *p*, and as more clearly shown in Fig. 4ª, a double bar-switch, S, may be introduced between the two sides thereof and the telephones, so that by its position the sub-station operator may determine the direction in which conversation shall be carried on—whether toward the central station or toward the outer terminal station. Each bar of the switch has two positions, and the two bars may be moved together by a non-conducting-link, *z*, to which a suitable knob or handle may be affixed. When the switch is turned to the left, the left-hand bar makes contact with button 8 and the right-hand bar with button 10; when turned to the right, the left-hand bar connects with button 9 and the right-hand bar with button 11. The left-hand switch-bar connects with plate 4 of the jack-wedge by wire 6, and the right-hand bar with plate 5 thereof by wire 7. The wire 14 connects at one end with one terminal of the telephone *t* and at the other with switch-buttons 8 and 11, and the wire 15 connects at one end with the remaining terminal of the telephone and at the other with switch-buttons 9 and 10, which are also in connection with the earth-wire 13. If, now, it be desired to communicate to or through the central station, the switch is turned to the left, as in station *d²*, Fig. 4, and thus the telephones are connected with the line in that direction so as to admit of conversation, as may readily be traced. If, on the other hand, it be desired to communicate with stations beyond, the switch is turned to the right, the position shown in station *d* and *d'*. A simpler use of the spring-jack appliance is, however, indicated in Fig. 8, where, instead of looping the talking-wire in, it is branched in, as in Figs. 2 and 3, and the branch *c* is united to one side, 2, of the jack. The talking ground terminal wire *x* is united with the other side, 3, of the jack; but in the use of this plan the two jack-plates must not normally be in contact with one another. The telephone-supporting switch *h* carries the double wedge, with its conducting-plates 4 and 5, and when the switch *h*, relieved from the weight of the telephone, moves upward, under the influence of the counter-spring *s*, the said plates respectively make contact with the jack-springs 2 and 3. The telephone *t* is connected with the wedge-plates by a double flexible conductor, 14, and may thus be introduced into the talking-circuit.

The operation of this system of circuits is extremely simple. When a call is to be sent by any sub-station or received at any sub-station, the ordinary method of signaling is adopted. When any sub-station desires to talk through the central station to stations upon another line, the action of the switch as the telephone is removed therefrom is to open that portion of the main-line circuit which includes the bells, and to establish a ground-connection upon the normally-open branch, but through the telephones at that particular station, so that the sub-station thus has a direct and clear line to the central station, unincumbered by the resistance and self-induction of the bell-circuit. Not only so, but the line of communication so established cannot be interrupted by any other subscriber, because the bell-circuit being open neither the call sending or receiving appliances of the remaining sub-stations have a continuous circuit to operate upon. The talking sub-station is thus absolutely protected from the interference of

other sub-stations upon the same line, and the central station, being well informed of the fact that the line is in use, will of course avoid such interference on its part. This arrangement of circuits is as readily utilized by sub-stations upon the same line who desire to communicate between themselves. They will signal the central station, so as to notify the operator there, and thus forestall interruption from that point, and then directly signal one another, and both switch to the talking-branch for conversation.

It is proper to state that although in each drawing one of the lines is shown as terminating at a central station the principle is equally adapted for lines which do not so terminate. In any event the talking-branch must diverge from the main line at a point between stations, whether these be a central and a sub-station or two sub-stations, so as to leave two or more stations on one side of the point whence the branch is derived.

Figs. 5, 6, and 7 are plans for the main line and talking-branch wires, illustrating the fact that it is not necessary that the talking-branch shall in all cases follow the main or bell line. The bells being necessarily in series, and the circuit ordinarily grounded at the ends, it follows that the route of the main line must in some measure be guided thereby, and that it frequently will traverse a longer route than would otherwise be necessary, because it must loop to each station or group of stations; but the talking-branch is bound by no such restrictions, and hence can be considerably abbreviated in many cases without affecting its usefulness adversely. Obviously it may avoid the loops and go straight to its various stations the shortest and most direct way. In Fig. 5, for example, leaving the point 1, a main branch, *b*, diverges, leading by sub branches *c* to the six outermost stations, while like sub-branches *c* from the main line proper run to the four preceding stations.

In Fig. 6 the branch *b* runs only to such stations as are grouped together at a distance laterally, while the intermediate stations are furnished with a talking-wire by means of short main-line branches *c*.

The arrangement, such as shown in Figs. 5 and 6, in which the sub-branches *c* are derived directly from the main line *a*, is within the invention with or without a branch, *b*, and is included in the term "derived or branch circuit extending in normally-open branches or loops to each station," as are also the various other arrangements shown in the drawings. So in Fig. 7 all the sub-stations are at a distance from the central station, but are arranged in three distinct groups, one of these groups being centrally located, while the others, respectively, are located at some distance on either side. In this case the talking-wire is led as one side of the loop to the group at one lateral extremity, but as branches *b* to the central and to the other side group. It will, however, be particularly noted that in each exemplification of the idea the junction of the talking-wire with the main line is effected at a point or points between the beginning of the line and the first sub-station, and that the switch invariably acts to break the bell-line and to establish the talking-line.

In all the plans which I have shown and described the call-sending appliances of the sub-stations shunted as usual, are of course included in the bell-circuit. They are symbolized in Fig. 3 and indicated by the letter M.

By means of this invention I am enabled to connect a number of stations with each circuit, dispensing with the cost of an individual circuit for each, while I am at the same time enabled to provide practically for each station an independent and unincumbered talking-circuit.

I claim—

1. An electric-telephone circuit which extends from a central office to two or more sub-stations, or more generally between three or more stations, and includes in series the calling-magnets of said stations, and is provided with a derived branch or system of branches extending from a portion of the main line between stations around the calling-magnets of two or more stations, on one side of said portion, and passing through said two or more stations, so that said branch or system of branches forms a shunt or shunts by which said stations may each talk around the bell-magnets of the two or more stations and over a remaining portion of the main line, substantially as described.

2. The combination, with an electric-telephone circuit which extends from a central office to two or more sub-stations, or more generally between three or more stations, and includes in series the calling-magnets of said stations and is provided with a derived branch or system of branches extending from a portion of the main line between stations around the calling-magnets of two or more stations on one side of said portion and passing through said two or more stations, of switches at said stations with contacts both in the derived branch or system of branches and in the portion of the main line shunted by said branch or system of branches, said switches serving to connect and disconnect the telephones with said branch or system of branches, to close the same for talking and open it at other times and to open the shunted portion of the main line for talking and close it at other times, substantially as described.

3. An electric-telephone circuit comprising, substantially as hereinbefore described, a main closed circuit for signaling purposes, extending through a series of telephone-stations and having the helices of the signaling appliances at the said stations included therein, and a derived or branch circuit therefor permanently attached to the main line of the closed circuit at a point between the first and second stations thereof and extending in normally-open branches or loops to each of the said stations

for the purpose of forming a talking-line absolutely free from electro-magnets.

4. A compound circuit for electric telephones, comprising, substantially as hereinbefore set forth, a main closed circuit extending through a series of telephone-stations, calling appliances at each station, the magnets whereof are included in the said closed circuit, whereby the said stations are enabled to send and receive call-signals, a normally-open derived or branch circuit totally free from electro-magnets permanently connected at one end with the main line of the said closed circuit at a point between the first and second stations thereof and extending in normally-open branches to each of the said stations, a normally-disconnected earth branch at each station, and telephone-instruments also at each station, also normally disconnected, but adapted to be included between the said earth branch and the entering branch of the derived circuit for the purpose of establishing a talking-circuit clear of electro-magnets.

5. An electric-telephone circuit comprising a main closed circuit connecting with a number of telephone-stations having telephones in grounded branches, said circuit including the signaling-magnets thereof for the purpose of sending and receiving signals, combined with an independent talking-circuit connected at one end with the closed circuit at a point between the two first stations thereof and extending therefrom to all stations, substantially as hereinbefore described, whereby the several stations of a multiple station-circuit are each practically provided, while conversing, with an independent and unencumbered talking-circuit.

6. In a system of electric telephony, the combination, substantially as hereinbefore set forth, of a main closed signaling-circuit extending from a central station to a series of sub-stations and including at each sub-station the calling appliances thereof, a normally-open branch or derived circuit permanently connected at one end with the closed main circuit at a point between the central station and the first sub-station and extending in normally-open branches into each of the said sub-stations, normally-disconnected telephones at each sub-station, and an automatic switch forming the telephone-support normally maintaining the continuity of the signaling-circuit through the calling appliances, but acting to break the said circuit and to close the branch or derived circuit through the telephones when the telephone is removed from the support.

7. A central telephone-station, a series of telephone sub-stations, a signaling-circuit extending from the central to the several sub-stations and grounded at both terminal stations, signal sending and receiving appliances at each sub-station included in the said signaling-circuit, a normally-open branch or derived circuit permanently connected with the closed circuit at a point between the central and the first sub-station and extending in normally-open sub-branches into each sub-station, an earth-wire at each sub-station, telephone-instruments at each sub-station, normally disconnected, but adapted to be connected between the open sub-branches of the derived circuit and the earth-wires, and an automatic switch at each station constituting the telephone-support, the said switch being adapted to maintain the integrity of the signaling-circuit through the said signaling-instruments when the telephone is in place and to break the same and to establish a talking-circuit through the earth-wire telephones and derived circuit when the telephone is removed, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 23d day of July, 1888.

ROBERT M. BAILEY.

Witnesses:
JNO. K. HAYS,
J. E. WILKINSON.