Charging Devices for Two-Wheel Vehicles

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1. Introduction

Two-wheel vehicles normally employ a system in which electricity is supplied to electrical loads such as the starter motor, head lamp, tail lamp and other illumination systems from the battery power supply. The battery charging system is comprised of three components consisting of the following:

① An alternating current generator that is coupled either directly or by means of a belt and so forth to the engine crankshaft, and converts the rotating energy of the engine into electrical energy.

② A rectifier/regulator (RECT/REG) that rectifies the output of the alternating current generator to charge the battery and maintain the battery at a constant voltage.

③ A battery that stores the electrical energy.

Shindengen is engaged in the design, production and sales of ② , the rectifier/regulator (RECT/REG).

2. Charging System and RECT/REG

The generators used in two-wheel vehicles consist of magnetic alternating current generators having a permanent magnet, or field alternating current generators in which a magnetic field is generated by an electromagnet in the same manner as in four-wheel vehicles. Which one of these types used is determined by the required generator output, the engine layout and the required flywheel mass. In two-wheel vehicles, since the structure is relatively simple, magnetic alternating current generators having a large flywheel mass are widely used in both small and large vehicles. Field alternating current generators are only used in some larger two-wheel vehicles. In addition, single-phase, center tap generators, which are also a type of magnetic generator, are used in smaller two-wheel vehicles, and primarily in scooters.

2-1 Charging System of Field Alternating Current Generators

Field alternating current generators are used to compose a

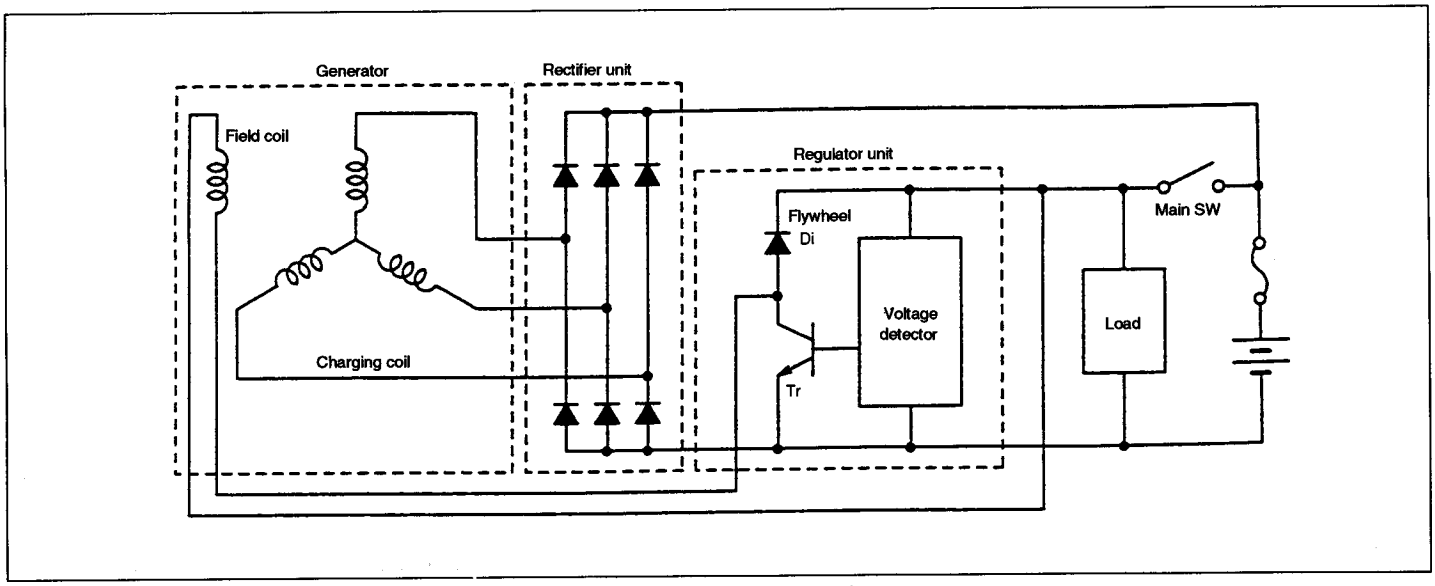

Fig. 1 Charging system diagram of field alternating current generator

system in which the amount of electricity generated by the generator is controlled by the strength of the electromagnet, and are suited for large capacity output. The charging system of a field alternating current generator is shown in Fig.1.

The magnetic field within the generator is emitted by a field coil wound inside the generator. The strength of the magnetic field is controlled by switching a transistor inside a regulator.

Voltage regulation of the charging system of a field alternating current generator is performed in the manner described below.

① Since the battery voltage is lower than the set voltage of the regulator unit when the amount of electricity generated by the generator is less than the amount of electricity required by the load, the transistor inside the regulator remains in the on state causing the generator to produce the maximum output.

② When the rotating speed of the generator increases and the amount of electricity generated rises, battery voltage gradually increases.

③ When the battery voltage exceeds the set voltage of the voltage detector of the regulator unit, the transistor is switched off causing the generator output to be decreased.

④ The transistor repeatedly switches on and off so that the battery voltage reaches the set value, and the current of the field coil is converted to direct current (pulsating current) by a flywheel diode inside the regulator.

⑤ As shown in Fig.2, if the on duty of the transistor is large, the current flowing to the field coil also increases. This causes the magnetic field to become stronger resulting in an increase in the amount of electricity generated. Conversely, if the duty of the transistor is small, the magnetic field weakens and the amount of electricity generated decreases. Battery voltage remains constant in order to regulate the duty of the transistor inside the regulator so that an amount of electricity is generated that matches the load requirement.

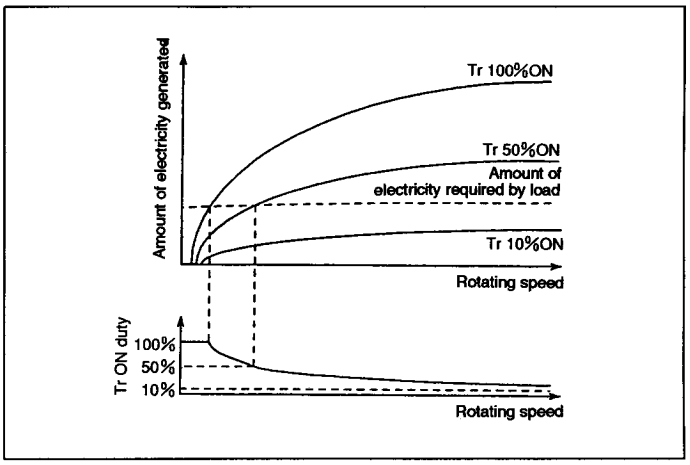

Fig. 2 Relationship between amount of electricity generated by a field alternating current generator and transistor ON duty

2-2 Charging System of Magnetic Alternating Current Generators

Since magnetic alternating current generators use a permanent magnet for the field, the amount of electricity generated is determined exclusively by rotating speed as shown in Fig.4. Accordingly, the amount of surplus electricity changes according to the load used and the condition of the battery.

It is necessary to discard any surplus electricity since the battery may be overcharged if this surplus electricity charges the battery.

In the example of a system shown in Fig.3, a bypass circuit is installed in the regulator unit that uses a thyristor.

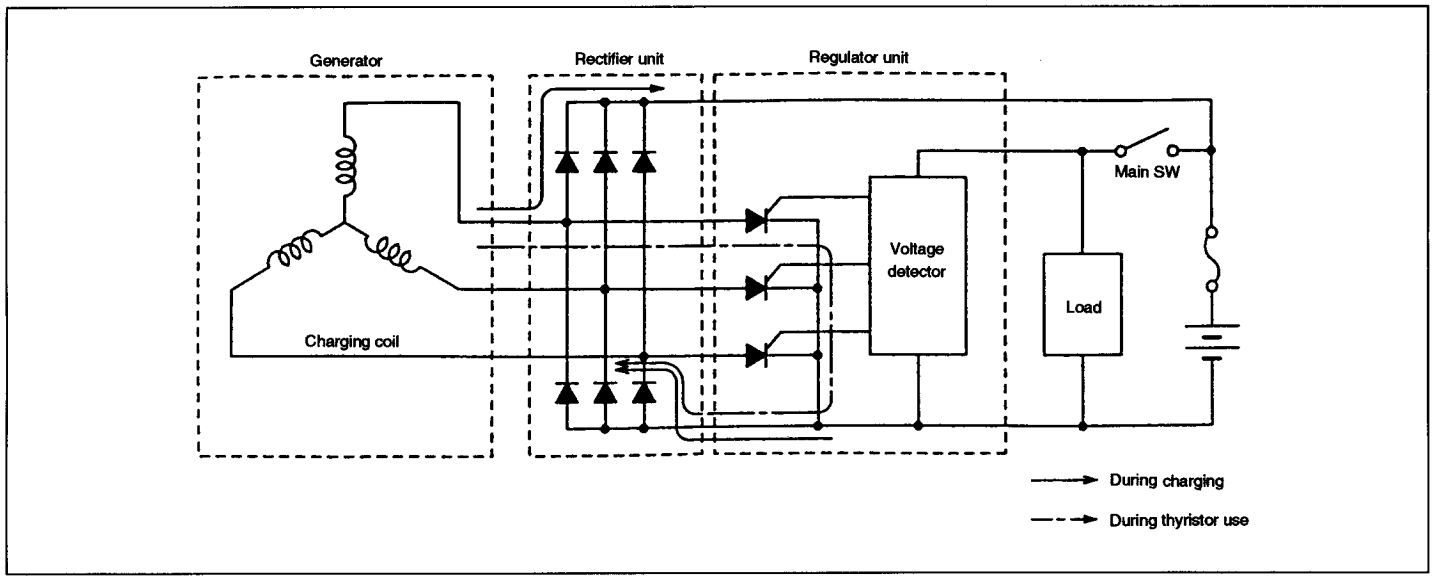

Fig. 3 Charging system diagram of a magnetic alternating current generator

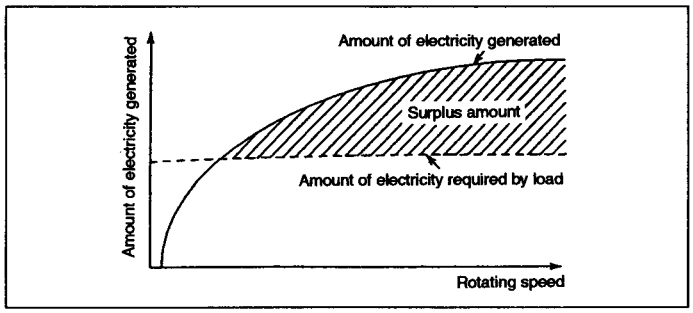

Fig. 4 Amount of electricity generated by magnetic alternating current generator

This type of system is typically referred to as a thyristor shorting system. The operation of this system is explained below.

① Current generated by the magnetic alternating current generator is rectified by the rectifier unit and used to charge the battery.

② Battery voltage increases as charging progresses.

③ The thyristor is triggered when the battery voltage exceeds the set voltage of the voltage detector inside the regulator.

④ Since the thyristor is activated which causes the output of the generator to return to the generator without passing through the battery, battery charging is stopped which prevents any further rise in voltage.

Although there is another type referred to as a thyristor open type in which the rectifier unit is composed of thyristor/diode mixed bridge, these are hardly ever used in two-wheel vehicles.

2-3 Single-Phase Center Tap Generator System

In order to ensure battery charging at low rotating speeds, center tap generators are composed by adding a generator coil to the lamp coil. As shown in Fig. 5, the positive cycle of the generator is used for charging, while the negative cycle is used for rms value control of the lamp. In addition, this system is characterized by illuminating the head lamp, which is the largest load, with alternating current, thereby making it possible to minimize electrical discharge from the battery when the engine is not running. The operation of this system is described below.

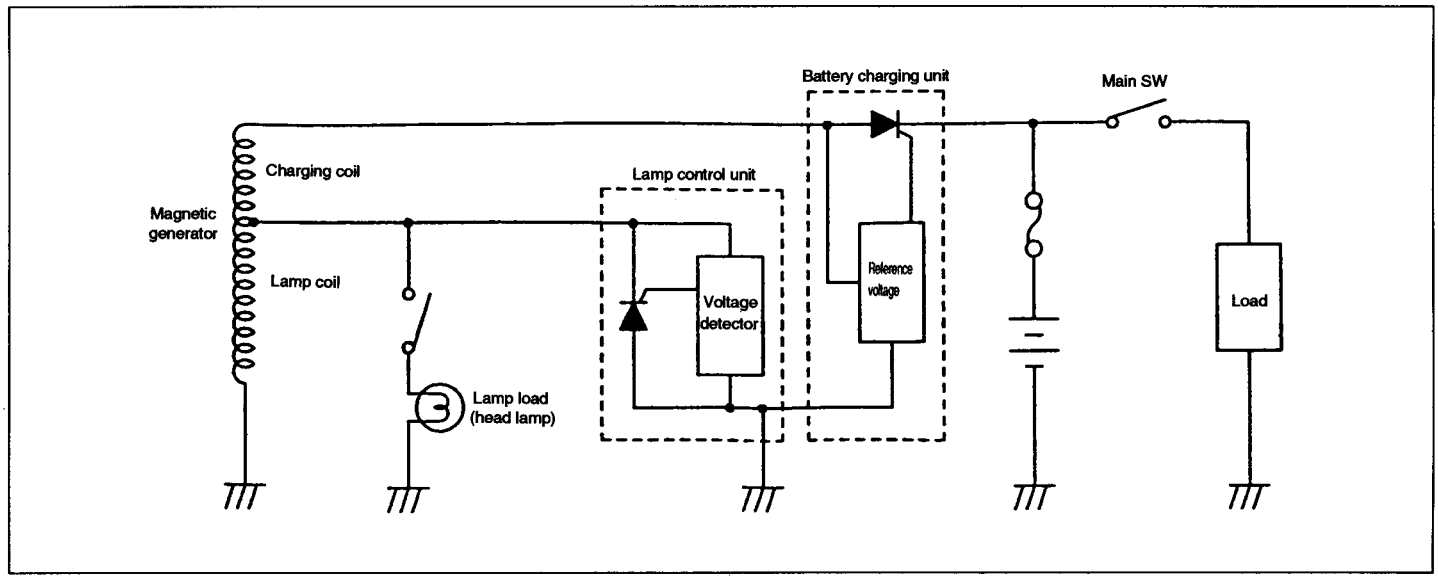

Fig. 5 System diagram of center tap generator

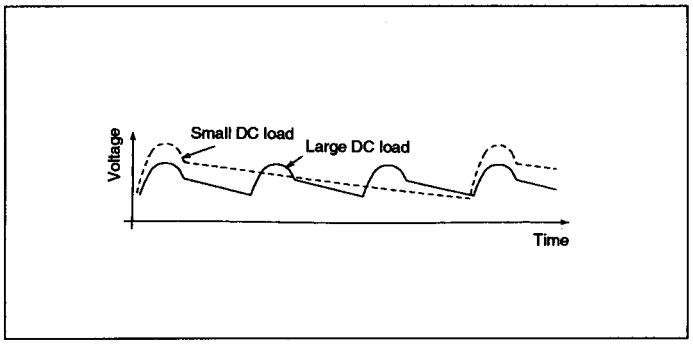

Fig. 6 Battery voltage control waveform

- The battery charging unit is composed of a thyristor and a reference voltage unit. Charging is controlled by comparing the battery voltage and reference voltage by means of gate of the thyristor. When the battery voltage is higher than the reference voltage, the thyristor maintains the blocked state, and when the battery voltage is low, current flows to the gate of the thyristor from the reference voltage unit causing the thyristor to become active and charge the battery. As a result of this operation, the battery voltage is charged intermittently as shown in Fig.6 so that it is maintained at a

constant level.

- The lamp control unit is composed of a thyristor that shorts both ends of the lamp coil and reduces the voltage applied to the lamp, and a voltage detector that detects the effective voltage at both ends of the lamp and changes the gate trigger phase of the thyristor. The gate trigger phase of the thyristor changes as shown in Fig.7 according to the voltage at both ends of the lamp, thereby allowing the effective voltage of the lamp to remain constant.

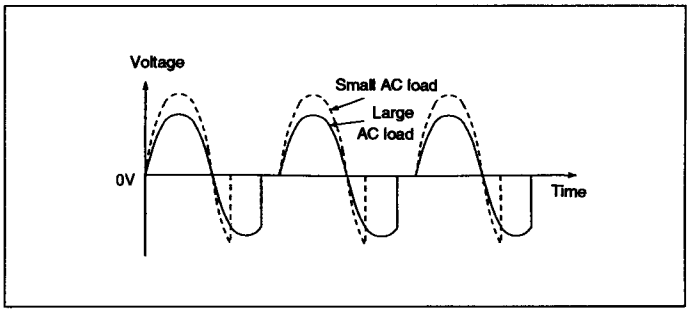

Fig. 7 Lamp voltage control waveform

3. RECT/REG Product Lineup for Two-Wheel Vehicles

Table 1 lists the lineup of RECT/REG products for two-wheel vehicles currently mass produced by Shindengen. The products offered by Shindengen for two-wheel vehicles include those for three-phase field AC generators and those for single-phase and three-phase magnetic AC generators.

Generating System			Rated Voltage	Max. Output Current
Field	3-phase, full-wave		6 V, 12 V	~ 30 A
Magnetic	3-phase, full-wave		6 V, 12 V	~ 40 A
	Single-phase	Single-coil, full-wave	6 V, 12 V	~ 24 A
		Center tap	6 V, 12 V	Charging unit: ~ 12 A Lamp control unit: ~ 12 A

Table 1 RECT/REG Product lineup for two-wheel vehicles

4. Conclusion

RECT/REG are merely one of the electrical components of two-wheel vehicles that simply perform current rectification and regulation of battery voltage. In the future, however, as the use of electronic components in control mechanisms continues to progress, RECT/REG devices will become essential for two-wheel vehicles. Consequently, these devices will be required to provide even higher levels of reliability. One of the factors that contributes to reduced reliability is excessive internal temperature rise caused by poor heat radiation conditions. For the future, it will therefore be necessary to develop RECT/REG devices having low heat radiation dependency and improve temperature toughness while focusing on this point.

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