

1,351,863.

J. MILLS.
TELEPHONE REPEATER.
APPLICATION FILED JAN. 15, 1917.

Patented Sept. 7, 1920.

2 SHEETS—SHEET 1.

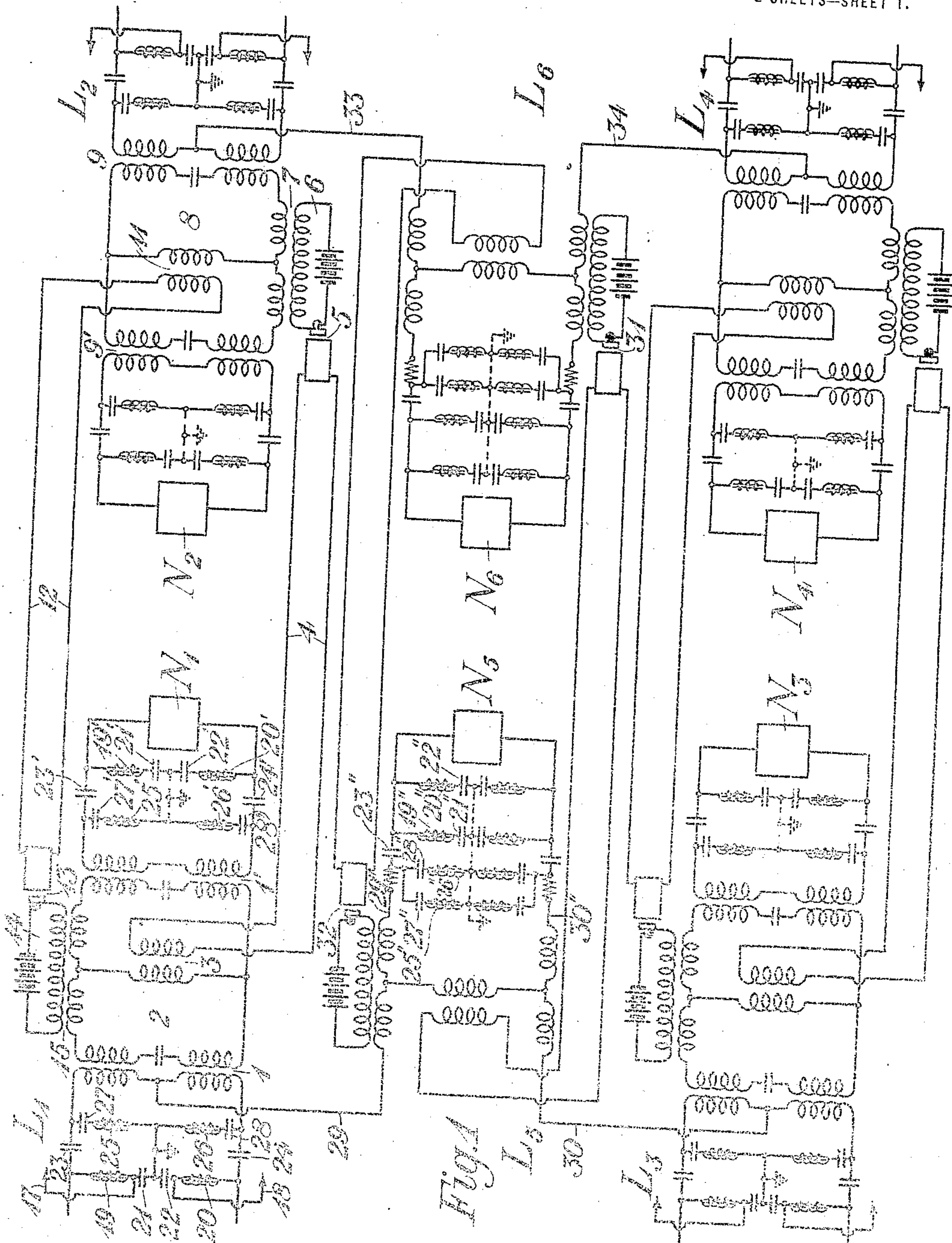


Fig. 1

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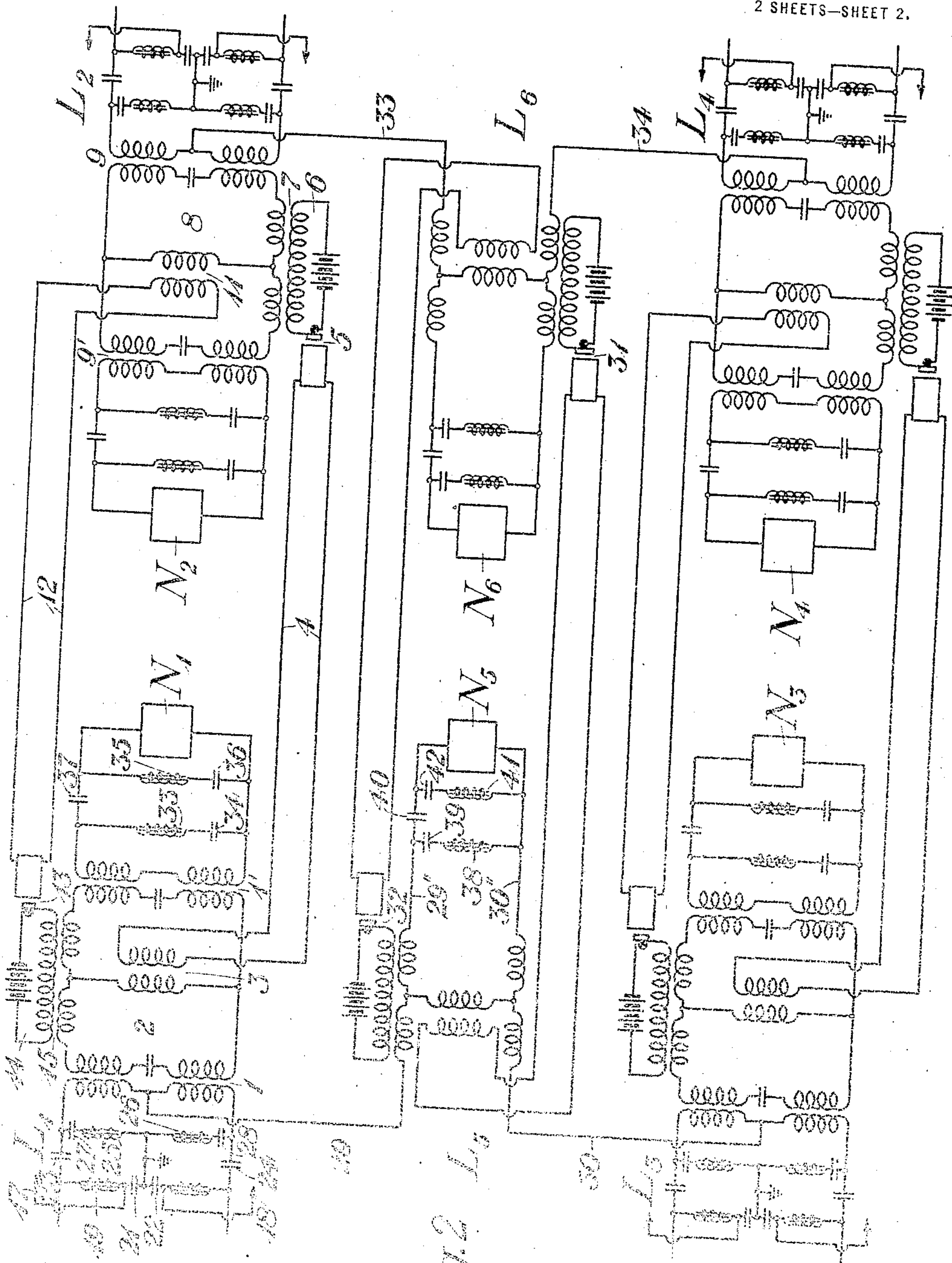


Fig. 2

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UNITED STATES PATENT OFFICE.

JOHN MILLS, OF WYOMING, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE-REPEATER.

1,351,863.

Specification of Letters Patent.

Patented Sept. 7, 1920.

Application filed January 15, 1917. Serial No. 142,436.

To all whom it may concern:

Be it known that I, JOHN MILLS, residing at Wyoming, in the county of Essex and State of New Jersey, have invented certain

5 Improvements in Telephone-Repeaters, of which the following is a specification.

This invention relates to telephone repeater circuits and more particularly to two-way, two-repeater circuits associated with

10 composited telephone and telegraph lines. Its object is to reduce and substantially eliminate the tendency of the repeater to sing. This result is accomplished by constructing an artificial line or balancing net-

15 work for the repeater which not only simulates the characteristics of the telephone circuit, but also simulates the characteristics of the composite and other auxiliary apparatus associated with said circuit.

20 The invention may be understood by reference to the accompanying drawing in which Figures 1 and 2 constitute diagrams of two circuit arrangements in which the invention may be embodied.

25 Referring to Fig. 1, L_1 is an incoming composited line working through a transformer 1 into a circuit 2 across which is bridged the primary of a transformer 3 whereby telephone currents incoming over

30 line L_1 are impressed upon the input circuit 4 of a repeater element 5, herein shown for convenience as a mechanical repeater although it may in practice be a vacuum tube or other type of repeater. The output

35 circuit 6 of the repeater 5 works through a transformer 7 into a circuit 8 similar to circuit 2. The amplified energy in output circuit 6 when impressed upon circuit 8 tends to divide, one-half working through a trans-

40 former 9 into an outgoing line L_2 , and the other half working through transformer 9' into a balancing artificial line or net-work N_1 . The primary of an induction coil 11 is bridged across circuit 8 in such manner that

45 its terminals are at equal potential with respect to output energy from repeater 5, so that no energy works back through input circuit 12 to repeater 13. Energy incoming over line L_2 , however, affects transformer 11

50 and is transmitted over input circuit 12 to repeater 13 where it is amplified in output circuit 14 and impressed upon circuit 2 through transformer 15. The energy in this circuit divides, one-half going to line L_1

through transformer 1 and the other half 55 working through transformer 1' into balancing artificial line or net-work N_1 without affecting repeater 5. In order to attain this result net-works N_1 and N_2 are constructed to simulate the characteristics of lines L_1 60 and L_2 in a manner well known in the art. Where, as in the present case, the lines are composited and phantomed, provision must be made to balance the composite and phantom apparatus. 65

In the arrangement shown the two conductors of each line are used to transmit telegraphic signals thereby necessitating the provision of certain auxiliary apparatus. For this purpose conductors 17 and 18 are 70 led to Morse sets from the line conductors through impedance coils 19 and 20 adapted to prevent the passage of telephone currents. Any telephone currents which may pass the impedance coils are shunted to 75 ground through condensers 21 and 22 which are opaque to telegraph currents. Condensers 23 and 24 are inserted in the line to prevent the passage of Morse currents to the repeater, but readily permit the flow of tele- 80 phone currents to the transformer 1. Any telegraph impulses which pass through the condensers 23 and 24 are shunted to ground through circuits containing inductances 25 and 26 and capacities 27 and 28 respectively. 85

In order to balance the auxiliary apparatus thus associated with the telephone repeater similar and equal elements may be inserted between the transformer 1' and the artificial line or net-work N_1 , the corre- 90 sponding elements being indicated by the same reference numerals primed. As the conductors 17 and 18 leading to the Morse sets do not affect the flow of telephone current they need not be duplicated. Similarly 95 the ground connections may be omitted without affecting the balance and are therefore shown in dotted lines.

It is often desirable to use the two conductors of a talking circuit as one side of a 100 phantom circuit thereby necessitating still further auxiliary apparatus. This arrangement is illustrated in the diagram where lines L_1 and L_3 form the two sides of the talking circuit of the phantom line L_6 while 105 the lines L_2 and L_4 form phantom line L_6 . This result is achieved by connecting conductors 29 and 30 to the mid-points of the

primary windings of induction coil 1 of line L_1 , and the corresponding coil of line L_3 , said conductors being associated with the input circuit of a repeater 31 by a transformer arrangement in all respects similar to that of repeater 5. Similarly a repeater 32 is associated with conductors 33 and 34 leading to the mid-points of primary windings of induction coil 9 of line L_2 and the corresponding coil of line L_4 . Phantom lines L_5 and L_6 are balanced by artificial lines or networks N_5 and N_6 . Provision must also be made in this case for balancing the composite apparatus. Accordingly a conductor 29'' (corresponding to conductor 29 of line L_5) leads to a resistance corresponding to the ohmic resistance of the primary windings of induction coil 1, and in parallel through condensers 27'', 28'' and impedance coils 25'', 26'' to ground, these elements corresponding to the elements of line L_1 having the same reference characters without the double primes. A similar bridge corresponding to the elements of line L_3 leads to ground from conductor 30''. The resistance may be omitted without appreciably affecting the balance as the induction coil 1 of line L_1 and the corresponding coil of line L_3 are of almost negligible resistance.

In order to balance the remainder of the composite apparatus a condenser 23'' having a capacity equal to that of condensers 23 and 24 is inserted in conductor 29'' and a similar condenser in conductor 30''. A double bridge including impedance coil 19'' and condenser 21'' in parallel with impedance coil 20'' and condenser 22'' is led to ground, the several elements bearing the same relation to each other as the corresponding elements of line L_1 . A similar bridge leads from conductor 30'' to ground. The composite apparatus of the line is now duplicated in the net-work, but it is at once apparent that the ground connection may be omitted without affecting the balance and it is accordingly shown in dotted lines.

By the arrangement above described the composited lines are balanced by duplicating the essential elements of the composite set in the net-work. However, as it is only necessary to balance the self impedances, any arrangement giving equivalent self impedance will be satisfactory. The arrangement may therefore be somewhat simplified by using the construction illustrated in Fig. 2 in which identical parts are indicated by the same reference characters as in Fig. 1. In this figure inductance coils 25' and 26' of Fig. 1 have been combined in a single inductance 33, while condensers 27' and 28' are combined as one condenser 34. So also impedance coils 19' and 20' appear as one impedance coil 35, condensers 21' and 22' being likewise combined as condenser 36. Condensers 23' and 24' may also be combined to

form a single condenser 37 in series with one artificial line conductor.

In a similar manner the phantom balancing apparatus may be combined, the four impedance coils of the shunt at the left of condenser 23' being combined in a single coil 38, the four capacities being likewise replaced by a single capacity 39. Capacity 23'' and the corresponding capacity of the conductor 30'' are combined in a single capacity 40. Finally the double bridge at the right of capacity 23'' may be simplified into a single bridge including an inductance 41 and capacity 42. It will be clear upon consideration that this simplified arrangement of Fig. 2 will obtain a balance so far as self impedance is concerned although quite simple in form.

While the invention has been disclosed as embodied in a certain specific arrangement it will be understood that it is capable of embodiment in a wide variety of modifications without departing from the spirit of the appended claims:

What is claimed is:

1. In a signaling system, two transmission line sections, two artificial lines individually associated with said line sections, translating apparatus, means to associate said translating apparatus with said transmission lines and said artificial lines, auxiliary apparatus associated with a line section and means electrically equivalent to said auxiliary apparatus similarly associated with the corresponding artificial line in order to balance the auxiliary apparatus with respect to the translating apparatus.
2. In a signaling system, two transmission line sections, two artificial lines individually associated with said line sections, translating apparatus, means to associate said translating apparatus with said transmission lines and said artificial lines, auxiliary apparatus associated with a line section and means associated with the corresponding artificial line to simulate the characteristics of said auxiliary apparatus.
3. A repeater system comprising a transmission line, a repeater, a balancing artificial line for balancing the transmission line with respect to the repeater, means to connect said repeater with said transmission line and artificial line, auxiliary apparatus associated with said line and means associated with the artificial line to simulate the characteristics of said auxiliary apparatus.
4. A repeater system comprising a telephone line, an artificial line to balance said telephone line, signaling equipment associated with said telephone line and means associated with the artificial line to simulate the characteristics of said signaling equipment.
5. A repeater system comprising a telephone line, a repeater, an artificial line to

balance said telephone line, impedance elements in shunt of said telephone line and equivalent impedance elements in shunt of said artificial line.

- 5 6. A repeater system comprising a telephone line, a repeater, an artificial line to balance said telephone line, ground taps connected to each side of said telephone circuit and each including an inductance and a capacity and means associated with the artificial line for balancing the ground taps
- 10

comprising an inductance and capacity in shunt of said artificial line.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses, this 12th day of January, 1917.

JOHN MILLS.

Witnesses:

M. L. METCALFE,
RALPH W. WOLF.