Electrical Equipment for the N700S Shinkansen High-Speed Train of Central Japan Railway Company

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Fuji Electric has been supplying electrical equipment for Shinkansen train throughout the entire history of the Tokaido Shinkansen, starting with the Series 0 up to the N700A. Central Japan Railway Company has developed the N700S, the first fully-redesigned in 13 years since the release of the N700 Series. The N700S is aimed at safer and more stable transportation and designed to improved environmental performance, such as energy savings, comfort, and convenience for passengers. The N700S is a standard train that is able to flexibly accommodate various train consists other than 16 car-sets, such as 8-car-sets and 6-car-sets.

To complete the next-generation N700S trains, Fuji Electric has developed the traction equipment and the fully active damper drive system to be incorporated into the fully active damping control system. We completed the functionality and performance evaluation of the electrical equipment using prototype train and delivered it for use in the mass-produced N700S trains (see Fig. 1).

Fig.1 N700S Shinkansen train
(Photo courtesy of Central Japan Railway Company)

1. Traction Equipment

1.1 Equipment specifications

Figure 2 shows the system configuration of the traction equipment, which consists of the main transformer, main converter inverters and traction motors. The secondary winding of the main transformer is split into three or four sections, each connected to a main converter inverter that drives four traction motors. Table 1 shows the equipment specifications.

1.2 Features

The N700S achieves a standard train that accommodates various train consists. This entailed optimally arranging the traction equipment under the floor. Furthermore, the traction system installed under the floor is highly required to be compact and

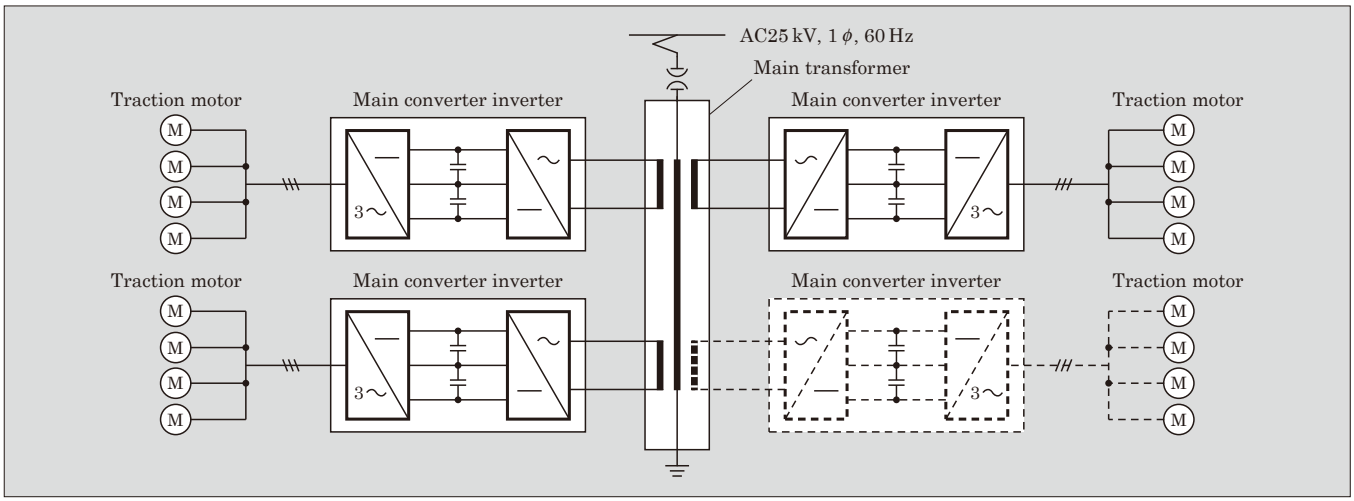

Fig.2 System configuration of traction equipment

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Table 1 Specifications of traction equipment

Item		Specification
Nominal overhead voltage		25 kV AC, single-phase, 60 Hz
Main transformer	Type	Single-phase shell-type pressureless sealed system (Secondary winding: Three-split or four-split)
Main converter inverter	Circuit configuration	3-level PWM converter 3-level PWM inverter
	Power device	SiC power semiconductor module
	Cooling system	Blower-less cooling system
Traction motor	Type	Squirrel cage induction motor
	Number of poles	6 poles
	Rated voltage	2,300 V AC
	Rated output	305 kW (continuous)

lightweight to leave the space for the large-capacity battery, which is used for self-propelled operation during extended power outage and improved convenience. Figure 3 shows the appearance of each piece of equipment.

The following features made it possible to reduce the size and weight of the traction equipment:

(1) The main transformer is designed to reduce the copper loss compared with the conventional model, and aluminum wire is used. Moreover, it utilizes a unit cooler for its cooling system. This design has reduced the main transformer with a four-split secondary-winding by 12% in size and 10% in weight.

(2) The main converter inverter uses SiC power semiconductor modules that combines silicon carbide Schottky barrier diodes (SiC-SBDs) and insulated gate bipolar transistors (IGBTs). The modules' low loss and high heat resistance allow the cooling system to be reduced in size and weight. Moreover, the main converter inverter achieved a 9% size reduction and 14% weight reduction compared to conventional models by adopting an optimized structure and conductor configuration in its power unit.

(3) For the traction motor, the number of poles has been increased from conventional four to six, and a low loss iron core material has been used. As a result, it has been reduced by 11% in size and by 17% in weight.

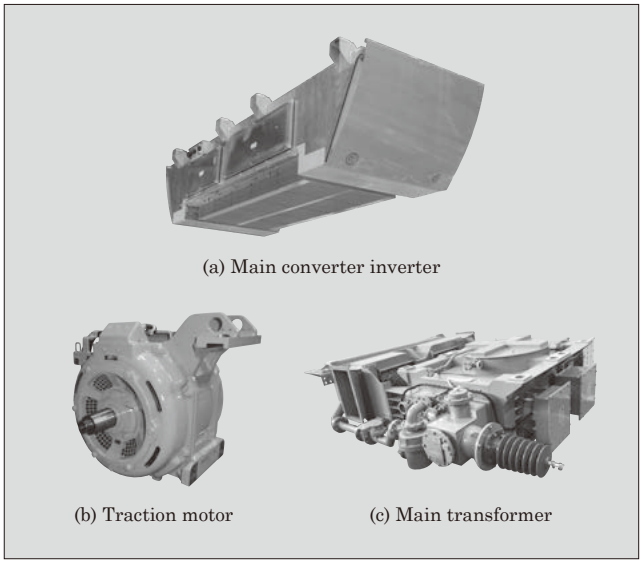

Fig.3 Traction equipment

2. Fully Active Damper Drive System

2.1 Equipment specifications

The N700S uses a fully active damping control system for the railcars, including green cars, to improve riding comfort. This control system includes a fully active damper drive system, which consists of a damper motor and its drive system. The damper motor drives a hydraulic pump that supplies hydraulic pressure to the damper to suppress the lateral vibration of the railcar, improving riding comfort. Table 2 shows the equipment specifications.

2.2 Features

The features of the fully active damper drive system are as follows: Figure 4 shows the appearance of the drive system.

(1) The drive system enclosure has a sealed structure to reduce the number of maintenance parts, such as filters. Therefore, it is designed to cool the internal components with only internal circulating air in the enclosure.

(2) A damper motor has been downsized to be in-

Table 2 Specifications of fully active damper drive system

Item		Specification
Motor drive system	Input voltage	100 V AC
	Output voltage	100 V AC (three-phase)
	Structure	Sealed enclosure, waterproof and dustproof
Damper motor	Type	Synchronous motor
	Voltage	100 V AC (three-phase)
	Rated torque	1.1 N·m
	Rated rotational speed	3,000 r/min

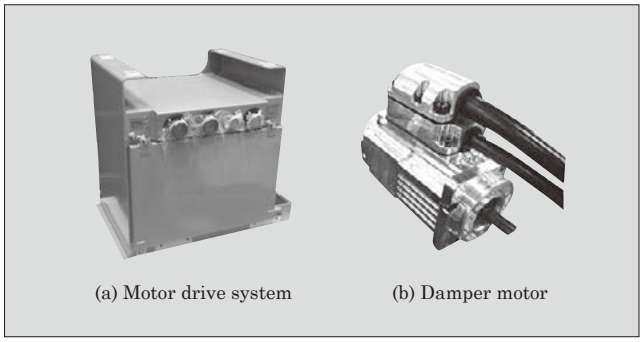

Fig.4 Fully active damper drive system

stalled in the limited space of a bogie and its vibration resistance has been improved in consideration of the actual conditions for running.

Start of commercial operation

July 2020

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