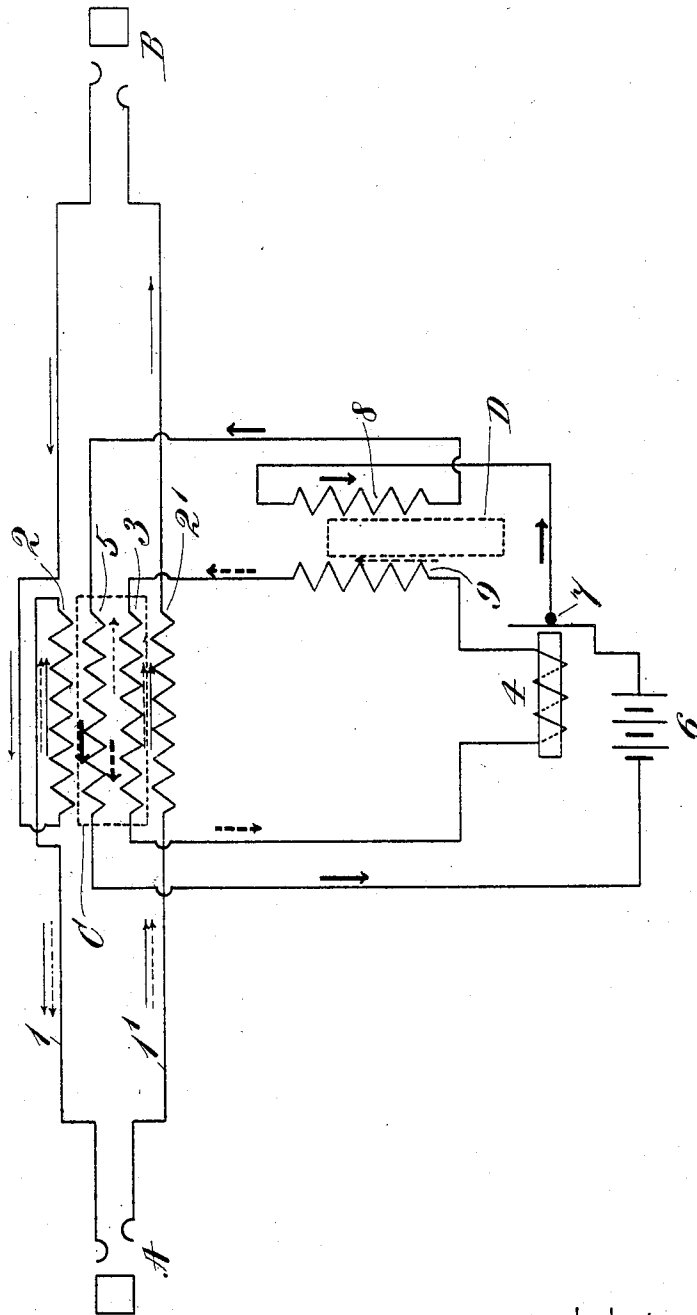


H. B. STONE.
 TELEPHONE REPEATER SYSTEM.
 APPLICATION FILED JAN. 15, 1909.

1,025,167.

Patented May 7, 1912.



WITNESSES:

E. B. Tomlinson
Patrick J. Conroy

INVENTOR=

Henry B. Stone
 by *Brown & Woodworth*
attys.

UNITED STATES PATENT OFFICE.

HENRY B. STONE, OF PROVIDENCE, RHODE ISLAND.

TELEPHONE REPEATER SYSTEM.

1,025,167.

Specification of Letters Patent.

Patented May 7, 1912.

Application filed January 15, 1909. Serial No. 472,449.

To all whom it may concern:

Be it known that I, HENRY B. STONE, a citizen of the United States, and a resident of Providence, in the county of Providence and State of Rhode Island, have invented a new and useful Improvement in Telephone Repeater Systems, of which the following is a specification.

My invention relates to telephone repeater systems and its object is to simplify and improve the efficiency of such systems in the manner hereinafter described.

In telephone repeater systems which are bridged across the main line it has been found that unless the two sections of the line are quite closely balanced efficient operation is impossible.

It has heretofore been proposed to connect the main circuit elements of a telephone repeater in series with the main line and so far as I am aware such series systems have proven unsatisfactory because the energy imparted to the line by the transmitter element of the repeater over-excites the receiver element thereof and causes the apparatus to "sing". In order to overcome this defect certain auxiliary apparatus in the nature of external artificial lines has been proposed to divert from the receiving element a certain portion of the current developed by the transmitting element. The use of such external apparatus impairs the efficiency of the system by wasting the energy developed by the transmitting element.

In the present invention I associate the several elements of the repeater system in such manner that the use of artificial lines or equivalent external devices is rendered unnecessary and all the energy produced by the transmitting element of the repeater is effective for reinforcing the original main line current.

In carrying out my invention I employ the usual repeater consisting essentially of a receiving circuit including a receiver and a transmitting circuit including a transmitter and a source of electrical energy, and I associate said circuits with the main line by means of a main repeating coil constructed to weaken the currents developed by the transmitting circuit in the receiving circuit, so that there is no tendency to the continuous operation of the apparatus commonly known as "singing." This repeating coil preferably has four windings wound on a common core, its primary

windings being connected in series with the two sides of the line circuit respectively and arranged to act cumulatively on the receiving circuit, and its secondaries being connected in series with the transmitting and receiving circuits respectively. In order to counteract the weakening of the currents developed in the receiving circuit by the transmitting circuit I may provide an auxiliary repeating coil inductively connecting said circuits and preferably having an adjustable core.

In the drawing which accompanies and forms a part of this specification the figure represents in diagram one embodiment of my invention.

In the figure, 1, 1' represent the main line having terminal stations A B. The primary windings 2 2' of the main repeating coil are connected in series with the two sides of the main line respectively. The secondary winding 5 of the repeating coil is connected in series with the transmitting circuit which includes the battery 6 or other suitable source of electrical energy and the transmitter 7. The secondary winding 3 of said repeating coil is connected in series with the receiver or receiving helix 4 and the latter is located so as to control the operation of the transmitter 7. The primary winding 8 of the auxiliary repeating coil is connected as shown in series with the transmitting circuit and the secondary winding 9 thereof is included in the receiving circuit.

C represents the common core for the windings of the repeating coil and D is the adjustable core of the auxiliary repeating coil.

The pulsations of current in the main line develop similar pulsations in the winding 3 of the receiving circuit which energizes the receiver 4 and cause very much stronger pulsations of current to flow in the transmitting circuit. The strong current pulsations in the transmitting circuit develop in the winding 3 currents opposing those developed therein by the main line current so that there is no tendency for the mutual reaction which ordinarily produces "singing" in telephone repeaters. A certain portion of the energy of the current flowing in the transmitting circuit is translated to the receiving circuit by the auxiliary repeating coil 8, 9 and opposes the current which is induced in the winding 3 by that which flows in the winding 5, the

current developed in the receiving circuit by said auxiliary repeating coil being in the same direction as that originally induced in said receiving circuit by the current flowing in the main line. The result is that the current in the receiving circuit is maintained at its full strength or at a value depending upon the adjustment of the core D with respect to the windings 8, 9 and is not wasted by external devices such as artificial lines heretofore used to tone down or counteract the over-excitation of the receiver.

The primary currents, or those developed in the transmitting or "primary" circuit, are represented by short solid arrows. The initial or repeating line currents are represented by long solid arrows. The reproduced or repeated currents, or those induced by the primary currents are represented by long broken arrows. The currents induced by the initial or repeating line currents in the receiving or "tertiary" circuit are represented by short broken arrows.

Where the representations of circuits and coils are horizontal, the arrow is placed above the circuit or coil and where they are vertical, the arrow is placed to the right thereof.

Pulsations of current in the main line or "secondary" circuit 1 1', passing through the winding 2 (or through the windings 2 2', if both windings be used) develop similar pulsations in the winding 3 of the receiving or "tertiary" circuit which energize the receiver 4 and cause very much stronger pulsations of current from the battery 6 to flow in the transmitting or "primary" circuit. These strong current pulsations spend their entire energy in developing similar pulsations in the main line only, such translation of energy to the main line being accomplished by the transformer whose primary consists of the winding 5 and whose secondary consists of the winding 2 (or the windings 2 2').

In order to prevent any portion of the energy of the current pulsations developed in the transmitting or "primary" circuit from being translated to the receiving or "tertiary" circuit and thereby operating the receiver 4 (said operation of said receiver producing "singing" or "howling") the transformer 8 9 is provided, the primary 8 being in the transmitting or "primary" circuit and the secondary 9 being in the receiving or "tertiary" circuit.

The strong pulsations of the primary current which pass through the winding 5 to the left, as shown by the short solid arrow, would develop in the secondary 3 relatively strong currents flowing to the right as shown by the long broken arrow placed above said secondary, were it not for the transformer 8 9.

The strong pulsations of primary current

which pass down the primary 8, as shown by the short solid arrow, would develop in the secondary 9 relatively strong currents flowing upward as shown by the long broken arrow placed to the right of said secondary, were it not for the transformer 8 9.

When, by means of the adjustable core D, or other suitable means, the inductive effect of the primary 8 on the secondary 9 is properly adjusted, the strong pulsations of primary current flowing in the primary 8 develop in the secondary 9 an electromotive force which is equal in value and opposite in sign to the electromotive force developed in the secondary 3 by the strong pulsations of primary current flowing in the winding 5. The result is that the receiving or "tertiary" circuit has applied to it two electromotive forces which are equal in value and opposite in sign, and accordingly no current is caused to flow in the receiving or "tertiary" circuit by the strong pulsations of the battery current. In fact, the only currents that can possibly flow in said receiving or "tertiary" circuit are those which are developed therein by the inductive effect of the initial or repeating line currents flowing in the winding 2 (or the windings 2 2') on the secondary 3, such currents being shown by the short broken arrows. Accordingly the two long broken arrows which are placed above the secondary 3 and to the right of the secondary 9 do not really represent currents at all, but merely equal and opposite electromotive forces.

After the best position for the core D has been ascertained experimentally, no further adjustments of the system are required for adapting the same to lines of varying electrical properties and by means of this system long lines may be connected to short lines without the use of any balancing apparatus.

It will be readily apparent that the winding 5 may be eliminated and the terminals of the transmitting system connected by the terminals of the winding 3.

Many other modifications will suggest themselves to those skilled in the art without departing from the principle of my invention, and accordingly I do not desire to be limited to the particular system of circuits herein described for the purpose of more fully disclosing my invention.

I claim:

1. A telephone repeater system comprising a main line, a receiving circuit including a receiver, and a transmitting circuit including a transmitter and a source of electrical energy; a main repeating coil having its primary windings connected in series with the two sides of said main line, respectively, and arranged to act cumulatively on said receiving circuit, said repeating coil having its secondary windings connected in

series with said transmitting and receiving circuits, respectively; and an auxiliary repeating coil having its primary winding connected in series with said transmitting circuit and its secondary winding connected in series with said receiving circuit; the said main repeating coil being arranged to weaken the current developed by said transmitting circuit in said receiving circuit and said auxiliary repeating coil being arranged to strengthen the current developed by the main line in said receiving circuit.

2. A telephone repeater system comprising a main line, a receiving circuit including a receiver, and a transmitting circuit including a transmitter and a source of electrical energy; a main repeating coil having its primary windings connected in series with the two sides of said main line, respectively, and arranged to act cumulatively on said receiving circuit, said repeating coil having its secondary windings connected in series with said transmitting and receiving circuits respectively; and an auxiliary repeating coil having its primary windings connected in series with said transmitting circuit and its secondary winding connected in series with its receiving circuit; the said main repeating coil being so arranged that the current developed by said transmitting circuit in said receiving circuit is opposed to the current developed therein by the main line and said auxiliary repeating coil being so arranged that the current developed by said auxiliary repeating coil in said receiving circuit is in the same direction as that developed therein by said main line.

3. A telephone repeater system comprising a main line, a receiving circuit including a receiver, and a transmitting circuit including a transmitter and a source of electrical energy; a main repeating coil having its primary windings connected in series with the two sides of said main line, respectively, and arranged to act cumulatively on said receiving circuit, said repeating coil having its secondary windings connected in series with said transmitting and receiving circuits, respectively; and an auxiliary repeating coil having its primary winding connected in series with said transmitting circuit and its secondary winding connected in series with said receiving circuit; the said main repeating coil being arranged to weaken the current developed by said transmitting circuit in said receiving circuit.

4. A telephone repeater system comprising a main line, a receiving circuit including a receiver, and a transmitting circuit including a transmitter and a source of electrical energy; a main repeating coil having its primary windings connected in series

with the two sides of said main line, respectively, and arranged to act cumulatively on said receiving circuit, said repeating coil having its secondary windings connected in series with said transmitting and receiving circuits, respectively; and an auxiliary repeating coil having its primary winding connected in series with said transmitting circuit and its secondary winding connected in series with its receiving circuit; the said main repeating coil being so arranged that the current developed by said transmitting circuit in said receiving circuit is opposed to the current developed therein by the main line.

5. A telephone repeater system comprising a main line provided with terminal stations, intermediate repeating apparatus including a receiving circuit and a transmitting circuit and having its main circuit elements connected in series with said stations, and an auxiliary repeating coil inductively connecting said transmitting and receiving circuits, said auxiliary repeating coil being arranged to strengthen the current developed by the main line in said receiving circuit.

6. A telephone repeater system comprising a main line, provided with terminal stations, intermediate repeating apparatus including a receiving circuit and a transmitting circuit and having its main circuit elements connected in series with said stations, an auxiliary repeating coil inductively connecting said transmitting and receiving circuits, said auxiliary repeating coil being arranged to strengthen the current developed by the main line in said receiving circuit, and a core for said auxiliary repeating coil adjustable with respect to the windings thereof.

7. A telephone repeater system comprising a main line provided with terminal stations, intermediate repeating apparatus including a receiving circuit and a transmitting circuit and having its main circuit elements connected in series with said stations, an auxiliary repeating coil inductively connecting said transmitting and receiving circuits, said auxiliary repeating coil being arranged to strengthen the current developed by the main line in said receiving circuit, and means for varying the inductive effect between the windings of said auxiliary repeating coil.

In testimony whereof, I have hereunto subscribed my name this 13th day of Jan. 1909.

HENRY B. STONE.

Witnesses:

OLIVER KENDALL, Jr.,

FREDERICK F. MANCHESTER.