Jan. 18, 1927. 1,614,546

R. W. DEARDORFF

MULTIPLEX TELEGRAPHY WITH MAGNITUDE DISCRIMINATION

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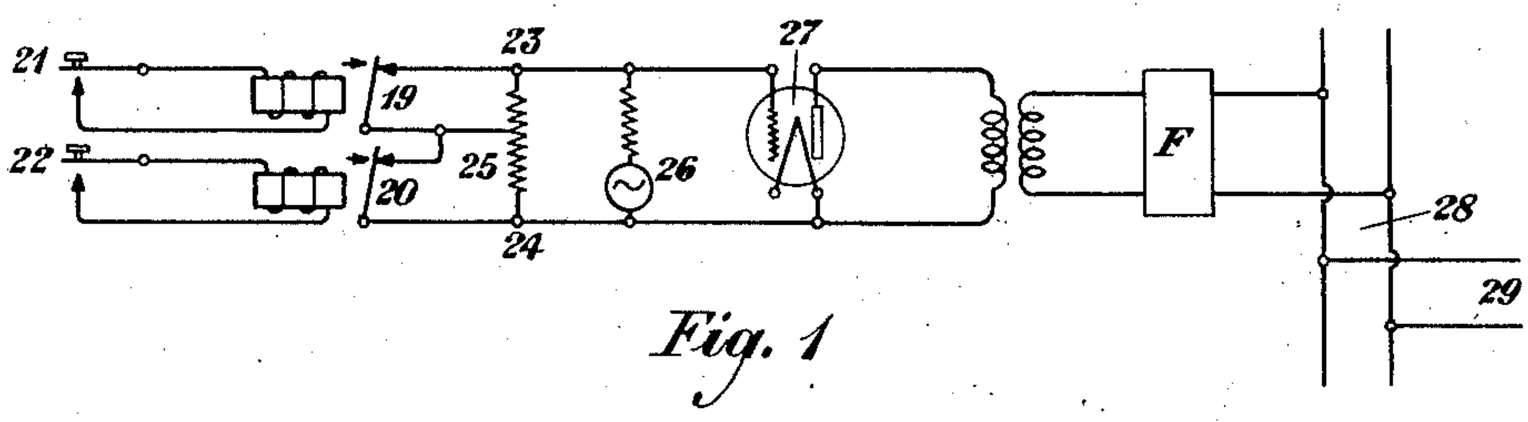

Fig. 1

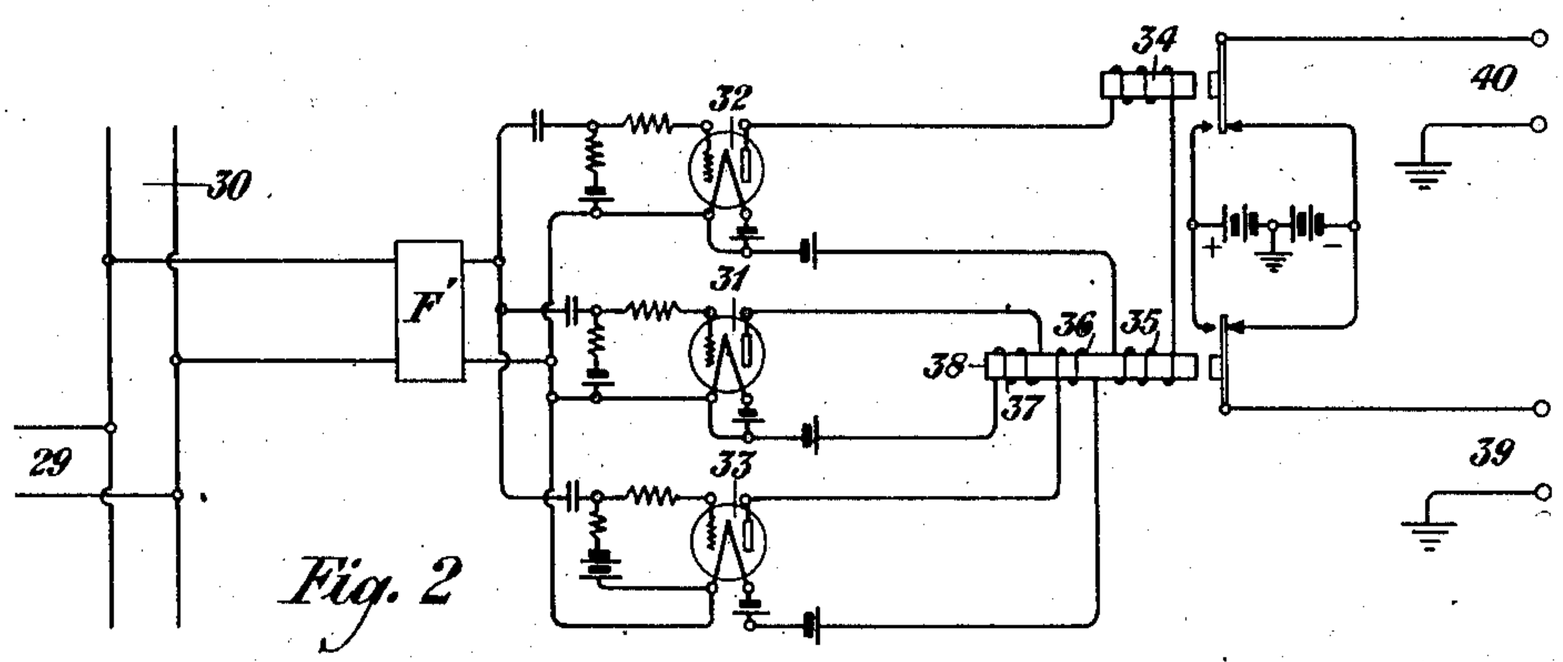

Fig. 2

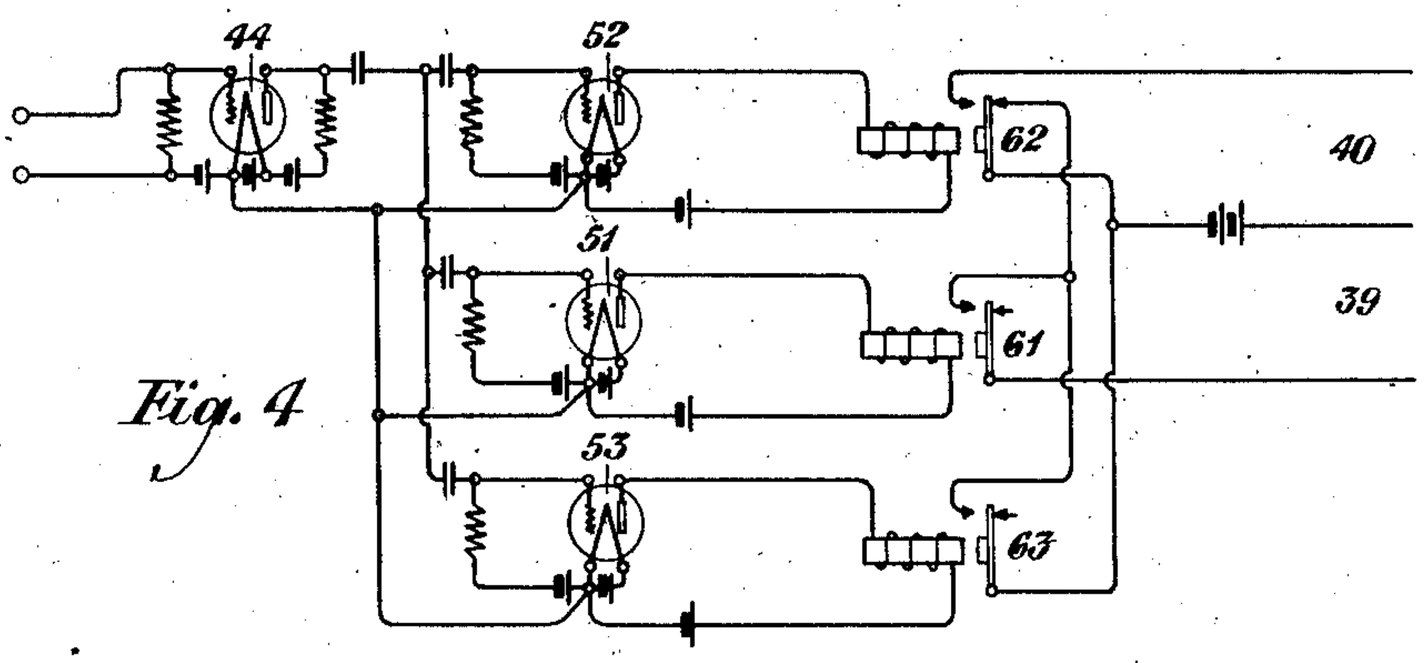

Fig. 4

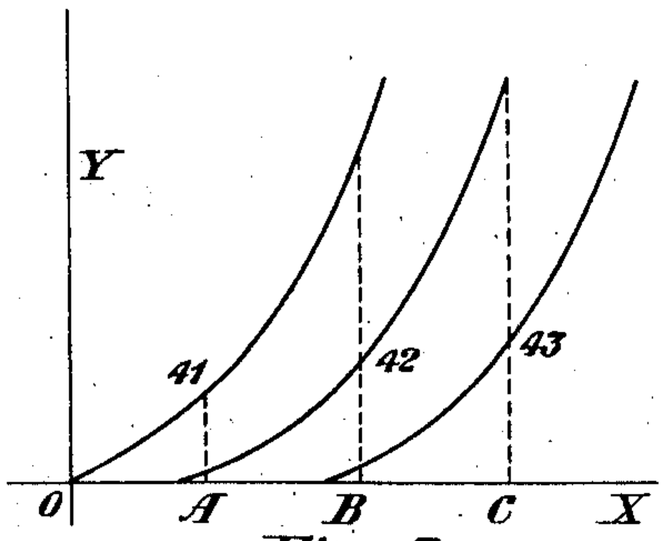

Fig. 5

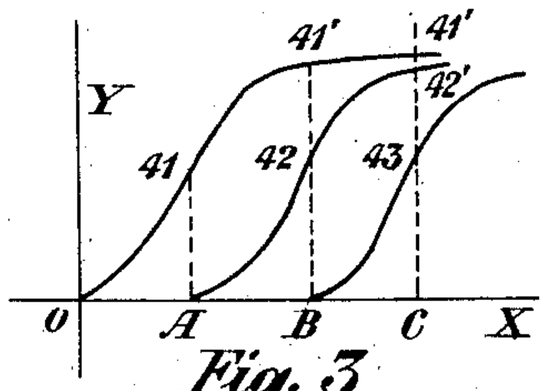

Fig. 3

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UNITED STATES PATENT OFFICE.

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MULTIPLEX TELEGRAPHY WITH MAGNITUDE DISCRIMINATION.

Application filed January 7, 1925. Serial No. 1,051.

An object of my invention is to provide a new and improved system of multiplex telegraphy in which the different messages on the same line are distinguished by magnitude differences of the signal elements. Another object of my invention is to provide for magnitude discrimination in such a system by means of vacuum tubes. These and other objects of my invetnion will be made apparent in the following specification, in which I have illustrated and described a limited number of specific embodiments of the invention. It will be understood that the following description relates to these particular examples of the invention and that the invention is defined in the appended claims.

Referring to the drawings, Figure 1 is a diagram of the sending end of a system embodying my invention; Fig. 2 is a diagram of the corresponding receiving end; Fig. 3 is a diagram of vacuum tube characteristics that will be referred to in connection with the explanation of Fig. 2; Fig. 4 is a diagram of a modified receiving system; and Fig. 5 is a diagram of vacuum tube characteristics that will be referred to in connection with the explanation of Fig. 4.

Referring to Fig. 1, a carrier current generator 26 puts a corresponding electromotive force on the grid of the three-electrode vacuum tube 27. As shown in the drawing, the grid is shunted by the armature contacts 19 and 20 controlled, respectively, by the sending keys 21 and 22. When both keys are open, the shunt is complete and the generator 26 puts no electromotive force on the grid. When the key 21 is closed, the contacts are opened at 19 and the resistance 23, 25 is interposed in the shunt referred to, so that a corresponding electromotive force is applied to the grid of the tube 27. On the other hand, when the key 22 is closed, the contacts 20 are opened and a larger resistance 24, 25 is interposed so that a larger electromotive force is applied to the grid.

Accordingly, the output from the tube 27 will have zero magnitude for both keys open, a certain magnitude for closure of the key 21 alone, a greater magnitude on closure of the key 22 alone, and a still greater magnitude upon closure of both of said keys. These currents of the frequency determined by the generator 26 and of the four different magnitudes determined by the keys 21 and 22 will go through the band filter F and the bus-bars 28 and thence to the line 29.

At the receiving end shown in Fig. 2, the currents from the line 29 go to the bus-bars 30 and those currents of frequency corresponding to the filter F will be passed by the band filter F′ to the grid circuits in multiple of the three vacuum tubes 31, 32 and 33.

The respective characteristics of these tubes are shown at 41, 42 and 43 in Fig. 3, the adjustment being made by adjusting the respective grid batteries.

For a received signal wave train of intensity determined by the key 21 alone, the input voltage on the tubes 31, 32 and 33 will be OA in Fig. 3. This will give a current only in the output circuit for the tube 31. For closure of the key 22 alone, the voltage on the grids of the tubes 31, 32 and 33 will be OB in Fig. 3, and tube 31 will have an output current represented by $B^{41'}$ and tube 32 will have an output current represented by B^{42} in Fig. 3. When both keys 21 and 22 are closed, the voltage on the grids of the three tubes 31, 32 and 33 will be OC in Fig. 3 and the respective output currents will be $C^{41'}$, $C^{42'}$ and C^{43}.

As shown in Fig. 2, the intermediate tube 32 has the relay 34 in its plate circuit and the relay 38 has windings in all three plate circuits. The windings 35 and 37 from tubes 31 and 32 are magnetically opposed so that they give a differential effect, while the winding 36 from tube 33 magnetically aids the winding 37 from tube 31.

With Fig. 3 in view, it will be seen that when the key 21 is closed, the only winding energized is 37 of relay 38, effecting the operation of the relay to give a signal element on the receiving branch circuit 39. When the key 22 alone is closed, both the windings 37 and 35 of relay 38 are energized by the currents represented respectively by $B^{41'}$ and B^{42} in Fig. 3, but the magnetic effect, being differential, is too small to operate the relay. However, the current represented by B^{42} in Fig. 3 in the winding of relay 34 energizes it and gives a signal element on the branch receiving circuit 40. When both keys 21 and 22 are closed, the relay 34 is energized as before and while the magnetic effect of the windings 35 and 37 remains negligibly small, the current represented by C^{43} in winding 36 from tube 33 is now sufficient to operate the relay 38 so that both re-

ceiving circuits 38 and 39 receive corresponding signal elements.

In the modification of Fig. 4 the received currents go to the amplifier 44 and thence to the input grid circuits in multiple of the three vacuum tube detectors 51, 52 and 53. These have the respective characteristics shown at 41, 42 and 43 in Fig. 5. Accordingly, when key 21 alone is closed, only the relay 61 is operated, circuit 39 receiving current from the battery through the back contact of relay 62 and front contact of 61. By reference to Fig. 5, it will be seen that when key 22 is closed, both relays 61 and 62 are operated and current goes to the circuit 40 through the front contact of relay 62. When both keys 21 and 22 are closed, all three relays 61, 62 and 63 are operated and current goes from the battery, through the front contact of relay 62 to circuit 40 and also through the front contacts of relay 63 and of 61 to the circuit 39.

I claim:

1. The method of multiplex receiving of messages on superposed currents of different magnitudes which consists in applying corresponding voltages to the grid circuits of vacuum tubes having similar characteristics adjusted to be relatively displaced, and thereby distinguishing the respective message currents in the output circuits of the vacuum tubes.

2. In combination, means to put on a line two currents of different magnitudes modulated respectively according to different massages, and at the receiving end vacuum tubes having relatively displaced characteristics of similar shape to which tubes the currents from the line are applied, and means associated with the output circuits of said tubes to distinguish the respective messages.

3. The method of multiplex receiving of messages on superposed currents of different magnitudes which consists in applying corresponding voltages to the grid circuits of vacuum tubes having similar characteristics and different constant voltages on the grids, and thereby distinguishing the respective message currents in the output circuits of the vacuum tubes.

4. In combination, means to put alternating signaling currents on a line of different magnitudes according to respective message channels, and at the receiving end vacuum tubes having relatively displaced characteristics of similar shape to which tubes the currents from the line are applied, and means associated with the output circuits of said tubes to distinguish the respective messages.

5. In combustion, means to put on a line two currents of different magnitudes modulated respectively according to different messages, and at the receiving end vacuum tubes having different constant grid voltages to which tubes the currents from the line are applied, and means associated with the output circuits of said tubes to distinguish the respective messages.

6. In combination, means to put on a line two currents of different magnitudes modulated respectively according to different messages, and, at the receiving end, vacuum tubes having similar characteristics relatively displaced to one another, to which tubes the currents from the line are applied, relays with relay windings in the respective output circuits of said tubes, local signaling circuits controlled by said relays, and compensating means to distinguish the messages without confusion whether superposed or separate.

7. In combination, means to put on a line two currents of different magnitudes modulated respectively according to different messages, and, at the receiving end, three vacuum tubes having similar characteristics relatively displaced, to which tubes the currents from the line are applied, a plurality of relays with windings thereon in the output circuits of said tubes, and compensating interconnections between the relays.

8. In combination, means to put on a line two currents of different magnitudes modulated respectively according to different messages, and, at the receiving end, three vacuum tubes having similar relatively displaced characteristics, to which tubes the currents from the line are applied, only one of these tubes being responsive to the current of smaller magnitude, and only two of them to the current of greater magnitude, and the remaining tube being responsive only to superposed currents of both magnitudes, and means associated with the output circuits of said tubes to distinguish the respective messages.

In testimony whereof, I have signed my name to this specification this 31st day of December 1924.

RALPH W. DEARDORFF.