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ATTENUATION CONTROLLING DEVICE

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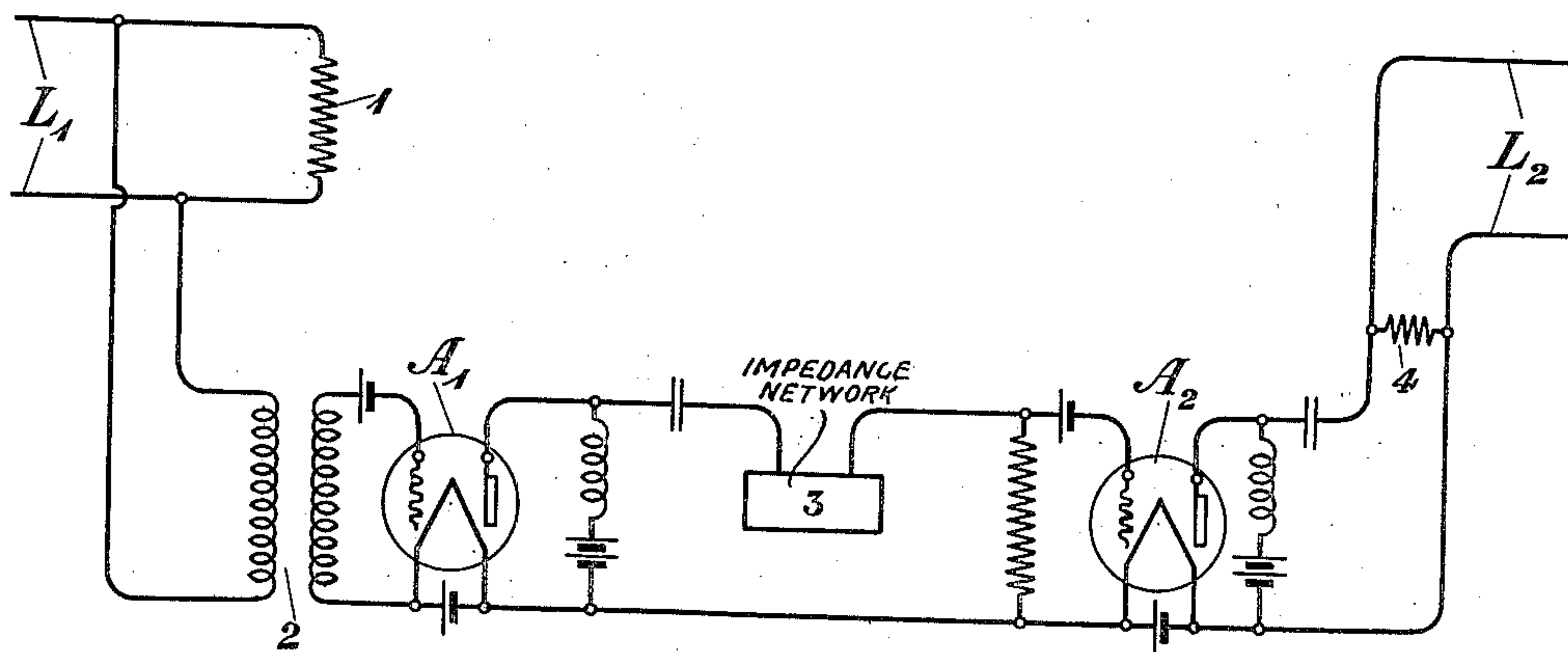


Fig. 1

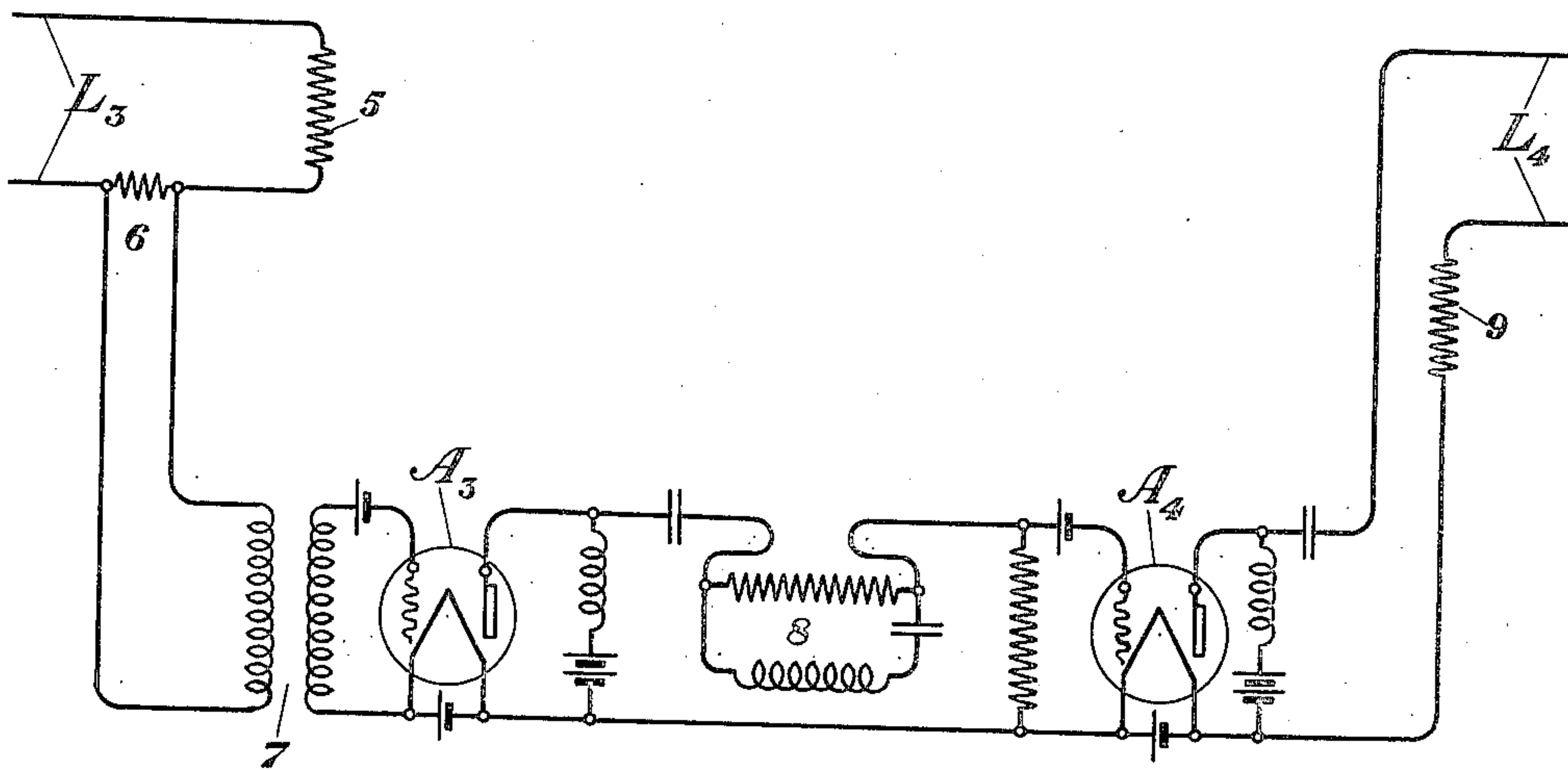


Fig. 2

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UNITED STATES PATENT OFFICE.

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ATTENUATION-CONTROLLING DEVICE.

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This invention relates to transmission systems and more particularly to transmission systems over which telephonic or multifrequency signals are transmitted.

5 It is often desirable in systems used for the transmission of frequencies varying over a considerable range to insert networks or combinations of impedances which affect the different frequencies in different
10 amounts. Such an arrangement, for example, might be expedient where it is desired to cut out certain bands of frequencies so as to permit different frequency ranges to be used for different purposes. Further-
15 more, in transmission systems the attenuation usually varies for different frequencies, and in the case of telephonic signals the higher frequencies are usually attenuated to such an extent as compared with the lower
20 frequencies that a considerable degree of distortion results. In such systems it may be desirable to include networks or combinations of impedance whereby a desired relation between frequencies and the trans-
25 mission efficiency of the system may be brought about, and whereby either uniform attenuation may be attained or the attenuation may be made to vary with frequency in a desired manner. It may be desirable
30 to include in transmission systems networks or impedance combinations for many other purposes in addition to those already specifically pointed out.

35 While it has been possible to devise many types of networks or impedance combinations, such as wave filters or attenuation equalizers, which affect the different frequencies in the desired manner, it has been difficult to satisfactorily associate these net-
40 works with the lines of a transmission system due to an interaction between the lines and networks resulting from the variations in impedance values between the lines and networks, which cause what are commonly
45 termed reflection losses. Accordingly it is the general purpose of this invention to provide arrangements whereby networks or devices for controlling attenuation or for other purposes may be associated with a
50 transmission system without the introduction of interaction effects between such apparatus and the lines. In the arrangements of this invention the network or impedance device is included in a circuit between two
55 one-way amplifiers, the input circuit of one

amplifier and the output circuit of the other amplifier being connected to different line sections of the transmission system. As the input circuits of the amplifiers are of a relatively high impedance, the association
60 thereof with the line sections will cause no appreciable disturbance in the impedance relations existing between the line sections and their terminating equipment. The network or impedance device may be thus asso-
65 ciated with the system without the introduction of interaction effects or reflection losses and the amplifying arrangements will furthermore serve to make up any trans-
70 mission losses due to the network or impedance device itself. Furthermore as the association of the device or network with a line section may thus be attained without effect on the line section, the line section
75 may be terminated in any desired manner. Other and further features of the invention may be clear from the following detailed description of the invention.

In the drawing is illustrated a circuit diagram embodying the arrangements of
80 the invention, in the Figure 1 of which is illustrated one form of the invention and in the Fig. 2 is shown another form thereof.

In Fig. 1 is shown a transmission line including the two line sections L_1 and L_2 .
85 The line section L_1 may represent a line section over which electro-magnetic waves are being received and with which it may be desirable to connect a network of im-
90 pedances to control the propagation characteristics of the circuit. If this network or combination of impedances was associated directly with the line section and was of an impedance value other than that of the line
95 section itself, there would be reflection losses introduced which might interfere with the desired action in the circuit. Accordingly the line L_1 is terminated in the impedance 1. If it is desired to obviate
100 reflection losses the impedance 1 may be made approximately equal to the impedance of line L_1 itself. In some instances it may not be desirable to entirely obviate reflection losses in the circuit and other reasons
105 may make it desirable to terminate the line L_1 in an impedance of a value other than that of the line L_1 itself. Accordingly the impedance value of element 1 is not fixed by this invention as of a value equal to that
110 of the line L_1 , but may be of any desired

value, and the line L_1 may thus be terminated in any desired manner. Bridged across line L_1 is shown the input circuit of an amplifier, terminating in the grid and filament of the vacuum bulb A_1 . The impedance presented between the grid and filament of the bulb may be made sufficiently high so that the input circuit, when bridged across line L_1 , will have a negligible effect on the flow of current over the line L_1 and its terminating impedance 1 and accordingly cause no disturbance in the impedance relation existing between line L_1 and its terminating impedance 1. Included between the output circuit of the repeater amplifier A_1 and the input circuit of another repeater amplifier A_2 is a network or combination of impedances, such as 3, whereby the propagation characteristics of the circuit may be controlled. Such a network might be either a wave filter, or an attenuation equalizer, or any other combination of impedance desirable. The output circuit of amplifier A_2 (or the output circuit of a series of amplifiers and networks if this is found desirable) may then be associated with the line section L_2 . Bridged across the output circuit of the last of the series of amplifiers, such as A_2 , is the resistance 4 which is designed to have a value small as compared to the impedance of the line section L_2 . In the arrangement as illustrated the network or attenuation controlling device, such as 3, will operate between the output impedance of the amplifier A_1 and the input impedance of the amplifier A_2 . As these amplifiers are one-way devices, the association of the network or attenuation controlling device with the line sections in this manner will cause no interaction effects between the apparatus and the line sections. With this arrangement voltage variations may be taken from a line section, such as L_1 , with any desired terminal impedance effect, may be amplified with the desired frequency control, and may be thus applied to another line section, such as L_2 . It is pointed out that in instances where interaction effects between the apparatus and the line L_2 were not involved or where the impedance relation between the apparatus 3 and line L_2 was not of importance the amplifier A_2 and impedance 4 might be omitted and the line L_2 connected directly to apparatus 3.

In Fig. 2 is shown a modification of the invention in which two line sections L_3 and L_4 are interconnected by means of an auxiliary circuit including the amplifiers A_3 and A_4 , between the output and input circuits of which is included an attenuation controlling device 8. The line L_3 is shown as terminating in an impedance element 5 similar to impedance 1 shown in Fig. 1. Included in series with line L_3 is a resistance 6 hav-

ing a value sufficiently small so that it does not affect the flow of currents over line L_3 within the desired degree of approximation. Connected to the line L_3 at the terminal points of resistance 6 is the input circuit of the vacuum bulb amplifier A_3 . Accordingly the voltage taken off across resistance 6, which will be proportional to the current flowing over line L_3 , will be amplified by amplifier A_3 , changed as desired by means of the attenuation device 8, and then impressed upon the input of amplifier A_4 . Included in the output circuit of amplifier A_4 is the resistance 9 which has a value large in comparison with that of line L_4 . For purposes of illustration resistance 9 might be of approximately 10,000 ohms and the line L_4 might be of 500 ohms. Accordingly any variation in the impedance characteristics of line L_4 would not have a very appreciable effect on the total impedance and would cause little disturbance on the electro-magnetic waves transmitted from the amplifier A_4 . In this manner a current, having the desired wave shape is established in line L_4 .

It is pointed out that the values of the impedances of lines L_1 , L_2 , L_3 , L_4 , elements 1, 5, 4 and 9, and networks 3 and 8, are not limited to certain specific values by this invention but may have a variety of values in order to bring about different effects on the currents of the different frequencies, as may be found desirable. Accordingly, in a transmission system which includes a line section over which electromagnetic waves are being received and a line section out over which it is desired to transmit these waves, the arrangements of the invention provide means for accomplishing this result with the following features. The incoming line section may be terminated in any desirable manner. Voltages may then be taken off either across the line section or proportional to the current flowing in the line section without affecting appreciably the currents or voltages flowing in the line section. These voltages may then be amplified and controlled by an impedance network in any desired manner in such a way as to involve no reaction upon the line section impedance. The voltages may then be impressed on the outgoing line section through such impedances as to prevent distortion of the voltage or current, or through any other impedances which might bring about any desired distortion of the voltage or current. Accordingly, while the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:—

1. An outgoing transmission line whose impedance may vary under different conditions, a circuit associated therewith for impressing energy upon said line, means to interconnect said line and said circuit comprising a terminal impedance device, said device being so associated with said line and being so proportioned with respect to the line that the impedance of the combination consisting of the line and said impedance device as viewed from said circuit will not materially differ from the impedance of said device.

2. An outgoing transmission line whose impedance may vary under different conditions, a circuit associated therewith for impressing energy upon said line, means to interconnect said line and said circuit comprising a terminal impedance device, said device being so associated with the line and its impedance being sufficiently different from that of the line that the impedance of the combination consisting of said line and said device as viewed from said circuit will not greatly differ from that of said device.

3. A transmission system including an incoming line section and an outgoing line section, an impedance device for terminating one of said line sections, a circuit for interconnecting said line sections, said circuit being so connected with respect to said line terminating impedance and being so proportioned with respect to said terminating impedance that the impedance of the combination consisting of the terminating impedance and the input impedance of said circuit as viewed from the line will not be greatly different from said terminating impedance alone, a second impedance device for interconnecting said circuit and said outgoing line, said second impedance device being so associated with the outgoing line and

its impedance being so proportioned with respect to that of the line that the impedance of the combination consisting of the outgoing line and said second impedance element as viewed from the interconnecting circuit will not differ greatly from the impedance of said second impedance device considered alone.

4. A transmission system including an incoming line section and an outgoing line section, an impedance device for terminating one of said line sections, a circuit for interconnecting said line sections, said circuit being so connected with respect to said line terminating impedance and being so proportioned with respect to said terminating impedance that the impedance of the combination consisting of the terminating impedance and the input impedance of said circuit as viewed from the line will not be greatly different from the terminating impedance alone, a second impedance device for interconnecting said circuit and said outgoing line, said second impedance device being so associated with the outgoing line and its impedance being so proportioned with respect to that of the line that the impedance of the combination consisting of the outgoing line and said second impedance element as viewed from the interconnecting circuit will not differ greatly from the impedance of said second impedance device considered alone, said interconnecting circuit also including a device for controlling the propagation characteristics of waves transmitted from the incoming line through said circuit to the outgoing line and a one-way device on each side of said last mentioned means.

In testimony whereof, I have signed my name to this specification this 21st day of October, 1919.

OTTO B. BLACKWELL.