Feb. 28, 1950 G. DEAKIN 2,498,654

REMOTE POSITION CONTROL SYSTEM

Filed Feb. 26, 1945 2 Sheets-Sheet 1

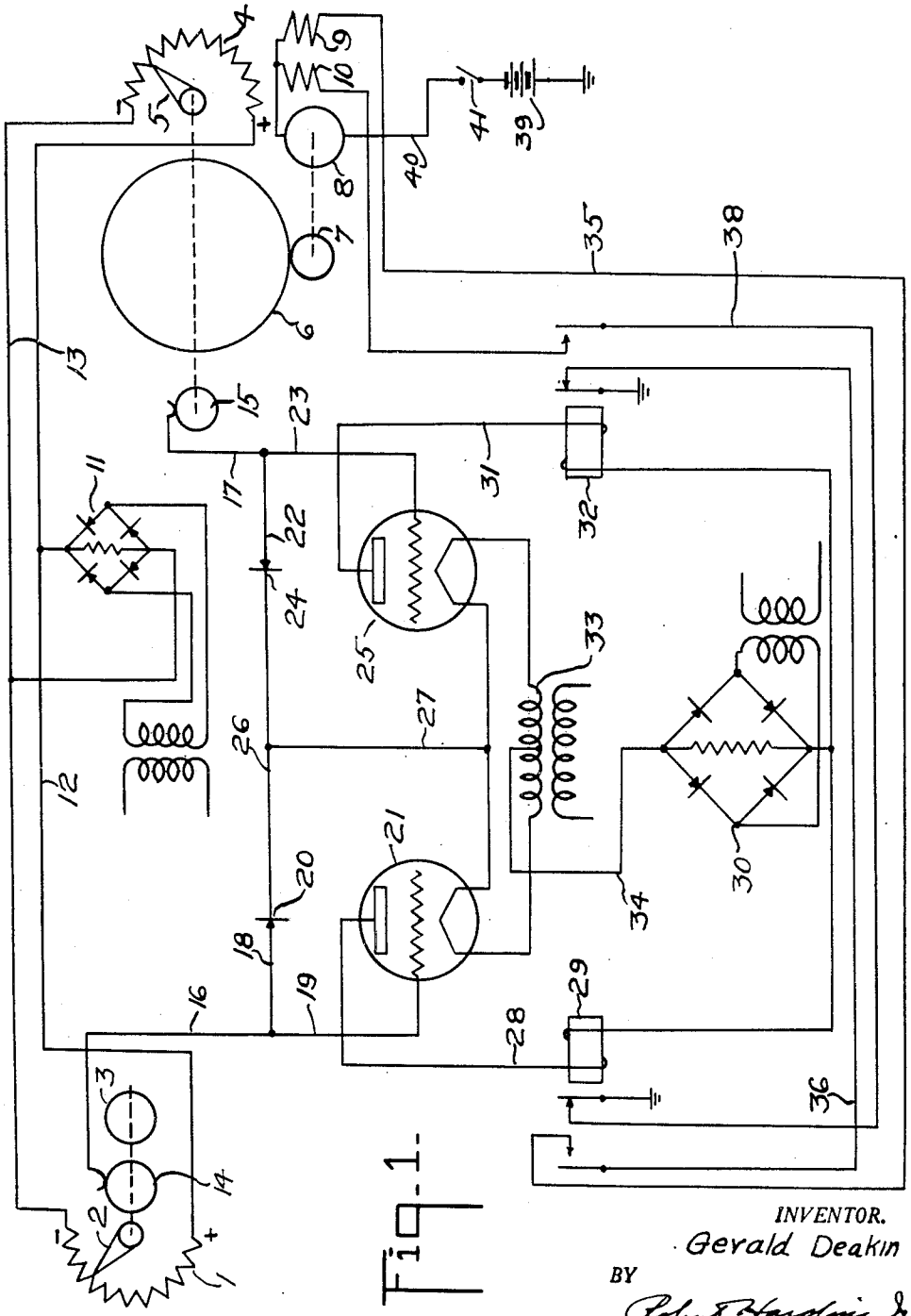


Fig. 1.

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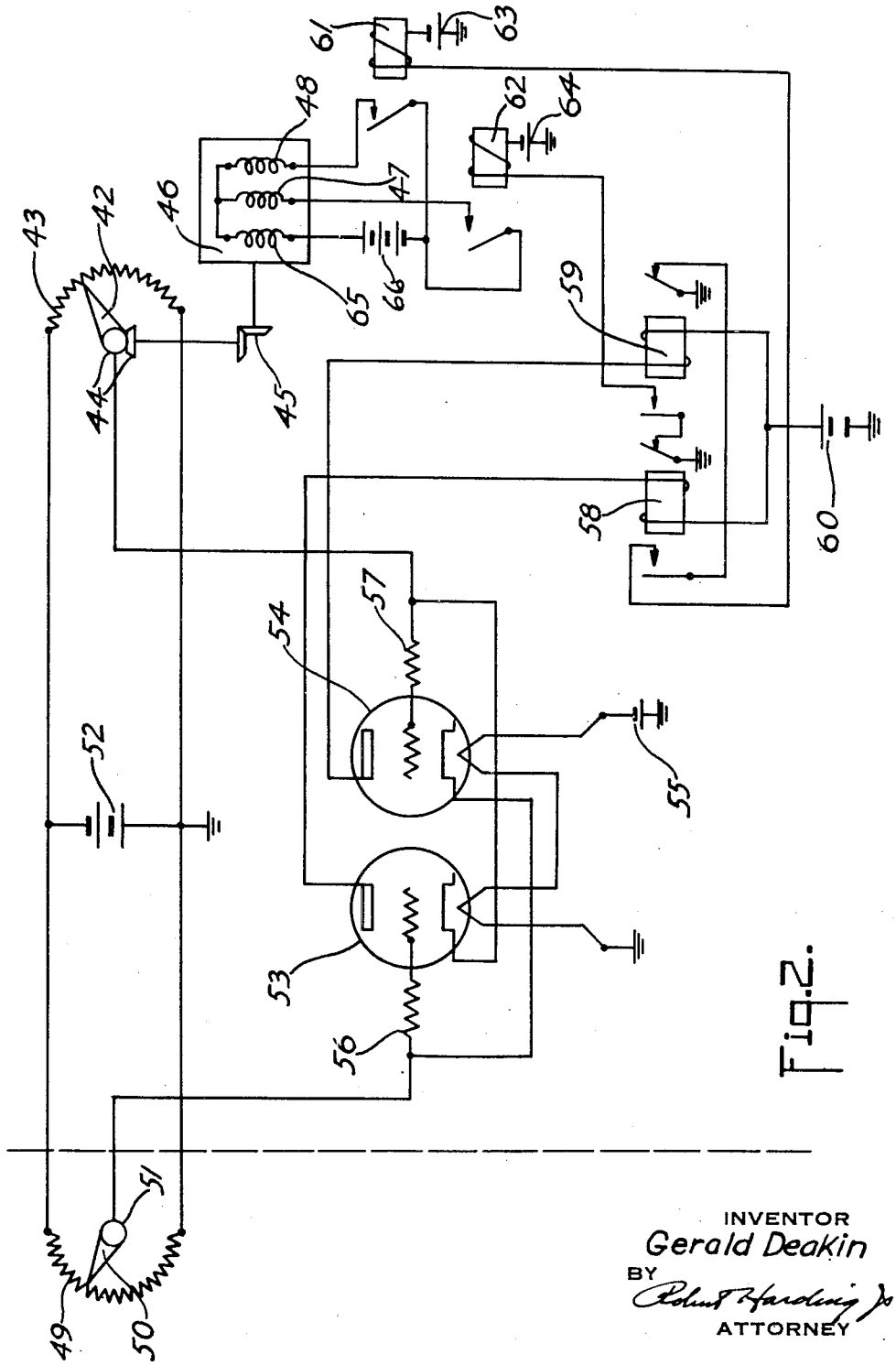


Fig. 2.

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REMOTE POSITION CONTROL SYSTEM

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15 Claims. (Cl. 318—29)

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The present invention relates to a remote control system and particularly to such a system wherein the setting of a pointer or the like at a control station causes the corresponding setting of a similar pointer at the remote station and at the same time the corresponding setting of a controlled device. For example, the control may be a directional antenna or the tuning means of a radio receiver or other such device which is at a distant point and is to be set in accordance with the setting of a manual control at the control station.

It is an object of the invention to provide a control system whereby the position or setting, angular or otherwise, of a device may be controlled from a remote location.

It is another object of the invention to provide such a device in which accuracy of setting is procured through the use of electronic devices and rectifiers.

It is a further object of the invention to provide such a device which shall be simple and positive in operation and economical in manufacture and maintenance.

Other objects and features of the invention will be apparent when the following description is considered in connection with the annexed drawing in which:

Figure 1 is a schematic circuit diagram illustrating an embodiment of the invention.

Fig. 2 is a similar diagram illustrating a modification of the invention.

Referring now to the drawing there is shown at 1 a potentiometer having an adjustable contact or slider 2, this potentiometer being manually controlled, as for example by the knob 3, and being located at the control station.

There is likewise provided at the distant station a similar potentiometer 4 having an adjustable contact or slider 5 which slider is mechanically coupled to a gear 6. The gear 6 is driven by means of a pinion 7 which is in turn driven by the motor 8. This motor 8 is provided with two oppositely wound field windings 9 and 10 which, as will hereinafter be described, are so connected as to cause the motor to rotate in either direction.

A source of current 11, which is shown as a rectifier but may, of course, be any direct current source, is connected to the two potentiometers 1 and 4 by the conductors 12 and 13. The adjustable contacts 2 and 5 of the respective potentiometers 1 and 4 are connected by means of the slip rings 14 and 15 to conductors 16 and 17 respectively. Conductor 16 is branched to form con-

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ductors 18 and 19 one of which, namely conductor 18, leads to the rectifier 20 and the other, 19, to the grid of triode 21. In a similar manner, conductor 17 is branched into two conductors 22 and 23 one of which leads to the rectifier unit 24 and the other to the grid of triode 25. Rectifiers 20 and 24 have their other terminals connected together by means of the conductor 26 and are connected by means of conductor 27 to the cathode or filaments of the electron tubes 21 and 25, shown as triodes. The plate of triode 21 is connected by means of conductor 28 to a relay 29 and to the source of current 30 in this instance a rectifier. In a like manner, the plate of tube 25 is connected by means of conductor 31 to the winding of relay 32 and to the source of plate current 30. Heating current is supplied to the filaments of tubes 21 and 25 by means of the transformer 33 and the plate battery is returned to a center tap of the secondary of transformer 33 by virtue of the conductor 34.

Winding 9 of the motor 8 is connected to a make contact of relay 29 by means of the conductor 35 and the associated armature of this relay is connected to a break contact of relay 32 over the conductor 36, the associated armature of this relay being connected to ground. In a similar manner, the field winding 10 of the motor 8 is connected by conductor 37 to a make contact of relay 32 and the associated armature is connected by conductor 38 to a break contact of relay 29, the associated armature of which is connected to ground.

In describing the operation of the system above set forth it will be assumed that the pointers 2 and 5 of the potentiometers 1 and 4 stand at corresponding positions. If a new setting is desired the pointer 2 will be moved and may, of course, be moved in either direction. If it is moved downwardly, as seen in the drawing, then the potential of pointer 2 will become positive with respect to that of pointer 5. The rectifier units 20 and 24 are poled so that current will flow from positive to negative in the direction of the arrows. Consequently, under the conditions mentioned above, namely the potential of pointer 2 being more positive than that of pointer 5, current will tend to flow from pointer 2 to pointer 5. Rectifier 20 will offer a very low impedance to this flow but rectifier 24, being poled in the opposite direction will offer a very high impedance to this flow. Consequently, the grid and filament of tube 21 will be at substantially the same potential whereas the grid of tube 25 will be at a negative potential with respect to its filament. Of course,

the potential on the filaments of the two tubes will be substantially the same.

Because of the negative bias on the grid of the tube 25 no plate current will flow and the relay 32 will remain inoperated.

Since tube 21 has no negative bias on its grid, current will flow from rectifier 30 through relay 29, conductor 28, plate of tube 21, filament of the tube 21 and through conductor 34 back to the rectifier 30.

Relay 29 will operate and a circuit will be established from ground through switch 41, which of course will be closed at this time, and through battery 39 to conductor 40, thence through the armature of motor 8 and field winding 9, conductor 35, make of relay 29, associated armature of that relay, conductor 36, break contact of relay 32 and associated armature to ground. This will cause the motor to rotate in such a direction as to cause pointer 5 to move downwardly.

When this pointer reaches a position corresponding to that of the pointer 2 at the control station a balanced condition results so that the potentials of the grids of tubes 21 and 25 are substantially the same as their cathodes, and the condition is such that plate current will flow in both tubes to operate both relays 29 and 32. This breaks the circuits to both field windings 9 and 10 of the motor 8, one at the break contact of relay 32 and the other at the break contact of relay 29.

If the pointer 2 is now moved upwardly, then the potential applied to pointer 2 will be less positive than that applied to the pointer 5. Consequently, there will be a tendency for current flow from positive at pointer 5 through the slip ring 15, conductor 17, conductor 22, rectifier 24, conductor 26, rectifier 20, conductor 18, conductor 16 and slip ring 14 to pointer 2. Since the rectifier 22 presents a low impedance to this flow of current the filament-grid circuit of the tube 25, which is in shunt to that rectifier will have substantially no potential applied thereto and this tube will therefore continue to conduct. On the other hand since rectifier 20 has a very high impedance to the flow of current in this direction there will be a considerable potential difference between the filament and grid of tube 21, the grid being negative and no current will flow in the plate circuit of this tube. As a result relay 29 will release and a circuit will be completed through the other field winding 10 of the motor 8 through the make contact and armature of relay 32 and the break contact and armature of relay 29. This will result in rotation of the motor in reverse direction until the pointer 5 has reached a position corresponding to that of pointer 2 when the balanced condition will again occur.

It will be understood that the tubes 20 and 25 may be so arranged as normally to maintain a negative bias on the grids thereof to result in deenergization of both relays 29 and 32 when the pointers are in corresponding positions instead of the operation thereof. In this event, the circuits to the field windings of the motor will be opened at the make contacts of the relays and the motor will stop. Thus, as has been described, the relays may either both operate or both deenergize when the setting is the same for each pointer.

In some instances it may be desirable to eliminate the rectifiers 20 and 24 in the control circuit and in such a case the circuit of Fig. 2 may be used. In this figure the device 42 to be controlled

is represented as the movable contact of the potentiometer 43. This contact is driven through suitable bevel gears 44 and 45 by means of a motor 46 which is similar to the motor 8 of Fig. 1. This motor has a field winding 47 which, when energized, drives the motor in one direction and a field winding 48, which, when energized, drives the motor in the opposite direction.

At the control point a potentiometer 49 is provided with a movable contact 50 provided with some means to adjust its position, as, for instance, the knob 51. For purposes of illustration I have shown both the potentiometers 49 and 43 as being connected across a source of direct current, similar to the arrangement of Fig. 1, except that in this case the source is indicated as a battery 52. It will be evident that in this case and also with the arrangement of Fig. 1 separate sources of voltage supply may be used for the two potentiometers.

Two tubes 53 and 54 are provided for controlling the operation of the motor 46 by the positions of the movable contacts 50 and 42 of the potentiometers 49 and 43, and these tubes may be triodes, as indicated. The tubes are preferably of the indirectly heated type, the heating filaments being insulated from the cathode and energized by a separate source of supply, indicated by the battery 55.

The contact 50 of the potentiometer 49 is connected to the control electrode of the tube 53 through a suitable grid resistor 56 and also directly to the cathode of the tube 54. The movable contact 42 of the potentiometer 43 is connected through a grid resistor 57 to the control electrode of the tube 54 and also directly to the cathode of the tube 53.

The anodes of the two tubes 53 and 54 are connected respectively to the windings of two relays 58 and 59, the other ends of the windings of these relays being connected to a suitable source of high voltage, as indicated by the battery 60. Each of the relays 58 and 59 is provided with a pair of make contacts and a pair of break contacts. The movable armature of each break contact is connected to ground, while the other break contact is connected to the movable armature of the make contact of the other relay. The other contacts of the make contact pairs are connected respectively to the windings of two relays 61 and 62 which have the other ends of their windings connected to batteries, indicated respectively at 63 and 64.

Relays 61 and 62 control the energization of the field windings 48 and 47, respectively, of the motor 46 by means of make contacts for the relay 61 which are in the operating circuit of the field winding 48 and armature 65, and make contacts for the relay 62 which are in the operating circuit of the armature 65 and the other field winding 47. A source of potential 66, as the battery indicated, is common to both circuits.

As far as the motor, potentiometers, and relays are concerned the circuit of Fig. 2 operates in a similar manner to that of Fig. 1. As long as the voltages supplied by the movable contacts of both potentiometers are the same, the control electrodes and cathodes of the tube are the same and both tubes draw anode current, with the result that both relays 58 and 59 are operated. This removes the ground at the break contacts of both relays for the operating circuits of relays 61 and 62 which remain deenergized thus opening their break contacts and opening any circuit through the motor 46.

If, then, the movable contact arm 59 is shifted in position so that its voltage is higher than that of the contact arm 42, the potential of the control electrode of the tube 53 will increase while at the same time the potential on the cathode of the tube 54 will increase. Thus, the tube 53 will continue to draw anode current and to maintain the relay 58 operated, while the tube 54 will be shut off because the cathode has become more positive than the control electrode. This deenergizes the relay 59 and applies ground at its break contact to the circuit through the make contacts of the relay 58 and the relay 61, which relay operates and at its make contacts energizes the motor 46 through the field winding 48. This drives the motor in the proper direction to bring the movable contact 42 of the potentiometer 43 to a position at which the voltage will correspond to that produced by the movable arm 50 of the potentiometer 49. Movement of the arm 50 of the potentiometer 49 in the other direction to a new position will cause the tube 53 to shut off with the result that the relay 58 will be deenergized to connect ground at its break contacts through the make contact of relay 59 to energize the relay 62 and thus operate the motor 46 through the other field winding 47 to cause the motor to turn in the other direction.

The circuit of Fig. 2 may be operated so that both tubes are either energized or shut off when the voltages from the two potentiometers are the same, which may be done by a suitable adjustment of the grid biases of the tubes.

While I have described preferred embodiments of my invention and have considered only angular movement of the pointers and the controlled instrument it will be obvious that linear movement may also be provided for by simply utilizing racks and gears or their equivalent. Therefore, I wish to be limited not by the foregoing description but solely by the appended claims.

What is claimed is:

1. In a system for adjusting a distant device in accordance with a local control, in combination, means for driving the device in either direction of adjustment, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact at the distant point being connected to said driving means, and device for operation therewith, means to adjust the position of the contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of unidirectional high impedances, said impedances being poled so that each presents a low impedance to current flowing to it from the corresponding potentiometer contact, and voltage responsive means connected in shunt to each of said impedances, said voltage responsive means causing operation of said driving means in a direction and for a duration of time sufficient to cause positioning of said potentiometer contact at the distant point to correspond with the positioning of the contact of the potentiometer at the control point.

2. In a system for adjusting a distant device in accordance with a local control, in combination, means for driving the device in either direction of adjustment, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said driving means and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of unidirectional high impedances, said impedances being poled so that each presents a low impedance to current flowing to it from the corresponding potentiometer contact, a pair of electron tubes each having its grid-cathode circuit in shunt across one of said impedances, and means in the plate circuits of said tubes for causing operation of said driving means in a direction and for a duration of time sufficient to position the said contact of said distant potentiometer in a position corresponding to the setting of said contact of said local potentiometer.

3. In a system for adjusting a distant device in accordance with a local control, in combination, means for driving the device in either direction of adjustment, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said driving means and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, and voltage responsive means connected in shunt to each of said rectifiers, said voltage responsive means causing operation of said driving means in a direction and for a duration of time sufficient to cause positioning of said potentiometer contact at the distant point to correspond with the positioning of the contact of the potentiometer at the control point.

4. In a system for adjusting a distant device in accordance with a local control, in combination, means for driving the device in either direction of adjustment, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said driving means and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, a pair of electron tubes each having its grid-cathode circuit in shunt to one of said impedances and means in the plate circuits of said tubes for causing operation of said drving means in a direction and for a duration of time sufficient to position the said contact of said distant potenti-

ometer in a position corresponding to the setting of said contact of said control potentiometer.

5. In a system for adjusting a distant device in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of unidirectional high impedances, said impedances being poled so that each presents a low impedance to current flowing to it from the corresponding potentiometer contact, and voltage responsive means connected in shunt to each of said impedances, said voltage responsive means causing energization of one of said field windings to thereby cause said motor to operate in a direction and for a duration of time sufficient to cause positioning of said potentiometer contact at the distant point to correspond with the positioning of the contact of the potentiometer at the control point.

6. In a system for adjusting a distant device in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of unidirectional high impedances, said impedances being poled so that each presents a low impedance to current flowing to it from the corresponding potentiometer contact, a pair of electron tubes each having its grid-cathode circuit in shunt across one of said impedances, and means in the plate circuit of each of said tubes for causing energization of one of said field windings to thereby cause operation of said motor in a direction and for duration of time sufficient to position the said contact of said distant potentiometer in a position corresponding to the setting of said contact of said local potentiometer.

7. In a system for adjusting a distant device in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, and voltage responsive means connected in shunt to each of said impedances said voltage responsive means causing energization of said field windings selectively to cause operation of said motor in a direction and for a duration of time sufficient to cause positioning of said potentiometer contact at the distant point to correspond with the positioning of the contact of the potentiometer at the control point.

8. In a system for adjusting a distant device in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, a pair of electron tubes each having its grid-cathode circuit in shunt to one of said impedances and means in the plate circuit of each of said tubes for energizing one of said field windings and causing operation of said motor in a direction and for a duration of time sufficient to position the said contact of said distant potentiometer in a position corresponding to the setting of said contact of said control potentiometer.

9. In a system for adjusting a distant device in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, a pair of electron tubes each having its grid-cathode circuit in shunt to one of said impedances, and a pair of relays each of which has its winding connected in the plate circuit of one of said tubes, and its contacts in the circuit of one of said field windings whereby upon operation of a tube the corresponding field winding of said motor is energized to cause setting of said device and its associated contact to a position corresponding to that of the local potentiometer contact.

10. In a system for adjusting a distant device

in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, a pair of electron tubes each having its grid-cathode circuit in shunt to one of said impedances, and a pair of relays each of which has its winding in the plate circuit in one of said tubes, a make contact and a break contact on each of said relays, each motor field winding being connected in a circuit which leads through the make contact of one of said relays and the break contact of the other of said relays whereby when either tube is conducting and the other non-conducting, the said motor is caused to operate in a corresponding direction and when both tubes are either conducting or non-conducting said motor is deenergized.

11. In a system for adjusting a distant device in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said variable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, a pair of electron tubes each having its grid-cathode circuit in shunt to one of said impedances to render one of said tubes conductive and the other non-conductive when the potential on said local potentiometer contact is higher than that on the distant potentiometer contact and to reverse the operation of said tubes when the potential on the distant potentiometer contact is greater than that on the local potentiometer contact, and means in the plate circuit of each of said tubes to control the energizing of one of said field windings and cause operation of said reversible motor in a direction and for a duration of time to position the contacts of said local and distant potentiometers in corresponding positions.

12. In a system for adjusting a distant device in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point,

a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said adjustable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, a pair of electron tubes each having its grid-cathode circuit in shunt to one of said impedances to render one of said tubes conductive and the other non-conductive when the potential on said local potentiometer contact is higher than that on the distant potentiometer contact and to reverse the operation of said tubes when the potential on the distant potentiometer contact is greater than that on the local potentiometer contact, and a pair of relays each of which has its winding connected in the plate circuit of one of said tubes and its contacts in the circuit of one of said field windings whereby the field windings of said motor are controlled by the tubes to cause setting of said device and its associated contact to a position corresponding to that of the local potentiometer contact.

13. In a system for adjusting a distant device in accordance with a local control, in combination, a motor having a pair of oppositely wound field coils, a potentiometer at the distant point, a potentiometer at the local control point, a source of direct current connected across said potentiometers, an adjustable contact for each potentiometer, said adjustable contact for the potentiometer at the distant point being connected to said motor and device for operation therewith, means to adjust the position of the adjustable contact of the potentiometer at the control station, circuit means interconnecting said adjustable contacts of said potentiometers, said circuit means including a pair of rectifiers having a high impedance to current flow in one direction and a low impedance to current flow in the opposite direction, said rectifiers being connected together in opposition and having low impedance to current flow from said potentiometer contacts to the connection between the rectifiers, a pair of electron tubes each having its grid-cathode circuit in shunt to one of said impedances to render one of said tubes conductive and the other non-conductive when the potential on said local potentiometer contact is higher than that on the distant potentiometer contact and to reverse the operation of said tubes when the potential on the distant potentiometer contact is higher than that on said local potentiometer contact, and a pair of relays each of which has its winding in the plate circuit of one of said tubes, a make contact and a break contact on each of said relays, each motor field winding being connected in a circuit which leads through the make contact of one of said relays and the break contact of the other of said relays whereby when either tube is conducting and the other non-conducting the said motor is caused to operate in a corresponding direction and when both tubes are conducting or non-conducting said motor is deenergized.

14. In a system for adjusting a distant device in accordance with a local control, in combination, power means for driving the device in either direction of adjustment, a first control means operated by said power means, a second control means at the control point adjustable to the desired position, a pair of electron tubes each having an anode, a control electrode, and a cathode, a first variable voltage means operably connected to said first control means, a second variable voltage means operably connected to said second control means, means to apply differentially the voltages from both variable voltage means to the control electrode and to the cathode of one of said electron tubes and means selectively responsive to the polarity of the difference in potential between the variable voltage means and disposed to produce an increase in the anode current of one tube and a decrease in the anode current of the other of said tubes, whereby when said variable voltages are equal, each of said tubes will have substantially the same potential difference between the cathode and the control electrode thereof, but when said variable voltages are unequal, the potential differences between the cathodes and control electrodes of said tubes will differ in such a manner that one of the tubes will draw increased anode current while the other will draw decreased anode current, the anode circuit of each tube includes a relay having a pair of break contacts and a pair of make contacts, a pair of circuits, one of said circuits containing the break contacts of one relay and the make contacts of the other relay, said circuits being operatively connected to said power means, one to control the operation thereof in one direction and the other to control the operation thereof in the other direction.

15. In an electrically controlled system adapted to cause a control device to assume a position substantially in accordance with the position of a controlling device, reversible power operated means operatively associated with the control device and disposed to vary the position thereof, a first potential varying means disposed to produce a potential whose magnitude varies in accordance with the position of the controlling device, a second potential varying means disposed to produce

a potential whose magnitude varies in accordance with the position of the controlled device in such manner that the potential difference between the potentials of the first and second potential varying means will be substantially zero when the controlled device is positioned in accordance with the position of the controlling device and such that the potential difference will have a predetermined polarity in accordance with the relative direction of deviation of the controlling and controlled devices, from a position of accord, a pair of electron tubes, each having a cathode, an anode, and a controlled grid, a first circuit means interconnecting the cathode-control grid circuits of the electron tubes and the two potential varying means, said circuit means including a pair of asymmetrically conductive resistive elements connected in opposing relationship and connected to the control grid-cathode circuits of the two tubes in a manner tending to produce a change in grid bias in greater magnitude in a predetermined one of the tubes and tending to produce a change in grid bias in decreasing magnitude in the other of the tubes in response to a potential difference of predetemined polarity, and further circuit means operatively associating the anodes of the electron tubes with the reversible power operated means and disposed to cause operation thereof in response to such potential difference in a direction tending to reduce the potential difference to zero.

GERALD DEAKIN.

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