

New Compact Gas-Insulated Switchgear

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1. Introduction

The gas-insulated switchgear (GIS) has many advantages such as reduced size, high reliability, and laborsaving maintenance. Consequently, GIS applications have expanded both in domestic and foreign markets over the past decade.

Further, the trend toward reduced costs, especially the request for lower personnel expenses, is also affecting substation equipment. Reduced construction time, simplified transportation and installation work, and minimized installation space have been strongly requested.

In response to these requests, GIS has been eagerly developed with the goals of downsizing, lighter weight and improved maintenance. The development of the 72.5kV class GIS, which has the largest number of bays, is especially remarkable.

This paper describes details of Fuji Electric's newly developed, compact size GIS.

This development aims to decrease the size and improve the cost performance of the total substation through the elimination of dead space and consideration of maintenance ease, in addition to the minimization of equipment.

2. Ratings and Specifications of the New Compact GIS

The main ratings and specifications of the newly developed compact GIS are indicated in Table 1.

The outer view of a new compact GIS (cable feeder bay) is shown in Fig. 1, and the inner construction of the GIS is shown in Fig. 2.

3. Special Features of the New Compact GIS

3.1 Development concept

During development, we realized many new challenges, some of which applied new technologies, based on our history of shipping many 72.5kV GIS. These concepts are as follows.

(1) Expanded range of equipment-integration

By integrating equipment on the line-cable connec-

tion unit [isolator (DS), earthing switch (ES), lightning arrester (LA), voltage transformer (VT), etc.], the present 3-tanks should be decreased to 1-tank.

However, the busbar unit and circuit breaker (CB) unit shall remain with the same construction as in the present integration.

Table 1 Ratings and specifications

Type designation		SDH208
Rated voltage (kV)		72.5
Withstand voltage	AC (kV)	140
	LIWV (kV)	350
Rated normal current (A)		800, 1,200, 2,000, 3,000
Rated short-time withstand current (kA)		20, 25, 31.5
Rated SF ₆ gas pressure (MPa)		0.5
CB	Rated voltage (kV)	72.5
	Rated interrupting current (kA)	20, 25, 31.5
	Rated interrupting time (cycle)	3
	Operating mechanism	Motor-spring
DS	Rated voltage (kV)	72.5
	Operating mechanism	Motor, motor-spring
ES	Rated voltage (kV)	72.5
	Operating mechanism	Motor-spring, manual
LA	Type	ZnO
	Rated voltage (kV)	84
	Nominal discharge current (kA)	10
	Switching surge duty capa. (μF)	25
VT	Type	Gas-insulated winding type
	Rated primary voltage (kV)	66
	Rated secondary voltage (V)	110
	Rated tertiary voltage (V)	110/3
	Rated burden (sec./tert.) (VA)	3 × 500/3 × 200
	Accuracy (sec./tert.) (class)	1P/3G
CT	Type	Gas-insulated, cable mount
	Rated primary current (A)	According to customer's spec.
	Rated burden (VA)	10, 40
	Accuracy (class)	1P

Fig.1 Outline of newly developed GIS (cable-feeder bay)

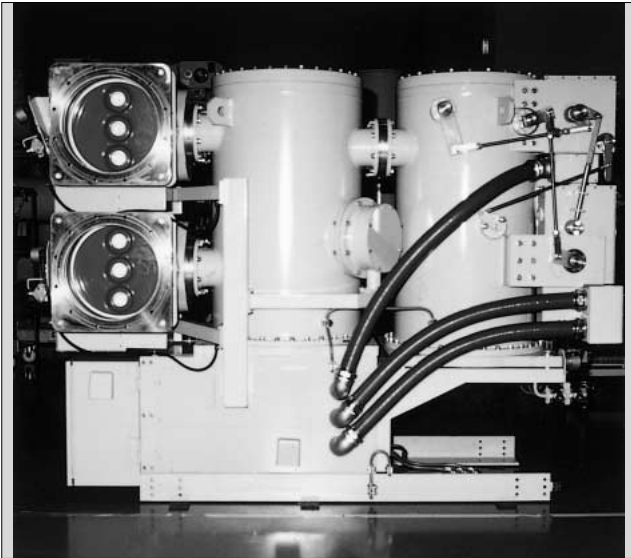
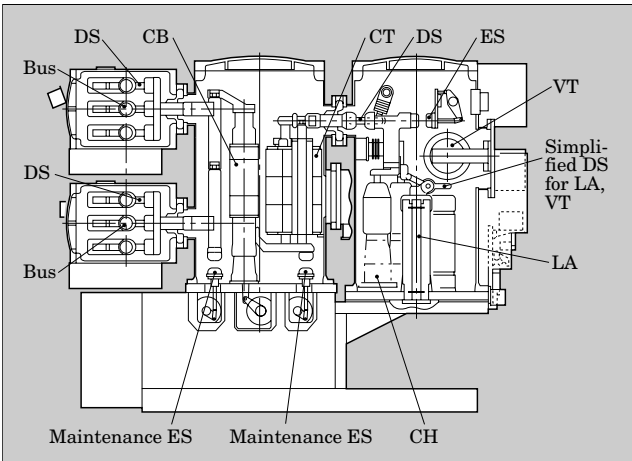


Fig.2 Sectional view of newly developed GIS



(2) Application of aluminum casting for the busbar tank

The use of aluminum casting for the busbar tank is expected to result in lighter mass and suppress the temperature rise.

(3) Structure that allows maintenance from front and rear

Operating mechanisms and monitoring devices that require maintenance are arranged at the front and rear of the GIS. Maintenance and inspection between bays is unnecessary.

(4) Low profile

Since the total height of the GIS is designed to be low, inspection scaffolding can be omitted. Further, since the fully assembled transportation of two or more bays is possible under certain circumstances, the onsite construction time can be shortened and productivity improved.

Fig.3 Principle of arc-quenching

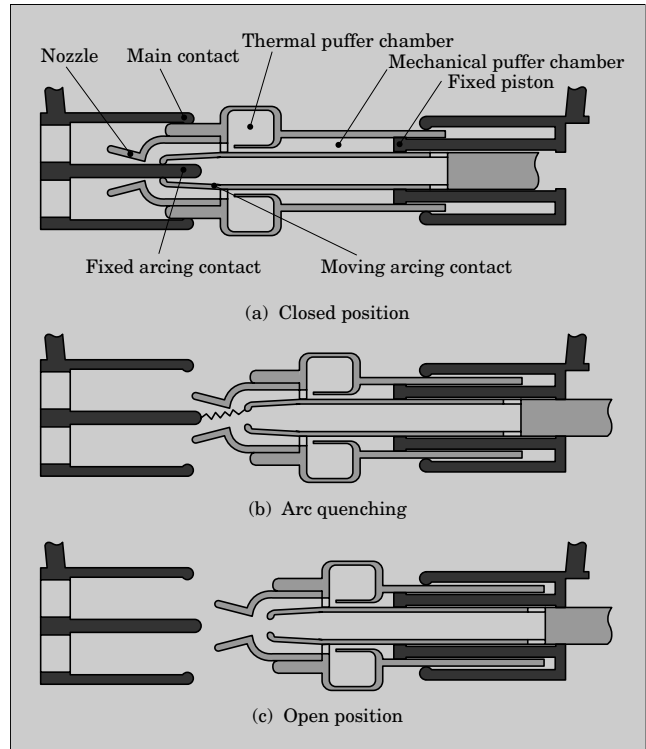


Fig.4 3-D model for earthquake analysis

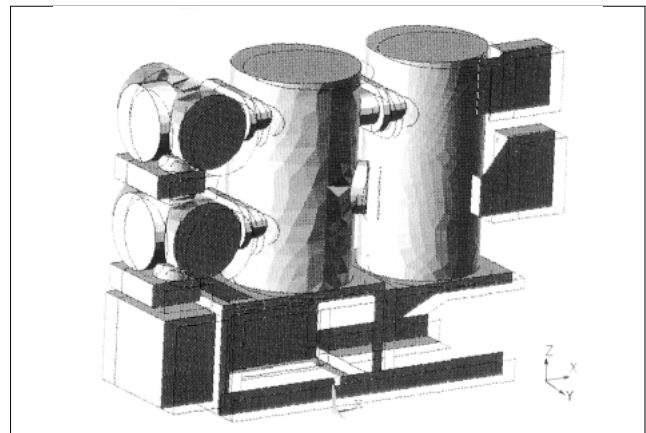


Fig.5 3-D model for electric field analysis (cable sealing end, lightning arrester)



3.2 Application of new technology

The following new technologies have been utilized in the development of the GIS.

- (1) Application of a mechanical and thermal puffer to the CB-interrupting unit, and application of a motor charged spring-type operating mechanism

This interrupting method has been widely used in the dead tank type SF₆ gas circuit breaker (GCB) and in the cubicle type GIS, but this is the first application to the GIS. The interrupting chamber of this method has two main mechanisms, one is the thermal puffer (self-arc-extinguishing) which increases the blast-gas pressure utilizing the thermal energy generated by the arc itself, and the other is the mechanical puffer in which the blast-gas pressure is generated mainly by mechanical compression and is useful for small current interruption.

By utilizing the thermal puffer, the operating energy could be decreased to less than 50% that of the conventional type of mechanical puffer. To help decrease the operating energy, a low-power motor-charged spring type operating mechanism was applied as a standard part.

- (2) Application of high-performance lightning arrester

By decreasing the thickness and increasing the

withstand voltage of the ZnO element, the height of the arrester unit could be shortened and its weight made lighter. Further, the residual voltage could be decreased.

By downsizing the arrester unit, the line-side

Fig.7 Comparison of the overload current carrying capability

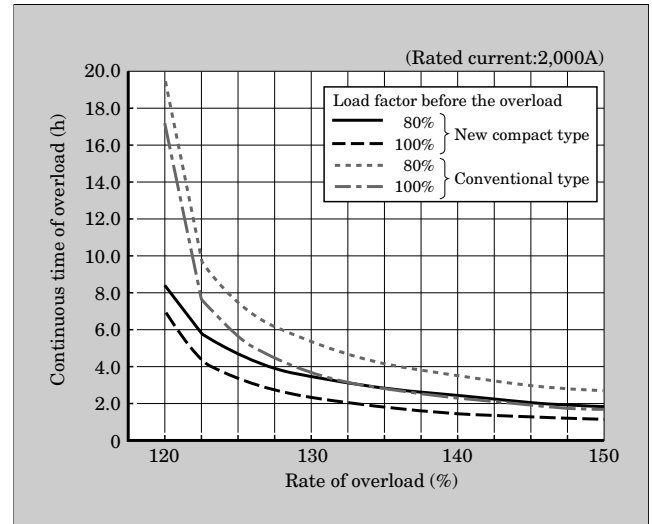


Fig.8 Transportation of full assembled GIS

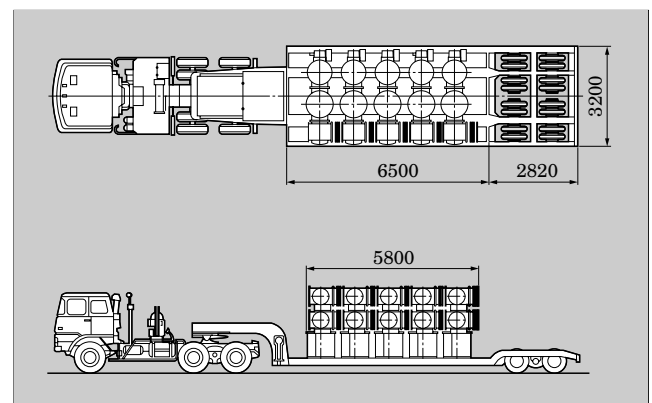
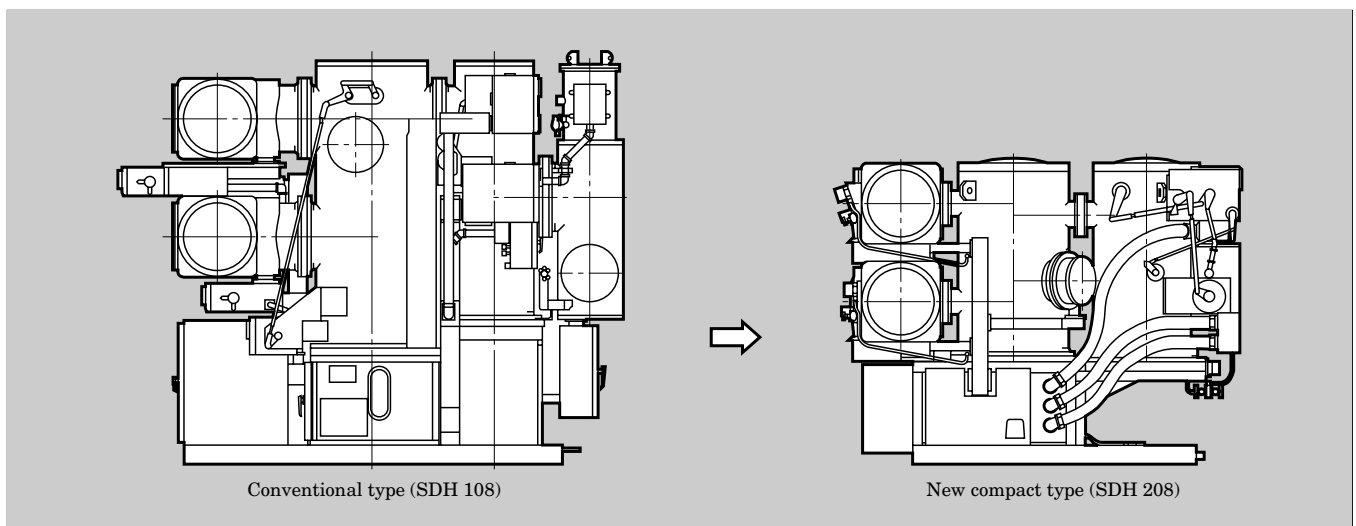


Table 2 The comparison between conventional type and new type

Item	Type	Conventional type	New compact type
Height	(mm)	3,100	2,300
Depth	(mm)	3,500	2,700
Bay width	(mm)	1,500	1,100
Mass	(%)	100	68
Installation space	(%)	100	57
Volume	(%)	100	42
Number of parts	(%)	100	70

Fig.6 Outline comparison of each type GIS



equipment could be integrated, the insulation coordination improved, and the LIWV decreased.

All of the newly designed parts, including the application of new technologies, were evaluated by 3D-electric field analysis and mechanical stress analysis. In addition, the specified and practical tests have been verified with an actual prototype GIS.

As an example analysis, the 3D-model for earthquake analysis is shown in Fig. 4 and the 3-D model for electric field analysis is shown in Fig. 5.

3.3 Comparison with conventional GIS

The new compact GIS, developed based on new concepts and new technologies, is compared to the conventional GIS and the results are shown in Table 2 and Fig. 6. By decreasing the bay width to 1,100mm, the total volume was decreased to 42% of that of the conventional GIS.

This fact can contribute, especially in the case of indoor substations, directly to decrease building dimensions and reduce costs. On the other hand, the increased rate of equipment integration and downsizing of the tank could lower the rated tolerance for temperature rise and the overload current carrying capability could become less than that of the conventional GIS. The overload current carrying capability at the rated current of 2,000A is shown in Fig. 7.

In the past, each GIS bay was transported on a

separate low-platform trailer. Now, the new compact GIS can be transported two bays at a time on a 10-ton truck, or completely assembled five bays at a time on a low-platform trailer (Fig. 8). These conditions are expected to decrease the onsite installation time.

To guarantee reliability, the following items in the GIS maintain their conventional construction.

- (1) SF₆ gas-insulated current transformer (CT)
- (2) Straight line arrangement of conductors in a gas-tight support insulator
- (3) Straight line movement of DS/ES contacts
- (4) Application of a motor charged spring-type operating mechanism to the DS/ES with current switching capacity

4. Conclusion

A summary of the new compact GIS has been presented. This GIS has been tested with the model test and special tests according to the related standards of each piece of equipment; good results were obtained, and consequently the verification of performance and functions of this GIS is complete.

In the future, we plan to make this new GIS maintenance-free, improve trouble shooting, and increase reliability furthermore. We sincerely hope that the customer would provide us with much of advice and encouragement in the future.





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