

DESCRIPTION

TRAFFIC SYSTEM

Technical Field

[0001] The present invention relates to a traffic
5 system for an electric vehicle and, more particularly,
relates to the traffic system suitable for an
electric vehicle which is capable of running even
under a section without an electric power supply.

Background Art

10 [0002] Recently, an electric vehicle equipped with
power storage means and which enables a vehicle
running even without the electric power supply has
been discussed. In this electric vehicle, such power
storage means as either a storage battery or a
15 capacitor is mounted. During a stop of the vehicle
in a station, a required power consumed by a vehicle
running or vehicle mounted electrical equipment
(hereinafter, referred simply to as a required power)
is charged into such a battery as described above and
20 the vehicle runs up to the next station. Then, while
the vehicle stops at each station, the subsequent
required power is charged into the vehicular power
storage means. In addition, each station requires a
substation equipment to supply the electric power to
25 the power storage means mounted in the vehicle. As
these substation equipment and vehicular power
storage means, those described in patent literatures
1 through 6 have been published.

[0003] Patent literature 1 describes that, in a
30 case where the storage battery mounted in a mobile
body (an electric vehicle) is completely consumed,
the completely consumed storage battery is drawn out

to an external of the vehicle and is replaced with a charged storage battery to enable a required electric power replenishment even in a short time of a vehicle stop. Patent literature 2 describes that an
5 electrical double layer capacitor is connected in parallel to a direct current feeder system to reduce capacities of rectifiers in the direct current feeder system. Patent literature 3 describes that a capacitor bank to store the electric energy is
10 mounted in the electric vehicle and a regenerative power of the electric vehicle is charged into the capacitor bank to reduce the supplied power. Patent literature 4 describes that in order to shorten a charge time for a lead-acid storage battery mounted
15 on vehicle, the lead-acid storage battery mounted on vehicle and the electrical double layer capacitor are connected in parallel, a charge power is quickly charged into the electrical double layer capacitor, and a small current is used to charge the lead-acid
20 storage battery during the run of the electric vehicle. Furthermore, each of patent literatures 5 and 6 describes that, in a railway vehicle in which a charging equipment is mounted, the electric power is charged into the battery while the vehicle is running
25 under a power feeder line and the battery is discharged to have the vehicle run at a section without the power feeder line.

[0004] Patent literature 1: a Japanese Patent Application Publication (tokkai) No. Heisei 10-224906
30 which is a published patent in Japan.

Patent literature 2: a Japanese Patent Application Publication (tokkai) No. Heisei 11-91415 which is a published patent in Japan.

Patent literature 3: a Japanese Patent Application Publication (tokkai) No. 2000-4507 which is a published patent in Japan.

Patent literature 4: a Japanese Patent Application
5 Publication (tokkai) No. 2000-253508 which is a published patent in Japan.

Patent literature 5: a Japanese Patent Application Publication (tokkai) No. 2001-78308 which is a published patent in Japan.

10 Patent literature 6: a Japanese Patent Application Publication (tokkai) No. 2002-281610 which is a published patent in Japan.

[0005] In order to charge the required power to the storage means mount type electric vehicle to enable
15 to run even under the section without the power supply, it is necessary to complete the charging time at a station while the vehicle is stalling at the station within a short period of time. It causes to increase the capacity of the substation equipment in
20 short time rating. Tremendous cost and large space are required when this substation equipment is designed with low voltage system. Therefore, high-voltage equipment is required for each substation.

[0006] In view of the above-described points, each
25 patent literature described above is considered as follows: The traffic system described in patent literature 1 requires an extra number of storage batteries and a personnel to replace them is required for each station.

30 [0007] Patent literature 2 utilizes a regenerative power of the electric vehicle so as to enable a capacity reduction in a rectifier and utilizes a quick charge which is possible by using an electrical

double layer capacitor. However, such a traffic system as achieving an electric vehicle run even under the section without the feeder line cannot be architected merely by providing the electrical double
5 layer capacitor as a part of the substation.

[0008] Although it is possible to perform the quick charge in the case of patent literature 3, rectifier and rectifier transformers of the substation require a larger capacity to accommodate
10 for the quick charge and this causes the installation to be increased in substation space and cost.

[0009] Although it is possible to perform the quick charge in the traffic system described in patent literature 4, an increase in an equipment capacity is
15 also required in accordance with a short-time rating and two different kinds of power storage means are required. Mounting space and weight of the storage means are required in the electric vehicle side. Thus, a running performance of the electric vehicle is
20 reduced.

[0010] In addition, in each of railway electric vehicles described in each of patent literatures 5 and 6, power storage means is mounted. Hence, it is possible to run even under the section without the
25 power feeder line. However, the quick charge in a short time requires an increase in capacity of the substation equipment. It is not suitable for the quick charge due to a reduction in a charge efficiency of the storage battery and due to a life
30 reduction of the storage battery.

Disclosure of the Invention

[0011] It is, in view of the above-described points, an object of the present invention to provide

a traffic system in which a capacity of a direct current power supply equipment is reduced, a mounting space of the power storage means in the electric vehicle is saved, and an electric vehicle which is quick chargeable for the vehicle in a short time is used.

[0012] According to one aspect of the present invention, there is provided a traffic system using an electric vehicle in which electric storage means which is charged by means of a substation equipment which carries out an electric power supply to the electric vehicle is mounted and which is capable of running even under a section without a feeder line or a third rail, characterized in that the electrical vehicle is equipped with an electric power storage equipment comprising: an electrical double layer capacitor; an electric power converting section having a regeneration function; and a driving motor controlled via the electric power converting section, with an energy stored in the electrical double layer capacitor as a power source, and the traffic system is constituted by an electric power supply device comprising: a rectifier to rectify an AC power supply to a DC power supply; a serial circuit of another electrical double layer capacitor and a chopper portion which is connected in parallel to the rectifier; and a current supply-and-receiving section for supplying an electrical charge charged in this other electrical double layer capacitor to the electric vehicle to charge the electrical double layer capacitor mounted in the electric vehicle.

[0013] According to another aspect of the present invention, there is provided the traffic system in

which a DC circuit breaker for starting the charge which is interposed between the electrical double layer capacitor of the power supply device and the current supply-and-receiving section.

5 [0014] According to a still another aspect of the present invention, there is provided the traffic system wherein the current supply-and-receiving section comprises a conductor connected to an end of the DC circuit breaker which is opposite to the
10 electrical double layer capacitor and a current collector arranged on the electric vehicle.

[0015] According to a further another aspect of the present invention, there is provided the traffic system wherein the current collector is either
15 a pantograph or the third rail.

Brief Description of Drawings

[Fig. 1] A configuration view of a preferred embodiment of a traffic system according to the present invention.

20 [Fig. 2] A model pattern of charging and discharging for explanation purpose.

Best Mode for Carrying Out the Invention

[0017] A preferred embodiment according to the present invention will be described in details with
25 reference to the accompany drawings.

[0018] Fig. 1 shows a configuration view representing a preferred embodiment according to the present invention. A reference numeral 1 denotes an AC circuit breaker, a reference numeral 2 denotes a
30 rectifier purpose transformer, an alternating current output of this transformer being rectified by means of a rectifier 3. A reference numeral 4 denotes a smoothing capacitor and a reference numeral 5 denotes

an electrical double layer capacitor, both of this station electrical double layer capacitor 5 and a chopper portion 6 being connected in series with each other. The serial circuit of these capacitor and the
5 chopper portion is connected to rectifier 3 in parallel. Chopper portion 6 is constituted by switching elements such as IGBTs and diodes connected in parallel with reverse direction to these switching elements. A control circuit omitted in the drawings
10 performs controls over gates of the switching elements and performs a charge-and-discharge control for electrical double layer capacitor 5. A reference numeral 7 denotes a DC circuit breaker, each element of these 1 through 7 constituting a power supply
15 device. This power supply device is installed at a charging station required or at a proximity to this charging station.

[0019] A reference numeral 10 denotes an electric vehicle, an electrical double layer capacitor 11
20 being mounted in this electric vehicle. A reference numeral 12 denotes an electric power converting section having a regeneration function, a reference numeral 13 denotes an AC driving motor, and a reference numeral 14 denotes rails. Driving motor 13
25 generates a driving force with electrical double layer capacitor 11 as a power source thereof and causes vehicle 10 to run along rails 14. A reference numeral 15 denotes a current supply-and-receiving section and is constituted by a conductor 15a
30 connected to one end of this DC circuit breaker 7 and a pantograph 15b installed on vehicle 10. When vehicle 10 is stopped, conductor 15a is previously positioned to meet pantograph position of 15b. In

addition, electrical double layer capacitor 11 is electrically connected with pantograph 15b and is charged via current supply-and-receiving section 15. Each of these elements 10 through 15 constitutes a power storage equipment of the electric vehicle and a current transfer section to this power storage equipment.

[0020] When, in the traffic system in which the power supply device and the power storage equipment constructed as described above, AC circuit breaker 1 is closed, the AC power is supplied to rectifier 3 via rectifier purpose transformer 2. This rectifier 3 converts AC power to the DC power and, thereafter, is smoothed by means of capacitor 4. A control circuit in chopper portion 6 controls a charging current while monitoring a charge state of electrical double layer capacitor 5. Hence, electrical double layer capacitor 5 is under a stand-by mode while maintaining the charge state of electrical double layer capacitor 5 which enables the power supply for the electric vehicle to be sufficiently run to the next charging station. A charging of electrical double layer capacitor 5 is performed at different time of the quick charge to electrical double layer capacitor 11 mounted in the vehicle, so that, the output of rectifier 3 via transformer 2 is longer than the quick charge and a large current charge is not required for charging.

[0021] When electric vehicle 10 enters and is stopped into station precincts, electric double layer capacitor 11 mounted in vehicle 10 is automatically connectable to current supply-and-receiving section 15 and is ready for the electrical connection.

Thereafter, DC circuit breaker 7 is closed to start the quick charge stored energy in electric double layer capacitor 5 through chopper portion 6, DC circuit breaker 7, current supply-and-receiving section 15, and, then, electric double layer capacitor 11 mounted in the vehicle in a short time. Consequently, electrical double layer capacitor 11 mounted in the vehicle is charged up to a state which enables the vehicle to run sufficiently to the next charging station.

[0022] Then, a brake is applied for electric vehicle 10 when electric vehicle 10 enters the station precincts and, at this time, a regenerative power is developed in motor 13. This regenerative power is supplied to electrical double layer capacitor 11 mounted in the vehicle via power converting section 12. That is to say, whenever motor 13 is in a regeneration state, electrical double layer capacitor 11 is charged and a considerable quantity of energy is accumulated at a time at which the vehicle reaches and stops at the next charging station. The charging from the power supply device during the stop of electric vehicle 10 may correspond only to balance of energy required for the vehicle to reach to the subsequent charging station. Therefore, the energy supply to charge electric double layer capacitor 11 mounted in the vehicle is saved. In addition, since a favorable charge-and-discharge characteristic of the electric double layer capacitor as compared with the other storage battery is used, this can achieve quick and efficient charges and discharges and further can save more time of power supply.

[0023] According to the present invention, the power supply quantity to the vehicle is small and it becomes possible to charge the power storage equipment in a short time during the stop of the vehicle. In addition, a rectifier capacity of the power supply device can be reduced and a low-voltage power reception can be used. The transformer and a switchboard can become a low-voltage power equipment. A construction cost of the substation can remarkably be reduced and a saving of a mounting space in the vehicle and a reduction in a weight thereof can be achieved. Hereinafter, a specific example will be described.

Suppose that a capacity of motor 13 installed in the electric vehicle is 600 kW and its operation state between a power running of motor 13 and the regeneration thereof at a section between stations is 2 versus 1. Fig. 2 shows a model pattern in this operation state. A longitudinal axis denotes an electric power quantity and a lateral axis denotes time. In addition, a running headway of the electric vehicle is supposed to be 180 seconds and a stalling time is supposed to be 30 seconds. In this supposition, the charging quantity of electric double layer capacitor 11 in the electric vehicle is given as follows:

$$600 \times 20 \times 0.5 - 600 \times 10 \times 0.5 = 3000 \text{ kW-S.}$$

Thus, the charge quantity of electrical double layer capacitor 11 of electric vehicle 10 when the vehicle is stopped at the station is an insufficient quantity of 3000KW-S (in the above equation, 0.5 is an electric energy coefficient, the regenerative power is assumed to be half of the power running energy).

In other words, it becomes necessary to charge 3000kW-S at the station in order to run vehicle to the next charging station. A capacity of rectifier 3 required for this charging is expressed as $3000/(180-5 \quad 30) = 20 \text{ kW}$. Hence, as the equipment based on the present invention, the following respective capacities can be realized. That is to say, the capacity of the electrical double layer capacitor mounted in the vehicle is 3000kW-S, the rectifier 10 capacity installed at the substation is 20 kW, and a capacity of the electrical double layer capacitor installed at the substation is 3000kW -S.

[0024] As described hereinabove, according to the present invention, the system is provided at both of 15 the power supply device which enables a power supply of a large current using the electrical double layer capacitor and the power storage equipment which is mounted in the electric vehicle and which enables a quick charge using the electrical double layer 20 capacitor, as well as charging of regenerative energy of the driving motor mounted in the vehicle during the vehicle running.

[0025] This enables quick charge to the electric vehicle during the stop of the vehicle in a short 25 time and this enables a provision of longer time to charge the electrical double layer capacitor in the power supply device from a rectifier of a substation. Furthermore, since a charging energy is small by the advantage of the regenerative power in the power 30 storage equipment, the rectifier capacity can be reduced, the low-voltage power reception can become possible, and the transformer and the switchboard can becomes the low-voltage equipment. In addition, the

construction cost of the substation can remarkably be reduced.

[0026] Since the rectifier capacity can be reduced to enable the quick charge in a short time, the power
5 storage means mounted in the electric vehicle can only include the electric double layer capacitor. It achieves the saving of mounting space and weight of vehicle, as compared with the vehicle in which the two kinds of the power storage means are
10 conventionally mounted in the vehicle.

CLAIMS

1 1. A traffic system using an electric vehicle in
2 which electric storage means which is charged by
3 means of a substation equipment which carries out an
4 electric power supply to the electric vehicle is
5 mounted and which is capable of running even under a
6 section without a feeder line or a third rail,
7 characterized in that the electrical vehicle is
8 equipped with an electric power storage equipment
9 comprising: an electrical double layer capacitor; an
10 electric power converting section having a
11 regeneration function; and a driving motor controlled
12 via the electric power converting section, with an
13 energy stored in the electrical double layer
14 capacitor as a power source, and the traffic system
15 is constituted by an electric power supply device
16 comprising: a rectifier to rectify an AC power supply
17 to a DC power supply; a serial circuit of another
18 electrical double layer capacitor and a chopper
19 portion which is connected in parallel to the
20 rectifier; and a current supply-and-receiving section
21 for supplying an electrical charge charged in this
22 other electrical double layer capacitor to the
23 electric vehicle to charge the electrical double
24 layer capacitor mounted in the electric vehicle.

1 2. The traffic system as claimed in claim 1,
2 wherein a DC circuit breaker for starting the charge
3 is interposed between the electrical double layer
4 capacitor of the power supply device and the current
5 supply-and-receiving section.

1 3. The traffic system as claimed in claim 1 or 2,
2 wherein the energy transfer section comprises a
3 conductor connected to an end of the DC circuit
4 breaker which is opposite to the electrical double
5 layer capacitor and a current collector arranged on
6 the electric vehicle.

1 4. The traffic system as claimed in claim 3,
2 Wherein the current collector is either a pantograph
3 or the third rail.