

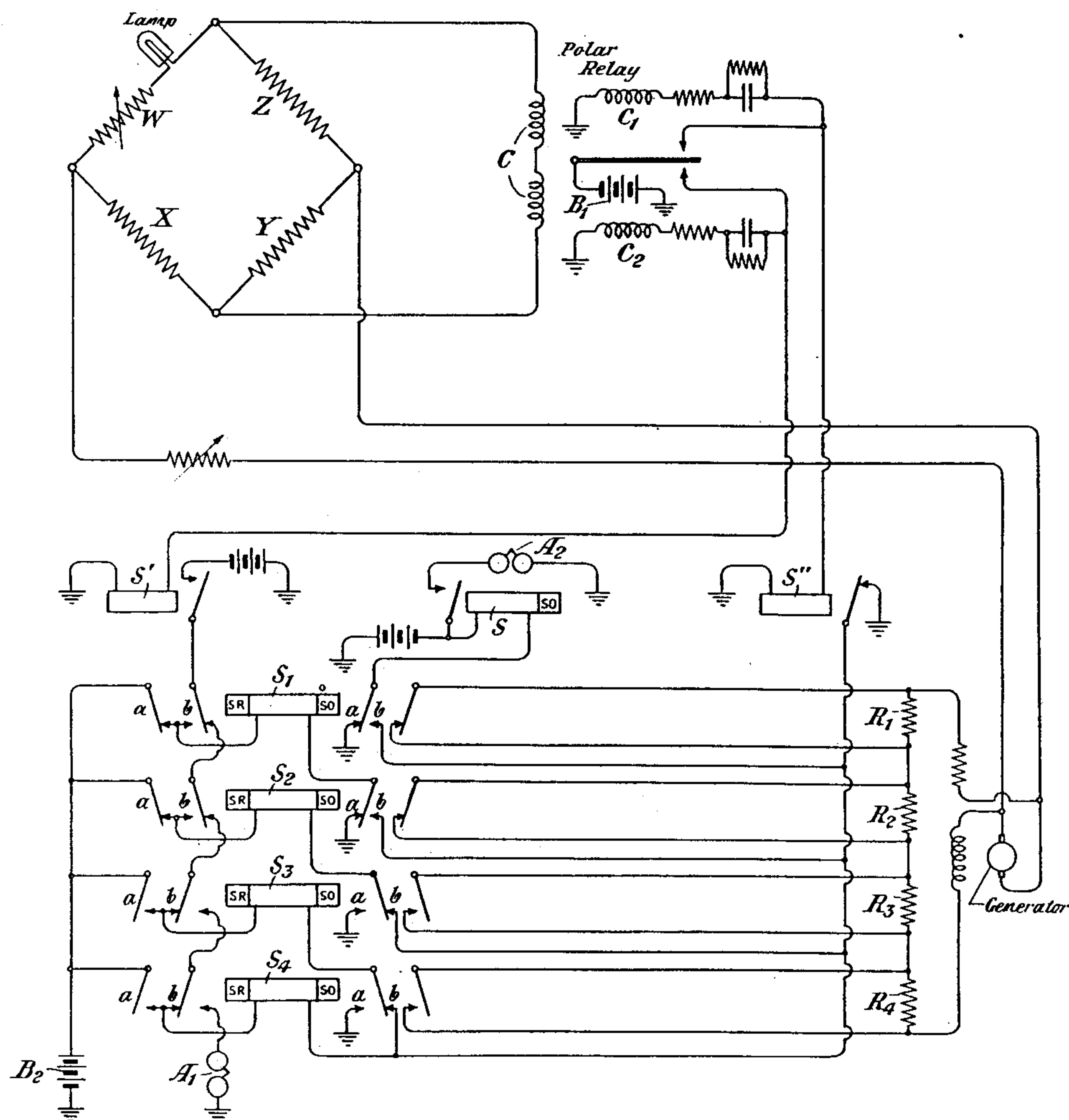
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VOLTAGE REGULATOR

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Contacts on either side of Relays S_1 , S_2 , S_3 , and S_4 —
Contacts a must make before
contacts b break.

INVENTOR.
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BY *gr for*
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UNITED STATES PATENT OFFICE.

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VOLTAGE REGULATOR.

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This invention relates to means for regulating the voltage of a source of electric current, and more particularly to automatic voltage regulating means which may be made highly sensitive.

The object of the invention is to provide a voltage regulator which may be made more sensitive than the regulators now used and which will not be subject in the same degree as those regulators to variations of sensitivity due to contact troubles.

The embodiment of my invention consists in general of a sensitive polar relay, a sensitive balance bridge associated with the current source, the unbalancing of this bridge serving to operate the polar relay, a plurality of fixed resistances associated with the current source and controlling the voltage, and switching means responsive to operations of the polar relay for varying the resistance associated with the current source.

A suitable embodiment of the invention is shown diagrammatically in the accompanying drawing.

My invention will be more clearly understood when the following detailed description is read with reference to the drawing. The current source is shown in the form of a generator and a field winding, associated with the fixed resistances R_1 , R_2 , R_3 and R_4 . A Wheatstone bridge is associated with the generator, as diagrammatically shown. The arms X and Z of this bridge consists of resistances of a low temperature coefficient; the arm W contains a resistance of a high temperature coefficient as compared with the resistances of arms X and Z, and the arm Y is formed of a resistance which may be of a temperature coefficient either high or low. If Y has a high temperature coefficient, the sensitivity may be doubled. The arm W is specifically disclosed as consisting of a lamp in series with a variable resistance. A lamp is advantageously used in this arm of the bridge since it is a convenient form of resistance of a high temperature coefficient. The variable resistance in series with the lamp may be used to compensate for differences between different samples of lamps. If a very high sensitivity is desired, the lamp connected in the arm W should be one such as the iron filament ballast lamp developed for use in vacuum tube filament circuits. The resistance of such a lamp is very greatly increased in response to a relatively small

increase of current through the filament. However, a considerable degree of sensitivity will be given by the use of an evacuated tungsten filament lamp. Variation of the intensity of current through the lamp of arm W causes a change of resistance which unbalances the bridge and causes the operation of the polar relay, which is connected in place of the meter usually associated with a Wheatstone bridge. This polar relay should be sensitive. It includes the operating windings C connected across the bridge, the windings C_1 and C_2 and an armature connected to ground through a battery B_1 . The two contacts of this relay are connected each through a condenser-resistance and one of the windings C_1 and C_2 to ground. The relay is so poled that when the voltage of the current source is of normal value and the bridge is balanced, the armature touches neither contact. When the voltage of the generator decreases, the armature of the polar relay is thrown to its lower contact (with reference to the drawing), and when the voltage increases, the armature touches the upper contact. When the armature touches the upper contact, for instance, there is a momentary flow of charging current through the condenser associated with this contact, and the winding C_1 is so poled that this charging current holds the armature firmly on the upper contact, the relay operation thus being made more positive. Similarly, when the armature touches the lower contact, the lower condenser is charged with the momentary current through the winding C_2 holds the armature firmly on the lower contact. The resistance connected around each of the condensers should be large, and serves to discharge the condenser when the armature is not touching the associated contact.

Let it be assumed that the voltage of the source has fallen below its normal value. As stated above, this decrease of voltage causes the armature of the polar relay to touch its lower contact, due to the poling of the relay, connecting battery B_1 to this contact. The closing of the contact completes a circuit through the winding of a relay S' to ground, and this relay operates. The operation connects battery through the relay armature and closed contacts of relays S_1 , S_2 and S_3 , through the winding of relay S_3 to ground over the contact of relay S'' . Relay S_3 operates and is locked up by a circuit

completed from battery B_2 through the winding of the relay to ground over the contact of relay S'' . The operation of relay S_3 closes a short circuit around the fixed resistance R_3 in series with the field winding of the generator and causes the generator voltage to increase. In addition, the operation of relay S_3 prepares a path, through closed contacts of relays S_1 , S_2 , S_3 and S_4 , through the winding of relay S_4 . With this path prepared, if the armature of the polar relay is again thrown to its lower contact as a result of a further voltage drop in the generator, relay S_4 will operate, lock up, close a short circuit around the resistance R_4 and prepare a path to a bell A_1 . If now the voltage of the generator drops again, the next operation of the armature of the polar relay connects battery to ground through the bell, which operates, summoning an attendant.

If the generator voltage rises above its normal value, the armature of the polar relay is thrown to its upper contact and causes the operation of relay S'' . This operation removes ground from the windings of relays S_2 , S_3 and S_4 , the first named relay being shown in an operated position. The removal of the ground through the contact of relay S'' releases relay S_2 , this release serving to break the short circuit around the fixed resistance R_2 . Consequently, this resistance is placed in series with the field winding of the generator, and the voltage is caused to decrease. The release of relay S_2 connects the winding of relay S_1 to ground through the contact of relay S'' . Therefore, if the generator voltage again increases, causing a second operation of relay S'' , relay S_1 will be released. This release breaks the short circuit around the resistance R_1 , causing a further decrease of generator voltage, and also connects the winding of relay S to ground through the contact of relay S'' . If a still further increase of the generator voltage again operates relay S'' , relay S will be released, closing a circuit through battery and the bell A_2 . This bell will then ring and summon an attendant.

It will be understood from the above discussion of the operation of the system that, with reference to each of the relays S_1 , S_2 , S_3 and S_4 , the contact affected by the armature farthest to the left must make before the next armature to the right breaks its contact; and again, the armature immediately to the right of the electromagnet must make the contact

on the left before it breaks the contact on the right. These four relays are slow acting in both operation and release, and relay S_1 furthermore, is slow operating, in the sense indicated on the drawing. The reason for this arrangement is to prevent the operation of the whole relay chain whenever the polar relay connection touches a contact.

While the invention has been disclosed in a specific embodiment which is deemed desirable, this disclosure being made for the purpose of clear illustration, it is to be understood that the scope of the invention is not limited thereby, but is defined by the appended claims.

What is claimed is:

1. In association with a source of electric current having a resistance associated therewith and controlling the voltage thereof, a system for regulating the voltage of said source, said system comprising a sensitive polar relay, a balance bridge in circuit with the source and responsive by unbalance to variation of the voltage of the source, the unbalancing of said bridge operating said polar relay, means responsive to the operation of said polar relay for changing said controlling resistance associated with the source, and means for giving an alarm if such change fails to restore the voltage level of the source.

2. In association with a source of electric current having a resistance associated therewith and controlling the voltage thereof, a system for regulating the voltage of said source, said system comprising a sensitive polar relay including an armature and two contacts associated therewith, a balance bridge in circuit with the source and responsive by unbalance to variation of the voltage of the source, the unbalance of said bridge due to an increase of voltage operating the armature of said relay to close the first of said contacts and the unbalance due to a decrease of voltage operating said armature to close the second contact, means operated by the closing of said first contact for increasing the controlling resistance associated with the source, means operated by the closing of said second contact for decreasing said resistance, and means operated by the closing of either contact for giving an alarm if the change of resistance fails to restore the voltage level of the source.

In testimony whereof, I have signed my name to this specification this 8th day of August, 1927.

LELAND C. ROBERTS.