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G. CRISSON

TELEPHONE REPEATER STATION

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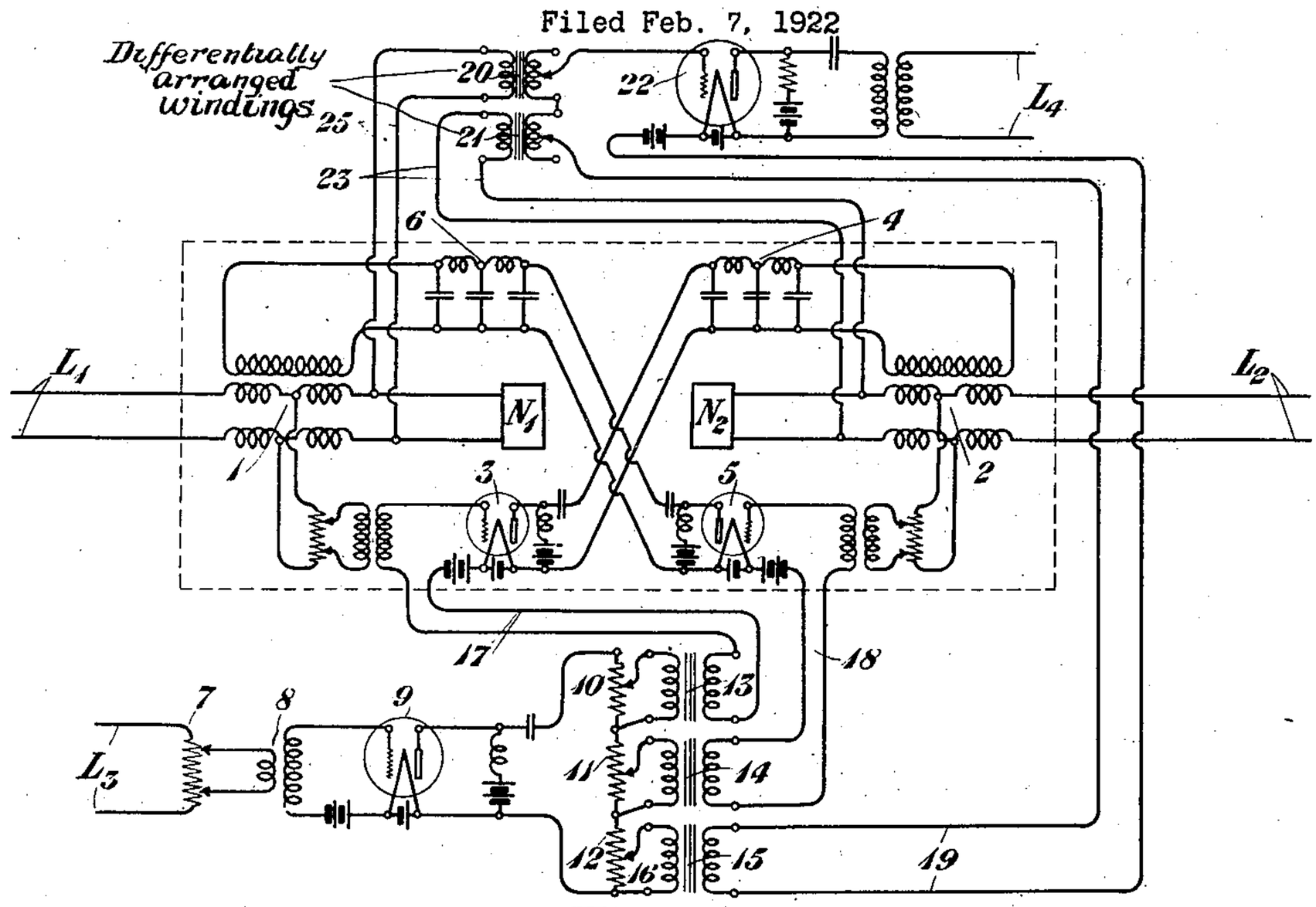

Fig. 1

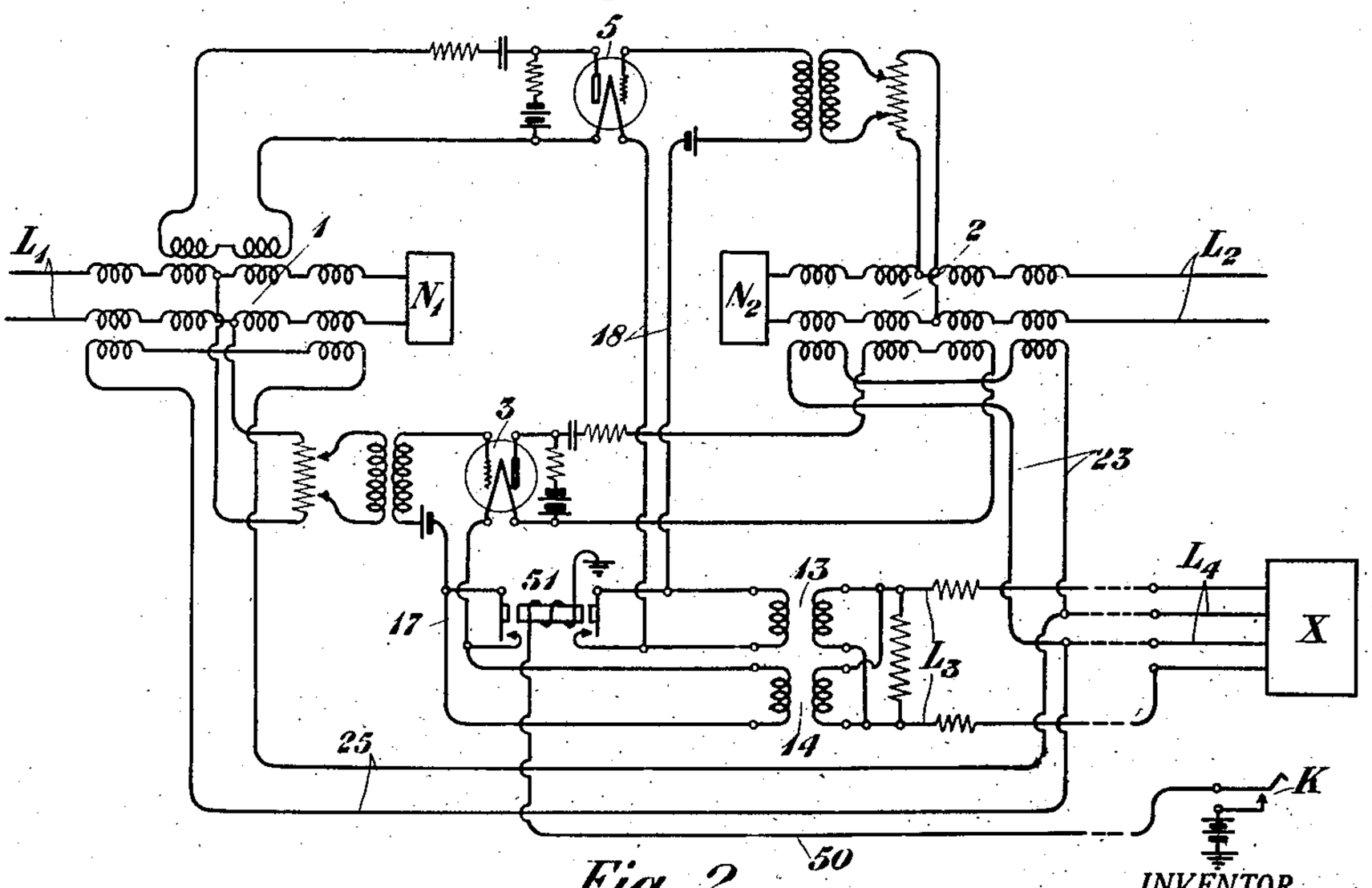

Fig. 2

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TELEPHONE REPEATER STATION.

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This invention relates to arrangements for establishing a three-way telephone connection at a repeater station. With the arrangements of the invention, three-way communication may be established between the two ends of a long telephone line and one or more intermediate stations, such as repeater stations, in connection with demonstrations of long distance telephony or in connection with the distribution of public speeches in which at one or more points on a line it may be desirable to permit audiences to hear speech coming from a single point and which may at the same time permit talking into the line from these various stations. The invention might find further application in other fields, such as on leased wire telephone lines in which service is to be distributed to a number of stations along the line in a manner to permit any one station to talk to any other station. The arrangements might also be utilized for monitoring purposes where it is desirable for the supervisor to talk into the line as well as to listen on the line.

The arrangements of the invention provide novel means for connecting talking and listening loops to a through telephone line whereby provision may be made for talking with equal volume in each direction from the repeater on the through line, or, if desired, with any given difference in volume in the two directions; for listening with equal efficiency to the conversation in either direction over the through line or with any desired efficiency in either direction; for unimpaired transmission through the repeater of conversation between the terminals of the line; and for an adjustable volume or side tone in the receiving loop. Other features and advantages of the invention will appear more fully from the detailed description hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawing, in the Figure 1 of which is illustrated a circuit diagram embodying the principles of the invention and in the Fig. 2 of which is shown a modification thereof.

In Fig. 1 is shown a conventional form of two-way two-element repeater interconnecting the two line sections L_1 and L_2. This repeater may be either of the cord circuit type or the through-line type and includes the usual net works N_1 and N_2 for balancing the lines L_1 and L_2, the three-winding transformers 1 and 2, the vacuum tube elements 3 and 5 and other apparatus, such as the filter 4 and 6. Connected with the input circuits of the tubes 3 and 5, by means of the circuits 17 and 18, is a talking circuit L_3 to which may be connected talking apparatus. The talking circuit L_3 includes the potentiometer 7, the transformer 8, a vacuum tube amplifier 9, the series resistance elements 10, 11 and 12, the transformers 13, 14 and 15. The resistance 12 is provided with an adjustable contact 16 so that it can function as a potentiometer. The resistance elements 10 and 11 are arranged in a manner similar to 12. Associated with transformer 15 is a side-tone circuit 19, which will be more fully described later. Bridged across the network conductors of the repeater are the circuits 23 and 25. These circuits are connected through the transformers 20 and 21 to a receiving circuit L_4, which may include telephone receiving apparatus. This receiving circuit also includes the vacuum tube amplifier 22. The side tone circuit 19 is associated with the input circuit of the tube 22.

Transmission between the lines L_1 and L_2 takes place in the usual manner and without interference from any of the added apparatus.

When it is desired to talk from the line L_3 over the lines L_1 and L_2, the voice currents arriving over line L_3 enter potentiometer 7, the drop in which is stepped up by the input transformer 8 and applied to the vacuum tube 9 in the usual manner. The output current of the vacuum tube traverses the resistances 10, 11 and 12 in series. Transformers 13 and 14 transfer the voltages across the resistances 10 and 11 to the two grid circuits of the vacuum tubes 3 and 5 of the line repeater to send speech currents in each direction through the line. Due to the very high grid-filament impedance of the vacuum tubes 3 and 5, no currents of appreciable magnitude are caused to flow in the grid circuits, and no interference between the two sides of the repeater occurs.

The volume of speech currents repeated from the talking loop L_3 to the through line depends upon the design of the apparatus associated with line L_3. It can be adjusted by means of the potentiometer 7. When, as is usually the case, it is desired to send equal speech currents in both directions from the repeater, the resistances 10 and 11 are equal, and transformers 13 and 14 have the same ratio. In this case a single resistance and a single transformer with two equal secondary windings could be used instead of the arrangement shown. By giving unequal values to the resistances 10 and 11, or by using transformers of different ratio, the speech currents transmitted in the two directions from the repeater may be made to differ from each other by any desired ratio. If the speech currents in the talking circuit L_3 are strong enough, it is possible to dispense with the amplifier 9 and transmit the currents directly to the resistances 10, 11 and 12.

The operation of the arrangements in receiving voice currents coming in over the lines L_1 or L_2 is as follows: If voice currents arrive over the through line, for example, from the line L_1, little or none of the disturbance will reach the network N_1, and the input transformers 20 of the listening circuit will be substantially unaffected. The speech currents will be amplified by the line repeater 3 and transmitted to the line L_2 and the network N_2. The voltage set up across the terminals of the network N_2 is impressed upon the primary winding of the input transformer 21 of the listening amplifier 22. This transformer steps the voltage up or down as may be necessary and impresses it upon the grid of the vacuum tube 22 of the listening amplifier, which repeats the speech currents into the listening circuit L_4 in the usual manner. Speech currents from the section L_2 of the through line reach the listening circuit L_4 in the same way, except that the input transformer 20 transfers the voltage across the network N_1 to the grid of the vacuum tube 22, while transformer 21 is unaffected. By this arrangement, the effects produced in the listening circuit L_4 depend only on the output voltage of the line repeater. If the transformers 20 and 21 were connected across the line terminals of the line repeater, it will readily be seen that both the input and output voltages of the line repeater would act in producing speech currents in the listening circuit L_4, and the resulting current would be the sum or difference of the currents, due to the input and output voltages of the repeater considered separately, depending upon the arrangement of the transformer connections. This would lead to some uncertainty as to the volume of the speech currents in the listening circuit L_4 and probably would cause distortion of these currents. These effects would become more harmful as the gain of the line repeater is reduced.

Ordinarily the two transformers 20 and 21 would have equal turn ratios, in order that the listening circuit L_4 would receive with equal efficiency the speech passing in either direction through the line repeater. By using transformers having different ratios, or by making the ratio of one or both transformers adjustable, the receiving efficiency could be made different for transmission in the two directions over the through line. This would make is possible to compensate for differences in the transmission level in the two directions and so cause each terminal of the line to be heard with equal volume in the receiving circuit L_4. The high impedance of the grid circuit of the vacuum tube 22 insures that there will be no interference between the two sides of the line repeater through the transformers 20 and 21. The primary windings of transformers 20 and 21 are wound to such high impedance that they do not appreciably affect the balance of the line repeater.

When speech currents reach the transmitting amplifier 9 over the talking circuit L_3, both networks N_1 and N_2 have voltages impressed upon them, which voltages are equal, if the system is ararnged to transmit equal currents each way from the line repeater. The transformers 20 and 21 will both be excited and both cause currents in the listening circuit L_4. If their connections are such that these currents aid each other, the volume of sound in the receiving circuit L_4 will be excessively large as compared to that produced by speech between the ends of the through line. To overcome this effect, connections of the transformers 20 and 21 are so arranged that the voltages of their secondary windings caused by speech currents from the talking circuit L_3 oppose each other, and little or no current is produced in the listening circuit L_4. In order that person listening to the receiving apparatus connected with circuit L_4 may hear what is said on the talking circuit L_3, the side-tone circuit 19 is provided. This consists of the potentiometer device 12 previously mentioned and a transformer 15 whose primary winding has impressed upon it an adjustable voltage from the potentiometer and whose secondary winding is connected in series with the secondaries of the input transformers 20 and 21 to the grid of the vacuum tube 22. Speech currents in the talking circuit L_3 thus produce speech currents in the listening circuit L_4 whose volume can be adjusted by means of the potentiometer contact 16 to be equal to that received from the

through line, or to any other desired value.

If the talking and listening station is at some distance from the line repeater, the talking and listening circuits L_3 and L_4 could, if desired, be combined into a single two-wire circuit by means of a hybrid coil in the usual manner, or could be combined into a single circuit in the manner illustrated in Fig. 2. In the arrangements of Fig. 2 similar reference characters are used to denote like parts with respect to Fig. 1. The supervisory apparatus is denoted as X and may include both talking and listening apparatus. The talking apparatus will be connected in substantially the same manner as in Fig. 1 by the circuit L_3 to the circuits 17 and 18 which are connected in series in the grid circuits of the tubes 3 and 5. A relay 51 controlled by switching means K at the set X is provided whereby the talking set at X may be operatively disconnected from circuits 17 and 18 when desired. The listening circuits 23 and 25 are connected to line L_4 and thence to the apparatus at X. The listening circuits 23 and 25 are coupled to the lines L_2 and L_1 in a different manner than in Fig. 1 being related inductively thereto by additional windings on the hybrid coils 2 and 1. As the operation would be substantially similar to the arrangements of Fig. 1 no further description thereof will be given.

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

What is claimed is:

1. In combination with a transmission line including a two-way repeater and networks for balancing the sections of the lines interconnected by the repeater, a listening circuit, and circuits bridged across the terminals of the networks associated with the line sections for associating said listening circuit with said repeater.

2. In combination with a transmission line including a two-way repeater and networks for balancing the sections of the lines interconnected by the repeater, a listening circuit having a vacuum tube included therein, and circuits bridged across the terminals of the networks associated with the line sections for associating said listening circuit with said repeater.

3. In a transmission system including a two-way vacuum tube repeater and networks for balancing the sections of the lines interconnected by the repeater, a talking circuit, a transformer having a plurality of secondary windings, the primary windings of said transformer being connected to said talking circuit and the secondary windings of said transformer being connected in series in the grid circuits of said vacuum tubes, a listening circuit, and circuits bridged across the terminals of the networks associated with the line sections for associating said listening circuit with said repeater.

4. In a transmission system including a two-way vacuum tube repeater and networks for balancing the sections of the lines interconnected by the repeater, a talking circuit, a transformer having a plurality of windings, the primary windings of said transformer being connected to said talking circuit and two of the secondary windings being connected in series in the grid circuits of said vacuum tubes, a listening circuit including a vacuum tube amplifier, circuits bridged across the terminals of the networks associated with the line sections for associating said listening circuit with said repeater, and a side tone circuit interconnecting said talking and listening circuits, said side tone circuit being connected in series in the grid circuit of said amplifier in said listening circuit and being inductively related to said talking circuit.

5. In a transmission system including a two-way vacuum tube repeater, a talking circuit including a potentiometer, an amplifier, a plurality of resistance elements in series in said circuit, transformer windings in parallel with said resistances, and secondary windings inductively related to said first mentioned transformer windings, said secondary windings being included in series in the grid circuits of said vacuum tubes.

6. In a transmission system a two-way repeater comprising two one-way vacuum tubes for transmission in opposite directions, a talking circuit, and a transformer having a plurality of windings, the primary windings of said transformer being connected to said talking circuit and the secondary windings of said transformer being connected respectively in series in the input circuits of the vacuum tubes of said repeater.

7. In a transmission system a two-way repeater, a talking circuit, transformers having their primary windings connected to said talking circuit, the secondary windings of said transformers being connected respectively in series in the input circuits of said repeater whereby transmission may take place from said talking circuit simultaneously over both of the line sections interconnected by said repeater, and means for adjusting the volume of transmission from said talking circuit to said line sections, said means comprising individual variable resistance elements connected in said talking circuit in parallel with each of the primary windings of said transformers.

8. In a transmission system including a two-way vacuum tube repeater and networks for balancing the sections of the lines inter-

connected by the repeater, a listening circuit including a vacuum tube amplifier, individual transformers with their secondary windings in series in the grid circuit of said amplifier, the primary windings of said transformers being bridged across the terminals of the networks associated with said line sections, and means for varying the condition of said transformer windings whereby the volume of transmission from either of said line sections to said listening circuit may be independently adjusted.

In testimony whereof I have signed my name to this specification this 4th day of February, 1922.

GEORGE CRISSON.