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MEANS FOR AND METHOD OF REGULATING THE TRANSMISSION OVER ELECTRIC CIRCUITS.

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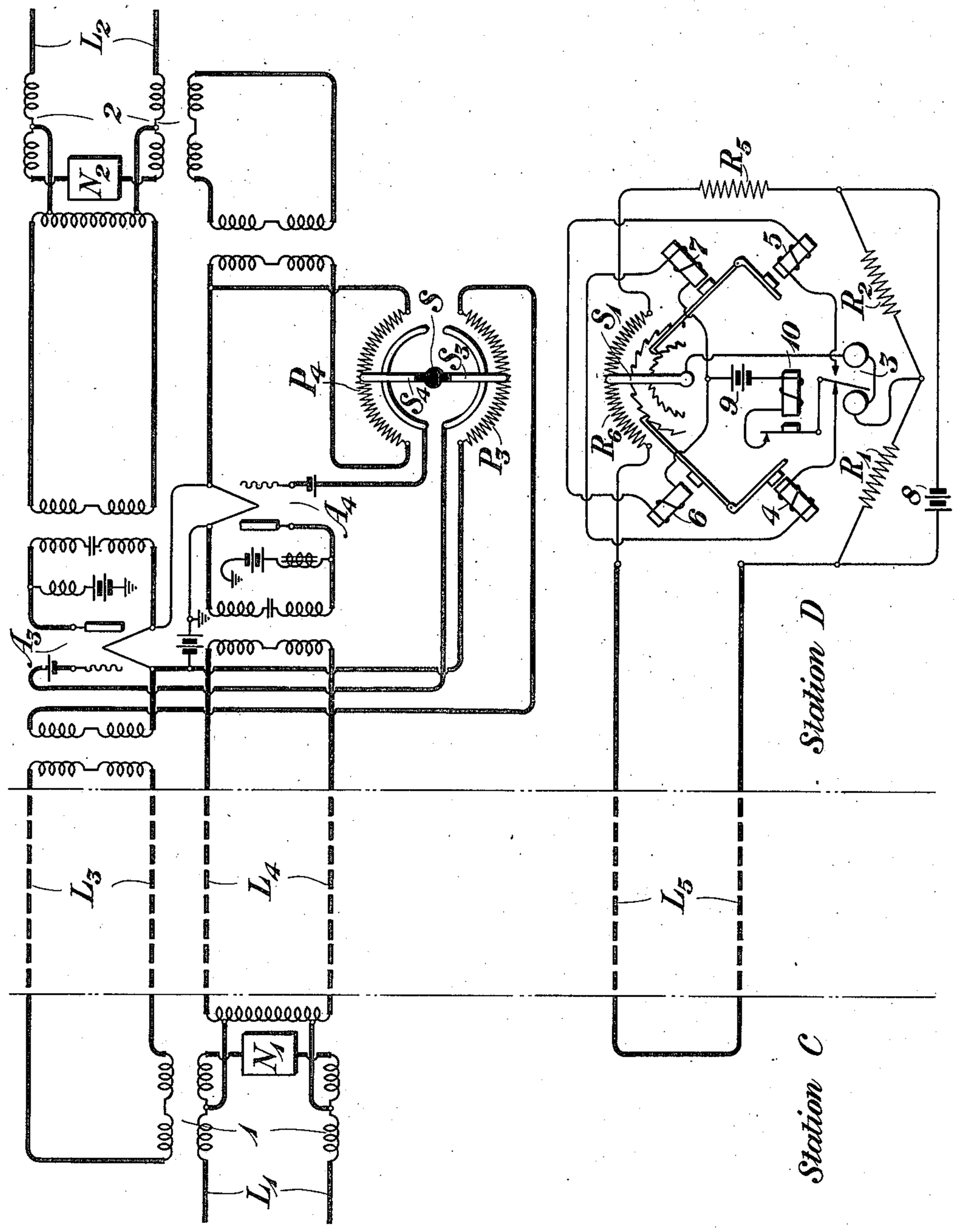

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MEANS FOR AND METHOD OF REGULATING THE TRANSMISSION OVER ELECTRIC CIRCUITS.

Application filed September 10, 1918. Serial No. 253,486.

To all whom it may concern:

Be it known that I, ALVA B. CLARK, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Means for and Methods of Regulating the Transmission Over Electric Circuits, of which the following is a specification.

This invention relates to transmission circuits, and more particularly to transmission circuits of the type known as four-wire circuits, although it is in general applicable to transmission circuits of any kind.

The principal object of the invention is to provide suitable methods and means for maintaining substantially constant the transmission equivalent of a circuit regardless of variations in the conditions affecting the electrical characteristics of the circuit. Other and further objects will, however, be clear from the description of the invention hereinafter given.

In general, the transmission equivalent of a circuit varies, due to a number of different causes. If the transmission circuit be of the four-wire type, in which a pair of separate transmission lines are employed for transmitting in opposite directions, these causes may be divided into two classes: The first class comprises causes which affect both sides of the circuit, or in other words, both transmission lines, in the same manner. Among these causes may be enumerated variations in the resistance of the conductors, loading coils etc., variations in capacity, inductance, or other electrical characteristics of the cable, and variations in the potential of repeater batteries common to repeaters in both sides of the circuit. The second class comprises causes which affect the two sides differently, such as variations in the structure of repeater bulbs where vacuum tube repeaters are employed, variations in the potentials of grid batteries, or accidental variations due to the resistance of bad joints, leakage due to poor insulation etc.

In the case of transmission circuits in which only one transmission line is used for transmission in the two directions, the factor of variation with respect to the two sides of the circuit will be absent, but some or all of the above causes may contribute to produce variations in the transmission equivalent of the circuit, thereby rendering it highly desirable that some provision be made for overcoming the effect of these variations.

The present invention contemplates eliminating these difficulties by varying some adjustable element of the transmission circuit to compensate for the variation introduced into said circuit. In general a number of methods may be employed in carrying out the objects of the invention. For example, in the case of a four-wire circuit, effects due to all possible variations in the two sides of the four-wire circuit way be compensated for by varying like elements in the two sides of the circuit on the assumption that the two sides vary alike. If greater precision is desired, the adjustment may be made for each side of the four-wire circuit separately to compensate for all causes of variation in either side. Still another method, applicable to transmission circuits of any type, involves compensating for the effects due to some one cause, such as temperature variations, by observing the changes produced in one circuit of a cable, then varying, in accordance with such changes, similar elements of a number of circuits which are affected in a like manner.

These methods may be carried out either manually or automatically, and by making adjustments either with variations in the circuit, or at intervals of suitable frequency. For purposes of illustration apparatus is herein disclosed for carrying out the last method above mentioned automatically, but it will be understood that the same results may be secured by manual apparatus.

The objects of the invention are secured as herein disclosed by causing a suitable translating apparatus to be actuated in accordance with changes in the electrical character of some one of a group of circuits. The remaining circuits of the group are then adjusted to compensate for the changes indicated by the first circuit. More specifically, these results are accomplished by arranging the first mentioned or pilot circuit in one element of a Wheatstone bridge arrangement, so that variable currents will flow through the bridge with variations in the conductivity of the pilot circuit. Apparatus in the bridge circuit is so arranged as to respond to the currents flowing therein to control an automatic switch for ad-

justing the potentiometers of amplifiers in the other transmission circuits. Other transmission varying devices might also be employed.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing, which constitutes a circuit diagram of an arrangement embodying the principles of this invention.

Referring to the diagram, a four-wire circuit is shown interconnecting stations C and D, said four-wire circuit comprising a pair of transmission lines L_3 and L_4 for transmitting in opposite directions. These transmission lines may include one-way repeaters at intermediate stations (not shown) and are associated at the terminal stations with terminating two-wire lines L_1 and L_2 through the usual three winding transformers 1 and 2. The two-wire lines are balanced at the terminal stations by means of artificial lines N_1 and N_2 of any well known type. For the purpose of adjusting the transmission equivalent of the four-wire circuit, amplifiers A_3 and A_4 are provided, the amplification of said amplifiers being controlled by the setting of potentiometers P_3 and P_4. The setting of the potentiometers is determined by means of an automatic switch S, having wipers S_3 and S_4. It will be understood that where a number of four-wire circuits are subject to the same conditions as for instance, where the conductors of the circuits are included in a common cable, the potentiometers for the amplifiers of a plurality of such circuits may all be controlled by the common switch S. In order to determine the operation of the switch S a pilot circuit L_5 is provided, said circuit being included in the same cable, or subject to the same conditions, as the four-wire circuits or two-wire circuits, as the case may be, which are to be regulated. The pilot circuit L_5 is included in one-branch of a Wheatstone bridge, of which the resistance R_5 which may be equivalent to the average resistance of the pilot circuit L_5, forms a second branch. Resistances R_1 and R_2 respectively constitute the third and fourth branches. In circuit with the pilot circuit L_5 and the resistance R_5 is an adjustable resistance R_6 for balancing the bridge, said resistance being controlled by a wiper S_1 carried by the switch S. The wiper S_1 is included in the bridge circuit of the Wheatstone balance, said circuit also including a polarized relay 3, which controls the operation of the switch S through the medium of the stepping magnets 4 and 5, and the holding magnets 6 and 7.

Assuming that a change takes place in the resistance of the pilot circuit L_5 due to a change in temperature or other cause. the Wheatstone bridge is unbalanced, and a current flows over the bridge circuit through the winding of the polarized relay 3 and over the wiper S_1. If the resistance of the circuit L_5 is increased, this current is in such a direction as to throw the armature of the polarized relay 3 to the left, as shown in the drawing, thereby completing a circuit from battery 9, through the winding and over the back contact of buzzer relay 10, over the left hand contact of polarized relay 3, winding of stepping magnet 4 and winding of release magnet 7. The release magnet 7 draws the pawl carried by the armature of stepping magnet 5 from engagement with the corresponding ratchet wheel, and the stepping magnet 4 operates its ratchet wheel step by step with each interruption of the circuit by the buzzer relay 10 to rotate the wiper S_1 in counter-clockwise direction. The division of the resistance R_6 between the arms of the bridge, including the pilot circuit L_5 and resistance R_5, is thereby changed so that the Wheatstone bridge is again balanced. This action moves the wipers S_3 and S_4 of the switch S in a counter-clockwise direction, thereby altering the setting of the potentiometers so that the amplification of amplifiers A_3 and A_4 is increased. If the change in the condition of the pilot circuit L_5 is of such nature as to cause a reduction of the resistance, the current flows through the windings of the polarized relay 3 in the opposite direction and a circuit is closed through the buzzer relay 10, stepping magnet 5 and release magnet 6, to step the switch S in a clockwise direction, thereby decreasing the amplification of the amplifiers A_3 and A_4.

By providing the switch S with a sufficient number of wipers such as S_3 and S_4 the transmission equivalent of as many circuits as desired may be regulated, assuming, of course, that similar variations take place in all of the circuits.

It will be seen that by means of this arrangement variations in conditions which affect a number of circuits alike may be substantially compensated for, and as in many cases variations of this character constitute the principal source of changes in the electrical characteristics of circuits, an adjustment of this kind will satisfy practical requirements.

It will be obvious, however, that the general principles herein disclosed may be embodied in many other organizations widely different from that illustrated, without departing from the spirit of the invention, as defined in the following claims:

What is claimed is—

1. The method of maintaining constant the transmission equivalent of a plurality of transmission circuits subject to similar variations in their electrical characteristics, which consists in transmitting an electrical current

over one of said circuits, impressing the effect thereof on a receiving apparatus, and varying the characteristics of the remaining circuits in accordance with the effect produced upon the receiving apparatus.

2. The method of compensating for changes in the electrical characteristics of a plurality of transmission circuits subject to similar conditions, which consists in determining the change in electrical characteristics of one of the circuits, and adjusting elements of the other circuits in accordance with the variations in the electrical characteristics of the determined circuit.

3. In a signaling system, a plurality of transmission circuits subject to similar conditions, means associated with one of said circuits and adapted to assume different conditions in response to changes in the electrical characteristics of said circuit, and means associated with the other circuits for adjusting the transmission equivalent thereof in accordance with conditions of said responsive means.

4. In a signaling system, a plurality of transmission circuits subject to similar variations in their electrical characteristics, means associated with one of said circuits and adapted to assume different conditions in response to changes in the electrical characteristics of said circuit, and means associated with the other circuits for varying the electrical characteristics thereof in accordance with the conditions of said first mentioned means.

5. In a signaling system, a plurality of transmission circuits subject to similar conditions, means associated with one of said circuits and responsive to changes in the electrical characteristics thereof, and means controlled by said responsive means for adjusting the transmission equivalent of the other circuits.

6. In a signaling system, a plurality of transmission circuits subject to similar variations in their electrical characteristics, means associated with one of said circuits and responsive to changes in the electrical characteristics thereof, and means controlled by said responsive means for varying the characteristics of the other circuits in accordance with the variations in the characteristics of said first mentioned circuit.

7. In a signaling system, a plurality of transmission circuits, a pilot circuit subject to influences similar to those affecting the transmission efficiency of said transmission circuits, means associated with said pilot circuit and responsive to variations in the electrical characteristics thereof, and means for varying the electrical characteristics of said transmission circuits under the control of said responsive means.

8. In a signaling system, a plurality of transmission circuits, a pilot circuit subject to influences similar to those affecting the transmission efficiency of said transmission circuits, a switch, means to automatically set said switch in accordance with the electrical condition of said pilot circuit, and means controlled by said switch for adjusting the transmission efficiency of said transmission circuits.

9. In a signaling system, a plurality of transmission circuits, amplifying means for said circuits, a pilot circuit subject to influences similar to those affecting the transmission efficiency of said transmission circuits, a switch, means to automatically set said switch in accordance with the electrical conditions of said pilot circuit, and means controlled by the setting of said switch for adjusting the amplification of said amplifying means.

10. In a signaling system, a plurality of transmission circuits, a pilot circuit subject to influences similar to those affecting the transmission efficiency of said transmission circuits, a Wheatstone balance circuit, said pilot circuit being included in one arm of said Wheatstone balance, a switch, means to automatically set said switch in accordance to the current flow in the bridge circuit of said Wheatstone balance, and means controlled in accordance with the setting of said switch for adjusting the transmission efficiency of said transmission circuits.

11. In a signaling system, a four-wire transmission circuit the conductors of which are subject to temperature variations, a pilot circuit subject to similar variations, means responsive to changes in the electrical characteristics of the pilot circuit due to temperature changes, and means controlled by said responsive means for adjusting the transmission equivalent of the four-wire circuit.

12. In a signaling system, a four-wire transmission circuit the conductors of which are subject to temperature variations, a pilot circuit subject to similar variations, an automatic switch, means responsive to changes in the electrical characteristics of the pilot circuit due to temperature changes for variably setting said switch, and means controlled by the setting of said switch for adjusting the transmission efficiency of said four-wire circuit.

In testimony whereof, I have signed my name to this specification this sixth day of September, A. D. 1918.

ALVA B. CLARK.