

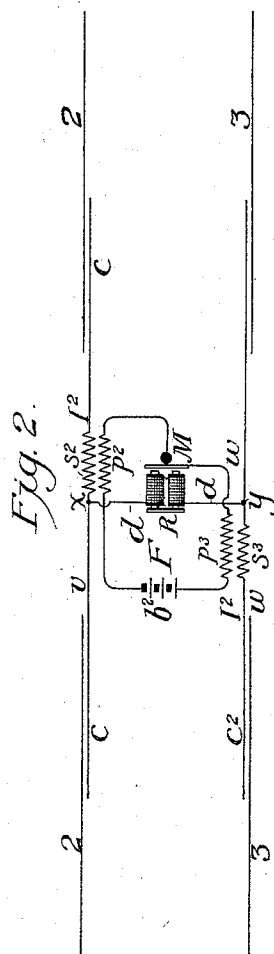
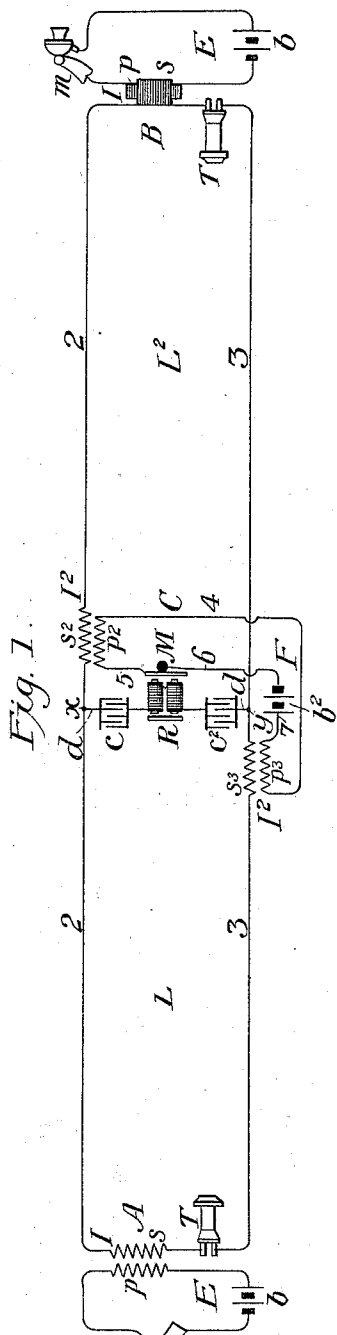
(No Model.)

C. H. ARNOLD.

TELEPHONIC REPEATING CIRCUIT AND APPARATUS.

No. 542,619.

Patented July 16, 1895.



Witnesses
Geo. Lewis
W. R. Edlin

Inventor.
Charles H. Arnold
 by *Jos. H. Moore*
 his attorney

UNITED STATES PATENT OFFICE.

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

TELEPHONIC REPEATING CIRCUIT AND APPARATUS.

SPECIFICATION forming part of Letters Patent No. 542,619, dated July 16, 1895.

Application filed March 16, 1895. Serial No. 542,060. (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 Repeating Circuits and Apparatus, of which the following is a specification.

When two telephone main circuits are united by link-conductors at a central station they virtually constitute a single main circuit extending between two terminal stations and the said central station becomes an intermediate station of such a line. Such a compound circuit may therefore be regarded either as one long circuit or as two independent circuits joined together for through communication. When the circuit so formed is very long—say over one thousand miles in length—the currents developed in it by the operation of the transmitter at either terminal station are liable to considerable dissipation in traversing the line, and as a consequence the speech is but imperfectly reproduced by the receiver at the other end. In consideration of such inefficient operation of the receiver it is desirable to provide a relay or repeating apparatus at some convenient intermediate station about the middle of the compound line, which shall be actuated by the relatively unweakened current flowing in a circuit of approximately but half of the total length of the said compound line, and which when so operated shall be capable of reinforcing the working-current by throwing upon the circuit a renewed current, due to a fresh source of electrical energy.

My invention proposes to provide such an apparatus, and to combine the same with a compound circuit of the above-mentioned character and constitution, and it comprehends a relay or repeating-magnet in a bridge-circuit controlling the resistance of a local repeating-circuit, which in turn reacts upon the main line through the intermediation of one or more induction-coils, and thereby reinforces the original current by bringing into play a new one supplied by a fresh and independent generator contained in the said local circuit. The primary winding of the induction-coil is included in the said local circuit and the secondary winding is placed

in the main-line conductors. To aid in the more perfect balancing of the line, the said secondary winding is preferably divided into two equal portions, one of which is connected in each conductor of the main circuit and on the two sides of the bridge connection respectively.

The characteristic feature, however, of my invention is that the repeating-magnet has no conductive connection with the main telephone circuit or circuits, and that its connection therewith is purely inductive, a condenser or condensers being interposed between main circuit and the bridge containing the said magnet. The said condensers may be of the ordinary or standard form, and they may be inserted one between each end of the bridge connection and the through circuit-conductors, the latter being without breach of continuity at the repeating-station, or they may be constructed by severing the continuity of the main conductors at the repeating-station and by connecting both ends of the bridge with relatively short parallel conductors running parallel with the said main conductors, in close inductive proximity thereto, but separated therefrom by a suitable dielectric.

Figure 1 is a diagram of the connections of a balanced reinforcing relay or repeater applied to a compound telephone-circuit, the condenser employed being of the ordinary or standard type; and Fig. 2 is a similar diagram illustrating the employment of a condenser formed of parallel line or strip-conductors with interposed dielectric sheathing, ribbon, or strip.

Similar parts are indicated in the two figures by similar letters and figures of reference.

In Fig. 1, A and B are two outlying or terminal stations of the compound talking-circuit formed by the union at the central, intermediate, or repeating station C of the conductors 2 and 3, respectively, of the two main telephone-circuits L I². At the said stations A and B the usual telephone apparatus is placed, but for the purposes of this invention it is only necessary to show the transmitter local circuits E, containing the variable transmitters *m*, and their sources of current *b* (ordinarily batteries) and the receiving-telephones T included in the main-line circuit,

an induction-coil I being also provided in a manner well understood and interposed between the local and main circuits, its coarse and short wire primary winding being included in the said local and its long and fine wire secondary winding being included in sequence with the receiving-telephone in the main circuit. The two main circuits L and L², being formed at the repeating-station C into one long-talking circuit, as shown, a repeating apparatus is associated with the said conjoint-circuit in the following manner: At the said repeating-station C an electrical connection is made between the main conductors 2 and 3 of the talking-circuit by joining to them an inductively-continuous bridge *d* at points *x* and *y*. This bridge contains one or more condensers *c c*² and a repeating-magnet R, (preferably a permanent magnet with soft-iron pole-pieces and short magnetizing-coils surrounding them.)

Although I prefer two condensers with the magnet placed between them, as shown, the arrangement is operative and fairly satisfactory when but one is employed, and in that case it may be placed on either side of the magnet.

The variable-resistance medium M of a repeating or reinforcing transmitter is mounted immediately in front of the armature or diaphragm of the repeating-magnet in position to be operated or controlled thereby, and the said variable resistance is placed in a local repeating-circuit F of a reinforcing-generator or source of current *b*²; which local circuit, traceable through the numerals 4, 5, 6, and 7, likewise contains the primary winding of an induction-coil I², which has its windings both centrally divided into two sections. One section *s*² of the secondary winding of the said induction-coil I² is placed in the main conductor 2 on one side of the bridge-junction *x*; and the remaining section thereof is placed in the main conductor 3 on the other side of the bridge-junction *y*. These windings are so disposed in order that a more accurate balance may be maintained, and it is obvious that the two sections are to be so wound or electrically connected that the currents generated in them by the action of the relay apparatus will be coincident in direction in the main conductors but opposite in direction through the bridge *d*, whereby the repeating-magnet R in the said bridge is free from any disturbing effects from the repeater-current while remaining fully subject to the control of currents due to the operation of the transmitters *m* at the distant stations A and B.

In Fig. 2 the connections and appliances are the same as in Fig. 1, and the sole difference consists in the construction and arrangement of the inductive bridge-circuit *d*. In it, instead of employing condensers of the ordinary and standard form, I elect to employ condensers based on a principle which has heretofore to some extent been used in cables, and

which is fully described and illustrated in Letters Patent of the United States, No. 469,475, granted to Hammond V. Hayes and John S. Stone, February 23, 1892, wherein the two opposing plates, members, or surfaces of the condenser are formed of two independent parallel conductors and are separated conductively from one another by an interposed layer or strip of suitable non-conducting material of high specific inductive capacity constituting the dielectric, but held in close inductive relation through the instrumentality of the same interposed non-conductor.

The main conductors 2 and 3 are severed at *v* and *w*, and auxiliary conductors *c c*² overlap the gap or space thus made and extend for some distance parallel to the main conductors on both sides thereof, being separated therefrom by a suitable partition of any suitable insulating material. The parallel portions of the main conductors and of the gap-spanning conductors thus constitute the opposing condenser-plates.

The bridge *d*, containing the repeating-magnet R, unites points *x* and *y* of the conductors *c* and *c*², respectively, and the secondary winding-sections *s*² and *s*³ of the repeater induction-coil I² are placed one on each side of the bridge, also in the gap-spanning conductors *s*² *s*³.

It will be observed that in both exemplifications of this invention the repeating-magnet has no conductive connection with the main circuit and that the original voice-currents act thereon by electrostatic induction, or by what has been called "admittance" condensers, suitably proportioned to the circuits, being, so to speak, transparent with respect to voice-currents. In Fig. 2, moreover, the same process is relied upon also for the maintenance of such communication as occurs between the severed portions of the two main conductors direct, as well as from either to the bridge and from the repeater to the receiving end of the main circuit.

Experience indicates that the employment of these forms of repeater results in a considerable amplification or reinforcement of volume.

I claim—

1. In a telephone circuit repeating system, the combination of a main telephone circuit; a local repeating circuit containing a source of current and a variable resistance repeating transmitter; a repeating or receiving electromagnet in a bridge having electrostatic or inductive electrical connection between the conductors respectively of said main circuit; placed in operative relation to the said repeating transmitter to actuate the same; and a repeating induction coil having its secondary winding divided into two sections, placed respectively at the two ends of the bridge and on different sides thereof, and provided with a similarly divided primary whose sections are both included in the local

circuit, and each associated with one of the said secondary sections; substantially as described.

2. In a telephone circuit repeating system
5 the combination substantially as hereinbefore described, of a main telephone circuit; a local repeating circuit containing a variable resistance transmitting medium, and a source
10 of current; a bridge conductor extending between the conductors of the said main circuit, and containing a repeating or receiving electro-magnet mounted in operative relation to the said variable resistance medium and
15 adapted to operate the same; a condenser interposed in the said bridge whereby it is divided conductively, but left inductively continuous; and a repeating induction coil interposed between the local and main circuits,
20 having its secondary windings in two sections placed in the main line conductors respectively, one on each side of the bridge, and its primary also in two sections placed in the local circuit, and associated each with one of the secondary sections.

25 3. The combination in a telephone circuit

repeating system, of a main telephone circuit; a local repeating circuit including a variable resistance transmitting medium; a bridge extending between the main circuit conductors; a repeating or receiving electro-magnet
30 mounted in operative relation to the said variable resistance medium; and a repeating induction coil having its secondary winding in two sections connected in the two main line conductors on different sides of the
35 bridge, and its primary also in two sections both in the local circuit, and each associated with one of the secondary sections; with two condensers included in the circuit of the bridge conductor one on each side of the re-
40 peating electro-magnet; substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 7th day of
45 March, 1895.

CHESTER H. ARNOLD.

Witnesses:

GEO. WILLIS PIERCE,
FRANK C. LOCKWOOD.