

C. S. DEMAREST, A. B. CLARK AND G. CRISSON.

TELEPHONE REPEATER EQUIPMENT.

APPLICATION FILED APR. 16, 1919.

1,384,994.

Patented July 19, 1921.

2 SHEETS—SHEET 1.

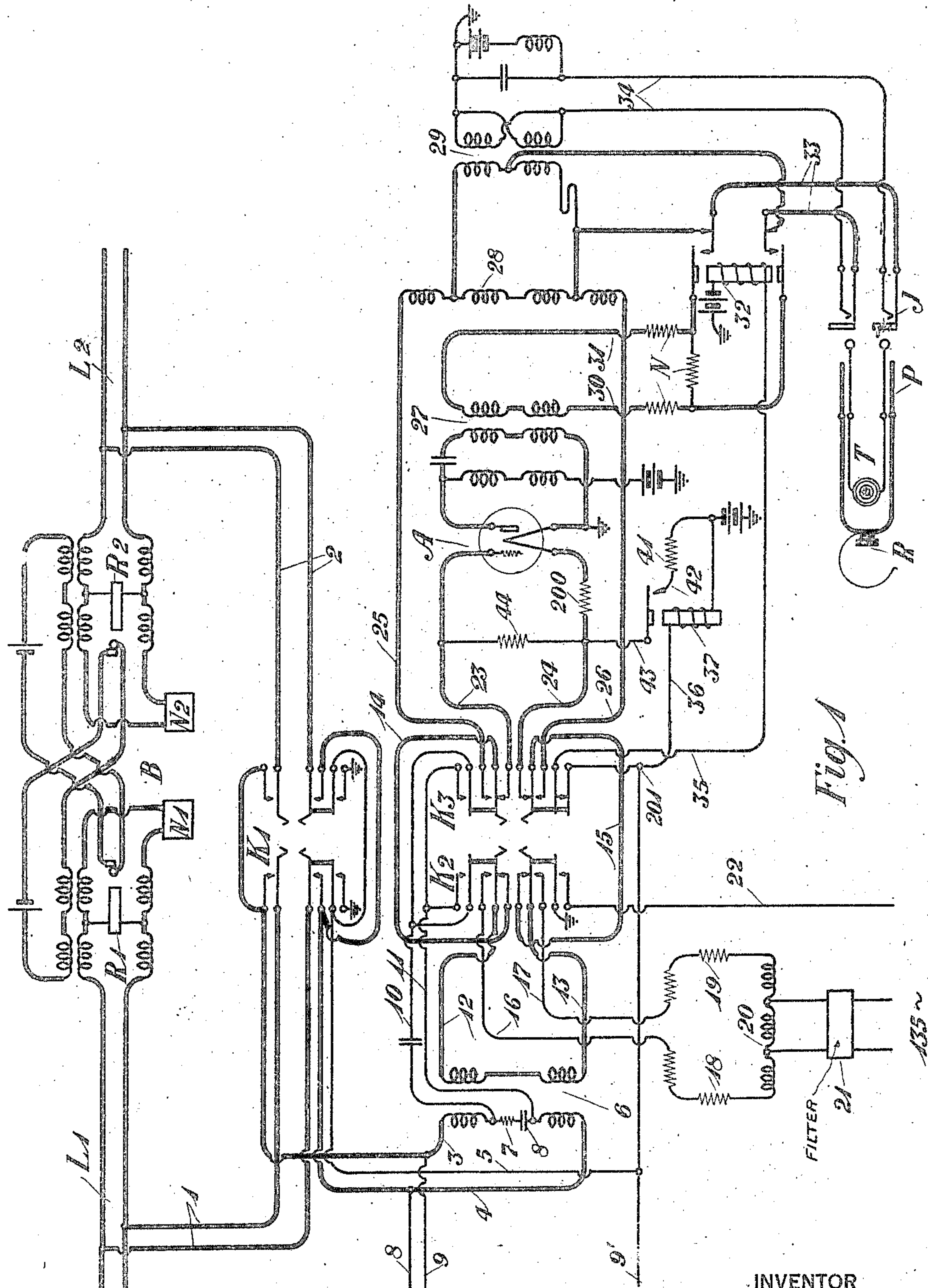


Fig. 1

INVENTOR

C. S. Demarest, A. B. Clark & G. Crisson

BY

J. V. F. 70

ATTORNEY

C. S. DEMAREST, A. B. CLARK AND G. CRISSON.

TELEPHONE REPEATER EQUIPMENT.

APPLICATION FILED APR. 16, 1919.

1,384,994.

Patented July 19, 1921.

2 SHEETS—SHEET 2.

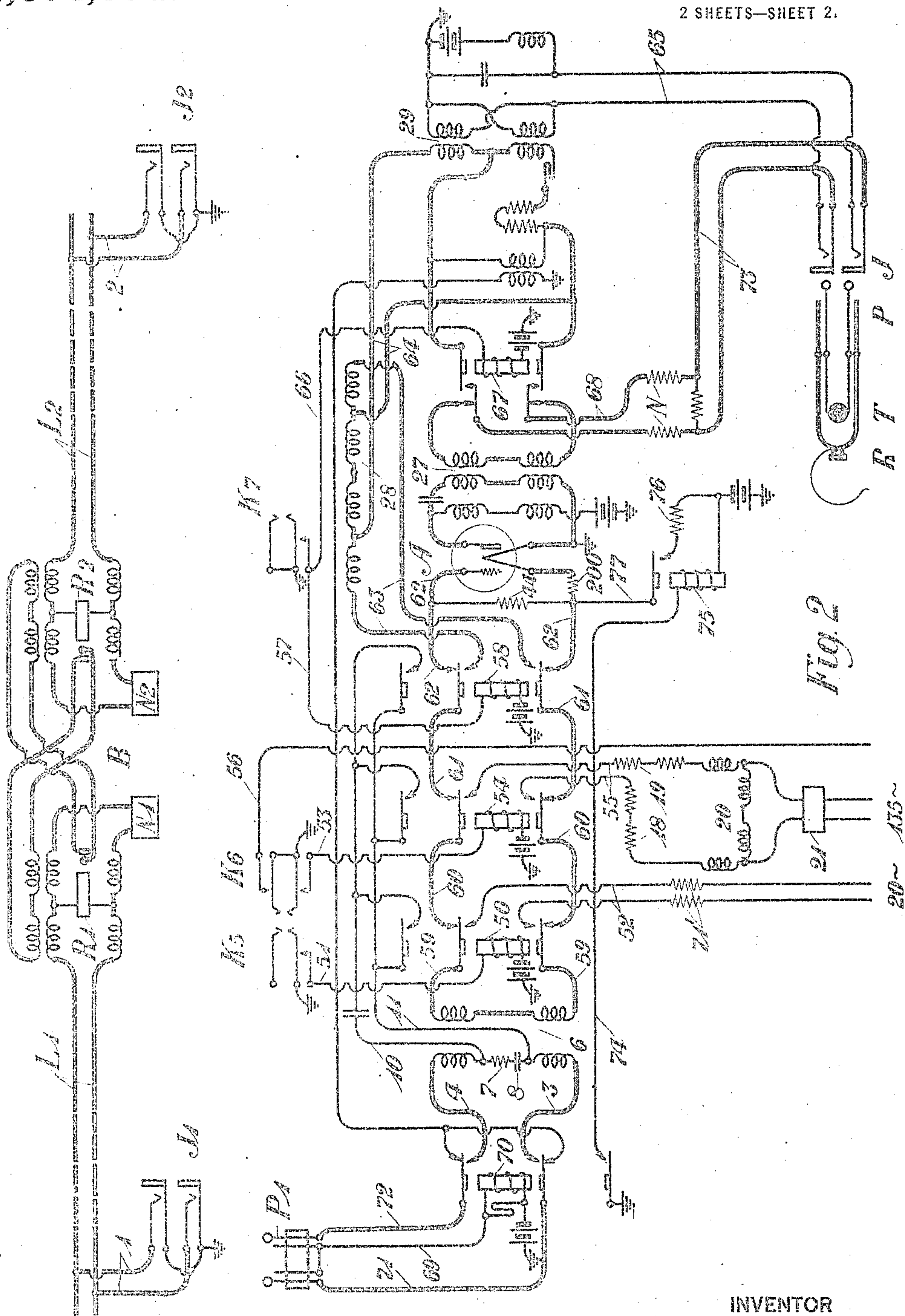


Fig. 2

INVENTOR

C. S. Demarest, A. B. Clark & G. Crisson

J. V. Folt
ATTORNEY

UNITED STATES PATENT OFFICE.

CHARLES S. DEMAREST, OF NEW YORK, ALVA B. CLARK, OF BROOKLYN, NEW YORK, AND GEORGE CRISSON, OF HOBOKEN, NEW JERSEY, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE REPEATER EQUIPMENT.

1,384,994.

Specification of Letters Patent. Patented July 19, 1921.

Application filed April 16, 1919. Serial No. 290,382.

To all whom it may concern:

Be it known that we, CHARLES S. DEMAREST, ALVA B. CLARK, and GEORGE CRISSON, residing at New York, Brooklyn, and Hoboken, in the counties of New York, Kings, and Hudson and States of New York, New York, and New Jersey, respectively, have invented certain Improvements in Telephone Repeater Equipments, of which the following is a specification.

This invention relates to transmission circuits and more particularly to arrangements whereby an operator may supervise, talk, and ring on transmission circuits which include repeater elements.

When a transmission circuit includes repeater elements the two line sections of the circuit which are interconnected by the repeater are balanced by artificial lines associated with the repeater. If a sufficiently high degree of balance is obtained between the line sections and artificial lines it is possible to prevent singing from taking place over the circuit. The association of equipment for supervision, talking, or ringing with such a circuit is apt to cause a degree of unbalance sufficient to cause singing. In former arrangements it has been the practice in order to obviate this difficulty to disconnect the repeater apparatus from the circuit whenever an operator, testboard man, or repeater attendant desired to talk or ring over the circuit, and provision was made for supervision by wiring a special series monitoring coil to jacks at each point where it was desired to listen on the circuit.

Accordingly it is an object of the invention to eliminate such undesirable features and to enable the operator, testboard man, or repeater attendant to supervise, talk, and ring on circuits equipped with telephone repeaters in the same manner as on lines not so equipped. A particular object of the invention is to provide an arrangement whereby the listening apparatus of an operator's supervising circuit may be associated with a section of a line including repeater apparatus without causing appreciable unbalance. Another object is to provide means whereby an operator's talking equipment may be associated with a section of a line including repeater apparatus without causing the repeater to sing. A further

object has reference to the provision of means whereby a listening operator may apply ringing current to such a line without causing serious unbalance between such a line and its balancing artificial line. These objects as well as others, will be clear from the following detailed description of the drawing and of the operation of the invention.

In the drawing Figure 1 illustrates a circuit diagram of a preferred form of the arrangements of the invention, while in the Fig. 2 is illustrated a modification thereof.

In Fig. 1 of the drawing is shown a transmission line, the sections L_1 and L_2 of which are interconnected by the two-element two-way repeater apparatus B. The repeater apparatus B is of a well known type, and includes the repeaters R_1 and R_2 , which are illustrated as of the mechanical type, although other types such as the vacuum bulb repeater may be employed. Furthermore, while the arrangements of this invention have been illustrated as associated with a circuit including a two-way two-element repeater, it is understood that the arrangements of the invention may be associated with other types of repeater circuits such as, for example, the four-wire repeater circuit. Associated with the repeater apparatus B are artificial lines N_1 and N_2 adapted to balance the sections L_1 and L_2 respectively of the transmission line. The supervising, talking and ringing equipment is associated with the contacts of the key K_1 which, when thrown in one direction bridges the equipment across section L_1 of the line, and when thrown in the other direction bridges the equipment across the section L_2 of the line. By means of conductors 8, 9 and 9', and other conductors (not shown) similar thereto, the supervising operator's equipment may be associated with the other keys similar to key K_1 and may be used in connection with a plurality of lines. The supervising equipment is associated with the contacts of key K_1 through the transformer 6, one winding of which is of sufficiently high impedance, so that, when the supervising equipment is bridged across a section of the line, no appreciable unbalance will result between the section of the line and its balancing artificial line. Connected in series with one of the wind-

ings of transformer 6 is the high resistance element 7 and the condenser 8, which serve as a filter to attenuate and practically extinguish currents of relatively low frequencies as compared with currents of telephonic frequencies, so as to reduce any interference in the supervising operator's receiver R which might be caused by the transmission over the sections L_1 or L_2 of the line of currents of telegraph or signaling frequencies. The telephone receiver R of the equipment is normally associated with the other winding of transformer 6 by means of an amplifier A. This amplifier is preferably of the vacuum tube type, in order that it may draw only an inappreciable amount of energy from the line, but at the same time will deliver enough energy to produce a proper volume of sound in the receiver. Under these conditions, the only energy drawn from the line is that required to excite the transformer 6, which works with the secondary effectively open. Between the output winding of the amplifier A and the receiver R is provided a network N including a series resistance and a shunt resistance. These resistances reduce the sound in the receiver to a volume suitable for monitoring purposes, and are proportioned so that substantially the same volume of sound will be obtained with either the high or low impedance type of receiver customarily used at the testboard.

Associated with the transformer 6 is the key K_2 , which when operated, disconnects the supervising apparatus and connects ringing apparatus to the transformer 6. When the key K_2 is operated a condenser is bridged about the filtering elements 7 and 8 in transformer 6 to provide a path for the low frequency ringing currents. As the ringing equipment which is to be bridged across the transmission line through the transformer 6 is of low impedance the condition of balance of the line and its artificial line would be materially altered. To avoid this, additional impedance is inserted in the bridge in the form of the resistance elements 18 and 19. Associated therewith is the autotransformer 20 which, when necessary, is used to increase the voltage of the ringing circuit to a value sufficient to give the desired current in the line. The resistances 18 and 19 serve to increase the impedance of the ringing circuit to a value which will not produce singing of the repeater. They have the lowest value consistent with this requirement. The strength of the ringing current is determined by the ratio of the auto-transformer 20. If the voltage of the ringing source is high enough, the autotransformer may be omitted and additional series resistances used to give the desired current. Associated with the source of ringing energy is the filter 21, which is of a type

well known in the art, and may be of the type illustrated in the U. S. Patent No. 1,227,113 to G. A. Campbell. The filter 21 serves to extinguish or attenuate currents transmitted from the ringing source which are of frequencies undesirable for signaling purposes, and readily allows the transmission of currents of the desired frequency for signaling, which in practice might be in the neighborhood of 135 cycles.

Associated with the transformer 6 is the key K_3 , which when operated bridges the operator's talking set across the transmission line. The operation of key K_2 closes a condenser bridge about the high impedance filtering elements 7 and 8 in transformer 6 to provide a path for the talking currents. As the operator's telephone set is of relatively low impedance, the operation of key K_3 would materially alter the condition of balance of the line and its artificial line. Accordingly there is provided in the talking circuit between the operator's set and transformer 6 an autotransformer 28. The impedance of the telephone set is stepped up by the autotransformer 28 and further stepped up by transformer 6 sufficiently, so that, when the telephone set is bridged across the transmission line no serious unbalance of the circuit will result.

With reference to the amplifier A no separate source of potential is provided for the grid, the proper grid potential being maintained by means of the resistance element 200 inserted in series in the filament circuit between the filament and the point of connection of the input transformer. Bridged across the input side of the amplifier is the resistance 44 which is of very high impedance and which serves to prevent disturbances which would be caused whenever the grid is entirely disconnected from the rest of the circuit by the operation of either of the keys K_2 or K_3 .

The invention may now be more fully understood from the following description of its operation. If the operator desires to supervise on one of the sections, such as section L_1 , of the transmission line, the key K_1 will now be thrown to the left and the left hand or high impedance winding of transformer 6 will be bridge across the section L_1 of the line, over conductors 3 and 4, make contacts of key K_1 , and thence over conductors 1. As has been formerly pointed out, this winding of transformer 6 includes the high resistance 7 and the condenser 8, which serve to reduce ringing and other low frequency disturbances. The impedance of this winding is so high that an inappreciable transmission loss results and no appreciable unbalance occurs between section L_1 of the line and the artificial line N_1 . The operation of key K_1 also closes the follow-

ing circuit: from ground, make contact of key K_1 , conductor 5, to connecting point 201; from connecting point 201, over the normal contact of key K_3 , conductor 35, winding of relay 32 to battery and ground. The closing of this circuit operates the relay 32. A circuit is also closed from connecting point 201, over conductor 36, winding of relay 37 to battery and ground, thereby energizing relay 37. The operation of relay 37 closes a circuit from ground and battery, resistance 41, conductor 42, contact and armature of relay 37, conductor 43, resistance 200, filament of amplifier A to ground. The closing of this last circuit conditions the amplifier A for operation. When the amplifier A is conditioned for operation and when the relay 32 is operated, the receiver R of the operator's supervision equipment is associated with the right hand winding of transformer 6 and with the transmission line L_1 as follows: from the right hand winding of transformer 6, over conductors 12 and 13, normal contacts of key K_2 , conductors 14 and 15, normal contacts of key K_3 , conductors 23 and 24, and thence through amplifier A and over the output circuit of amplifier A, through the left hand winding of transformer 27, thence from the right hand windings of transformer 27, over conductors 30 and 31, network N, armatures and contacts of relay 32, over conductors 33, contacts of jack J and plug P to the receiver R.

Should the operator desire to ring over one of the sections, such as L_1 , of the transmission line, the key K_1 will then be thrown to the left and the left hand winding of transformer 6 bridged across the section L_1 of the line as formerly pointed out. The key K_2 will then be thrown. The operation of the key K_2 opens at its contacts the formerly traced circuit from the receiver R of the operator's monitoring set to the right hand winding of transformer 6, thereby disconnecting the receiver R from the transformer 6 and the section L_1 of the transmission line. The operation of the key K_2 at its upper make contact closes a condenser bridge over conductors 10 and 11, about the high resistance element 7 and the condenser 8 connected in series with the left hand windings of transformer 6. The operation of the key K_2 also connects a source of ringing current suitable for use over the transmission line to the right hand windings of transformer 6 as follows: from the right hand windings of transformer 6, over conductors 12 and 13, make contacts of key K_2 , over the conductors 16 and 17, resistance elements 18 and 19, and thence to the auto-transformer 20 and the filter 21, to the source of ringing current. The resistance elements 18 and 19 serve to increase the impedance of this circuit sufficiently so that no serious

unbalance will occur between the section L_1 of the line and the artificial line N_1 . The operation of the key K_2 also closes a circuit from ground, over its lower make contacts and over the conductor 22 to apparatus which will start the ringing arrangements in operation. It is pointed out that the circuit over which the ringing current is now applied to the section L_1 of the transmission line, includes the auto-transformer 20, whereby the voltage of the ringing apparatus is sufficiently stepped up to give the desired ringing current in the line L_1 when the resistances 18, 19 are in circuit. By this arrangement the ringing apparatus when bridged across the transmission line will have sufficiently high impedance so that no serious unbalance will occur between the section L_1 of the line and the artificial line N_1 .

If the operator desires to talk over a section, such as the section L_1 , of the transmission line, the key K_1 will be thrown to the left and the left hand winding of transformer 6 will be bridged across the section L_1 of the line as previously pointed out. The key K_3 will now be thrown. The operation of the key K_3 closes a condenser bridge at its upper make contact, over conductors 10 and 11, about the high impedance elements 7 and 8 in the left hand winding of transformer 6. At its lower normal contact the key K_3 when operated will open the circuit formerly traced about the winding of the relay 32, thereby preventing the relay 32 from operating and disconnecting the receiver R from the induction coil 29. The talking apparatus of the operator's set upon the operation of the key K_3 , will now be associated with the right hand windings of transformer 6 and with the section L_1 of the line as follows: from the right hand windings of transformer 6, over conductors 12 and 13, normal contacts of key K_2 , conductors 14 and 15, make contacts of key K_3 , conductors 25 and 26, windings of the auto-transformer 28, through the transformer 29, over conductors 34, contacts of jack J and plug P to the operator's talking set. This last mentioned circuit includes the auto-transformer 28, whereby the relatively low impedance of the operator's talking set will be stepped up sufficiently so that, when the talking set is bridged across the section L_1 of the transmission line, but little transmission loss will result thereover and no serious unbalance will occur between the section L_1 of the line and the artificial line N_1 .

In the Fig. 2 is illustrated a modification of the arrangements shown in Fig. 1, which terminates in the cord and plug P_1 . Similar reference numerals have been used to denote like parts in both arrangements. The supervising, talking, and ringing equipment is associated with the transmission line by inserting the plug P_1 in jacks, such as

jacks J_1 and J_2 , associated with the line. The operator's supervising set is normally associated with the high impedance transformer 6 which is of sufficiently high impedance so that when bridged across the transmission line it will cause very little transmission loss thereover and will cause no appreciable unbalance to exist between the transmission line and its balancing artificial line. Two ringing keys, K_5 and K_6 , are provided which control relay means whereby the operator's supervising set will be disconnected from the transformer 6 and different types of ringing current suitable for use over the transmission line may be applied thereto. Under the control of a talking key K_7 , are relay means which will disconnect the operator's supervising set from the transformer 6 and will connect the operator's talking set thereto.

If the operator desires to supervise over a section, such as section L_1 , of the transmission line, the plug P_1 will be inserted in the jack J_1 and the following circuit will be closed: from ground, contacts of jack J_1 , and plug P_1 , conductor 69, winding of relay 70, to battery and ground. This will operate the relay 70 and will bridge the left hand winding of transformer 6 across the sides of section L_1 of the transmission line as follows: from the left hand windings of transformer 6, over conductors 3 and 4, contacts and armatures of relay 70, conductors 71 and 72, contacts of plug P_1 and jack J_1 , and thence over conductors 1 to the sides of section L_1 of the transmission line. The receiver R of the operator's supervising set is associated with the right hand windings of transformer 6 and with the section L_1 of the transmission line as follows: from the right hand windings of transformer 6, over conductors 59, armatures and normal contacts of relay 50, conductors 60, armatures and normal contacts of relay 54, conductors 61, armatures and normal contacts of relay 58, conductors 62, through the amplifier A , through the transformer 27, normal contacts of relay 67, conductors 68, network N , conductors 73, contacts of jack J and plug P , to the receiver R . Upon the aforementioned operation of relay 70 the following circuit will be closed: from ground, armature and contact of relay 70, conductor 74, winding of relay 75, to battery and ground. This will operate relay 75 and close the following circuit: from ground and battery, resistance 76, contact and armature of relay 75, conductor 77, resistance 200, filament of amplifier A to ground. This will condition the amplifier A for operation, so that the currents which have been attenuated by the high impedance in the left hand winding of transformer 6, will be sufficiently amplified to produce the desired volume of sound in the receiver R .

If the operator desires to talk over a section, such as section L_1 , of the transmission line, the plug P_1 will be inserted in the jack J_1 and the relay 70 will operate and bridge the left hand winding of transformer 6 across the section L_1 of the line in the same manner as previously pointed out. The key K_7 will now be thrown and the following circuit will be closed: from ground, contact of key K_7 , conductor 57, winding of relay 58 to battery and ground. This will operate the relay 58 which will pull up its armatures and bridge a condenser over conductor 10, upper make contact and armature of relay 58, and conductor 11, about the high impedance elements 7 and 8 in the left hand winding of transformer 6. Upon the operation of key K_7 , the following circuit will also be closed: from ground, contact of key K_7 , conductor 66, winding of relay 67, to battery and ground. This will operate relay 67 which will pull up its armatures and connect the receiver R of the operator's monitoring set to the transformer 29. Upon the aforementioned operation of relay 58, the transmitter T of the operator's talking set will now be associated with the right hand winding of transformer 6 and with the section L_1 of the line as follows: from the right hand winding of transformer 6, over conductors 59, armatures and normal contacts of relay 50, conductors 60, armatures and normal contacts of relay 54, conductors 61, armatures and make contacts of relay 58, conductors 63, auto-transformer 28, conductors 64, transformer 29, conductors 65, contacts of jack J and plug P to the transmitter T . It is pointed out that this last mentioned circuit includes the autotransformer 28, whereby the relatively low impedance of the operator's talking set will be stepped up sufficiently to insure that when the talking set is bridged across section L_1 of the transmission line but little transmission loss will result thereover and no serious unbalance will occur between the section L_1 of the line and the artificial line N_1 .

If the operator desires to ring over a section of the line such as the line L_1 , the plug P_1 is inserted in the jack J_1 and the left hand winding of transformer 6 will be bridged across the line as formerly pointed out. The operator will now throw either the key K_5 or the key K_6 . If the key K_6 is thrown, the following circuit will be closed: from ground, contact of key K_6 , conductor 53, winding of relay 54, to battery and ground. This will operate the relay 54 which at its upper make contact will close a condenser bridge over conductors 10 and 11 about the high impedance elements 7 and 8, included in the left hand winding of transformer 6. The operation of the key K_6 will also close a circuit from ground, contact of key K_6 , over conductor 56, to

mechanism in the generating apparatus which will start the generating apparatus in operation. Ringing current of the frequency suitable for use over the transmission line, such for example as 135 cycle ringing current, will now be transmitted from the generating apparatus to the transformer 6 and to the section L_1 of the line as follows: from the generating apparatus, through the filter 21, autotransformer 20, resistance elements 18 and 19, conductors 55, make contacts and armatures of relay 54, conductors 60, normal contacts of relay 50, conductors 59, to the right hand windings of transformer 6. It is pointed out that this last mentioned circuit over which the ringing current is now applied to the section L_1 of the transmission line, includes the high impedance of elements 18 and 19 and also the autotransformer 20, whereby the voltage of the ringing apparatus is sufficiently stepped up to give the required current in the line. By this arrangement the ringing apparatus, when bridged across the transmission line, will have sufficiently high impedance so that but little transmission loss will result over the line and no serious unbalance will occur between the section L_1 of the line and the artificial line N_1 . If the operator should desire to transmit over the line ringing current of a different frequency, such, for example, as ringing current of a frequency of 20 cycles, the key K_s would be thrown. The throwing of the key K_s will operate the relay 50. The operation of the relay 50 will, in a manner similar to the relay 54, close a condenser bridge about the high impedance elements in the left hand winding of transformer 6 and will connect to the right hand windings of transformer 6 a source of ringing current. Included in the conductors leading to this source of ringing current are the resistance elements 71, which serve to give the desired impedance in the left hand windings of transformer 6 and regulate the amount of ringing current transmitted to the line.

While the invention has been disclosed in certain specific arrangements which have been deemed desirable, it is understood that it is capable of embodiment in many and widely varied forms without departing from the spirit of the invention, as defined in the appended claims.

What is claimed is:

1. A transmission circuit including lines interconnected by repeater apparatus, means to balance said lines, an operator's telephone set of low impedance, means to include said set in a bridge across one of said lines, and an autotransformer in said bridge whereby the impedance of said telephone set may be stepped up sufficiently to prevent serious unbalance of said line.

2. A transmission circuit including lines

interconnected by repeater apparatus, means to balance said lines, ringing equipment of low impedance, means to include said equipment in a bridge across one of said lines, and an autotransformer in said bridge whereby the impedance of said ringing equipment may be stepped up sufficiently to prevent serious unbalance of said line.

3. A transmission circuit including lines interconnected by repeater apparatus, means to balance said lines, operator's equipment of low impedance, means to bridge said equipment across one of said lines, and an autotransformer associated with said bridge for increasing the impedance of said equipment sufficiently to prevent appreciable unbalance of said line.

4. A transmission circuit including lines interconnected by repeater apparatus, means to balance said lines, operator's equipment including a talking set, a listening set, and ringing apparatus, switching means whereby said equipment may be bridged across one of said lines, and an autotransformer included in said equipment whereby the impedance of said equipment may be sufficiently increased to prevent serious unbalance of said line.

5. A transmission circuit including lines interconnected by repeater apparatus, means to balance said lines, means to complete a bridge across one of said lines, means to include in said bridge either a talking set, a listening set, or a ringing set, and means individual to each of said sets operative when one of said sets is included in said bridge to increase the impedance of said bridge sufficiently to prevent serious unbalance of said line.

6. A transmission circuit including lines interconnected by repeater apparatus, means to balance said lines, a circuit adapted to be bridged across one of said lines and including elements of sufficiently high impedance to prevent appreciable unbalance of said line, an operator's listening set, means to complete said bridge circuit through said listening set, an operator's talking set, switching means whereby an auxiliary circuit may be closed about said high impedance elements and said listening set may be disconnected from said bridge circuit and said circuit may be completed through said talking set, and means associated with said talking set whereby the impedance of said bridge circuit as now completed may be sufficiently increased to prevent serious unbalance of said line.

7. A transmission circuit including lines interconnected by repeater apparatus, means to balance said lines, a circuit adapted to be bridged across one of said lines and including elements of sufficiently high impedance to prevent serious unbalance of said line, an operator's listening set, means to complete

said bridge circuit through said listening set, an operator's talking set, ringing equipment, switching means whereby an auxiliary circuit may be closed about said high impedance elements and said listening set may be disconnected from said bridge circuit and said circuit may be completed through either said talking set or said ringing equipment, and means individual to said talking set and to said ringing equipment whereby

the impedance of said bridge circuit may be sufficiently increased to prevent serious unbalance of said line.

In testimony whereof we have signed our names to this specification this 15th day of 15 April, 1919.

CHARLES S. DEMAREST.
ALVA B. CLARK.
GEORGE CRISSON.