(No Model.)

E. J. HALL & F. A. PICKERNELL.

SIGNALING APPARATUS AND CIRCUIT.

No. 492,482. Patented Feb. 28, 1893.

Fig. 1.

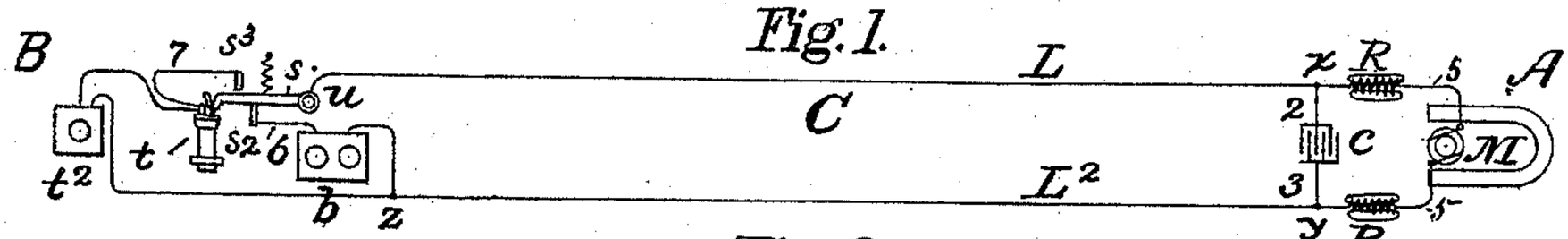


Fig. 2.

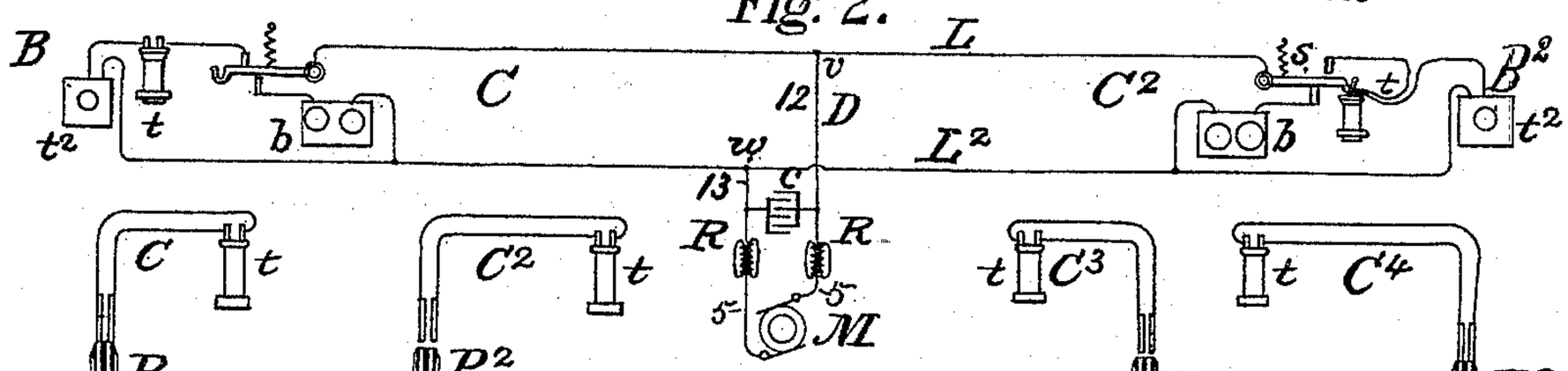


Fig. 3.

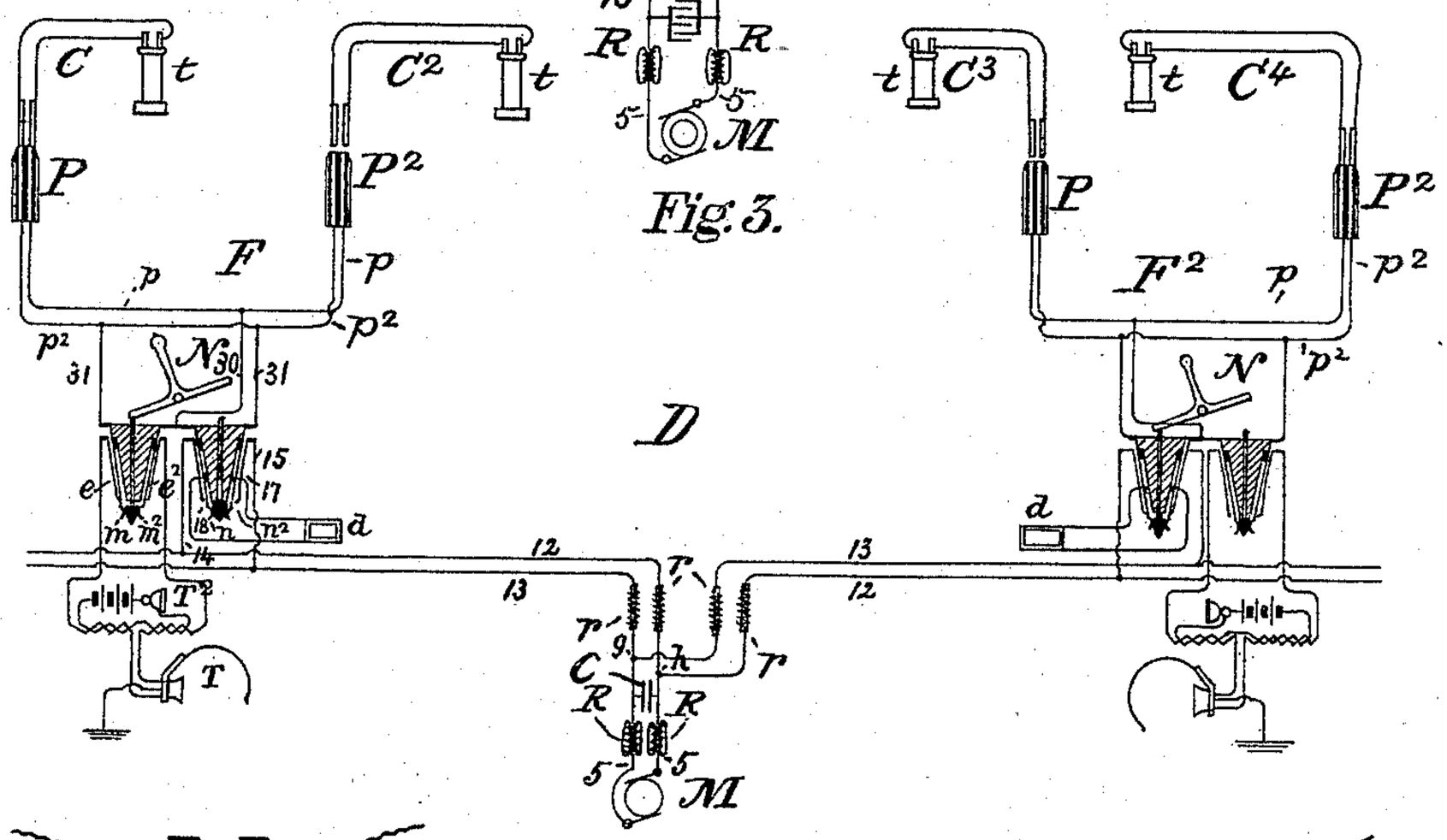


Fig. 4.

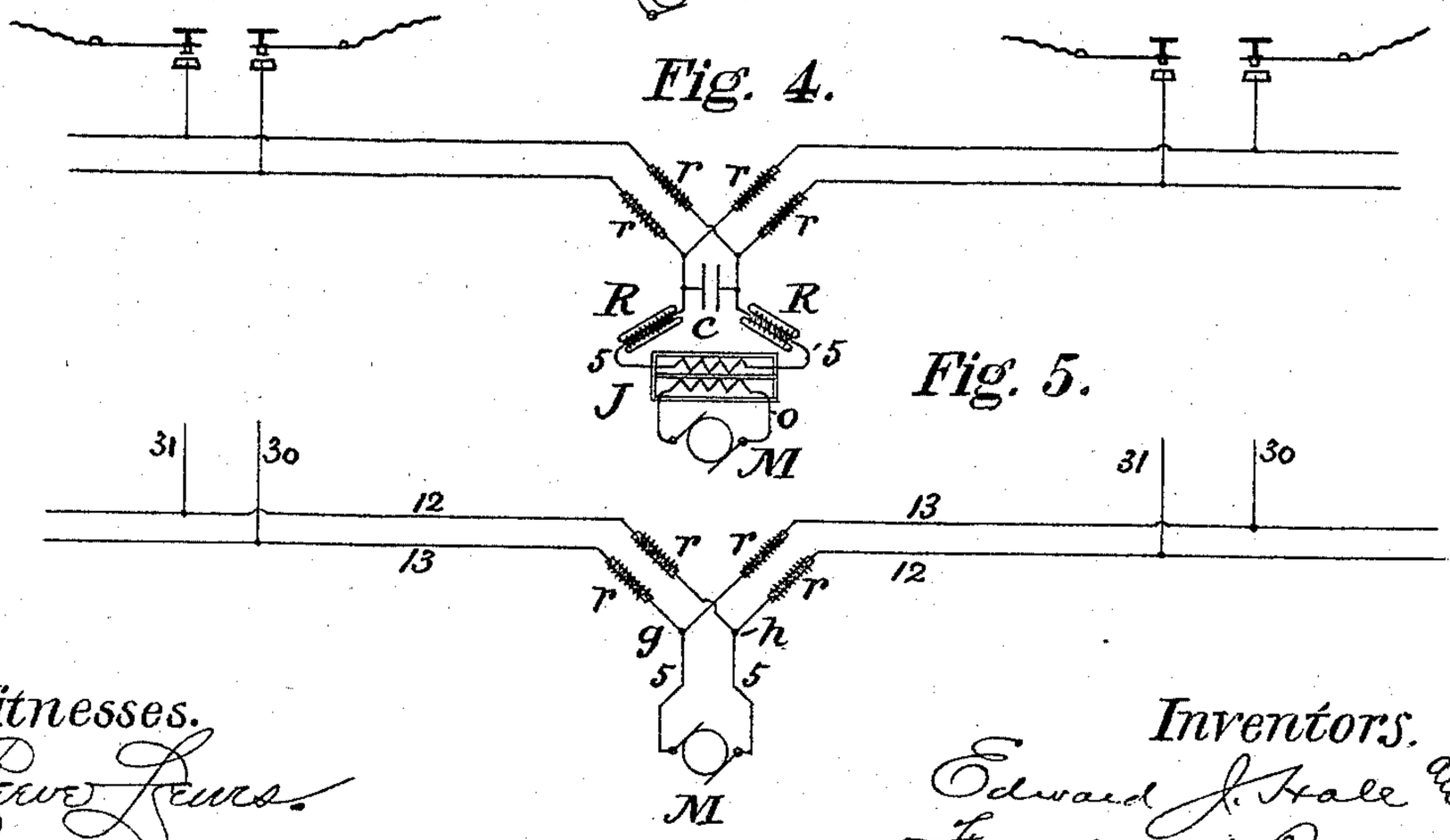
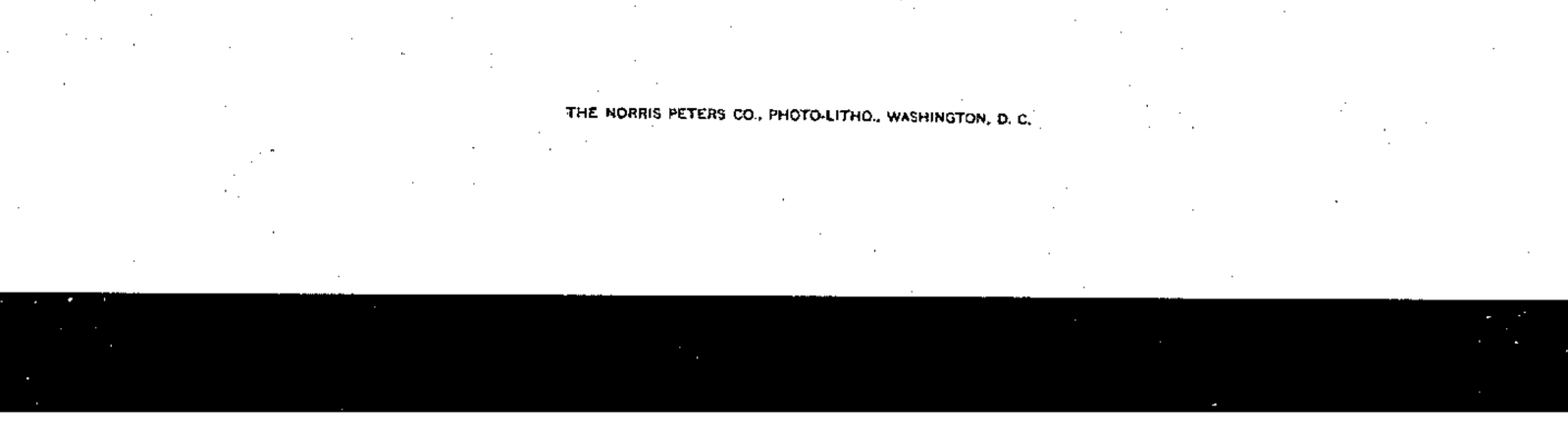


Fig. 5.



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UNITED STATES PATENT OFFICE.

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SIGNALING APPARATUS AND CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 492,482, dated February 28, 1893.

Application filed October 13, 1892. Serial No. 448,766. (No model.)

To all whom it may concern:

Be it known that we, EDWARD J. HALL, residing at Morris township, in the county of Morris, and FRANK A. PICKERNELL, residing at Newark, in the county of Essex, State of New Jersey, have invented certain Improvements in Signaling Apparatus and Circuits, of which the following is a specification.

This invention relates to call generators for telephone exchanges, to their circuits, and to devices for graduating, controlling and differentiating their currents.

It frequently becomes necessary and more frequently desirable, in the operation of telephone circuits to have a magneto receiving telephone, and a call bell in circuit at the same time, so that whether words or calling currents are transmitted at the distant station, either may without delay be received and attended to; this contingency however requires that the telephone shall be at the ear of the attendant.

In the specification of a separate application for Letters Patent, filed of even date herewith by Edward J. Hall, Serial No. 448,762 and describing a system of divided switchboards, with office trunk conductors, and means for operating and interconnecting a series of substation circuits upon said switchboards, such a desirability is adverted to, and we have shown as one mode of carrying out the operation of signaling the substation called for, apparatus, whereby as soon as the operator at one switchboard has called for a line at the other, the call generator terminals by means of a suitable key or switch at the first switchboard may be united to the trunk conductors to which the line at the second switchboard is to be united. As soon therefore as the second switchboard connection is made, the bell of the desired station is rung, while the telephone at the calling station which has been introduced into the circuit to give the order, is still held to the ear of the person desiring communication; and not only is this the case, but after the attendant at the second substation has brought his telephone into the circuit to see what is wanted and to exchange conversation, the call generator at the central station may remain connected with the talking circuit and continue to send call signals over the line, and through both substation telephones, until the operator, having finished other business taken up *ad interim*, returns to this connection, and turns the generator switch, thus disconnecting the call generator.

Heretofore when a receiving telephone has either deliberately or inadvertently been left in circuit during the operation of sending a call signal by means of a magneto generator, the telephone has uniformly been fully responsive to said generator and the instrument has been so affected by the circulation of the call currents through its helices, as to emit intensely loud and rattling sounds, representing such currents, and productive of great discomfort to the person at whose ear the said telephone is held.

The purposes of our present invention are twofold: The first is to provide means for ringing polarized bells by means of alternating current magneto electric generators or equivalent apparatus, without materially affecting speech receiving instruments included in the same circuit; and the second is to furnish efficient means whereby a call generator common to a number of switchboard connecting cords, some of which may be channels for voice currents, and other simultaneously forming conductors for the call currents of said generator, may be employed without involving telephonic interference, or the transit of voice currents between any two such cords. In attacking the problem stated by the first of these purposes, a study of the following considerations have been found useful. Electrical impulses succeeding one another at a comparatively low rate of speed, say fifteen per second as is usually the case with those employed in call-signals for telephone stations, are when regular and uniform, virtually inaudible in a telephone. The reason why with an ordinary generator they are audible, is that the curve representing the electromotive force is irregular and rapidly changing, so

that instead of fifteen impulses per second, a very much larger number is produced. The sharp and ragged points in the curve of electromotive force would correspond to harmonics obtained from causing a tuning fork to vibrate through an amplitude greater than that required by its fundamental. We attain the desired object by associating with the circuit including the bell which is to be affected, and the telephone which is not to be affected, a call generator graduated by the suitable application of retardation coils or electromagnetic resistances and condensers, in such a manner that the currents it develops have the crests of their alternations so rounded, that while continuing to efficiently operate polarized bells, they produce no material sound in telephones. We connect the condenser between the two generator main conductors near the terminals thereof, so that it forms an electrostatic shunt therefor; and between each of the said terminals, and the junction of the condenser shunt, we include in circuit a suitably proportioned retardation coil or electro-magnetic resistance having few convolutions and therefore little real resistance, but also containing in its core and casing, a large amount of iron, and therefore a high apparent resistance due to self-induction.

To carry out the second part of the invention, the generator main conductors have auxiliary or branch conductors, leading in pairs, to keys having each a connection with some one of a number of switchboard connecting cords which are used to unite any two circuits for through communication; and in the circuit of both conductors of each pair of such auxiliary conductors are placed retardation coils or electromagnetic resistances wound with a comparatively large number of convolutions, so as to offer a relatively high real resistance; but containing comparatively little iron, whereby they are enabled to offer an apparent resistance attributable to self-induction, relatively high to voice currents, and relatively low to calling currents. It may here be explained that helices or coils of wire which surround or are surrounded by iron, offer by reason of their self-induction a high retardation or apparent resistance both to the call currents and to voice currents, since these both undergo a constant change, generally by alternating their direction; this apparent resistance largely depends upon the amount of iron contained in the coil. But the rate of change is much higher in the voice currents, than it is or can be in the call current, and the apparent resistance offered by a given construction of coil is also largely dependent on such rate; hence though by reducing the amount of iron contained in the coils, the apparent resistance they offer to the call currents which have a low rate of change can be greatly diminished, until in fact it closely approximates the real resistance only; the said reduction of iron does not materially diminish the apparent resistance offered to voice currents whose rate of change is so much higher. The graduating electromagnetic resistances in the generator mains which are to affect the call currents, are for this reason made to contain a large amount of iron, while the circuit differentiating electromagnetic resistances in the auxiliary conductors which are intended to oppose the passage of the voice currents only, while affording an unopposed passage to call currents, are therefore made to contain little iron.

In the drawings which illustrate and form a part of this specification, Figure 1 is a diagram showing the invention applied to a simple telephone circuit of two stations. Fig. 2 is a similar diagram indicating conventionally a compound telephone circuit extending between two stations through a third. Fig. 3 is a detail diagram indicating in full, the connections of a call generator by means of suitable call keys and connecting cords with telephone circuits. Fig. 4 is a diagram showing a converter interposed between the generator proper and its working circuits. Fig. 5 is a diagram illustrative of the second feature only of the invention.

In Fig. 1 we have an electric circuit C, having direct and return conductors L and L^2, and extending between two telephone stations A and B. At A a graduated magneto generator M, is included in the circuit; and at B there is a polarized bell *b*, and receiving and transmitting telephones *t*, t^2. The direct conductor L, at B, connects at *u* with the usual automatic telephone switch *s*, on the hook of which the receiver *t* is hung, the circuit being supposed to be at rest. The telephone being thus hung on the switch, the circuit continues through the said switch to the contact s^2 forming the terminal of the branch 6 which joins the return main conductor L^2 at the point *z*, and in which is connected the bell *b*. The telephone branch 7 extends from the terminal contact s^3, through the telephones to the same point *z*, and is closed by the removal of the telephone from the hook, the bell branch being at the same time opened.

At station A a condenser *c* has its terminals 2 and 3 united with the circuit conductors L and L^2 respectively at *x*, and *y*, bridging them, and establishing an electrostatic shunt round the generator; and an electromagnetic resistance or retardation coil R is included in each of the generator mains 5 between the generator terminals and the condenser junctions *x* and *y*. The said retardation coils are made with a comparatively few turns of wire, but contain in their cores and casings a relatively large amount of iron. We have found coils having a real or conductor resistance of about forty ohms answer well. It is necessary that the conductor resistance of these coils shall be low, in order that the currents developed by the generator M may be of sufficient volume to supply as many circuits as it may at any

time be necessary to ring over at once. And it is also necessary that there shall be a considerable amount of iron in and about the coils, in order that their apparent resistance, or counter-electromotive force shall be sufficiently high to graduate the current, whereby it may be caused to assume a character or form to which the telephone when in circuit is irresponsive. The several terms "electromagnetic resistance," "inductive resistance," "retardation coil," "choking coil" and "self induction coil" have all been in the art applied to such coils R, which are intended to oppose the currents traversing them, an apparent resistance which is composed of their real resistance and their inductance, and we understand the said terms to be interchangeable.

We have found condensers, having a capacity of three microfarads, to operate satisfactorily; and such a condenser, associated as described, with the retardation coils R, efficiently achieves the desired graduation.

In Fig. 2, the connections at both terminal stations are alike, and are identical with those of station B in Fig. 1. The telephone *t* at station B^2 is however hung on its hook, and the circuit there is through the bell *b;* while at station B the telephone *t* is removed from the switch, and consequently is in circuit. The two sections C and C^2 of the circuit are united at a central or intermediate station D to form one compound circuit, having a bell in circuit at one station and a telephone in circuit at another. At D an alternating current call generator M, graduated as described above by retardation coils R and a condenser *c*, is connected in derived circuit or in multiple arc with the said compound telephone circuit, one of its main conductors 12 joining the conductor L of such circuit at *v*, and the other 13 joining the conductor L^2 at *w*. Under these conditions the alternating currents of the graduated generator M will sound the call in the bell *b* at B^2, but will not disturb or produce sounds in the telephone *t* at B though both alike are in the circuit and equally traversed by such alternating currents.

Fig. 3 indicates the connections of two pairs of switchcords F and F^2 with the generator M. These may be regarded as being located either at different sections of the switchboards, or at the same section; but some of the arrangements shown are necessary only, where they are at different switchboards. Hence the former view is the one to be preferred.

C and C^2 are circuits leading from substations where are telephones *t*, to the central station D where they are united by the flexible switchcord F, which has conductors *p* and p^2 and plug terminals P and P^2. Other two circuits C^3 and C^4 are in like manner shown as being connected or adapted to be connected with one another through a second switchcord F^2, its conductors *p* and p^2 and terminal plugs P and P^2.

M is the generator, 5 its main conductors, R its graduating retardation coils, and C its graduating condenser. Branching from any points *g h*, on the mains 5, are paired conductors 12 and 13, leading to the several switchcords; and the generator may be common to any number of such pairs of conductors.

In the circuit of each member of each pair of conductors 12 and 13, is an auxiliary retardation coil *r*. These retardation coils *r* contain a comparatively small amount of iron, but are wound with a comparatively large number of turns of wire. We have satisfactorily used coils wound up to a conductor resistancce of one hundred and fifty ohms. The construction adopted for the coils *r*, readily permits the passage of the alternating call current of the generator; but the more rapidly alternating telephonic currents are strongly opposed; the apparent resistance offered by such coils to voice currents being much greater than that offered to call currents. As soon therefore as the connection is made at the connecting board the bell at the desired station being connected with the generator will ring continuously until the attendant there takes down his telephone and begins to talk. But when that is done, though the generator connection continues, two persons talking at the two connected stations are not disturbed thereby, because their telephones do not respond to the graduated call currents. The position of coils *r*, in the circuits of the branched conductors 12 and 13 is necessary, as otherwise all circuits over which the ringing current was simultaneously being sent will be telephonically cross-connected at the terminals of the retardation coils R, or at the branching points *g h;* but the interposition of the coils *r* which may be said to be opaque to voice currents, presents an effectual bar to the passage of such currents, and virtually prevents such crossconnection so far as concerns telephonic transmission.

N is a three way cam and spindle switch, which controls the connection with the switchcord conductors of the operators' telephones, the generator circuits, and the disconnecting annunciator *d*.

When the said cam lever is turned to the side shown in connection with the switchcord F, the operators' telephones T T^2 are connected through their terminal contacts *e* and e^2, and the corresponding contacts *m* and m^2 of the bridge conductors 31 and 30, between the switchcord conductors *p* and p^2. When the cam is turned into the opposite extreme position, the generator conductors 12 and 13 are by subbranches 14 and 15 and contact springs 17 and 18 and corresponding contact springs *n* and n^2 connected with the bridge conductors 30 and 31, and thereby with the switch cord conductors; and when the cam is caused to take the middle position, both tele-

phones and generator are disconnected from the cords, and the disconnecting drop *d* only is bridged across the circuit.

Fig. 4 differs only in slight particulars from the organization shown in Fig. 3. The cord and key connections are omitted as being identical, and a converter J is interposed between the generator M and the retardation coils R and *r;* one helix of the converter is joined up in a circuit *o* with the armature coils, and the other has its terminals united to the main conductors 5. In this case, the generator and converter together virtually constitute the working generator. In some cases it is conceivable that the latter object of our invention namely the isolation or differentiation telephonically of the several cord circuits of the generator, is alone to be attained. In such cases the retardation coil R and the condenser, may be dispensed with, and this is shown in Fig. 5, where the generator mains divide into their branch conductors at the points *g* and *h* without any previously interposed resistances or retardation coils; the coils *r* being however connected as usual, in each of the branch conductors 12 and 13.

We have so far exclusively spoken of a magneto electric call generator, but we may of course substitute therefor any well known practical equivalent thereof, such as a battery and pole changer, without departing from the spirit of our invention.

We claim—

1. The combination of an electric circuit; and a polarized bell and magneto telephone included therein; with an alternating current call generator graduated to produce electrical currents adapted to operate said bell, but to which the said telephone is irresponsive.

2. In an electric circuit, the combination substantially as hereinbefore described, of a polarized electromagnetic bell; and a magneto telephone; with an alternating current call generator; and graduating devices therefor, consisting of a condenser shunting the said generator, and an electro-magnetic resistance included in the circuit between each pole of the generator and the condenser.

3. A telephone circuit extending between two terminal stations through an intermediate or central station; a receiving telephone and a call bell connected with said circuit at the said terminal stations; combined with an alternating current call generator connected with said circuit at the intermediate station; and graduating devices therefor, comprising a condenser constituting an electro-static shunt for the said generator, and an electromagnetic resistance or retardation coil interposed between each terminal of said generator and the condenser, whereby the currents developed by said generator are enabled to operate said bell without the production of disturbing sounds in the said telephone, substantially as described.

4. The combination substantially as hereinbefore described, of an electric circuit; a polarized electro-magnetic bell: and a magneto telephone included therein; with a magneto electric generator, and graduating devices therefor comprising a converter or induction coil having its secondary connected with the said electric circuit, and its primary included in a closed circuit with said generator; a condenser bridging or shunting the said secondary; and an electromagnetic resistance included in circuit between the terminals of said secondary, and the terminals of said condenser bridge, substantially as described.

5. The combination with a series of telephone circuits, and call sending keys therefor; of a common call generator having conductors extending in pairs to said call keys; and a retardation coil in each of the said generator conductors for preventing the passage of telephonic currents between circuits simultaneously connected with any two pairs of the said conductors, substantially as described.

6. The combination with a series of telephone circuits; and call sending keys therefor; of a common magneto call generator; a series of pairs of conductors extending from the poles thereof to said call keys; and an inductive resistance or retardation coil constructed to offer a relatively low apparent resistance to call currents, and a relatively high apparent resistance to voice currents, included in each of the said generator conductors; substantially as described.

7. The combination with a series of telephone circuits, and call sending keys therefor; of an electric call generator common to the series, having conductors extending to said call keys; and means as indicated for preventing the passage of telephone currents through their respective call keys, generator conductors, and common portions of the said generator circuit, between any two telephone circuits over which calls are simultaneously being sent.

8. The combination of a series of telephone main circuits converging to a central station; switchboard connecting cords at said station for uniting any two circuits; call sending keys one for each connecting cord included in circuit therewith; a common magneto electric call generator having conductors extending in pairs to the said keys, and adapted to be thereby connected with the connecting cord circuit; and an electromagnetic or retardation coil included in the circuit of each of the said paired conductors, the said coils being so constructed as to offer a relatively low inductive resistance to call currents, and a relatively high inductive resistance to voice currents, substantially as and for the purposes specified.

9. The combination of a series of telephone circuits, each extending from a substation to a central station; a telephone and call bell at each substation; switchboard conducting

cords at the central station for uniting any two circuits; call keys one for each cord, connected in circuit therewith; a magneto call generator common to the series of circuits, having branch conductors in pairs extending from its terminals to said call keys; main conductors connecting the generator terminals respectively with their several branches; a condenser shunting the generator; a retardation coil in each main between the generator terminal and the condenser; and an auxiliary retardation coil in each branch conductor; substantially as described and for the purposes specified.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 23d day of September, 1892.

EDWARD J. HALL.

Witnesses:
GEO. WILLIS PIERCE,
VICTOR M. BERTHOLD.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses, this 30th day of September, 1892.

FRANK A. PICKERNELL.

Witnesses:
GEO. WILLIS PIERCE,
FRANK C. LOCKWOOD.