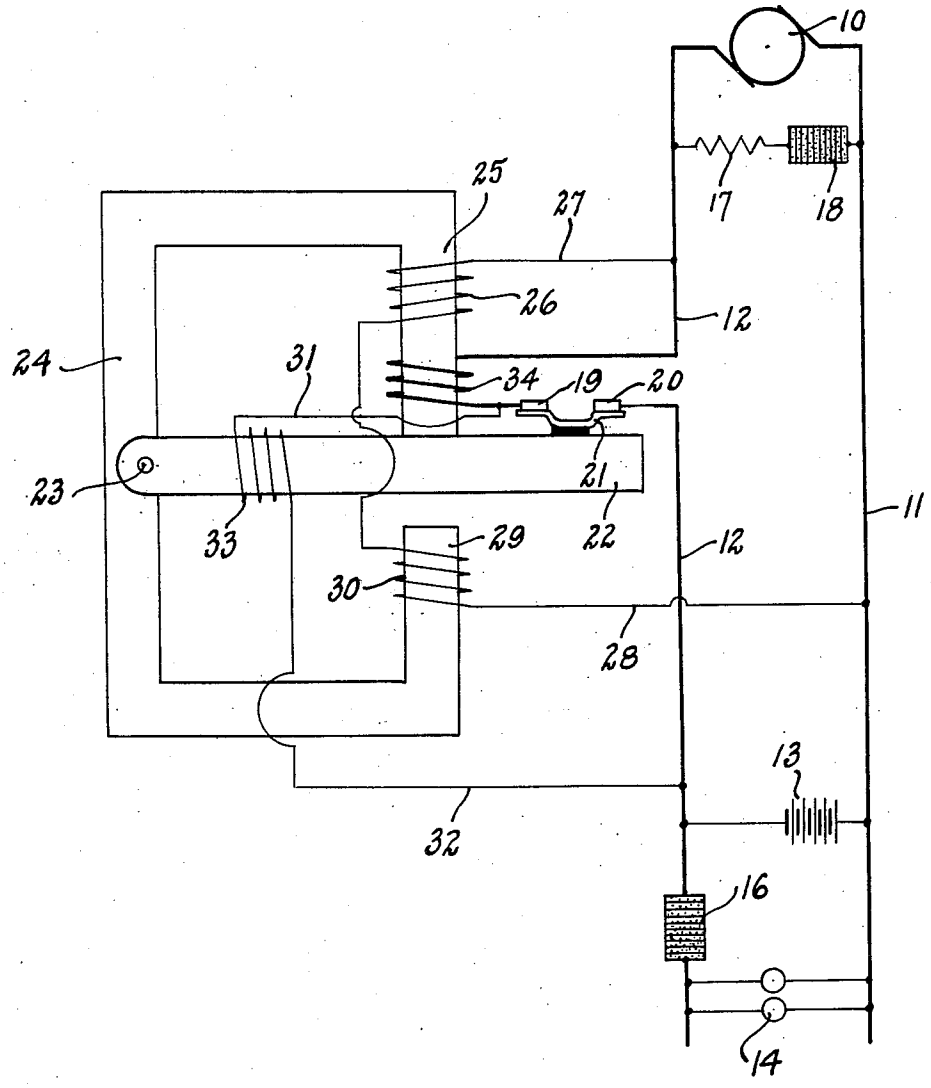
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SWITCH CONSTRUCTION

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UNITED STATES PATENT OFFICE

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SWITCH CONSTRUCTION

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This invention relates to switch construction and more particularly to a switch construction adapted for use in a system of electrical distribution wherein a storage battery is intended at times to be connected to and disconnected from an intermittently operating and variable speed generator, as, for example, in systems of railway car lighting.

One of the objects of the invention is to provide a switch construction for use in a system such as the above and which is capable of accurate and dependable operation under all conditions. Another object is to provide a construction of the above nature capable of a wide range of operation. Another object is to provide a construction of the above nature whereby accidental or unintentional connection of the storage battery and the generator is effectively guarded against. Another object is to provide a switch construction of the above nature which is entirely automatic in action and by means of which the generator is connected to the battery immediately upon the generator voltage reaching substantially the value of the battery voltage, regardless of the wide range of variation in the battery voltage. Another object is to provide a construction of the above nature characterized by simplicity of construction and efficient arrangement of parts. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing in which is shown one of various possible embodiments of this invention, the single figure is a diagrammatic representation of the switch construction embodied in a car lighting system.

Referring now to the drawing in detail, there is shown a generator 10 which is driven from a variable source of power, in this instance from the axle of a railway car. The speed of the generator will thus vary substantially with the speed of rotation of the car axle and the operation of the generator is dependent upon the movement of the car. Energy from the generator 10 is supplied through the conductors 11 and 12 to a storage battery 13 and a translation circuit indicated in this instance as lamps 14.

It is desirable that the voltage across the lamps 14 be kept at a substantially constant value. The voltage impressed across the conductors 11 and 12 may be subjected to substantial variations depending upon various factors. To keep substantially constant the voltage of the translating circuit, that is the voltage across the lamps 14, there is interposed between the translation circuit and the battery a variable resistance device 16 shown in this instance as taking the form of a carbon pile which is automatically controlled. This device is shown only diagrammatically and not in detail since of itself it constitutes no part of the present invention and may take any of various well known forms.

The output of the generator 10 is preferably controlled by controlling in turn the excitation of the generator where the latter takes the form of a shunt-wound generator as in the diagrammatic structure herein disclosed. The field winding of the generator 10 is shown at 17 and interposed in series therewith is a variable resistance device preferably taking the form of a carbon pile 18. This carbon pile may be controlled automatically by any desired well known form of mechanism adapted for this purpose and, thus controlled, this device regulates the excitation of the field 17 in such manner as to maintain the output of the generator voltage at substantially constant value throughout its variations in speed. This regulating device is not shown in detail herein, since, as above-mentioned, it may take any of various well-known forms.

In a system of electrical distribution of the nature of that herein disclosed, it is important that the generator be connected to the storage battery only when the generator voltage is equal to or greater than the battery voltage. If the generator and battery are connected when the battery voltage is greater than the generator voltage, the battery will

discharge back through the generator with disastrous results and probably resulting in ruining the battery. In order to disconnect the generator from the battery, there is interposed in the lead 12 a main line switch. This switch is adapted to operate automatically to connect the generator with the battery upon the generator voltage building up to a value equal to that of the battery voltage, and adapted to disconnect the generator and battery upon the generator voltage dropping below that of the battery. If this switch is closed by accident or otherwise at a time when the generator voltage is less than that of the battery, the disastrous results outlined above will follow.

In a car lighting system such as that disclosed herein, since the actuation of the generator is dependent upon movement of the car, the generator voltage varies from substantially zero when the car is at rest to its maximum value permitted by the regulator 18 when the car has come up to speed. On short-haul runs, that is, in cases where the train makes a number of stops at short intervals, the generator may remain for considerable periods of time at a voltage which is substantially lower than that of the battery. During this time the train may be subjected to severe shocks which may tend to close the switch between the generator and the battery or, the switch may be closed accidentally by a trainman brushing against the movable contact of the switch. It is highly desirable, therefore, when the switch is moved to open position, that it be dependably locked in such position until such time as it may properly be closed.

Moreover, it is highly desirable that the switch close immediately upon the generator voltage attaining a value as great as that of the battery voltage in order that the charging of the battery and supplying of the translation circuit with energy from the generator be started at once. It will be understood that in a system such as that described, the voltage of the battery 13 may vary throughout a wide range. For example, if the translation circuit has been in operation for a considerable length of time while the generator 10 has been idle or running at very slow speed, the battery may approach a state of substantial discharge. On the other hand, at times the battery may be fully charged and at maximum voltage.

Referring again to the drawing, the spaced contacts 19 and 20 inserted in the lead 12 represent the fixed contacts of the main switch of the character described above. The movable contact 21 is adapted to bridge the contacts 19 and 20 and is carried by a lever 22 pivoted at 23 upon an arm 24 which forms a part of a core of magnetic material. Upon the portion 25 of this core is wound a coil 26 which is a voltage coil connected across the terminals of the generator 10 as by the conductors 27 and 28. This coil 26 when energized produces a flux in the core 24—25 which tends to draw the lever 22 upwardly and close the switch at the contact 21. About the portion 29 of the core is a second voltage coil 30 which may conveniently be connected in series with the coil 26 as shown. This coil 30 when energized sets up a flux in the core which tends to hold the lever 22 down against the core portion 29 and thus tends to prevent closing of the switch. The arrangement of the coils 26 and 30 upon the pole pieces 25 and 29 respectively is such that opposite polarity is produced at the extremities of the two pole pieces. Preferably the coils 26 and 30 are each of substantially the same number of turns so that, acting alone, they exert substantially equal forces in opposite directions upon the lever 22.

Connected across the terminals 19 and 20 of the switch by means of conductors 31 and 32 is a coil 33 which may be positioned, for example, upon the lever 22 as shown, the lever 22 being formed of magnetic material as is the core upon which it is pivoted. The current flowing through the coil 33 is dependent upon the difference in voltage between the generator and the battery. The flux set up by the coil 33 tends to hold the lever 22 down against the core portion 29 and thus to hold the switch open. When the generator voltage is lower than that of the battery, the direction of current flow through the coil 33 is such that the flux produced thereby is in the same direction as that produced by the coil 30 and acts in conjunction with the flux of the coil 30. Thus the coil 33 serves as a locking coil and dependably locks the switch in open position as long as the generator voltage is lower than that of the battery. As soon as the generator voltage builds up to a value equal to that of the battery voltage, the current through the coil 33 is reduced to zero and, upon further increase of the voltage of the generator, the direction of current flow in the coil 33 is reversed. The flux produced by the coil 33 is thus reversed in direction and opposes or bucks the flux set up by the coil 30.

Prior to the building up of the generator voltage to a value equal to that of the battery voltage, the coil 26 is unable to lift the lever 22 against the combined actions of the coils 30 and 33 and thus the switch is dependably locked in open position. Immediately upon the generator voltage exceeding the battery voltage, however, the current flow through the coil 33 is reversed in direction and the flux produced by this coil opposes the flux produced by the coil 30, whereupon the coil 26 at once predominates and snaps the lever 22 upwardly to close the switch. When this occurs and the switch is thus closed by the contact 21 bridging the

contacts 19 and 20, the coil 33 is short-circuited and has no effect as long as the switch remains closed. However, the coil 30 is unable to again open the switch against the pull of the coil 26 because of the increased air gap between the lever 22 and the core portion 29 and the decreased air gap between the lever 22 and the core portion 25. Moreover, there is provided in the main lead 12 a series or current coil 34, wound about the core portion 25. This coil 34 comes into action immediately upon closing of the switch and flow of current from the generator to the battery and it dependably holds the switch in closed position.

It may be here noted that the coil 30 is of dominant importance since, without the action of this coil 30, the switch under certain conditions might never close. For example, assume the battery voltage to be very low, as may well be the case as explained above. The coil 33 locks the switch in open position as long as the battery voltage is greater than the generator voltage. As soon as the generator voltage builds up to the equal of the battery voltage, the current in the coil 33 is reduced to zero and its holding effect is zero. At this moment the coil 26 should raise the lever 22 and close the switch. If the battery voltage is low, the generator voltage, which equals the battery voltage at this instant, may not afford the coil 26 sufficient energization to enable the coil to raise the arm 22 to close the switch. Immediately upon a slight further raise in the generator voltage, the coil 33 is again energized by current flowing therethrough in reverse direction and, without the action of the coil 30 at this instant bucking the flux of the coil 33, the coil 33 would again lock the switch in open position and the switch would never close. The coil 30 thus positively prevents this action. For, as explained above, immediately upon the current reversing in the coil 33, the fluxes of the two coils 30 and 33 act in opposition so that after the generator has attained a voltage in excess of the battery voltage, the coil 26 always predominates.

From the above it will be seen that the switch herein disclosed acts dependably to connect the generator with the battery immediately upon the generator voltage attaining a value very slightly greater than the battery voltage, and that this action will take place regardless of the variations in the battery voltage. When the switch is in open position it is dependably locked in such position and this lock is dependably rendered ineffective at precisely the proper time.

Assuming now that the switch has been closed as above described and that the generator is thus supplying current to the battery and the translation circuit, the switch is locked in closed position by the series coil 34. Now when the generator voltage again drops below the battery voltage, the battery will momentarily discharge back through the generator, reversing the direction of current flow through the series coil 34. The flux of the coil 34 then opposes the flux of the lifting coil 26 and the switch immediately opens due to the pull of gravity and the pull of the coil 30. As soon as the switch opens the coil 33 again comes into action to lock the switch in open position until such time as it may properly be closed.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing, is to be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In apparatus of the character described, in combination, a generator, a storage battery, a switch for connecting said generator and said battery, electromagnetic means arranged to exert a tractive effort upon said switch substantially proportional to the generator voltage and tending to close said switch, and electromagnetic means for opposing a closing movement of said switch including an energizing coil responsive to generator voltage and an energizing coil responsive to the difference between generator voltage and battery voltage.

2. In apparatus of the character described, in combination, a generator, a storage battery, a switch for connecting said generator and said battery, electromagnetic means arranged to exert a tractive effort upon said switch substantially proportional to the generator voltage and tending to close said switch, electromagnetic means arranged to act in opposition to said first-mentioned means including a coil for exerting an opposing tractive effort upon said switch substantially equal to the tractive effort exerted thereon by said first-mentioned means, and means for supplementing the tractive effort of said coil while the generator voltage is less than the battery voltage and for counteracting the tractive effort of said coil when the battery voltage exceeds the generator voltage.

3. In apparatus of the character described, in combination, a generator, a storage battery, a switch for connecting said generator and said battery, electromagnetic means arranged to exert a tractive effort upon said switch substantially proportional to the generator voltage and tending to close said switch, electromagnetic means arranged to act in opposition to said first-mentioned means including a coil for exerting an opposing tractive effort upon said switch substantially equal to the tractive effort exerted thereon by said first-mentioned means, and a coil responsive to the difference between gen-

erator voltage and battery voltage for affecting the tractive effort of said coil.

4. In apparatus of the character described, in combination, a generator, a storage battery, a switch for connecting said battery and said generator, two coils serially connected across said generator, the one coil tending to close said switch and the other coil tending to hold said switch open, and means arranged to assist the action of said second-mentioned coil while the generator voltage is less than the battery voltage and to oppose the action of said second-mentioned coil should the generator voltage begin to exceed the battery voltage, thereby to effect a closure of said switch.

5. In apparatus of the character described, in combination, a generator, a storage battery, a switch for connecting said battery and said generator, two coils serially connected across said generator, the one coil tending to close said switch and the other coil tending to hold said switch open, and a coil responsive to the difference between generator voltage and battery voltage so related to said second-mentioned coil that the action of the latter is supplemented while the generator voltage is less than the battery voltage and is opposed should the generator voltage begin to exceed the battery voltage, thereby to effect a closure of said switch.

6. In apparatus of the character described, in combination, a generator, the voltage of which may vary; a storage battery; a switch for connecting said generator and said battery; a coil responsive to a function of the generator voltage for closing said switch; electromagnetic means for holding said switch open and adapted to vary in its effect throughout a range from substantially zero voltage to battery voltage and throughout a range from substantially zero voltage to the value of the difference between generator voltage and battery voltage when the former exceeds the latter; and means for preventing said electromagnetic means from holding said switch open during said second-mentioned range.

7. In apparatus of the character described, in combination, a generator, the voltage of which may vary; a storage battery; a switch for connecting said generator and said battery; a coil responsive to a function of the generator voltage for closing said switch; electromagnetic means for holding said switch open and adapted to vary in its effect throughout a range from substantially zero voltage to battery voltage and throughout a range from substantially zero voltage to the value of the difference between generator voltage and battery voltage when the former exceeds the latter; and means for assisting said electromagnetic means in holding said switch open during said first-mentioned range and for preventing said electromagnetic means from holding said switch open during said second-mentioned range.

8. In apparatus of the character described, in combination, a generator, the voltage of which may vary; a storage battery; a switch for connecting said generator and said battery; a coil responsive to a function of the generator voltage for closing said switch; a coil connected to be responsive to the difference between generator voltage and battery voltage for holding said switch open and exerting a holding action throughout a range from substantially zero voltage, when the battery and generator voltages are substantially equal, to the voltage of the battery when the generator voltage is zero, and throughout a range from substantially zero voltage, when the battery and generator voltages are substantially equal, to a voltage equal to the difference between the generator voltage and the battery voltage when the former exceeds the latter; and a coil responsive to generator voltage for assisting said second-mentioned coil during said first-mentioned range and opposing it during said second-mentioned range, thereby to prevent said switch from being held open during said second-mentioned range.

In testimony whereof, I have signed my name to this specification this 7th day of June, A. D. 1926.

CARL W. EISENMANN.