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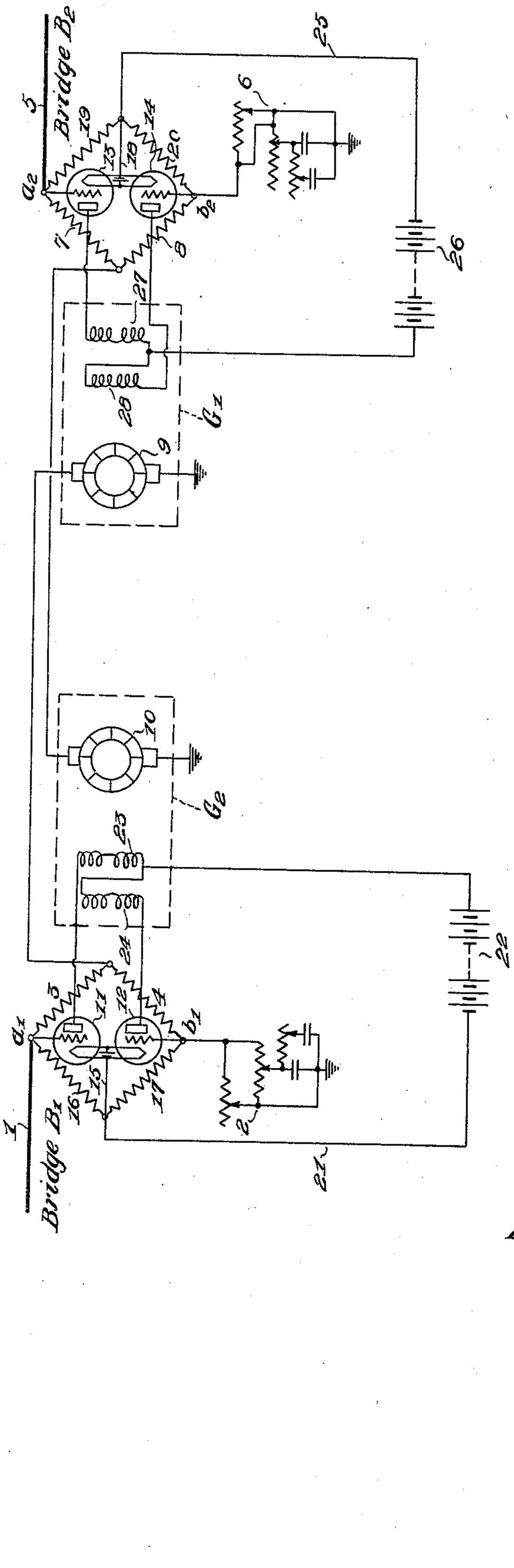

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VACUUM TUBE TELEGRAPH REPEATER

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This invention relates to repeaters for telegraph circuits, and in particular to a bridge type of duplex repeater employing thermionic vacuum tubes to control the field current of a generator whose armature is connected to the transmitting point of the bridge on the opposite side of the repeater.

Broadly, the object of the invention is to provide novel means for reversing the field of the repeating generator in accordance with incoming signals to be repeated.

An object of the invention is to utilize the differential action of vacuum tubes connected in the arms of a normally balanced bridge network for controlling the polarity of current impulses applied to the line at the transmitting point of the repeater bridge.

Another object of the invention is to make the flow of current in the armature of the repeating generator dependent upon a condition of inequality in the instantaneous potentials applied to the two grids of a pair of like thermionic vacuum tubes connected across the bridge.

The invention is disclosed, in its preferred embodiment, in connection with a bridge type of duplex repeater working on a ground circuit. In the figure:

A pair of telegraph lines 1 and 5 are connected for duplex operation by way of a repeater comprising bridge B_1 and bridge B_2. Bridge B_1 comprises four arms, of which the resistances 3 and 4 form two of the arms, and line 1 and artificial line 2 the other two arms. The resistances 3 and 4 are usually, though not necessarily, equal in value. Resistances 16 and 17 form a potentiometer which will be discussed hereinafter.

Similarly, bridge B_2 comprises four arms, of which line 5 and artificial line 6 are two and the resistances 7 and 8 the other two. If the line 5 and balancing line 6 have equal impedances, resistances 7 and 8 should also be equal.

The generator G_1 has its armature 9 connected from ground to the transmitting point of the bridge B_1, which is the junction of the resistances 3 and 4. Similarly the armature 10 of generator G_2 is connected to ground and to the transmitting point of bridge B_2, that is, to the junction of the resistances 7 and 8. Generator G_2 is thus connected across one diagonal of bridge B_1 and generator G_2 is connected across one diagonal of bridge B_2.

The terminals of the second diagonal of each bridge are connected respectively to the grids of a pair of similar thermionic vacuum tubes. Thus the junction a_1 of line 1 and resistance 3 is connected to the grid of a vacuum tube 11 while the junction b_1 of artificial line 2 and resistance 4 is connected to the grid of tube 12. Similarly, the grids of tubes 13 and 14 are connected to the junction a_2 of line 5 and resistance 7, and to the junction b_2 of artificial line 6 and resistance 8, respectively.

The filaments of tubes 11 and 12 are connected together and to a conductor 15 which extends to the electrical midpoint of a resistance having equal halves 16 and 17. These resistances 16 and 17 are thus connected across the input electrodes of the two tubes 11 and 12. Resistances 16 and 17 may be considered to comprise a potentiometer which insures that the filaments of the tubes shall be at a potential which is midway between that of the two grids when there is any potential drop across the potentiometer.

Similarly, the filaments of tubes 13 and 14 across bridge B_2 are connected by a common conductor 18 to the junction of two equal resistances 19 and 20 which are connected across the input circuits of the tubes 13 and 14 respectively. Resistances 19 and 20 form a potentiometer which brings the filaments to a potential midway between that of the grids or that of the terminals of the bridge terminals a_2 and b_2.

The plate or anode circuits of tubes 11 and 12 of bridge B_1 are completed through a common conductor 21 which is a continuation of conductor 15, through battery 22 and separately through the two field coils 23 and 24, respectively, of generator G_2. These field coils, like vacuum tubes 11 and 12, are equal or identical, but they are connected in opposite directions to each other.

Similarly, for bridge B_2 the plate or anode circuit of tube 13 extends from the filament through conductor 18, conductor 25, battery

26 and field coil 27 of generator G_2 back to the plate electrode of tube 13, while the plate circuit of tube 14 extends from its filament by way of conductors 18 and 25, battery 26 and field coil 28 of generator G_2 back to the plate electrode of tube 14.

Although the elements 3, 4 and 7, 8 are shown as resistances they could be inductances, condensers or any possible combination of inductance, resistance and capacity which will give the desired wave form to the input circuits of the vacuum tubes.

The operation of the circuit will be understood from the following:

When the same potential, be it positive, negative or zero with respect to the filament, is applied to the grids of the tubes 11 and 12 across bridge B_1 there will be no potential across the armature 10 of generator G_2, since equal currents will flow from battery 22 through the field coils 23 and 24 which are connected in opposite directions and the resultant field flux will be zero.

If an incoming signal current produces a potential drop across the points a_1, b_1, the grids of tubes 11 and 12 will be of opposite polarities and the plate currents flowing through field coils 23 and 24 will no longer be equal. The current in one of these coils will increase and that in the other will decrease, so that a resultant field flux is set up and a current induced in armature 10 of generator G_2. The induced current in armature 10 flows to line 5 and artificial line 6 from the transmitting point of bridge B_2 over resistances 7 and 8 respectively.

When the artificial lines are adjusted to have the same impedance as the real lines and resistances 7 and 8 are equal, the armature of generator G_2 will impress the same potential between the ground and points a_2 and b_2 on bridge B_2. Accordingly the grids of tubes 13 and 14 will receive equal potentials and the plate circuits of these tubes will be affected in the same manner, with the result that the currents flowing through coils 27 and 28 will continue to be equal and the resultant flux in generator G_1 will remain zero.

The direction of the current induced in armature 10 of generator G_2 depends on which of the field coils 23 and 24 has the predominating current. When the grid of tube 11 is made positive, for example, current in coil 23 may increase and, in predominating over the current in coil 24, cause a current of positive polarity to be induced in armature 10 of generator G_2 and applied to the line 2. When the grid of tube 11 becomes positive with respect to its filament, the grid of tube 12 becomes negative with respect to its filament, so that the plate current of tube 11 increases and the plate current of tube 12 decreases. When the grid of tube 11 becomes negative, that of tube 12 becomes positive and the plate current of tube 11 decreases while the plate current of tube 12 increases. The current through one of the generator field windings will increase and that through the other will decrease, each winding setting up a field flux dependent on the current flowing and the algebraic summation of the two fluxes so produced determines the magnitude and direction of the resultant field flux. Thus the magnitude and direction of the resultant potential across the generator armature is determined by the polarity of the incoming signal, and the received signal will be repeated in amplified form over the opposite line from which it was received.

When the artificial lines of the repeater are adjusted so that they have the same impedance characteristics as the real telegraph lines, care must be taken not only that the two bridge arms connected to the generator associated with the other bridge shall have the same impedance but also that they shall have the same phase angle, in order that the current induced in one generator shall not affect the circuits of the tube associated with the opposite bridge.

It will be obvious that the operation for current incoming to bridge B_2 is the same as that described for currents incoming to bridge B_1. In either case the balanced condition of the bridge connected to the line from which the signal currents are received, will be upset by the application of unlike signal potentials to the grids of the associated tubes. This will result in the application of current of polarity like that of the incoming current, to the transmitting point of the balanced bridge on the other side of the repeater.

The operation as described depends on the two vacuum tubes used in the same bridge having the same plate current grid potential characteristics.

It is worthy of note that as one of the tube grids is always positive and the other is always negative while signals are being received, the total impedance of the bridge network including the input circuits of the tubes is constant.

I claim:

1. A vacuum tube repeater comprising an incoming line, a balanced bridge connected thereto including a pair of vacuum tube relays having normally balanced input circuits and opposed balanced output circuits, a dynamo electric generator, means for applying incoming signals of different polarities to said pair of relays and means under control of said opposed output circuits for controlling the polarity of the current produced in the armature of said generator in accordance with the polarity of the signal incoming from said line.

2. A vacuum tube telegraph repeater comprising a balanced bridge, a pair of three-electrode vacuum tubes with their grids connected to those terminals of said bridge to

which the telegraph line and its balancing line are connected, a generator having its field differentially controlled by the plate circuits of said vacuum tube and means for connecting the armature of said generator to the output side of said repeater.

3. A vacuum tube telegraph repeater comprising a balanced bridge, two arms of which are formed by the incoming telegraph line and its balancing line, a pair of three-electrode vacuum tubes with their grids connected to the bridge terminals of said line and balancing line, a generator having a pair of differentially connected field coils, means for connecting one field coil in the plate circuit of each of said tubes and means for connecting the armature of said generator to the output side of said repeater.

4. A vacuum tube telegraph repeater comprising a balanced bridge, two arms of which are formed by the incoming telegraph line and its artificial line, a pair of three-electrode vacuum tubes with their grids connected respectively to the bridge terminals of said line and artificial line, resistance between said grids having its midpoint connected to the filaments of said tubes, a pair of differentially connected coils in the plate circuits of said tubes, a generator connected to the output side of said repeater and means for controlling the field of said generator by the differential effect of said plate circuit coils.

5. A vacuum tube telegraph repeater comprising a balanced bridge two arms of which are formed by the incoming telegraph line and its artificial line, a pair of matched three-electrode vacuum tubes with their grids connected respectively to the bridge terminals of said line and artificial line, a pair of like impedances connected between said grids and with their junction point connected to the filaments of said tubes, the impedances being so designed as to form shaped networks in the input circuits of said tubes, a pair of differentially connected coils in the plate circuits of said tubes, a generator connected to the output side of said repeater with its field constituted by said differentially connected plate coils.

6. A vacuum tube telegraph repeater comprising a balanced bridge two arms of which are formed by the incoming telegraph line and an artificial line, a pair of matched three-electrode vacuum tubes with grids connected respectively to the bridge terminals of said line and balancing line and means for maintaining said grids at like potentials in the absence of signal currents, a generator connected to the output side of said repeater and means for controlling the field of said generator, upon the receipt of signal potentials, by the differential effect of the currents in the plate circuits of said tubes.

7. A duplex vacuum tube telegraph repeater comprising a pair of balanced bridges, each bridge comprising a line, a balancing line and a pair of impedance arms, a generator for each bridge connected to the junction of said impedance arms, a pair of three electrode vacuum tube relays for each bridge having their input circuits connected in normally balanced relation to the bridge terminals of said line and balancing line, and their output circuits connected in opposed relation, and means for controlling the field of the generator connected to the opposite bridge, in accordance with the differential effect of said opposed output circuits when incoming signals are received.

8. A duplex vacuum tube telegraph repeater comprising a pair of balanced bridges each bridge comprising a line, an artificial line and a pair of impedance arms, a generator for each bridge connected to the junction of said impedance arms and comprising a pair of opposed field coils, a pair of three electrode vacuum tubes for each bridge having their grids connected to the bridge terminals of said line and balancing line, and their plates connected to said opposed field coils.

9. A duplex vacuum tube telegraph repeater comprising a pair of balanced bridges, each bridge comprising a line, a balancing line and a pair of impedance arms, a generator for each bridge connected to the junction of said impedance arms and comprising a pair of opposed field coils, a pair of three electrode vacuum tubes for each bridge having their grids connected to the bridge terminals of said line and balancing line, resistances connected between said grids and their corresponding filaments, and means connecting the field coils of the generator in the plate circuits of said tubes.

10. A duplex vacuum tube telegraph repeater comprising a pair of balanced bridges, each bridge comprising a line, an artificial line, and a pair of impedance arms, a dynamo electric generator under the control of each bridge having its armature connected to the junction of the impedance arms of the other bridge, a pair of vacuum tubes for each bridge having their input circuits connected to opposite points on the bridge and their output circuits each connected in series with one of two opposed field coils of said generator, and balanced wave shaping impedances connected in the input circuits of said pair of vacuum tubes.

11. A vacuum tube repeater comprising a balanced bridge including a pair of vacuum tube relays having balanced input circuits and opposed balanced output circuits, a dynamo electric generator, and means under control of said opposed output circuits for controlling the direction of current produced in the armature of said generator.

In testimony whereof I affix my signature.

HARLOW M. CASE.