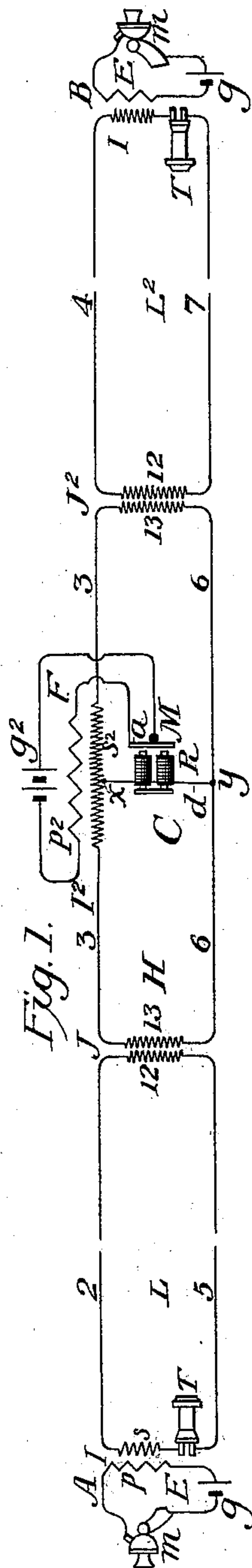


(No Model.)

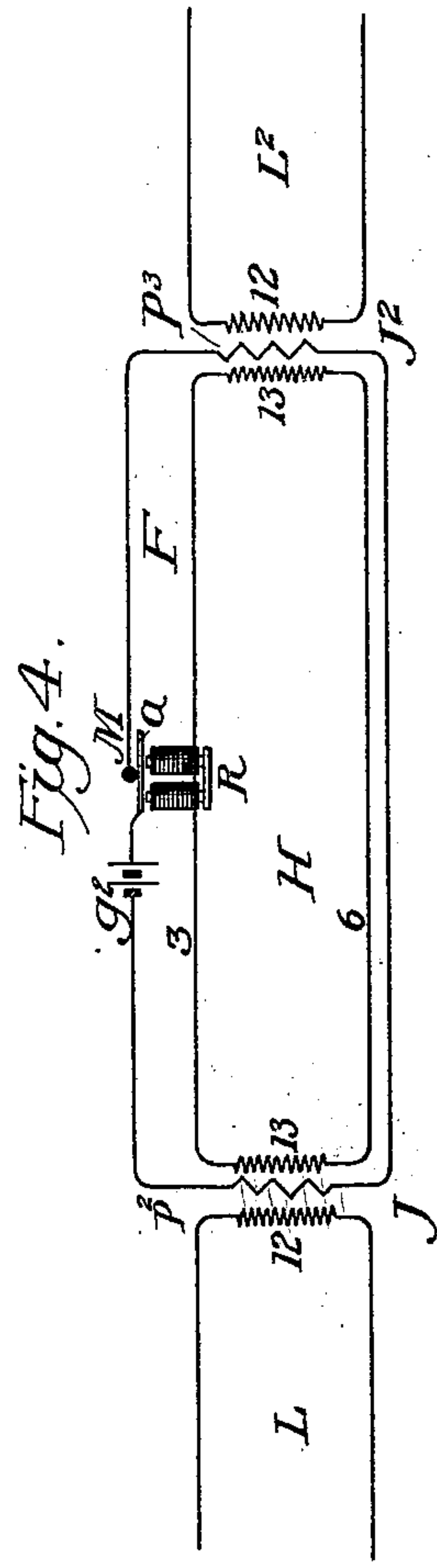
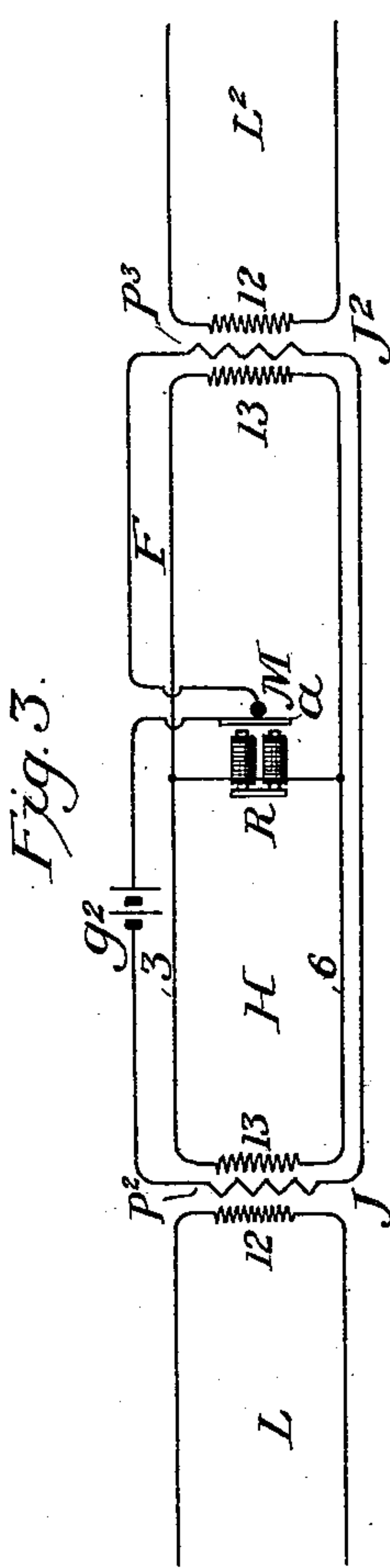
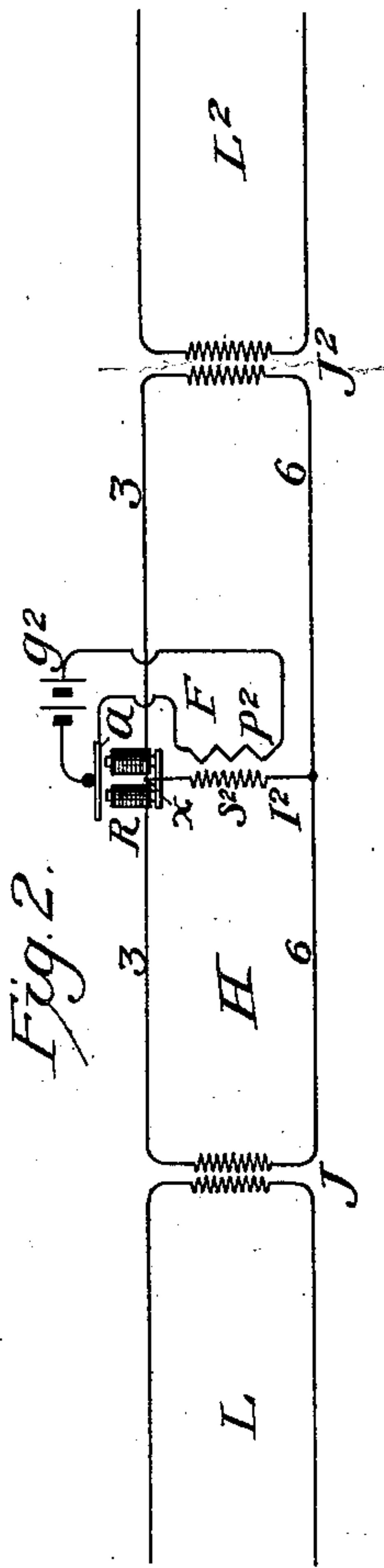
C. H. ARNOLD.
TELEPHONIC RELAY OR REPEATING SYSTEM.

No. 542,913.

Patented July 16, 1895.



Witnesses.
Benjamin
W. R. Edeben



Inventor.
Charles H. Arnold
by *J. J. Mauro*
his attorney.

UNITED STATES PATENT OFFICE.

CHESTER H. ARNOLD, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE
AMERICAN BELL TELEPHONE COMPANY, OF SAME PLACE.

TELEPHONIC RELAY OR REPEATING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 542,913, dated July 16, 1895.

Application filed March 16, 1895. Serial No. 542,059. (No model.)

To all whom it may concern:

Be it known that I, CHESTER H. ARNOLD, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Telephonic Relay or Repeating Systems, of which the following is a specification.

This invention relates to telephone relay or repeating systems, and its object is to facilitate the balancing of the system, to make the desired operation of reinforcing the current in the receiving-circuit more certain, and more surely to provide for the nullity of the receiving or repeating magnet to the reinforcing-currents generated in consequence of its own action, while remaining perfectly responsive to the action of the distant transmitters.

The essence of the invention consists in associating the relay or repeating apparatus proper, including its local repeating-circuit, with a short but conductively-complete auxiliary section of the main line, and in combining the said section and its associated repeater mechanism and arrangement with the two main telephone-circuits which are desired to repeat into each other, in such a way that it is inductively connected with both by means of repeating induction-coils, and thus constitutes a link connection between the said two main circuits, uniting them into a single compound circuit for through communication. At the same time the balance is much facilitated by reason of the shortness of the complete middle line-section thus interposed at the central, intermediate, or repeating station between the ends of the two circuits concerned.

In the drawings, Figures 1 to 4 are all diagrams representing different arrangements of telephone-circuits embodying the invention.

In Fig. 1, which indicates the simplest exemplification of the invention, A and B are sub-stations at the outer ends of the telephone-circuits L and L², and C is a central intermediate or repeating station entered by the other end of both circuits, and where they may be joined up electrically to constitute a compound or conjoint circuit for through communication. The said circuits may with

equal propriety be regarded as two distinct circuits connected for intercommunication, or as a single circuit of extra length, and in either case they are associated with a repeater placed at the central station C, by means of which the currents developed by the transmitter of either end station in the act of transmission are reinforced with similar currents derived from a fresh and centrally-placed source, these being caused by the action of said repeater to copy the form of the original voice-currents and then passed along to the distant receiving-station.

At the terminal stations A and B is the ordinary sub-station apparatus, consisting of a receiving-telephone T, a variable-resistance transmitter *m* in the local circuit E of a current-generator *g*, and the transmitter induction-coil I, whose primary winding is in the said local circuit and whose secondary winding is in the main circuit.

At the central station C is a short closed circuit H, forming the link for through communication interposed between the main circuits or sections of circuits L L², and thus constituting a central section of the compound telephone-circuit formed by the union effected through its interposition of the said two main circuits.

Extended between the two conductors 3 and 6 (which are virtually continuations of the conductors 2 and 5 of circuit L on one side and of the conductors 4 and 7 on the other) is the bridge-conductor *d*, containing the receiving or repeating electromagnet R of usual construction. The armature or diaphragm *a* of this magnet carries or is otherwise in operative relation to the variable-resistance medium of a repeating transmitter M, and controls the same, the said medium being placed in a local repeating-circuit F, including also a reinforcing-generator or source of current *g*².

An induction-coil I² is interposed between the local circuit F and the central-station section H of the main line, and by its instrumentality the variations of current occurring in the said local circuit are impressed in reinforced magnitude upon the said main-line section. The long and fine wire secondary winding *s*² of

the induction-coil I^2 is placed in the circuit of the main-line section H and is split or divided by the bridge connection at x , so that one-half of the said winding is on each side of the said bridge connection. The single or undivided coarse and short wire primary winding p^2 is in the local repeating-circuit F.

It only remains to describe the means of effecting the connection between the conductively-closed repeating-station section H of the main circuit with the principal or interstation-sections L and L^2 thereof. To this end I interpose repeating induction-coils J and J^2 between the two ends of the said station-section H and the central-station ends of the said principal sections L and L^2 , respectively, one winding J^3 of both coils being in the section H and the remaining winding J^2 of one of the repeating-coils J being in the section L, while the winding J^2 of the other repeating-coil J^2 is connected in the section L^2 . The repeating-coils J and J^2 may be constructed on any preferred plan, provided only that the two windings have similar proportions as to length and size of wire, and provided that the said windings are so relatively disposed that their mutual induction is at a maximum, so that the currents induced by either in the other is of like potential. This is necessary because transmission is reciprocal and because, therefore, that winding which at one moment is in a circuit which is receiving may at any other moment be in a transmitting-circuit, as the direction of conversation changes.

By the introduction of a short conductively-complete repeating-station section of main line connected with the two principal sections by repeating-coils it becomes possible to equalize the two sides of the electrical balance with great facility and substantial accuracy, first, because they can be made exactly of the same length, and, second, because they are both short.

Fig. 2 discloses the same essential elements as are found in Fig. 1, viz: the line-sections L L^2 and the office-section H of the compound main circuit, the repeating-coils J and J^2 , the local repeating-circuit F, the repeating-magnet R, controlling the resistance of the said local circuit by its action on the variable-resistance medium M, the reinforcing-battery g^2 in the local circuit, and the induction-coil I^2 associated with the repeater. The differentiating feature is the transposition and rearrangement of the repeating-magnet and induction-coil.

In Fig. 2 the receiving-magnet is placed in one of the conductors 3 of the office main-line section H, one-half of its winding or one of its spool-helices being placed on either side of the point x of the bridge connection, while the secondary winding s^2 of the induction-coil remains undivided and is connected as a bridge between the conductors 3 and 6

of station main-circuit section H. There is no material change in the mode of operation.

In Fig. 3 the separate repeating induction-coil I^2 is dispensed with, and the local repeating-circuit contains two coarse-wire windings, one associated with the two windings of each of the two main-line repeating-coils J and J^2 , so that the said coarse-wire winding p^2 serves as a primary for the coil J, while the winding p^3 serves as a primary helix for the coil J^2 . In this way the repeating-coils J and J^2 are enabled to replace the repeating induction-coil I^2 , so that when the transmission is from L to L^2 , J^2 acts as the said repeating induction-coil I^2 , while when the direction of transmission is reversed the coil J acts as the repeating induction-coil.

In Fig. 4 the special bridge is dispensed with, the repeating-magnet R being placed in one of the conductors 3 or 6 of the repeating-station main-line section, and the division of the local repeating-circuit primary winding into the two sections p^2 and p^3 , and their association with the two repeating-coils J and J^2 , is relied upon for the establishment of the requisite balance. This arrangement may in some cases be convenient, but I regard it as being in some respects inferior to those already described, of which it forms a modification.

Having now described my invention, I claim—

1. In a telephone repeating or relay system, the combination of two main telephone circuits or sections of circuits; an associated auxiliary circuit inductively connected with and between the said main circuits or sections to constitute with them a compound through circuit; a receiving electro-magnet in the said associated auxiliary circuit; a local repeating circuit including a variable resistance medium controlled by the said repeating magnet; and an induction coil with its primary and secondary windings included in the local circuit and the through circuit respectively, whereby the variations of current set up in the local repeating circuit, by the action of the receiving magnet, are enabled to induce similar and reinforced varying currents in the said compound through circuit; substantially as described.

2. In an automatic telephone repeating apparatus, the combination of a compound through telephone circuit comprising two main line sections extending from outlying stations to a repeating station, and a short central section located at said repeating station; repeating induction coils uniting the said central section to the main line sections respectively; a bridge uniting the conductors of the said central section, and a receiving magnet included therein; a local repeating circuit containing a repeating transmitter responsive to the said receiving magnet, and a battery; and a repeating induction

coil having a primary winding in said local circuit, and a secondary winding included in the central main line section on the two sides of the bridge respectively substantially as described.

two subscribing witnesses, this 7th day of March, 1895.

CHESTER H. ARNOLD.

Witnesses:

GEO. WILLIS PIERCE,
WILTON L. RICHARDS.

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