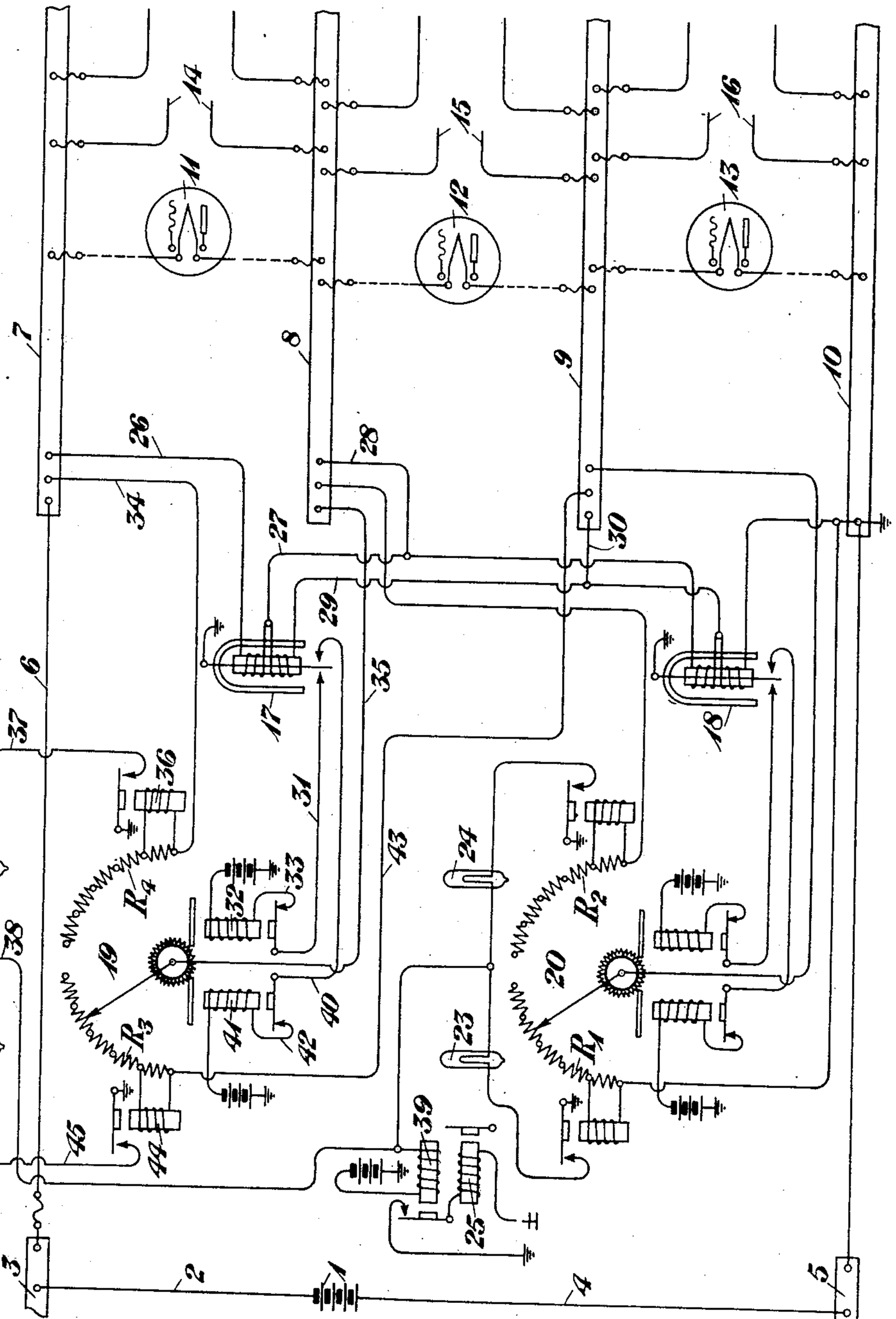
S. P. SHACKLETON.

CURRENT SUPPLY CIRCUIT FOR VACUUM BULBS.

APPLICATION FILED MAY 31, 1919.

1,404,799.

Patented Jan. 31, 1922.



INVENTOR.

S. P. Shackleton

BY

ATTORNEY.

UNITED STATES PATENT OFFICE.

SAMUEL P. SHACKLETON, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE & TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

CURRENT-SUPPLY CIRCUIT FOR VACUUM BULBS.

1,404,799. Specification of Letters Patent. Patented Jan. 31, 1922.

Application filed May 31, 1919. Serial No. 300,986.

To all whom it may concern:

Be it known that I, SAMUEL P. SHACKLETON, residing at New York, in the county of Bronx, and State of New York, have invented certain Improvements in Current-Supply Circuits for Vacuum Bulbs, of which the following is a specification.

This invention relates to telephone circuits, and more particularly to battery supply circuits for repeater installations involving a plurality of vacuum bulb repeater elements.

In vacuum bulb repeater installations, in order to avoid the provision of a large number of separate current supply sources for heating the filaments of the bulbs, it has heretofore been customary to connect the filaments of two bulbs in series with a common source and also as many additional such series combinations as may be desired in parallel. It has been found that such an arrangement of vacumu bulbs in telephone repeater circuits and in telephone signaling circuits does not make economical use of the energy for heating the filaments when the present standard 24 volt central office battery is used as the source of power for this purpose. This is due to the power or energy loss occurring in the external resistances in series with the filament circuits which are required to regulate the potential supplied from the 24 bolt battery to the desired value at the bulbs. A specific illustration of conditions wherein such a power or energy loss would be of considerable magnitude, would be in the case of cable type repeater installations where the filament heating current for a large number of bulbs is supplied from a common source.

Accordingly it is a general object of this invention to provide vacuum bulb repeater installations wherein the power or energy loss in the filament circuits will be considerably reduced and whereby the arrangements will operate in a much more economical manner than heretofore and reduce the cost of operation. These objects are accomplished in the arrangements of this invention by employing a secondary bus-bar system for supplying current to the bulbs. The standard central office battery is connected to a main bus-bar through a current regulating mechanism so that a potential of approximately 21 volts is applied to the main bus-bar. Connected in series with the main bus-bar are three secondary bus-bars from which current is supplied to the bulbs. When three secondary bus-bars are employed the potential drop between the secondary bus-bars will be approximately 7 volts, which has been found satisfactory for the operation of the bulbs. With such an arrangement the filament circuits of three bulbs, instead of only two as in former arrangements, may be connected together in series, under which condition a saving in the power costs of approximately 33 per cent. is effected. It is pointed out that in order to maintain the potential drop between the secondary bus-bars the same and at approximately 7 volts, the repeater circuits must be wired so that the same number of bulbs are connected to each bus-bar for normal operation. If some of the bulbs are cut out of operation or removed from one of the secondary bus-bars and an equivalent number is not removed from the other bus-bars, a condition of unbalance will result and there will be an unequal distribution of voltages across the bus-bars which may be sufficient to cause current variations outside the allowable limits unless compensated for. In order to compensate for such a condition of unbalance between the secondary bus-bars a number of polarized relays are connected thereto which operate whenever a number of the bulbs are cut out of service or removed therefrom. These polarized relays control rheostats whereby resistance units will be connected across the secondary bus-bars from which the bulbs have been removed and thereby maintain a desired distribution of voltages across the bus-bars.

The invention may be more clearly understood from the following description when taken in connection with the accompanying drawing in which is illustrated a circuit diagram of a preferred arrangement of the invention. In the drawing the standard central office battery 1 is connected to a main bus-bar 3 and a main ground bus-bar 5. Connected in series with main bus-bars 3 and 5 are the secondary bus-bars 7, 8, 9 and 10. Included either in the circuit connecting battery 1 to bus-bar 3 or in the circuit connecting bus-bar 3 to bus-bar 7 is a voltage regulating mechanism (not shown) adjusted so that a potential of approximately 21 volts will be applied to the secondary bus-bar 7. Accordingly if an equal

load were distributed across bus-bars 7 and 8, 8 and 9, and 9 and 10, there would be a potential drop between bus-bars 7 and 8 from 21 volts to 14 volts, and between bus-bars 8 and 9 from 14 volts to 7 volts, and between bus-bars 9 and 10 from 7 volts to zero. Accordingly to maintain an equal voltage distribution across the bus-bars and a voltage of approximately 7 volts which has been found suitable for satisfactory operation of the bulbs, for normal operation an equal number of bulbs are connected across each set of bus-bars. The filaments of bulbs 11, 12 and 13 are illustrated as connected across the bus-bars. Additional bulbs may be connected thereto by means of conductors such as 14, 15 and 16. Included in a bridge across bus-bars 7 and 8 is a winding of a polarized relay 17. Included in a bridge across bus-bars 8 and 9 is another winding of relay 17. The two windings of relay 17 are differentially arranged and accordingly when the loads across the two sets of bus-bars are equal and the distribution of voltage is the same the relay will not operate. However, when a condition of unbalance exists due to some of the bulbs being removed from one set of bus-bars, more current will flow through one of the windings of the relay than through the other and the relay will operate. The operation of relay 17 serves to control the rheostat mechanism 19 whereby bridges including resistance elements, such as R_3 or R_4, may be completed across either of the sets of bus-bars from which the bulbs have been removed, thereby compensating for such removal, and restoring the apparatus to a desired condition of balance. Included in bridges across bus-bars 8 and 9, and 9 and 10, are the differentially arranged windings of a polarized relay 18, which is similar to relay 17. The relay 18 in turn controls a rheostat mechanism 20 similar to mechanism 19 which in a similar manner serves to compensate for unbalance in the loads connected across bus-bars 8 and 9, and 9 and 10. The signal lamps 21, 22, 23, 24 and the buzzer mechanism 25 are associated with the rheostats 19 and 20 and operate whenever the unbalance becomes great enough to require manual adjustment.

The operation of the invention is as follows: If a potential of approximately 21 volts is applied from battery 1 to the secondary bus-bar 7, current will flow from bus-bar 7 through the filament of vacuum bulb 11 to bus-bar 8, and through the filament of vacuum bulb 12 to bus-bar 9, and through the filament of vacuum bulb 13 to bus-bar 10 and ground. Current will also flow through other parallel circuits including vacuum bulbs, as for example, vacuum bulbs connected to conductors 14, 15 and 16. If an equal number of bulbs is connected between bus-bars 7 and 8, between bus-bars 8 and 9, and between bus-bars 9 and 10, there will be a potential drop from bus-bar 7 to bus-bar 8 from 21 volts to 14 volts, and from bus-bar 8 to bus-bar 9 from 14 volts to 7 volts, and from bus-bar 9 to bus-bar 10 from 7 volts to zero. Accordingly there will be an equal voltage distribution of 7 volts across each of the bus-bar branches. At the same time current will flow from bus-bar 7 over conductor 26, upper winding of relay 17, conductors 27 and 28 to bus-bar 8. Current will also flow from bus-bar 8 over conductors 28 and 27, lower winding of relay 17, conductors 29 and 30, to bus-bar 9. It there is an equal load across bus-bars 7 and 8 and across bus-bars 8 and 9 of approximately 7 volts, as pointed out, the currents flowing through the windings of relay 7 will be of equal value, and as the windings of relay 7 are differentially arranged, the relay will not be operated. However, if, for purposes of illustration, some of the bulbs are cut out of service or no longer connected across bus-bars 7 and 8, the resistance across said bus-bars will be increased and a lesser drop in potential will take place across bus-bars 7 and 8 than across bus-bars 8 and 9. Accordingly more current will now flow through the lower winding of relay 17 than through the upper winding thereof, and the relay 17 will be operated and its armature deflected to the left. This will close the following circuit: from ground, armature and left hand contact of relay 17, conductor 31, armature and contact of relay 32, conductor 33, winding of relay 32, to battery and ground. This will operate the relay 32 and operate ratchet mechanism whereby the needle of rheostat 19 will be deflected to the right. This will complete the following bridge across bus-bars 7 and 8; from bus-bar 7, conductor 34, resistance elements R_4, needle of rheostat 19, conductor 35, to bus-bar 8. The polar relay 17 and the relay 32 will continue to function until the proper number of resistance units in the resistance R_4 are included in this bridge to compensate for the removal across bus-bars 7 and 8 of the resistance of the vacuum bulbs disconnected therefrom. The additional resistance units thus connected in parallel across bus-bars 7 and 8 will restore a condition of balance between bus-bars 7 and 8 and bus-bars 8 and 9, so that there will be an equal potential drop across said bus-bars. By this means the current flowing over the filament circuits of the vacuum bulbs connected across bus-bars 7 and 8 will not be allowed to increase beyond desirable limits for the effective operation of the bulbs. If a sufficient number of tubes were cut out of service and the needle of rheostat 19 were deflected so that only the last resistance unit on the extreme right was included in the bridge

circuit the relay 36, which is connected in parallel therewith will operate and close the following circuit: from ground, armature and contact of relay 36, conductor 37, filament of signal lamp 22, conductor 38, winding of relay 39 to battery and ground. The closing of this circuit will operate signal lamp 22 and will start the buzzer apparatus 25 into operation, so that the repeater attendant may be notified that the automatic adjustment effected by rheostat 19 will not be sufficient, and may adjust the mechanism manually. If a number of the bulbs normally connected across bus-bars 8 and 9 were cut out of service, the drop in potential across bus-bars 8 and 9 would be less than the drop in potential across bus-bars 7 and 8. Accordingly, when such is the case, more current will flow through the upper winding of relay 17 than through the lower winding of relay 17, and the relay 17 will be operated and its armature deflected to the right. This will close the following circuit: from ground, armature and right hand contact of relay 17, conductor 40, armature and contact of relay 41, conductor 42, winding of relay 41 to battery and ground. This will operate the relay 41, which in turn will operate ratchet mechanism to deflect the needle of rheostat 19 to the left, and thereby include in a bridge across bus-bars 8 and 9, units of the resistance element R_3. This bridge is completed as follows: from bus-bar 8 over conductor 35, needle of rheostat 19, resistance units R_3, conductor 43 to bus-bar 9. The polar relay 17 and relay 41 will continue to operate until a sufficient number of the units of resistance R_3 are included in this bridge to cause the potential drop across bus-bars 8 and 9 to be equal to the potential drop across bus-bars 7 and 8 and thereby compensate for the removal across bus-bars 8 and 9 of the parallel resistance circuits of the vacuum bulbs cut out of service. Connected in parallel with this bridge is the relay 44 which is similar in operation to relay 36 and which will operate and close the following circuit: from ground, armature and contact of relay 44, conductor 45, filament of signal lamp 21, conductor 38, winding of relay 39, to battery and ground. The closing of this circuit will operate the lamp 21 and start the buzzer apparatus 25 into operation, so that if a condition of balance between the two bus-bar branches may not be automatically effected by rheostat 19, the repeater attendant may be notified and may adjust the apparatus manually. Bridged across bus-bars 8 and 9 is the upper winding of the polar relay 18. Bridged across bus-bars 9 and 10 is the lower winding of polar relay 18. These windings are differentially arranged. Relay 18 is similar in operation to relay 17 and controls the rheostat mechanism 20 which in turn is similar to rheostat 19. Accordingly, when the drop in potential between bus-bars 8 and 9 differs from the drop in potential from bus-bar 9 to bus-bar 10, due to the cutting out of service of some of the bulbs associated with one of these bus-bar branches, the relay 18 and the rheostat mechanism 20 will operate in a manner similar to that already pointed out to bridge across the bus-bars from which the bulbs have been removed resistance units to compensate for such removal, and to restore the branches to a condition of balance.

It is pointed out that, while the invention has been specifically illustrated in arrangements wherein three secondary bus-bars across which there is a voltage distribution of approximately 7 volts are employed, that the invention is not limited to the specific arrangements disclosed. Types of work circuits other than those including filaments of vacuum bulbs might be connected across the secondary bus-bars. In such arrangements a voltage distribution across the bus-bars of other than 7 volts or even an unequal distribution of voltage might be desirable and it might be desirable to apply to the bus-bar 7 in the first instance a potential other than approximately 21 volts. Furthermore the number of secondary bus-bars is not limited to three as the balancing arrangements might equally well be employed with two pairs of such bus-bars. Accordingly 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 as defined in the appended claims.

What is claimed is:

1. In a current supply system for work circuits, a source of current, more than three bus-bars connected in series therewith through said work circuits, and automatically operating means associated with said bus-bars for maintaining a constant potential difference between adjacent pairs of said bus-bars, said automatically operating means comprising bridges across each adjacent pair of bus-bars including variable resistances, a polarized differentially wound relay, one of the windings of said relay being included in a bridge across the first and second of said bus-bars, the other winding of said relay being included in a bridge across the second and third of said bus-bars, a second polarized differentially wound relay, one of the windings of said relay being included in a bridge across the second and third of said bus-bars, the other winding being included in a bridge across the third and fourth of said bus-bars, and means controlled by said relays for varying said resistances.

2. In a current supply system for work

circuits, a source of current, more than three bus-bars connected in series therewith through said work circuits, and automatically operating means associated with said bus-bars for maintaining a constant potential difference between adjacent pairs of said bus-bars, said automatically operating means comprising bridges across each adjacent pair of bus-bars including variable resistances, a plurality of polarized differentially wound relays, each relay having windings bridged across adjacent pairs of said bus-bars and one winding of each of two adjacent relays being bridged across the same pair of bus-bars, and means controlled by said relays for varying said resistances.

In testimony whereof, I have signed my name to this specification this 28th day of May, 1919.

SAMUEL P. SHACKLETON.