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TRANSMISSION REGULATOR SYSTEM

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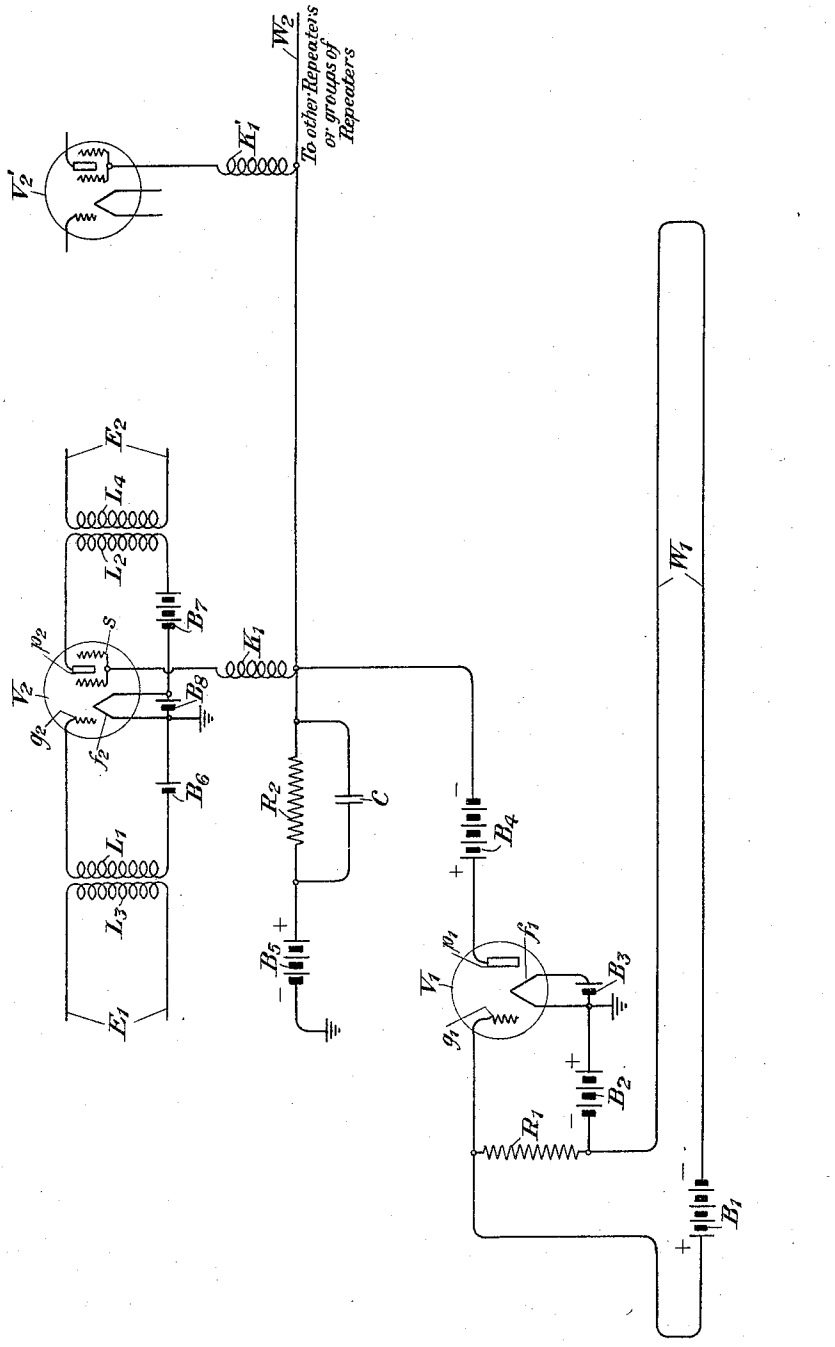

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TRANSMISSION REGULATOR SYSTEM

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This invention relates to signaling systems and particularly to those employing repeaters to adjust the magnitude of transmitted signals. More particularly, this invention relates to arrangements for automatically adjusting the gain of a repeater in order to compensate for variations in the transmission equivalent of one or more conductors forming a circuit when the temperature of these conductors changes under varying atmospheric conditions.

In signaling systems employing cable circuits for the transmission of energy in which amplifiers are located at repeater points for increasing the level of the transmitted energy so as to overcome the attenuation of the conductors, it has been determined that variable temperature is an important factor in changing the effective attenuation of the circuit. At high temperatures, the attenuation is quite large and, conversely, it is low at low temperatures. A pilot wire is often set aside in a cable and this wire forms a circuit which is connected to a repeater so that the gain of the repeater may be changed in accordance with variations in the temperature of the pilot wire. It is the purpose of the arrangement to increase the gain of the repeater when the resistance changes by virtue of an increase in temperature and to decrease its gain with a decrease in temperature.

It is an object of this invention to provide a pilot wire regulating system intended for use with the repeaters of signaling systems to automatically adjust the gain of each repeater so as to take care of temperature changes which bring about variations in the transmission equivalent of the conductors forming the signaling circuit. This object may be carried out with the apparatus shown in the drawing, details of which will now be described.

Referring to the drawing, the reference character W_1 designates two conductors forming a cable pair or circuit. Such a pair or circuit is known as a "pilot wire". It may be said of this pilot wire, as well as of each of the other conductors of the cable, that its resistance changes in accordance with temperature. It is well known that an increase in temperature causes an increase in the transmission loss and, conversely, a decrease in temperature causes a decrease in the transmission loss.

The pilot wire W_1 is connected in a series circuit which includes a battery B_1 and a resistance R_1. It will be apparent that as the temperature of the pilot wire increases, its resistance increases and, consequently, the flow of current from battery B_1 through the resistance R_1 will decrease. Conversely, a decrease in temperature will cause a greater flow of current from battery B_1 through the resistance R_1.

A vacuum tube designated V_1 includes three electrodes, a grid electrode g_1, a plate electrode p_1 and a filament electrode f_1. The grid electrode is connected to the filament electrode through the resistance R_1 and a battery B_2. A battery B_3 is connected across the filament electrode f_1 and one side of this battery is grounded. The plate electrode p_1 and the filament electrode f_1 are connected in a circuit which includes, in addition to these elements, a battery B_4, a resistance R_2, a battery B_5 and ground. The resistance R_2 is shunted by a condenser C.

The reference character V_2 designates a vacuum tube which includes four elements, a plate electrode p_2, a filament electrode f_2, a grid electrode g_2 and a screen grid electrode s. The grid electrode g_2 is connected to the filament electrode f_2 through a winding L_1 and a battery B_6, this battery being employed for biasing the grid electrode g_2 at a suitable negative potential with respect to the filament electrode f_2. The plate electrode p_2 is connected to the filament electrode f_2 through a winding L_2 and a battery B_7, the battery B_7 providing a suitable positive potential for the plate electrode p_2. The filament f_2 is connected to a battery B_8, one terminal of which is grounded. The screen grid electrode s is connected to the negative terminal of battery B_4 through a choke coil K_1. This screen grid electrode may be maintained at a positive potential and the magnitude of this positive potential may be changed in order to correspondingly vary the gain of the vacuum tube V_2. The manner in which the

gain of the vacuum tube may be controlled will be described in greater detail hereinafter.

A winding L_3 is connected to a source of signals E_1 and the signals that reach the winding L_3 may be of the voice frequency type or carrier current modulations corresponding to voice frequency signals or of any other type. Windings L_1 and L_3 are inductively related to each other and the winding L_1 transmits the currents impressed upon the winding L_3 through the circuits associated with the vacuum tube V_2 to a winding L_4. The winding L_4 is inductively related to winding L_2 and, moreover, it transmits the signals amplified by the vacuum tube V_2 to an output circuit E_2.

The degree of amplification of the vacuum tube V_2 is determined by the relative potential of its screen grid electrode *s*. As the positive potential of the screen grid electrode increases, the amplification of the vacuum tube will increase and upon a decrease in the positive potential of the screen grid electrode *s*, the amplification of the tube will be correspondingly decreased. Thus, it will be apparent that the gain in the signals transmitted from the source E_1 to the circuit E_2 may be changed by any desired amount merely by the control in the size of the potential impressed upon the screen grid electrode *s*.

Under normal conditions of temperature, the flow of current from battery B_1 through resistance R_1 will produce a potential difference across resistance R_1 which opposes the voltage established by the battery B_2. Under normal conditions, the voltage of the battery B_2 is greater than the potential difference across the resistance R_1 and the difference between these voltages determines the negative potential impressed upon the grid electrode g_1 of the vacuum tube V_1 with respect to the filament electrode f_1 of that tube. The vacuum tube V_1 is operated on the straight line portion of its plate current-grid voltage characteristic curve in order that any change in the effective potential of grid electrode g_1 will cause a corresponding change in the thermionic emission between the filament electrode f_1 and the plate electrode p_1 of the tube V_1. When there is a decrease in the temperature of the pilot wire W_1, the potential difference determined by resistance R_1 will be increased and, therefore, the flow of current in the plate circuit of the tube V_1, which has been described hereinabove, will be increased. Similarly, an increase in temperature will decrease the potential difference across resistance R_1, correspondingly increasing the negative potential of the grid electrode g_1 of the tube V_1 with respect to its filament electrode f_1 and correspondingly decreasing the flow of current in the plate circuit of the tube V_1.

So, it will be seen that the flow of current through the resistance R_2 which is in the plate circuit of the vacuum tube V_1 changes in accordance with the temperature of the pilot wire W_1. An increase in temperature brings about a decrease in the current flowing through resistance R_2 and a decrease in temperature produces an increase in the flow of current through resistance R_2.

The screen grid electrode *s* of the vacuum tube V_2 is connected in series with choke coil K_1, resistance R_2, battery B_5 and ground. The battery B_5 and the magnitude of the current flowing through the resistance R_2 determine the effective potential of the screen grid electrode *s*. When the current flowing through resistance R_2 increases as a result of a decrease in the temperature of the pilot wire W_1, the potential difference established by resistance R_2 will be increased and the potential of the screen grid electrode *s* will be dropped below its normal value. Similarly, a decrease in the flow of current through resistance R_2 as a result of an increase in the temperature of the pilot wire W_1, will increase the positive potential of the screen grid electrode *s* above its normal value. Thus, the gain of the repeater which includes the vacuum tube V_2 will be increased when the temperature of the pilot wire increases and the gain will decrease as the temperature of the pilot wire decreases.

The screen grid electrode of another vacuum tube V'_2 is connected in series with the resistance R_2, battery B_5 and ground. The gain of the repeater which includes this vacuum tube will be effected by temperature changes of the pilot wire W_1 in the same manner as the repeater which includes the vacuum tube V_2 is effected. The conductor W_2 may extend to other repeaters or groups of repeaters.

The choke coil connected in series with each screen grid electrode is employed to prevent alternating currents from being impressed upon these electrodes. These choke coils together with the condenser C substantially eliminate crosstalk between repeaters.

The repeater regulating system employed in this invention is automatic in operation and has a great many advantages over those regulating systems known in the art. It employs no relays or moving parts and, consequently, there can be no trouble due to the sticking of contacts or due to dirty or corroded contacts. The complete absence of moving parts eliminates mechanical difficulties. Moreover, changes in the gain of the repeaters are made gradually and not step by step. Furthermore, the cost of installation as well as the cost of maintenance will be considerably smaller than that of any repeater regulating arrangement now used in the art.

While this invention has been shown in a certain particular arrangement merely for the purpose of illustration, it will be under-

stood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A gain control system including a first tube having plate, filament and grid electrodes, a second tube having the same electrodes as the first tube and in addition a screen grid electrode, a first resistance, first and second sources of direct current potential connected in series with said first resistance between the plate and filament electrodes of the first tube, the screen grid electrode of the second tube being connected to the plate electrode of the first tube through the second source of direct current potential, a second resistance connected between the grid and filament electrodes of the first tube, and a source supplying direct current potentials which vary in accordance with temperature, the latter source being connected in series with said second resistance.

2. A gain control system including a first tube having plate, filament and grid electrodes, a first resistance connected between the grid and filament electrodes of said tube, a second vacuum tube having plate, filament, grid and screen grid electrodes, the filament electrodes of both tubes having a common connection, an input circuit connected between the grid and filament electrodes of said second tube, an output circuit connected between the plate and filament electrodes of said second tube, the screen grid electrode of the second tube being connected to the plate electrode of the first tube, a second resistance, a source of potential connected in series with said second resistance and the plate and filament electrodes of the first tube, and a pilot wire connected in series with the first resistance.

3. A gain control system for a plurality of repeaters each of which includes a tube having plate, filament, grid and screen grid electrodes, including a three-element tube having plate, filament and grid electrodes, a first resistance connected between the plate and filament electrodes of said three-element tube, all of the screen grid electrodes being connected to the filament electrode of said three-element tube through said first resistance, a second resistance connected between the grid and filament electrodes of said three-element tube, a pilot wire, and a source of potential connected in series with said pilot wire and said second resistance.

In testimony whereof, I have signed my name to this specification this 4th day of March, 1930.

THOMAS D. DUTTON.