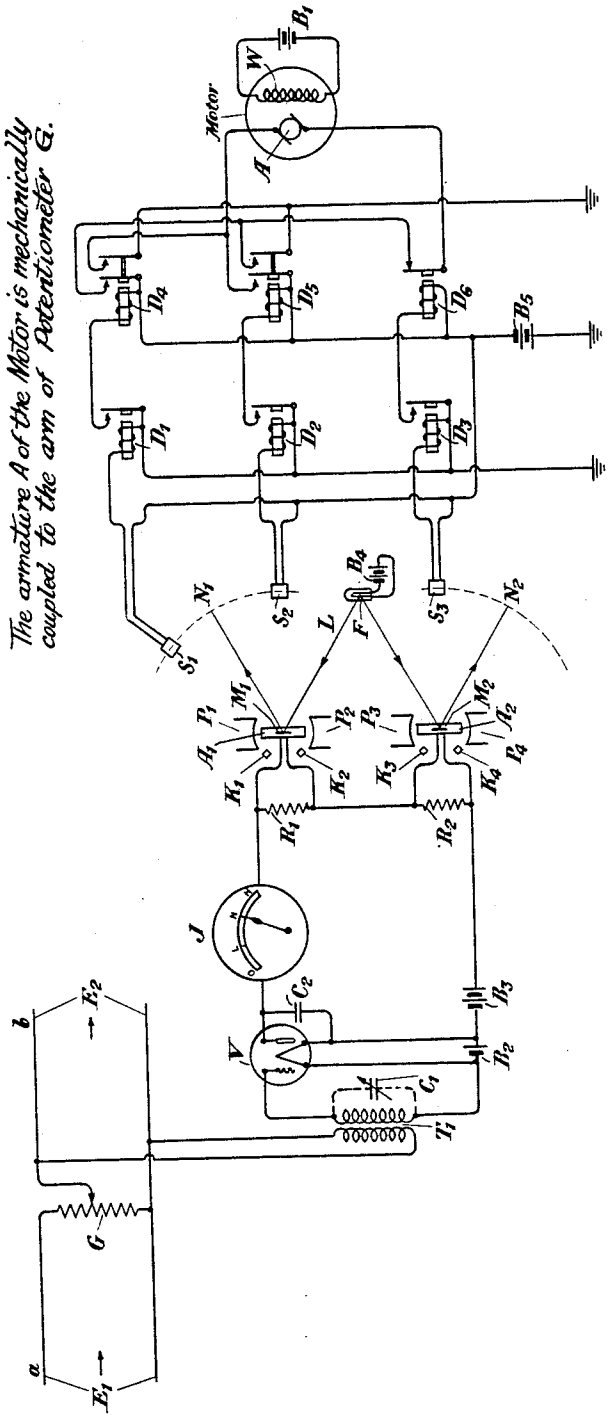
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ENERGY CONTROL ARRANGEMENT

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ENERGY CONTROL ARRANGEMENT

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This invention relates to signaling systems, and particularly to transmission systems employing devices for automatically controlling the energy levels therein.

Circuits for the transmission of voice frequency signals, such as telephone circuits or the like, may undergo variations in attenuation due, for example, to weather changes. Corrections must be applied to such circuits in order to maintain the circuit equivalents substantially constant. One form of regulating circuit for applying the desired corrections may consist of one or more light valves of, for example, the selenium type. Such valves normally exhibit a high impedance in darkness and yet they undergo a substantial change in impedance when exposed to light. Accordingly, such valves may be arranged to increase or decrease the quantity of the energy flowing in a signaling system as conditions necessitate.

Accordingly, it is one of the objects of this invention to provide two light cells, either of which may be exposed to light in order to undergo a substantial change in impedance, to thereby regulate the energy flowing through a transmission circuit.

It is another object of this invention to couple the energy adjusting means of a transmission circuit to an electrical motor so that when either of two light valves become energized, the motor may be set into rotation in one direction or in the other to correspondingly vary the energy adjusting means.

It is a further object of this invention to pick up a small portion of the energy flowing from an input circuit into an output circuit, which are interconnected by an energy adjusting means, to rectify the energy so picked up and cause that energy to operate one light control valve or another, to accordingly revolve the armature of a motor in one direction or in the other, and to thereby cause the energy adjusting means to be correspondingly varied.

While this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, an input circuit E_1 is shown connected to an output circuit E_2 through an energy adjusting means G which may, for example, be a potentiometer, as shown. Alternating current which may be transmitted for the purpose of actuating the adjusting mechanism will flow from the input circuit E_1 to the output circuit E_2 in the direction indicated by the arrows. In this invention, the level of the energy of this current in the input circuit may vary within certain limits and it is desired to keep the level of this energy as applied to the output circuit within small limits of variation, preferably by automatic means. The potentiometer or energy adjusting means may have sufficient range of variation on manual adjustment to effect by the level of the energy flowing into the output circuit E_2, but in this invention means will be provided for automatically changing the position of the potentiometer or energy adjusting means G in accordance with changes in the level of energy flowing in the transmission circuit.

A motor having an armature A and a field coil W is so related to the system that armature A may be caused to rotate in one direction or in the other as found desirable. The field coil W of the motor is supplied with current from a source B_1 which may be of the alternating current type as well as of the direct current type as shown. The armature A of this motor is mechanically coupled to the movable arm of the potentiometer G, preferably through a train of gears (not shown). Thus, when the armature A rotates in one direction, the energy passing through the potentiometer G may be increased and when the armature rotates in the opposite direction, the energy passing through potentiometer G may be decreased. A small portion of the current transmitted to the output circuit E_2 is applied to the primary winding of a transformer T_1, the impedance of the primary winding being preferably substantially high to thereby limit the

amount of energy so applied. The current applied to the primary winding of transformer T_1, however, becomes similarly applied to the input circuit of a rectifying device which may, for example, be a rectifier tube of the three-electrode type. This energy is accordingly applied between the grid and filament of a rectifier tube V. The filament of the tube V is heated to an electron emitting temperature by a battery B_2. A condenser C_1, shown in dotted lines, bridges the secondary winding of transformer T_1. Thus, a tuned circuit is provided, including the secondary winding of a transformer T_1 and condenser C_1 which may be employed for selectively applying, between the grid and filament of the vacuum tube V current of the frequency which is to be transmitted for the purpose of actuating the adjusting mechanism, thus separating it from currents of other unwanted frequencies which may also be transmitted at the same time, such as, for example, currents of frequencies directly involved in the transmission of speech. It will be understood, however, that any other rectifying device may be employed instead of vacuum tube V within the scope of his invention.

The plate circuit of the vacuum tube V includes a meter J, resistances R_1 and R_2, a battery B_3 and the filament and plate of the vacuum tube V. This is a direct current circuit. A by-pass for alternating currents is provided by a condenser C_2, shown connected between the plate and filament of vacuum tube V. The meter J of this circuit may have a dial which is graduated to indicate whether the energy flowing through this circuit is normal, high or low. When normal current flows through meter J, its pointer may rest in position N. When current of higher magnitude flows therethrough, the pointer of this meter may reach the H position, and when current lower than normal flows therethrough, this pointer may reach the L position. Thus, when the pointer of this meter is at its N position, the level of the energy in the output circuit E_2 is normal. When the pointer reaches the H position, the apparatus of this invention will be set into operation to cause the potentiometer or energy adjusting means G to be lowered and to accordingly decrease the level of the energy in the output circuit E_2. Conversely, when the pointer of meter J reaches the L position, the apparatus of this invention will be again set into operation, causing the potentiometer or energy adjusting means G to become increased, to thereby increase the level of the energy in the output circuit E_2.

Two galvanometers which may be, for example, of the D'Arsonval type bridge resistances R_1 and R_2. These galvanometers have moving coils A_1 and A_2 interposed between pole pieces P_1 and P_2 and between pole pieces P_3 and P_4, respectively. Mirrors M_1 and M_2 are mounted on the respective moving coils A_1 and A_2 and revolve with these moving coils. when the potential drop across resistance R_1 changes, the moving coil M_1 will be rotated. The rotation of the moving coil M_1 may be in a clockwise direction when the potential drop across resistance R_1 increases and in a counter-clockwise direction when this potential drop decreases. Similarly, moving coil A_2 may move in a clockwise direction with an increase in the potential drop across resistance R_2 and in a counter-clockwise direction with a decrease in the potential drop of resistance R_2.

A source of light which may be an electrical lamp is indicated by the reference character F. The filament of this lamp is connected to a battery B_4. Light of source F impinges upon mirrors M_1 and M_2 and if these mirrors are in their normal positions, this light will be reflected therefrom along the lines N_1 and N_2, respectively. A change in the potential across either the resistance R_1 or resistance R_2 will cause the rotation of the corresponding moving coil to effect a corresponding deviation of the reflected light from the associated mirror.

Three light valves or cells are designated by the reference characters S_1, S_2 and S_3. These valves or cells may be of the selenium type, each exhibiting a high impedance in darkness and a substantially lower impedance when exposed to light. Light cell S_1 is positioned so as to be affected by the reflected beam of light from mirror M_1 when this mirror rotates in a counter-clockwise direction. Light cell S_2 is acted upon by reflected light when mirror M_2 is rotated through a predetermined angle in the clockwise direction. Similarly, cell S_3 becomes exposed to reflected light when mirror M_2 is rotated in a counter-clockwise direction. The windings of relays D_1, D_2 and D_3 are connected to the light cells S_1, S_2 and S_3, respectively. Each winding remains deenergized until the corresponding light cell has become exposed to light of source F reflected by one of the mirrors. Relays D_4, D_5 and D_6 are associated with relays D_1, D_2 and D_3, respectively, each of these relays becoming operative when the winding of the associated relay has become energized due to the action of the associated light cell.

When the level of the energy in the input circuit E_1 decreases from its normal value, the magnitude of the rectified current will also decrease. The pointer of meter J will move to the left of position N, thereby indicating the magnitude of the difference between the normal current in the input circuit E_1 and its value at the time of measurement. The potential drops of resistances R_1 and R_2 will become decreased and will affect the rotation of mirrors M_1 and M_2 in a counter-

clockwise direction, the angle of rotation being proportional to the difference between the normal current which may flow through the input circuit E_1 and the current which flows through that circuit at the time of measurement. If the rotation of the mirror M_1 in a counter-clockwise direction is great enough to cause the beam of reflected light to fall upon light cell S_1, this cell will undergo a substantial change in impedance, causing the energization of the winding of relay D_1, current flowing through the winding of relay D_1 from a battery B_5. The armature of relay D_1 will accordingly become attracted, causing the operation of relay D_4, current flowing through the winding of D_4 from battery B_5. The two armatures of relay D_4, which are mechanically coupled, are so connected to the armature A of the motor as to close a circuit to cause its rotation. Thus, current flows from the battery B_5 through one of the armatures of relay D_4, through the armature of relay D_6, armature A of the motor, the second armature of relay D_4 and ground. Due to the coupling of armature A of the motor and the potentiometer or energy adjusting means G, the rotation of armature A in the proper direction will cause an increase in the energy flowing through the potentiometer or energy adjusting means G. The armature A of the motor will continue to rotate until the current rectified by the vacuum tube V is increased sufficiently to cause the rotation of mirror M_1 by the amount necessary to remove the reflected beam of light from light valve S_1. When the reflected light is removed from cell S_1, its resistance will increase substantially and the current flowing therethrough and through the winding of relay D_1 will be insufficient to maintain it operated, whereupon the armature of relay D_1 will become released. Thereupon, the armatures of relay D_4 will become released and the armature A of the motor will fail to continue in rotation.

In order to prevent the moving coil A_1 of the galvanometer associated with resistance R_1 from rotating so far in a counter-clockwise direction due to an exceedingly large decrease in the level of the alternating current in the input circuit E_1 so that the reflected beam of light may pass beyond light cell S_1, a mechanical stop, such as K, may be provided, in such a position that the maximum rotation of the counter-clockwise direction of the armature A_1 will cause the beam of reflected light to fall upon light cell S_1 and to remain in that position.

If, on the other hand, the level of the energy in the input circuit E_1 increases beyond its normal value, the magnitude of the rectified current will increase, thereby increasing the indication at meter J. Armatures or moving coils A_1 and A_2 of the respective galvanometers will be rotated in clockwise direction. Thus, armature A_1 may rotate sufficiently to cause the reflected beam of light to illuminate light cell S_2. Light cell S_2 then undergoes a substantial change in impedance, causing the operation of relay D_2. Attraction of the armature of relay D_2 will cause the operation of relay D_5 and will thereby cause the armature A of the motor to rotate in the opposite direction. Consequently, the potentiometer or energy adjusting means which is coupled to the armature A of the motor will be moved in the proper direction to decrease the energy level at the output circuit E_2. The armature A of the motor will continue to rotate until the magnitude of the rectified current approaches its normal value, reflected light being then deviated so as to cease to illuminate light cell S_2. Accordingly, the impedance of light cell S_2 will become greatly increased, causing the release of relay D_2 as well as relay D_5 and stopping the rotation of armature A of the motor. To prevent an excessive rotation of the moving coil A_1 in a clockwise direction a stop K_2 may be provided, reflected light impinging upon light cell S_2 while moving coil A_1 remains fixed against stop K_2.

The H and L positions on meter J indicate the limits at which the armature A of the motor is started in rotation in the process of readjusting the energy flowing through the potentiometer G. These limits correspond to a definite magnitude of resistance shunting the moving winding, such as A_1, of one of the associated galvanometers. These limits also correspond to a certain tension in the spring holding the moving armature of each galvanometer in a proper position in equilibrium against the torque produced by the flow of current therethrough. Obviously, these limits may be made wide or narrow, as found necessary, by changing both the value of the resistance in shunt with each galvanometer and the tension of the spring at the galvanometer. Thus, if these limits are to be made wider, the magnitude of the resistance R_1 should be decreased as well as the tension of the spring at the galvanometer. A decrease in the magnitude of the resistance R_1 causes the application of a smaller potential drop to the galvanometer, resulting in the production of a smaller torque, which requires a reduced spring tension to establish a balance of the galvanometer in the normal position, and resulting further in the necessity for a larger change in rectified current to be sufficient to illuminate one or the other of the light cells. Obviously, if these limits are to be made narrower, the magnitude of the resistance R_1 should be increased as well as the tension of the spring at the moving coil A_1 of the associated galvanometer.

The second galvanometer shunting resist-

ance R_2 is provided to render the adjusting mechanism inoperative when the rectified current falls greatly below the normal value. Thus, when the level of the energy in the input circuit E_1 decreases, the armatures A_1 and A_2 rotate in a counter-clockwise direction, as has been mentioned herein above. Resistance R_2 may, however, be smaller in magnitude than resistance R_1. Accordingly, armature A_2 will be less sensitive than A_1 and will move more slowly. The sensitivity of armature A_2 may be adjusted so that the beam of light reflected from M_2 will not fall upon light cell S_3 until the rectified current has dropped to a predetermined low value. Such a great drop in the rectified current may be due to a change in the level of the energy of the transmission circuit so suddenly as to prevent correction by the energy adjusting means in the usual manner. Such a steep drop in the rectified current may also be due to the fact that the energy level at the transmission circuit has fallen beyond the point where a correction may conveniently be applied. When the light cell S_3 becomes illuminated, relay D_3 will become operated, its armature attracted, causing the operation of relay D_6. The attraction of the armature of relay D_6 opens the circuit in series with the motor so that the armature A cannot be started in rotation. When this occurs, the armature A of the motor cannot start in rotation even though the light cell S_1 has become exposed to reflected light.

A light cell of the selenium type may be made by depositing light-sensitive selenium upon a considerable length of two wires connected in parallel, thus creating numerous paths in parallel from wire to wire through the selenium. The wires may of course be wound in such a manner as to confine the cell to dimensions of convenient proportions. The sensitivity of such a cell, that is, the ratio of its conductivity when exposed to light to its conductivity in darkness, depends among other things, on certain processes employed in its manufacture. It is to be understood, however, that any other light cell, as, for example, a photoelectric cell, may be employed in this invention instead of the selenium cell or that any other device may be employed instead of the selenium cell described herein, particularly if that device undergoes a substantial change in impedance when exposed to light, within the scope of this invention.

While this invention has been pointed out in one particular embodiment merely for the purpose of illustration, it is to be distinctly understood 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. The combination of a source of current of varying amplitude, a mirror which reflects incident light at an angle corresponding to the difference in amplitudes between the instantaneous value of the current of said source and an arbitrary and predetermined value, a first light cell which undergoes a substantial change in impedance when the reflected light makes a predetermined angle with respect to the incident light in a clockwise direction, a second light cell which similarly undergoes a substantial change in impedance when the reflected light makes a different predetermined angle with respect to the incident light in a counter-clockwise direction, a motor, means for rotating the motor in one direction when the first light cell is acted upon, means for rotating the motor in the opposite direction when the second light cell is acted upon, and a gain control device associated with said source of current whose gain may be changed a predetermined amount in accordance with the rotation of said motor.

2. The combination of two mirrors, means for revolving said mirrors, a source of light transmitting a beam simultaneously incident upon said mirrors, three selenium cells each of which may be energized when light of said source is reflected thereupon, one cell being energized when the first mirror revolves through a predetermined arc in one direction, the second cell being energized when the first mirror revolves in the opposite direction through a predetermined arc, the third cell being energized when the second mirror revolves through a predetermined arc in the first-mentioned direction.

3. In a signaling system, the combination of a source of light, a mirror receiving a beam of light from said source, two light sensitive cells on opposite sides of the normally reflected beam of light, a source of signaling energy the level of which may vary, means for rectifying a portion of the said signaling energy, a resistance through which the rectified current may flow, and means coupled to said resistance and responsive to an increase in the level of the rectified current by a predetermined amount to rotate the mirror in one direction and cause a substantial change in the impedance of one of the light cells, said means being also responsive to a decrease in the level of the rectified current by a predetermined amount to rotate the mirror in the opposite direction and cause a substantial change in the impedance of the other of the light cells.

4. The combination of a source of light, a mirror upon which falls the light of said source, two light responsive devices on opposite sides of the beam of light reflected by said mirror, each light responsive device undergoing a substantial change in resistance

when the reflected beam of light falls thereon, a transmission circuit in which the level of the energy transmitted therethrough may vary, a vacuum tube device for rectifying a portion of the energy of said transmission circuit, means responsive to an increase in the level of the rectified energy above a predetermined limit to rotate the mirror in one direction and throw the reflected beam of light upon one of the light responsive devices, means responsive to a decrease in the level of the rectified energy below a predetermined limit to rotate the mirror in the opposite direction so as to throw the reflected beam of light upon the other of the responsive devices, a motor, and means to rotate the motor in one direction or the other in response to a change in the resistance of one light responsive device or the other.

5. The combination of a source of light, a mirror receiving a beam of light from said source, two light cells on opposite sides of the beam of light reflected by said mirror, each light cell undergoing a substantial change in impedance when the reflected beam falls thereon, a source of current of variable amplitude, means for rectifying a portion of the current of said source, means responsive to an increase in the amplitude of the rectified current above a predetermined value to rotate the mirror in one direction so that the reflected beam may fall upon one light cell, means responsive to a decrease in the amplitude of the rectified current below a predetermined value to rotate the mirror in the opposite direction so that the reflected beam may fall upon the other light cell, and a motor which may be rotated in one direction in response to a change in the impedance of one light cell and which may be rotated in the opposite direction in response to a change in the impedance of the other light cell.

6. In a signaling system, the combination of a source of current representing signals the level of which may vary, means for rectifying a portion of the current of said source, a mirror upon which a source of light impinges, means responsive to the rectified current for rotating the mirror through an angle corresponding to the difference in amplitude between the instantaneous value of the rectified current and a predetermined value, a first light cell which substantially changes in resistance when the reflected light makes a predetermined angle with respect to the incident light, a second light cell which also substantially changes in resistance when the reflected light makes a different predetermined angle with respect to the incident light, and means to increase the level of the current emanating from said source when the first light cell changes in resistance and to decrease the level of the current emanating from said source when the second light cell changes in resistatnce.

7. The combination of a source of current of varying amplitude, a potentiometer connected to said source of current to control the level of emitted current, a mirror which reflects incident light at an angle corresponding to the difference in amplitudes between the instantaneous value of the current of said source and an arbitrary and predetermined value, a first light cell which undergoes a substantial change in impedance when the reflected light makes a predetermined angle with respect to the incident light, a second light cell which similarly undergoes a substantial change in impedance when the reflected light makes a different predetermined angle with respect to the incident light, a motor which is coupled to said potentiometer, means for rotating the motor in one direction in response to a substantial change in impedance in the first light cell, and means for rotating the motor in the opposite direction in response to a similar change in impedance in the second light cell.

8. The combination of a source of current of varying amplitude, gain control means connected to said source of current, a mirror which reflects incident light at an angle corresponding to the difference in amplitudes between the instantaneous value of the current of said source and an arbitrary and predetermined value, a first light cell which undergoes a substantial change in impedance when the reflected light makes a predetermined angle with respect to the incident light, a second light cell which similarly undergoes a substantial change in impedance when the reflected light makes a different predetermined angle with respect to the incident light, a motor which is coupled to said gain control means, means responsive to a substantial change in impedance of the first light cell for rotating the motor in one direction, and means responsive to a similar change in impedance of the second light cell for rotating the motor in the opposite direction.

In testimony whereof, I have signed my name to this specification this 24th day of August, 1927.

RUSSELL H. LINDSAY.