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AUTOMATIC REGULATING ARRANGEMENT

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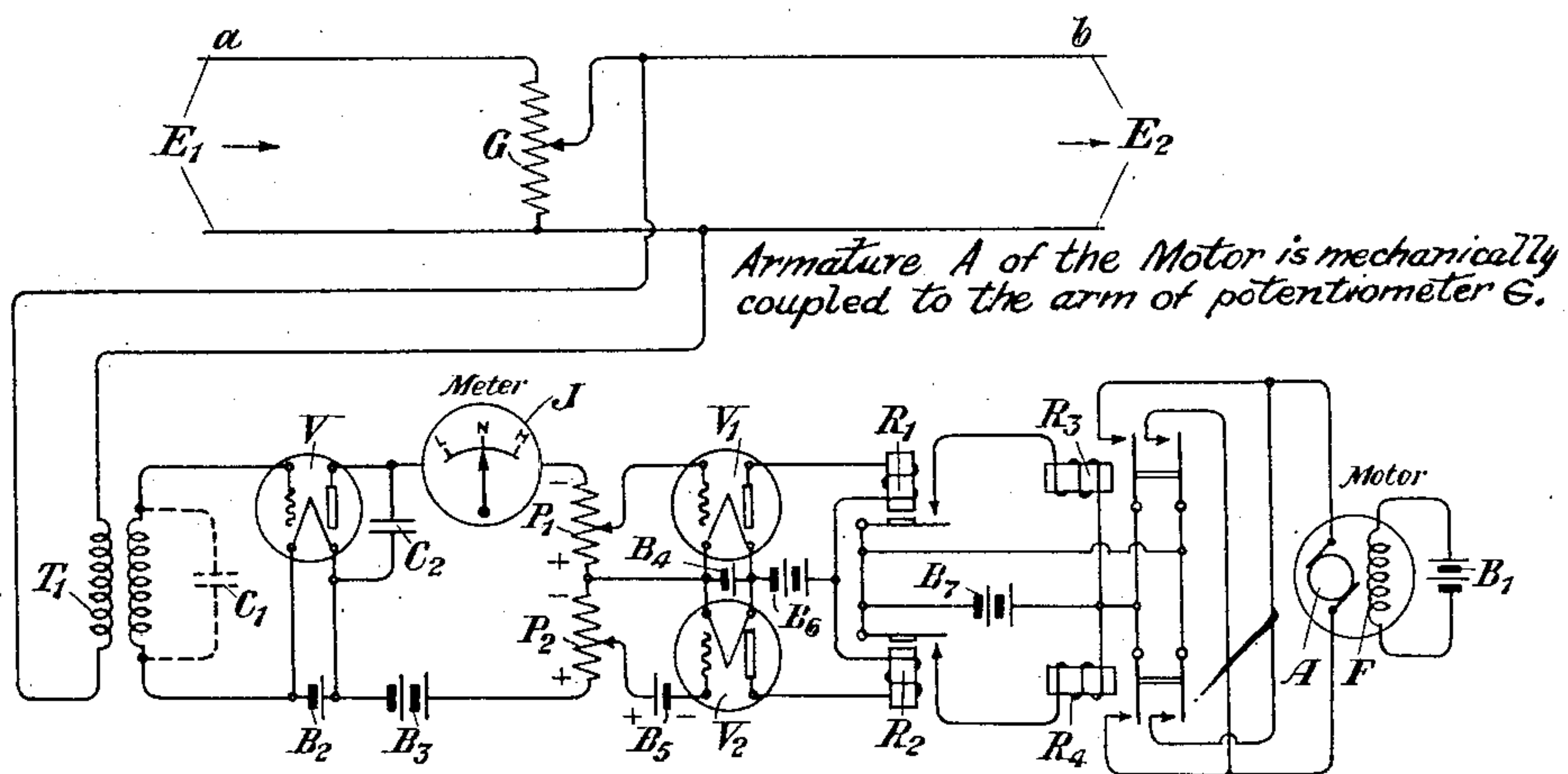


Fig. 1

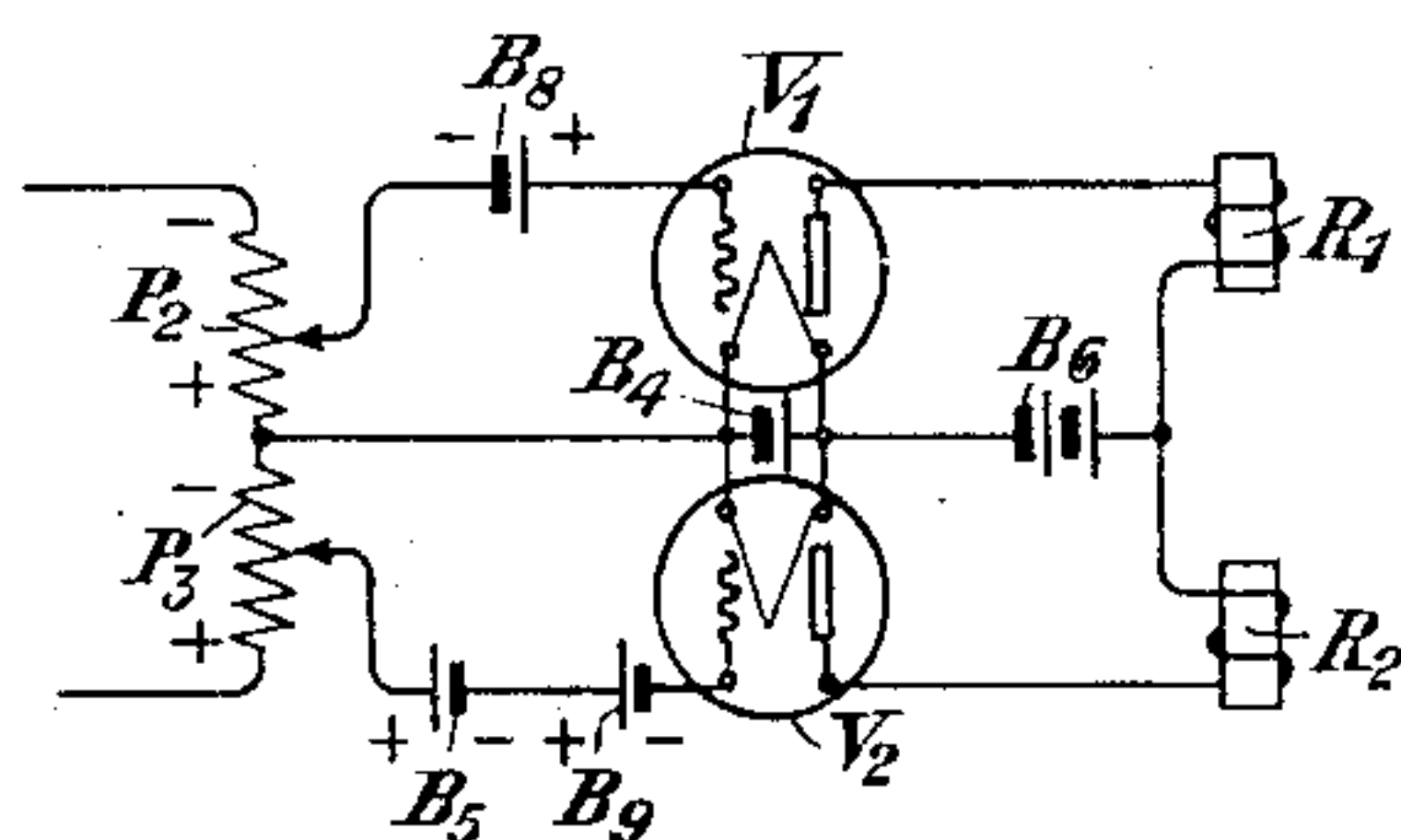


Fig. 2

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AUTOMATIC REGULATING 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.

5 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
10 such circuits in order to maintain the circuit equivalents substantially constant. One form of regulating arrangement for applying the desired corrections may consist of two or more vacuum tubes of, for example,
15 the three-electrode type. The grid electrode of such a tube normally is biased negatively with respect to the filament and it controls the electronic emission between the filament and the plate. The grid electrode of such
20 a tube may also be so biased negatively with respect to the filament that the electronic emission between the filament and the plate will be practically negligible under normal conditions. Two such tubes may be so biased
25 negatively as to prevent the passage of currents in their respective plate circuits, one or the other of these grid electrodes subsequently becoming less negatively biased with respect to its filament when there is
30 to be an increase or a decrease in the energy flowing in the signaling system.

Accordingly, it is one of the objects of this invention to provide two vacuum tubes, both of which have grid electrodes which
35 may be greatly biased negatively with respect to their filaments, and to substantially diminish the negative bias on one or the other of these grid electrodes when the energy control means of a transmission circuit is to be increased or decreased.

40 It is another object of this invention to couple the energy control means of a transmission circuit to an electrical motor so that when either of the grid electrodes of two
45 three-element vacuum tubes undergoes a substantial diminution in its negative bias, the motor may be set into rotation in one direction or the other to correspondingly vary the energy adjusting means.

50 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
55 so picked up and cause that energy to substantially change the bias on the grid electrode of either of two three-element vacuum tubes, to accordingly revolve the armature of a motor in one direction or the other and
60 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 herein-
65 after following, when read in connection with the accompanying drawing showing two embodiments of the invention merely for the purpose of illustration.

70 Referring to Figure 1 of the drawing, an input circuit E_1 is shown connected to the 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,
75 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
80 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
85 limits of variation, preferably by automatic means. The potentiometer or energy adjusting means may have sufficient range of variation upon manual adjustment to properly affect the level of the energy flowing into
90 the output circuit; but in this invention means will be particularly provided for automatically changing the position of the potentiometer or energy adjusting means G in accordance with changes in the level of
95 energy flowing in the transmission circuit.

A motor having an armature A and a field coil F 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 F is supplied with current from
100

a battery B_1 which may be a source of alternating current, as well as a source of the direct current, 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 is increased, and when the armature rotates in the opposite direction, the energy passing through potentiometer G is 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 applied to transformer T_1 . The current applied to the primary winding of this transformer becomes similarly applied to the input circuit of a rectifying device which may, for example, be a rectifier tube of the three-electrode type. Thus, this energy may be applied between the grid electrode and filament of a rectifier tube V . The filament of 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 which includes the secondary winding of transformer T_1 and condenser C_1 , which may be employed for selectively applying, between the grid electrode and the 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 this current from other currents of undesired frequencies which may also be transmitted at the same time, such as, for example, the 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 this invention.

The plate circuit of the vacuum tube V includes a meter J , resistances P_1 and P_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 , condenser C_2 being connected between the plate and filament of the vacuum tube V .

The meter J of the direct current circuit may have a dial which is graduated to indicate whether the energy flowing in this circuit is normal, high or low. When normal current flows through meter J , its pointer will 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, to be described hereinafter, will be set into operation to cause the potentiometer or energy adjusting means G to become lower 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 again be set into operation, causing the potentiometer or energy adjusting means to become increased to thereby increase the level of the energy in the output circuit E_2 .

Two vacuum tubes of, for example, the three-electrode type, are designated by the reference characters V_1 and V_2 , each of these vacuum tubes having a grid electrode, a filament and a plate. The filaments of these vacuum tubes are heated to electron emitting temperatures by the flow of current from a battery B_4 . The input circuit of the vacuum tube V_1 includes the grid electrode and filament of the vacuum tube V_1 and the adjustable resistance P_1 . The input circuit of the vacuum tube V_2 includes the grid electrode and filament of the vacuum tube V_2 , the adjustable resistance P_2 and a battery B_5 . The output circuit of vacuum tube V_1 includes the filament and plate of the vacuum tube V_1 , the winding of relay R_1 and a battery B_6 . The output circuit of the vacuum tube V_2 includes the filament and the plate of the vacuum tube V_2 , the winding of relay R_2 and battery B_6 . The battery B_6 is common to both output circuits and maintains the plates of the vacuum tubes V_1 and V_2 at suitable positive potentials.

When normal current flows through the resistances P_1 and P_2 , the grid electrodes of vacuum tubes V_1 and V_2 will be biased negatively with respect to their corresponding filaments. The negative potential for the grid electrode of vacuum tube V_1 is derived from the drop in potential across the adjustable resistance P_1 , while the negative potential for the grid electrode of the vacuum tube V_2 is derived from the adjustable resistance P_2 and from the battery B_5 . Without the presence of battery B_5 , the grid electrode of vacuum tube V_2 would normally be biased positively with respect to its filament. The battery B_5 is so poled and is of such a voltage that it normally opposes and overcomes the voltage obtained from the adjustable resistance P_2 , thereby biasing the grid electrode of the vacuum tube P_2 suitably negative with respect to its filament. Thus, battery B_5 is so connected that its negative terminal faces the grid electrode, and this battery has a greater voltage than the voltage normally derived from the adjustable resistance P_2 .

If the level of energy flowing in the out-

put circuit E_2 increases, the current rectified by vacuum tube V will also increase and this will be indicated upon the dial of meter J . Moreover, the drops in potential across resistances P_1 and P_2 will increase by corresponding amounts. An increase in the drop in potential across resistance P_1 merely renders the grid electrode of vacuum tube V_1 more negative with respect to its filament and further insures the system against the passage of current through the winding of the relay R_1 . The increased drop in potential across the resistance P_2 , however, will have the effect of reducing the negative potential impressed upon the grid electrode of the vacuum tube V_2 . Thus, if this reduction in voltage is sufficiently great, current will begin to flow in the output circuit of the vacuum tube V_2 , and if this current reaches a sufficiently high value, i. e., a predetermined value, relay R_2 will become operated. Accordingly, a relay R_4 will be operated, current flowing through the winding of relay R_4 from a battery B_7 through the armature of relay R_2 and its contact. The operation of relay R_4 causes the attraction of its two armatures so that current may flow from battery B_7 through the armature A of the motor, the circuit of armature A of the motor including battery B_7 , one of the armatures of relay R_4 , armature A of the motor and the other armature of relay R_4 . Thus, the motor is revolved in one direction, and, by virtue of the coupling existing between the armature A of the motor and the energy adjusting means G , causes a decrease in the energy flowing past the adjusting means G . Yet, the motor continues to operate until the rectified current derived from the output circuit E_2 returns to a value approximating the normal value, the rectified current being then insufficient to cause the transmission of a current through the winding of relay R_2 sufficient to operate that relay. Hence, relay R_4 will become released and the motor will stop.

If, on the other hand, the level of the energy in the output circuit E_2 decreases, the current rectified by vacuum tube V will also decrease, and the decrease will be indicated upon the dial of meter J . Accordingly, the drops in potentials across resistances P_1 and P_2 will also decrease. The decrease in the drop in potential across resistance P_2 will merely bias the grid electrode of the vacuum tube V_2 more negatively with respect to its filament and thereby insure the system against the operation of relay R_2 . However, the decreased drop in potential across resistance P_1 may tend to permit the flow of current in the output circuit of vacuum tube V_1 , and if the decrease in potential across resistance P_1 be sufficiently great, a current may flow in the

output circuit of vacuum tube V_1 of a magnitude sufficient to cause the operation of relay R_1 . Upon the operation of relay R_1 , relay R_3 will operate, current flowing through its winding from the battery B_7 through the armature of relay R_1 and its contact. The operation of relay R_3 will attract its two armatures so that current may flow from battery B_7 through the armature A of the motor, the circuit through armature A of the motor including battery B_7 , one of the armatures of relay R_3 , armature A of the motor, and the other armature of relay R_3 . Accordingly, the motor will be started in rotation in the opposite direction. Consequently, the potentiometer of energy adjusting means G will be moved so as to increase the flow of energy, thereby causing an increase in the magnitude of the rectified current of vacuum tube V . The motor A will continue to operate, however, until the magnitude of the rectified direct current will be insufficient to maintain relay R_1 in its operative condition. Hence, relay R_3 will be released and the motor will stop.

The H and L positions of meter J indicate the limits at which armature A of the motor is started in rotation in the process of readjusting the energy flowing through potentiometer G . These limits will correspond to definite magnitudes of the resistances P_1 and P_2 . These limits may be made wider or narrower by changing the impedance of the resistances P_1 and P_2 . Assume, for the sake of illustration, that the drops in potential across resistances P_1 and P_2 are substantially equal, and that the voltage of battery B_5 is normally twice the drop in potential in resistance P_2 . Thus, when there is a change in the rectified current as indicated on meter J , the rate of change and the voltage effective upon the grid electrodes of the vacuum tubes V_1 and V_2 will be substantially the same. To decrease the limits H and L at which the adjusting mechanism is to be started in operation, the drop in potential across resistance P_1 should be decreased, while the drop in potential to be effected in resistance P_2 should be increased. When this is done, however, the rate of change in the voltage impressed upon the grid electrode of the vacuum tube V_2 with respect to a change in the reading of the meter J will become greater than the rate of change in the voltage impressed upon the grid electrode of the vacuum tube V_1 . Consequently, vacuum tube V_2 will become more sensitive to changes in the rectified current, and vacuum tube V_1 less sensitive. On the other hand, if it is desired to increase the limits H and L , the drop in potential to be effected by resistance P_1 should be increased, while the drop in potential in P_2 should be decreased. Thus, there will be an increase in sensitivity in vacuum tube V_1 and a de-

crease in sensitivity for vacuum tube V_2 . It is to be understood, however, that if the limits H and L are to be changed and the sensitivity in both vacuum tubes maintained substantially alike while equal voltage drops will be effected by resistances P_1 and P_2 , changes may be made in the setting of resistance P_2 and accompanied by changes in the voltage of battery B_5 , so that the voltage of battery B_5 may always be substantially twice the voltage derived from resistance P_2 when normal current flows through meter J.

If the vacuum tube system is to have greater sensitivity in response to changes in the flow of current through the meter J at any particular limits of operation, such as the H and L limits, it may be obtained by increasing the magnitudes of resistances P_1 and P_2 and compensating for the increase in these resistances by additional batteries or other direct current voltages in the grid circuits of the respective vacuum tubes. Fig. 2 of the drawing shows the grid circuits of the vacuum tubes V_1 and V_2 , to which additional batteries have been added, battery B_8 being shown in the grid circuit of the vacuum tube V_1 , while battery B_9 , as well as B_5 are in the grid circuit of the vacuum tube V_2 . In this embodiment of the invention, the resistances P_1 and P_2 may be set for greater voltage drops. Battery B_8 is connected so that its positive terminal faces the grid electrode of the vacuum tube V_1 , while the negative terminal of battery B_9 faces the grid electrode of the vacuum tube V_2 . This vacuum tube system may be made more sensitive by virtue of the fact that the change in the potential drop across each resistance for a given change of current flowing therethrough is proportionate to the magnitude of the resistance, and, therefore, if the magnitude of resistance P_2 or P_3 be made larger, the voltage change upon the grid electrode of the corresponding vacuum tube will be larger for a given change in the magnitude of the rectified current, and the sensitivity of the system will be correspondingly increased. The chief purpose in adding batteries or other direct current sources to the grid circuits of the vacuum tubes is to maintain the grid electrodes at suitable negative potentials with respect to the corresponding filaments under normal conditions.

While this invention has been pointed out in certain particular embodiments 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 or the scope of the appended claims.

What is claimed is:

1. The combination of an input circuit

and an output circuit interconnected by energy adjusting means, a rotatable device which may be rotated in either direction, two three-element vacuum tubes each having a grid electrode, a plate and a cathode, both grid electrodes being so biased negatively with respect to the corresponding cathodes as to prevent a substantial flow of current in the corresponding plate circuits, a substantial flow of current being established in one plate circuit or on the other when the energy applied to said adjusting means materially increases or decreases, respectively, means associated with the plate circuit of the first vacuum tube to cause the rotation of the rotatable device in one direction when the current in the corresponding plate circuit becomes substantial, and means associated with the plate circuit of the second vacuum tube to cause the rotation of the rotatable device in the opposite direction when the current in the corresponding plate circuit becomes substantial.

2. The combination of two three-element vacuum tubes each having a grid electrode, a plate and a cathode, means for rendering said grid electrodes equally negative with respect to the corresponding cathodes, means for substantially decreasing the negative bias on the grid electrode of the first vacuum tube, thereby substantially increasing the plate current of that vacuum tube, means for substantially decreasing the negative bias on the grid electrode of the second vacuum tube, thereby substantially increasing the plate current of that vacuum tube, a rotatable device which may be rotated in a clockwise direction or in a counter-clockwise direction, means for rotating said device in a clockwise direction when there is a substantial, increased plate current in the first vacuum tube, and means for rotating said device in a counter-clockwise direction when there is a substantial, increased plate current in the second vacuum tube.

3. The combination of an input circuit and an output circuit interconnected by energy adjusting means, a rotatable device coupled to said energy adjusting means which, when rotated in one direction, causes an increase in the energy flowing through said adjusting means and, when rotated in the other direction, causes a decrease in the energy flowing through said adjusting means, a rectifier which rectifies a portion of the energy flowing in said output circuit, two electron tube circuits energized by the rectified current, a substantial current flowing in the plate circuit of one of the electron tubes when the rectified current increases materially, a substantial plate current flowing in the output circuit of the other of the electron tubes when the rectified current decreases materially, means for causing the

rotation of the rotatable device in one direction when there is a material increase in the flow of current in the plate circuit of one of the electron tubes, and means for causing the rotation of the rotatable device in the other direction when there is a material increase in the flow of current in the plate circuit of the other of the electron tubes.

4. In combination, an input circuit, an output circuit, a potentiometer interposed between said circuits for controlling the level of the energy of the input circuit applied to the output circuit, a motor coupled to the arm of the potentiometer, a duplex vacuum tube system interconnecting the output circuit and the motor, a portion of the energy of the output circuit being applied to the vacuum tube system, means for effectively energizing one of the paths of the vacuum tube system when the level of the energy impressed thereon rises above a first predetermined limit, means for effectively energizing the other of the paths of the vacuum tube system when the level of the energy impressed thereon falls below a second predetermined limit, means for rotating the motor in one direction when one of the paths of the vacuum tube system is effectively energized, and means for rotating the motor in the opposite direction when the other of the paths of the vacuum tube system is effectively energized.

5. The combination of an output circuit and an input circuit interconnected by a potentiometer employed to control the level of the energy flowing between the input circuit and the output circuit, a motor mechanically coupled to the potentiometer, means coupled to the output circuit for rectifying only a small portion of the energy applied to the output circuit by the input circuit, means including a first vacuum tube system to rotate the motor in one direction when the level of the rectified energy increases above a first predetermined value, and means including a second vacuum tube system to rotate the motor in the opposite direction when the level of the rectified energy decreases below a second predetermined value, the motor remaining stationary when the level of the rectified energy lies between said first and said second predetermined values.

6. The combination of two three-element vacuum tubes each having a grid electrode, a plate and a cathode, each grid electrode being normally biased highly negative with respect to the corresponding cathode so as to prevent the flow of current in the corresponding plate circuit, a source of rectified current of variable amplitude coupled to the grid electrodes of said vacuum tubes, means whereby one of said grid electrodes will be rendered less negative with respect to the corresponding cathode so as to cause a substantial flow of current in the corre-

sponding plate circuit and the grid electrode of the second vacuum tube will be rendered more negative with respect to its cathode when the amplitude of the rectified current of said source increases beyond a predetermined value, and means whereby the grid electrode of the second vacuum tube will be rendered less negative with respect to its cathode so as to cause a substantial flow of current in the corresponding plate circuit and the grid electrode of the first vacuum tube will be rendered more negative than normally with respect to its cathode when the amplitude of the rectified current of said source decreases below a predetermined value.

7. The combination of two three-element vacuum tubes each having a grid electrode, a plate and a cathode, means including a source of direct current for rendering the grid electrodes in said vacuum tubes equally negative with respect to the corresponding cathodes, said source of direct current being of variable amplitude and being coupled to the grid electrodes of said vacuum tubes, means whereby the negative bias on the grid electrode of one of the vacuum tubes will be substantially decreased and the negative bias on the grid electrode of the other vacuum tube will be substantially increased when the amplitude of the current of said direct current source rises above predetermined value, and means whereby the negative bias on the grid of the first vacuum tube will be substantially increased and the negative bias on the grid electrode of the second vacuum tube will be substantially decreased when the amplitude of the current from said direct current source drops below a predetermined value.

8. The combination of an input circuit and an output circuit interconnected by energy adjusting means, a rotatable device coupled to said energy adjusting means which when rotated in one direction will cause an increase in the gain of said adjusting means, and, when rotated in the opposite direction, will cause a decrease in the energy flowing through said adjusting means, two three-element vacuum tubes coupled to the output circuit, each vacuum tube having a grid electrode, a plate and a cathode, each grid electrode being normally maintained at a suitable negative potential with respect to the corresponding cathode, means for substantially decreasing the negative bias on the grid electrode of the first vacuum tube so as to cause a substantial increase in the flow of current in its plate circuit, means for substantially decreasing the negative bias on the grid electrode of the second vacuum tube so as to cause a substantial increase in the flow of current in its plate circuit, means for rotating the rotatable device in one direction when the

plate current of the first vacuum tube is substantially increased, and means for rotating said rotatable device in the opposite direction when the plate current of the second vacuum tube is substantially increased.

9. The combination of first and second three-element vacuum tubes each having a grid electrode, a plate and a cathode, two resistances each of adjustable magnitude, one associated with each vacuum tube, two sources of direct current potential, one associated with each vacuum tube, one resistance and one source of direct current potential being connected to the grid electrode and cathode of each vacuum tube, and a source of rectified current coupled to said resistances, a substantial current flowing in the plate circuit of the first vacuum tube and a negligible current flowing in the plate circuit of the second vacuum tube when the magnitude of the current flowing from said source of rectified current increases materially, a substantial current flowing in the plate circuit of the second vacuum tube and a negligible current flowing in the plate circuit of the first vacuum tube when the magnitude of the current flowing from said source of rectified current decreases materially.

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

RUSSELL H. LINDSAY.