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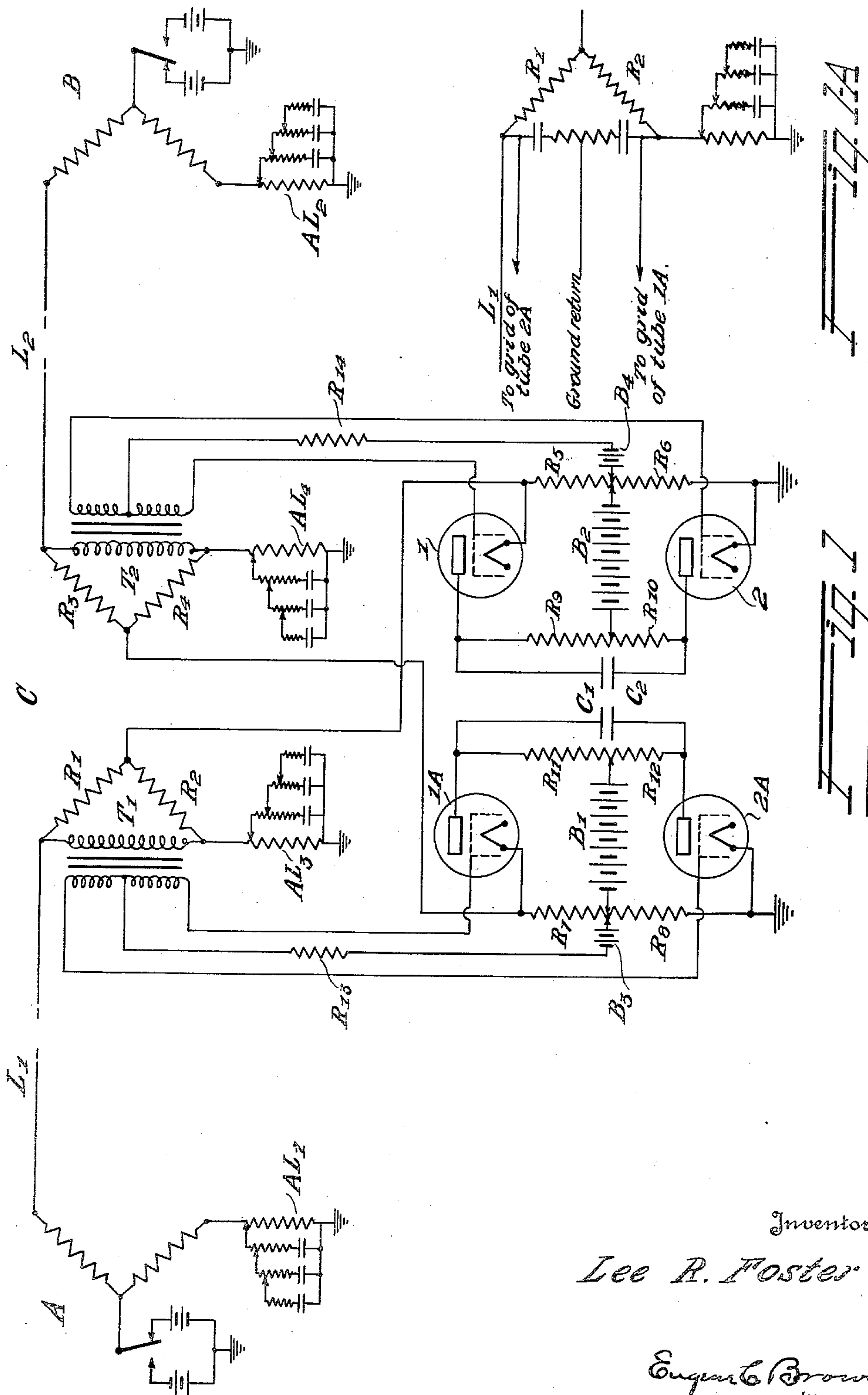
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DUPLEX TELEGRAPH SYSTEM

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2 Sheets-Sheet 1



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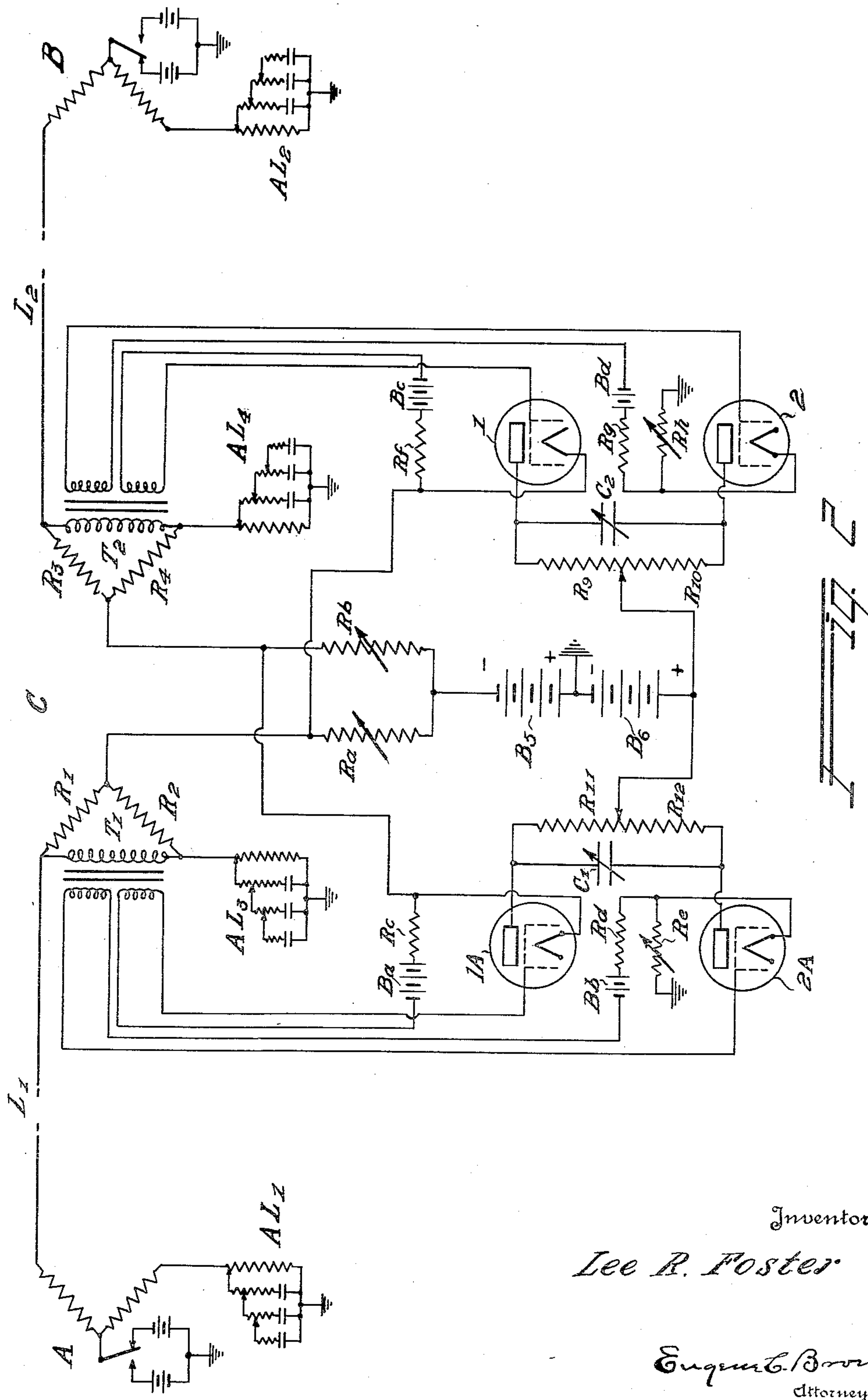
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DUPLEX TELEGRAPH SYSTEM

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This invention relates to duplex telegraph systems, and more particularly to an arrangement for repeating or relaying telegraph signal in a duplex system.

5 An object of my invention is to devise a relay or repeating system employing thyatron relays for repeating telegraphic signals in a duplex system.

10 In a duplex telegraph circuit each end of the duplexed line is subjected to battery potential at all times. This potential may be changed at will from positive to negative or vice versa, but the potential supplied at either end of the line must not affect the receiving
15 equipment at that end. In this invention I propose to employ at an intermediate or relay station thyatron relays for repeating telegraphic signals between two sections of a duplexed line. In such a repeater, the opera-
20 tion must be the same as at any terminal station, that is, battery potential must be applied at each end of both line sections at all times, and this potential impressed upon one line section must be varied in polarity in accordance with incoming signals transmitted over
25 the other line section.

My invention is illustrated in the accompanying drawings in which:—

30 Figure 1 is a circuit diagram of one form of the invention,

Figure 1—A is a circuit diagram illustrating a modification of the arrangement shown in Figure 1, and

35 Figure 2 is a circuit diagram illustrating another form of my invention employing a single source of operating potential for all thyatron relays at the relay station.

40 Referring to Figure 1, A and B are terminal stations located at the ends of a duplexed telegraph line divided into two sections indicated as L1 and L2 connected by an intermediate relay station indicated generally at C. Each terminal station is provided with
45 suitable transmitting apparatus for impressing positive and negative battery upon the line sections in accordance with desired telegraphic messages. The terminal stations are also provided with balancing artificial lines
50 to prevent the currents transmitted from

each station from affecting the receiving apparatus at that station.

At the repeater station C, line section L1 is terminated in a balanced duplex bridge arrangement comprising resistance arms R1 and R2, artificial line AL3, and a trans-
55 former T1 connected across arms R1 and R2. Line section L2 is likewise terminated at repeater station C in a bridge arrangement comprising resistance arms R3, R4, artificial
60 line AL4, and transformer T2 connected across arms R3 and R4. The apex of the bridge for line L1 is connected to ground through resistance R5 and R6; and the apex of bridge for line L2 is connected to ground
65 through resistances R7 and R8. A thyatron relay 1 has its cathode connected to the apex of the bridge of line L1, and its plate circuit includes resistance R5, battery B2 and resistance R9. A second thyatron re-
70 lay 2 has its cathode connected to ground, and its anode circuit includes resistance R6, battery B2 and resistance R10. A condenser C2 is connected between the anode elements of relays 1 and 2 across resistances R9 and
75 R10. In a similar manner, the cathode of a thyatron tube 1A is connected to the apex of the bridge of line L2, and its plate circuits include a resistance R7, battery B1, and
80 resistance R11. Also, the cathode of a fourth thyatron relay A2 is connected to ground, and its anode circuit includes a resistance R8, battery B1 and resistance R12. A condenser C1 is connected between the
85 anode elements of tubes 1A and 2A.

The outer terminals of the secondary of transformer T1 are connected respectively to the grid or control elements of relay tubes 1A and 2A. The midpoint of the secondary
90 winding of this transformer is connected to the negative side of plate battery B1, and this connection includes a resistance R13 and a stabilizing battery B3. Likewise, the outer terminals of the secondary of trans-
95 former T2 are connected respectively to the grid elements of relays 1 and 2, and the midpoint of this secondary winding is connected to the negative terminal of battery B2, with a resistance element R14 and a stabilizing bat-
100 tery B4 included in this connection.

It is characteristic of thyatron tubes to operate when the grids become positive with respect to the filaments, and to remain operated until the plate circuit is broken or the plate potential is reduced to a point below that required to start the tube. The batteries B3 and B4 are provided for the purpose of maintaining the grids of the tube below the operating voltage to prevent self-operation of the tubes when no signals are being received.

Operation of Figure 1 is as follows: Suppose stations A and B are transmitting a positive signal or impulse. The signal from station A is received at the repeater station C over line L1 for retransmission into line L2. The positive signal so received at the intermediate station from line L1 causes a difference of potential across the bridge of the duplex circuit and therefore energizes the primary winding of the transformer T1 connected to line L1.

The secondary of the transformer T1 is so poled that a positive signal from the line exciting the primary winding causes an induced E. M. F. in the secondary of the transformer in such a manner as to make the portion of the secondary associated with the grid of tube 1A positive with respect to the center tap of the transformer and the other side of the secondary winding (that connected to tube 2A) negative with respect to the center or mid-tap of the transformer. The mid-tap of the transformer in both cases is the grid return, hence the positive potential applied to the grid of tube 1A causes this tube to become operative and the negative potential prevents the operation of tube 2A.

When tube 1A is operated, a circuit is established from battery B1, resistance R11, plate and filament of tube 1A, resistance R7 to negative battery. At the same time a circuit is established from the filament of tube 1A to the apex of line L2 from whence it divides into two circuits for the normal duplex operation of a line. In either branch circuit the return is to ground at the intermediate station or at station B from whence the return to battery is accomplished from ground, resistance R8 and battery B1. The signal from station A is in this manner repeated at the intermediate station into the apex of line 2 and transmitted to station B.

In a like manner the positive signal transmitted from station B operates the transformer T2 and energizes the grid of tube 1, thereby causing a positive potential to be applied to the apex of line L1 at the intermediate station, and the signal so supplied is thus repeated to station A.

Suppose station A next sends a negative signal to station B. This signal is received at the intermediate station over line L1 and energizes transformer T1 in the opposite di-

rection, thereby causing the grid of tube 2A to become positive and the grid of tube 1A negative with respect to the grid return or mid-tap of the transformer. Tube 2A therefore is operated, and in so doing it causes a drop in the potential applied to the plate of tube 1A by the action of condenser C1 and the resistance R11 and R12. Tube 1A is therefore stopped. The operation of tube 2A takes place in the circuit from battery B1, resistance R12, plate and filament of tube 2A, resistance R8 to battery B1. A second circuit is energized from filament of tube 2A to ground through line L2 by means of the ground connection at station B, resistance R3 to apex of line, also ground at the intermediate station, artificial line AL4, resistance R4 to apex of line thence to R7 to battery B1. This circuit causes a negative potential to be applied to the apex of the line due to the fact that the positive side of battery B1 has been connected to ground, and the return of the apex is to negative battery through resistance R7.

The negative signal from station A is thus repeated into line L2 as long as tube 2A remains operated. The next positive signal will cause the operation of tube 1A which in turn stops tube 2A. In this manner signals from one line section are retransmitted by the tubes into the next line section.

In Figure 1—A I have shown an alternative method for connecting the grids of the thyatron tubes in place of the transformer T1 or T2 shown in Figure 1.

While the arrangement shown in Figure 1 is for bridge duplex operation, it will be understood that the differential duplex arrangement may be employed in which case the primary winding is inserted in place of resistances R1 and R2 (or R3 and R4) and the apex connection is made to mid-tap connection of the primary winding.

Standard practice in the telegraph field is to use one battery as far as possible for the various circuits at any stations; also to ground the mid-point of the battery for grounded circuits or make the mid-point a common point for metallic circuits.

Figure 2 shows an arrangement in which only one battery is used for both halves of a repeater or a group of repeaters at the same stations. It is understood that the receiving and retransmission equipment and the necessary connections thereto associated with each line constitutes half of the repeater, thus operation in both directions requires a whole repeater.

The battery connections of Figure 2 is so arranged that the same battery may be used either for thyatron tube transmission or for relay transmission which at present is the common method for repeating telegraph signals.

The arrangement shown in Figure 2 dif-

fers from that in Figure 1 in that tubes 2 and 2A do not serve to transmit signal impulses to the line sections, but these tubes serve only to stop the operation of tubes 1 and 1A respectively. Also tubes 1 and 1A operate to transmit only one polarity of signal impulses, and the opposite polarity is transmitted by battery B5 when tubes 1 and 1A are deenergized.

As will be seen from the drawing, tubes 1A and 2A are provided with separate secondary windings for energizing their grid circuits, and separate stabilizing batteries B_a and B_b, and also separate current limiting resistances R_c and R_d. In a like manner separate transformer windings, stabilizing batteries and limiting resistances are provided for the grid circuits of tubes 1 and 2. The common energizing battery for the system is formed of two sections B5 and B6, the midpoint of which is grounded. The apex of the bridge associated with line section L1 is connected to the ungrounded terminal of battery B5 through an adjustable resistance R_a, and the apex of the bridge for line L2 is connected to the same battery terminal through an adjustable resistance R_b. These connections normally impress negative battery upon the apex points of both line sections. The apex of line L1 is also connected to the cathode of tube 1, and the apex of line L2 is likewise connected to the cathode of tube 1A. The anode elements of tubes 1 and 2 are connected to the positive terminal of battery B6 through resistances R9 and R10 respectively, and a condenser C2 is connected between these anode elements. Likewise, the anode elements of tubes 1A and 2A are connected to the positive terminal of battery B6 through resistance elements R11 and R12, and condenser C1 is connected between the anode elements. The cathode element of tube 2A is connected to ground through an adjustable resistance R_e, and the cathode element of tube 2 is connected to ground through an adjustable resistance R_f. The function of variable resistances R_e and R_f is to limit the current in the anode circuit of tubes 2A and 2 to a value sufficient to cause the stopping of the other two tubes.

From an inspection of Figure 2 it will be seen that the operation or non-operation of thyatron relays 2 and 2A will not affect the current flowing in either line section.

Resistances R_a and R_b connected in the apex circuits of the two line sections are adjustable in order to equalize the currents for both positive and negative signals. Increasing these resistances decreases the negative signal strength and increases the positive strength. The resistances are, therefore, adjusted until the current in the line for positive and negative signals is equal.

Since the operation is the same in either direction, signals will be described as being

transmitted from station A to station B through the repeating station C.

When a negative signal from station A is received at the intermediate station for retransmission to station B, the grid of tube 2A becomes positive by the action of transformer T1 as explained in connection with Fig. 1. Tube 2A becomes operative due to the action of the potential of its grid as explained for the operation of thyatron tubes, and a circuit is established from battery B6, resistance R12, plate and filament of tube 2A, resistance R_e to ground and back to the split of the battery. Current in this circuit causes a drop in potential across condenser C1 great enough to stop tube 1A if it is in operation. Whenever the tube 1A becomes non-operative, current flows in the circuit from negative battery B5, resistance R_b into the apex of line L2, to ground at station B, and to ground through resistance R4 and artificial line AL4 at the intermediate station and to the positive battery B5. Since the negative side of battery B5 is connected to the apex of line L2, the negative signal is sent into the apex of line L2, which is grounded to the positive side of battery B5.

When a positive signal is received from station A, tube 1A becomes operative and in doing so stops tube 2A. The circuit is from positive battery B6, resistance R11, plate and filament of tube 1A, resistance R6, to negative battery B5; also from tube filament to apex of line L2, to ground at both stations B through line L2 or at the intermediate station through the artificial line. The adjustment of resistance R_b is such that the apex of the line becomes of a positive potential great enough to force the same amount of current through the line in the opposite direction from that caused by the negative battery B5 for the negative signal. Due to the action of battery B6 and resistance R_b the apex of the line is at a higher potential than the midpoint of battery, hence a positive signal is supplied to the apex of the line.

I claim:

1. In a signaling system, a pair of line sections terminating in a repeater station and each provided with balanced transmitting and receiving circuits for duplex operation, means at the repeater station for normally impressing current upon the transmitting circuit of each line section, and means including a thyatron relay responsive to signals received over one line section for reversing the polarity of the current applied to the other line section.

2. In a signaling system, a pair of line sections terminating in a repeater station and each provided with balanced transmitting and receiving circuits for duplex operation, means at the repeater station for normally impressing current upon the transmitting circuit of each line section, and a thyatron

relay associated with each section for reversing the polarity of the current applied to the other section in response to a received signal impulse of a polarity opposite to the polarity
5 of the impressed current.

3. In a signaling system, a pair of line sections terminating in a repeater station and each provided with balanced transmitting and receiving circuits for duplex operation,
10 means at the repeater station for normally impressing current upon the transmitting circuit of each line section, means including a thyatron relay responsive to signals received over one line section for reversing the polar-
15 ity of the current applied to the other line section, and means responsive to signal impulses of opposite polarity for deenergizing said thyatron relay.

4. In a signaling system, a pair of line sections terminating in a repeater station and each provided with balanced transmitting and receiving circuits for duplex operation,
20 means at the repeater station for normally impressing current upon the transmitting circuit of each line section, a thyatron relay associated with each section for reversing the polarity of the current applied to the other section in response to a received signal impulse of a polarity opposite to the polarity
25 of the impressed current, and means responsive to a received signal impulse of the same polarity as the impressed current to deenergize said thyatron relay.

5. In a signaling system, a pair of line sections terminating in a repeater station and each provided with balanced transmitting and receiving circuits for duplex operation, a pair of thyatron relays at said station and having their input circuits connected in op-
40 posed relation to the receiving circuit of one line section, and their output circuits included in opposed relation in the transmitting circuit of the other line section, and means associated with said relays for deenergizing
45 one relay upon the energization of the other.

6. In a signaling system, a pair of line sections terminating in a repeater station and each provided with balanced transmitting and receiving circuits for duplex operation, a
50 pair of thyatron relays associated with each line section at said repeater station, each pair of relays having their input circuits connected in opposed relation to the receiving circuit of one line section and their output circuits
55 included in opposed relation in the transmitting circuit of the other line section, and means associated with each pair of relays for deenergizing one relay of the pair upon energization of the other.

7. In a signaling system, a pair of line sections terminating in a repeater station and each provided with balanced transmitting and receiving circuits for duplex operation,
60 means at the repeater station for normally impressing current upon the transmitting

circuit of each line section, a thyatron relay associated with each section for reversing the polarity of the current applied to the other section in response to a received signal im-
pulse of a polarity opposite to the polarity
70 of the impressed current, and a second thyatron relay associated with each line section and being responsive to received signal im-
pulses of the same polarity as the impressed current to deenergize said first thyatron re-
75 day.

In testimony whereof I affix my signature.
LEE R. FOSTER.