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TRANSMISSION SYSTEM

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FIG. 1

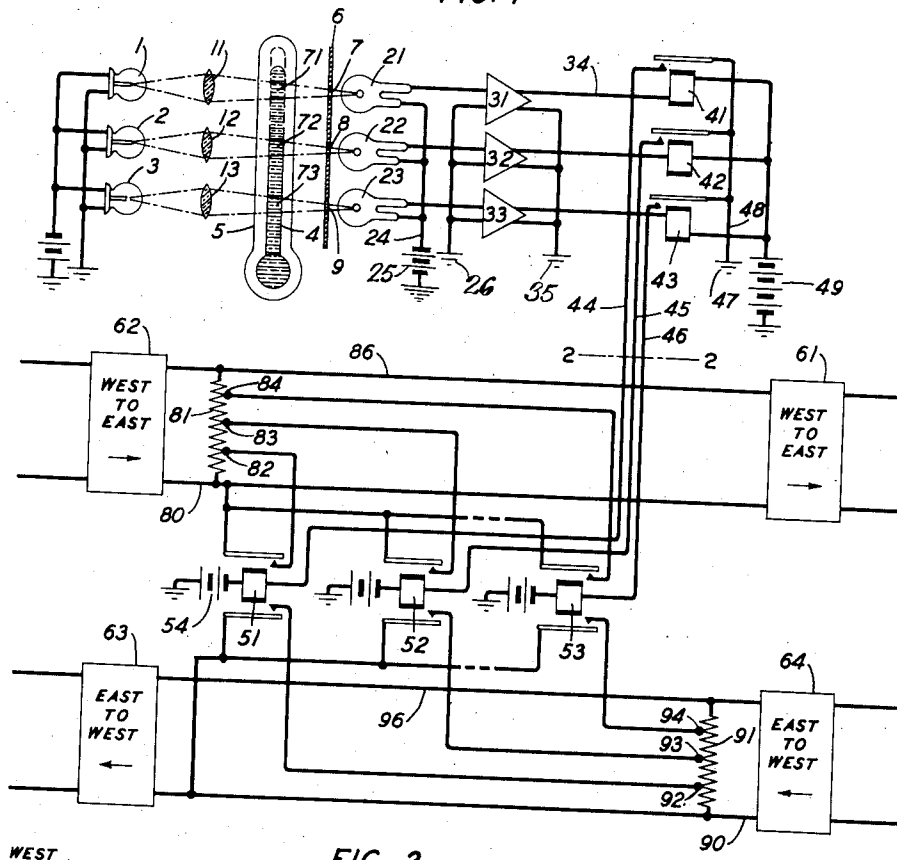
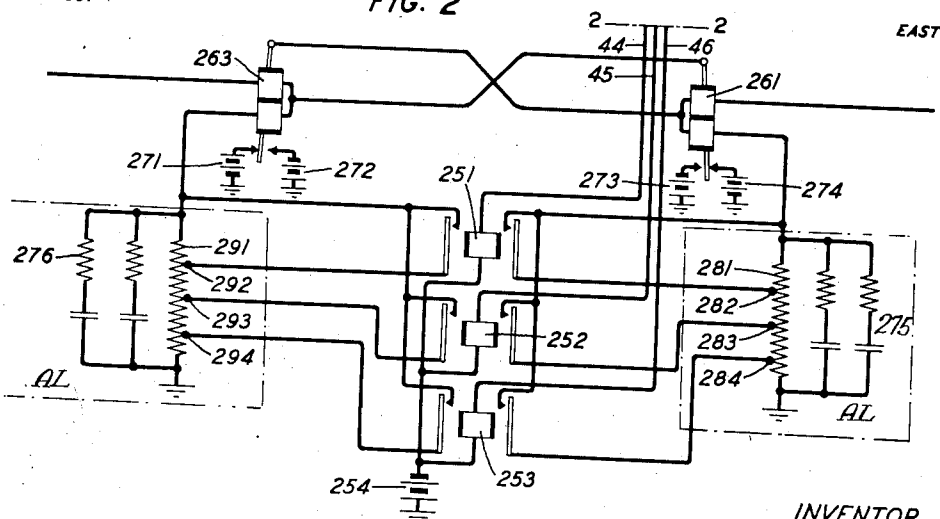


FIG. 2



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TRANSMISSION SYSTEM

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2 Claims. (Cl. 178—69)

This invention relates to means for automatically actuating electric relays by temperature changes and, more particularly, to means for changing the electrical characteristics of a balancing network in accordance with variations in temperature. The invention is capable of wide application and may be used on such apparatus as open-wire telephone lines. Also, in a telegraph cable, having repeaters connected into the cable at spaced intervals, the invention can be used as a regulator for causing the ohmic resistance balances of the repeaters to be raised or lowered by an amount necessary to compensate for the effect of resistance changes in the cable.

Many forms of apparatus, such as open-wire telephone lines, are subject to variations in temperature which cause transmission changes in the line circuits. These transmission changes may be very large even in the course of only one day due to the direct effect of the sun's rays. Therefore, in order to maintain uniform transmission in transmission systems under varying temperature conditions, some type of regulator must be employed.

Accordingly, it is an object of this invention to provide means for automatically actuating electric relays in response to temperature changes whereby the electrical characteristics of a balancing network will be changed to accord with the changes in the electrical characteristics of the real line caused by variations in temperature.

Another object of this invention is to provide control means for causing the impedance of local transmission equipment to correspond with the impedance of a transmission line connected to the local equipment.

Broadly speaking, the invention may be embodied in an electric circuit including a source for emitting a beam of light, a photoelectric cell, and a thermo-responsive instrumentality, such as a mercury thermometer, for effecting a visible indication of variations in temperature. This thermometer is interposed between the source of light and the photoelectric cell and is so located that its mercury column is in the path of the beam of light. As the mercury falls and rises with variations in temperature, the photoelectric cell is energized and deenergized. This energizes a relay, or relays, which controls local circuits for performing whatever functions may be desired, such as to change the resistance component of a balancing network in accordance with variations in temperature.

These and other features of the invention will be described in detail in connection with the description of the accompanying drawing in which:

Fig. 1 represents an application of the invention to a telephone repeater system; and

Fig. 2 represents an application of the invention to a telegraph repeater system.

Fig. 1 shows in diagrammatic form a particular embodiment of the invention including an arrangement of incandescent lamps 1, 2, and 3 associated with suitable lenses 11, 12, and 13, a mercury thermometer 5, photoelectric cells 21, 22, and 23, amplifiers 31, 32, and 33, master relays 41, 42, and 43, network control relays 51, 52, and 53, and associated repeater equipment 61, 62, 63, and 64. Although the drawing shows three lamps, three photoelectric cells and three control circuits, it is to be understood that the invention is not limited to this amount of equipment because the number of lamps, cells, control circuits, etc., may be increased or decreased in accordance with the degree of control desired. All of this equipment is shown to be located at one repeater station of a communication system, but it is to be understood that other repeater stations in the system may be similarly equipped if desired.

In this specific embodiment of the invention, which is shown for purposes of illustration, the bank of lamps 1, 2, and 3 is arranged vertically and the lenses 11, 12, and 13 are associated with lamps 1, 2, and 3, respectively, in such a manner that the lenses 11, 12, and 13 will cause the beams of light from the lamps 1, 2, and 3 to converge on any selected points, such as 71, 72, and 73, respectively, on the thermometer 5. A shield 6 with openings 7, 8, and 9 is interposed between the thermometer 5 and the photoelectric cells 21, 22, and 23 in order to restrict the beams of light to their respective photoelectric cells.

Opposite the points 71, 72, and 73 on thermometer 5 are located photoelectric cells 21, 22, and 23, respectively. In the circuits through the photoelectric cells 21, 22, and 23, are amplifiers 31, 32, and 33 and master relays 41, 42, and 43.

The mercury column 4 of thermometer 5 is adapted to interpose itself between the beams of light from the lamps 1, 2, and 3, and the photoelectric cells 21, 22, and 23. The beams of light from lamps 1, 2, and 3 cannot pass through the mercury column 4 of thermometer 5. Consequently, the photoelectric cells 21, 22, and 23 will not be energized as long as the mercury column 4 is interposed between the points 71, 72, 55

and 13. When a drop in the surrounding temperature causes the mercury column 4 of thermometer 5 to be lowered in the usual manner sufficiently to be below point 71 on thermometer 5, the beam of light from lamp 1 will pass through the thermometer 5, through opening 7 in screen 6, and will converge on photoelectric cell 21.

Photoelectric cell 21 will become energized and will function in the usual manner to cause current to flow from battery 25, over conductor 24, through cell 21, amplifier 31, and then to ground 26. This, in turn, causes current to flow in the control circuit traced from battery 49, relay 41, conductor 34, amplifier 31, and then to ground 35, thereby operating relay 41. Operation of relay 41 closes a circuit from ground 47, conductor 48, armature of relay 41, conductor 44, relay 51, and then to battery 54 thereby energizing relay 51. Relay 51 will operate its armatures and will short-circuit a bottom portion of resistance 81 at point 82. At the same time, relay 51 will short-circuit a bottom portion of resistance 91 at point 92. Thus, the gains of the repeating equipment 61, 62, 63, and 64 will be lowered to compensate for the effect of changes in the resistance of the line.

If a decrease in temperature causes the mercury column 4 of thermometer 5 to fall below point 72 on thermometer 5, the beam of light from lamp 2 will be focused by lens 12 on photoelectric cell 22. This will energize cell 22 and will cause its associated control circuit to function in the manner described above for photoelectric cell 21. Current through this second control circuit will cause relay 42 to operate thereby causing relay 52 to become energized. The operation of the armature of relay 52 will shunt out an additional section in both resistances 81 and 91 at points 83 and 94, respectively. This further lowers the gains of the repeaters to correspond with the decrease in the line resistance. It is to be kept in mind that relays 41 and 51 remain operated during the entire time that relays 42 and 52 are operated.

As the temperature drops still lower, photoelectric cell 23 will be energized by light from lamp 3 and will cause its associated control circuit to function as described above for photoelectric cells 21 and 22. Current through this third control circuit will energize relay 43 which will cause relay 53 to become energized. The operation of the armatures of relay 53 will shunt out an additional section of resistances 81 and 91 at points 84 and 94, respectively.

During the time that relays 43 and 53 are operated, relays 41, 42, 51, and 52 will also be operated. However, this condition causes no inconvenience.

As the temperature rises and causes the mercury column 4 of thermometer 5 to rise, the mercury column 4 will be interposed between lamp 3 and photoelectric cell 23 and cell 23 will be deenergized. When the photoelectric cell 23 is deenergized, current in the control circuit through relay 43 is reduced thereby causing relay 43 to become deenergized. Relay 42 will now release its armature thereby opening the energizing circuit for relay 53 which will release its armatures. This opens the shunt around the top sections of the resistances 81 and 91 thereby increasing the resistance in the circuits through east to west repeaters 63 and 64 and through west to east repeaters 61 and 62.

As the mercury column 4 continues to rise, photoelectric cells 22 and 21 will each be deenergized in turn and will cause the relays 42 and 41

to become deenergized. Release of relays 42 and 41 will open the energizing circuits of relays 52 and 51, respectively, and thereby remove the shunts around additional sections of resistances 81 and 91. This results in further increases in resistance in the circuits through east to west repeaters 63 and 64 and through west to east repeaters 61 and 62, thereby causing the gains of the repeater equipment to fluctuate with the line resistance.

Fig. 2 represents the application of the invention to a telegraph repeater system. It employs the same lamps 1, 2, and 3, lenses 11, 12, and 13, thermometer 5, photoelectric cells 21, 22, and 23, amplifiers 31, 32, and 33, master relays 41, 42, and 43, and conductors 44, 45, and 46 leading from the master relays 41, 42, and 43. In other words, the arrangement shown in Fig. 2 is the same as that shown at the top of Fig. 1 down to the dotted line 2-2. Below the line 2-2, the apparatus for this application of the invention is different from that shown in Fig. 1. Accordingly, this different apparatus is shown in Fig. 2.

In Fig. 2, the repeating relay 263 is used for repeating west to east communication and repeating relay 261 is used for repeating east to west communication. Relays 251, 252, and 253 are comparable to relays 51, 52, and 53 shown in Fig. 1 and perform approximately the same functions. Resistances 281 and 291 are comparable to resistances 81 and 91 shown in Fig. 1 and serve about the same purpose.

Upon the transmission of signals from west to east, the signals will follow two paths. One path leads through the top winding of relay 263, armature of relay 261, either battery 273 or 274, and then to ground. The other path also leads through the top winding of relay 263, but then passes through the lower winding of relay 263, artificial line, or balancing network, 276, and then to ground. In passing through the winding of relay 263, the west to east signals will cause the armature of relay 263 to follow the significant current variations employed for signal transmission. The armature of relay 263 will accordingly connect current from first battery 271 and then battery 272 to the line leading from the armature of relay 263 to relay 261. Here the current will divide, one portion passing through the lower winding of relay 261 and then through the artificial line, or balancing network, 275 to ground. The other portion of current will pass through the top winding of relay 261 and then over the line to the east station.

To prevent the armature of relay 261 from following any of these signals it is necessary that the impedance of the artificial line 275 balance the impedance of the real line leading to the east station. Since the impedance of the real line will vary with variations in temperature, it is necessary that the impedance of the artificial line be caused to be correspondingly varied. Therefore, when the temperature begins to fall, photoelectric cell 21 will be energized and will, in turn, cause relay 41 to be energized. Relay 41, in operating, will close a path for current from battery 254 to pass through relay 251, over conductor 44, over the armature of relay 41, and then to ground 47. This causes relay 251 to operate its armatures thereby shunting out a top section of resistances 281 and 291 at points 282 and 292, respectively. This causes the impedance of the balancing networks 275 and 276 to be varied to correspond with the impedance of the real lines.

When the temperature falls still further, photoelectric cell 22 will be energized and will operate relay 42 which, in turn, will operate relay 252 in a manner similar to that in which relay 251 was operated. Relay 252 will operate its armature and shunt out at points 283 and 293, respectively, additional sections of resistances 281 and 291 in the artificial lines 275 and 276 thereby changing their resistance components.

This procedure will also be followed when the temperature goes down to a point low enough to enable photoelectric cell 23 to be energized. Then relay 253 will be energized in a manner similar to that in which relay 251 was energized. When relay 253 operates its armatures, it shunts out at points 284 and 294, additional sections of resistances 281 and 291, thereby further reducing the resistance of the balancing networks 275 and 276.

This procedure will be followed in the same manner for east or west communication except that here the significant current variations will come in through the top winding of relay 261 and will pass to the armature of relay 263. Relay 261 will follow the significant current variations and will cause its armature to be shifted so as to apply current from either battery 273 or battery 274 to the line. Current from batteries 273 and 274 will pass over the armature of relay 261, through the top winding of relay 263, and then out to the west station. In this case, it is intended that the armature of relay 263 shall not follow these signals. Accordingly, it is necessary that the impedance of the artificial line 276 be varied to correspond with the impedance of the real line leading to the west station. This can be done in a manner similar to that described above for varying the impedance of the artificial line 275 for west to east communication.

The above specific embodiments have been shown and described in order to illustrate the invention. It is to be understood that various changes and modifications may be made without departing from the scope of the invention

which is to be limited only by the claims appended hereto. For example, the number of photoelectric cells may be increased or decreased. Also, the balancing networks can be reversed, if desired, so that they will add resistance when the temperature goes down.

What is claimed is:

1. A control device comprising in combination a plurality of photo-sensitive instrumentalities, a plurality of sources of light, means for focusing the rays of light from the plurality of sources upon the photo-sensitive instrumentalities, the light from each source being focused upon a different photo-sensitive instrumentality, a thermoresponsive instrumentality interposed in the path of the rays of light for determining which of the photo-sensitive instrumentalities will be energized for a given temperature condition, a plurality of switching relays having energizing circuits, and a plurality of control relays for selectively opening and closing said energizing circuits, said control relays being operatively responsive to the energization of the photo-sensitive instrumentalities.

2. A control device for controlling a balancing network having a variable resistance, said control device including in combination a bank of photoelectric cells, a bank of incandescent lamps for illuminating the photoelectric cells, a thermometer having an opaque mercury column interposed between the photoelectric cells and the incandescent lamps, means for converging the light from each of the lamps upon selected points on the column of the thermometer, the light from each lamp being focused upon a different point on the column, a plurality of switching relays for varying the resistance of the balancing network, energizing circuits for energizing the switching relays, and a plurality of control relays for selectively opening and closing said energizing circuits, said control relays being operatively responsive to the energization of the photoelectric cells by the light from the lamps.

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