Fuji Electric

Innovating Energy Technology

Phase Segregated Type

SF_6 Gas Insulated Switchgear

Type SDA514 for 72.5 to 145 kV

06B1-E-0015

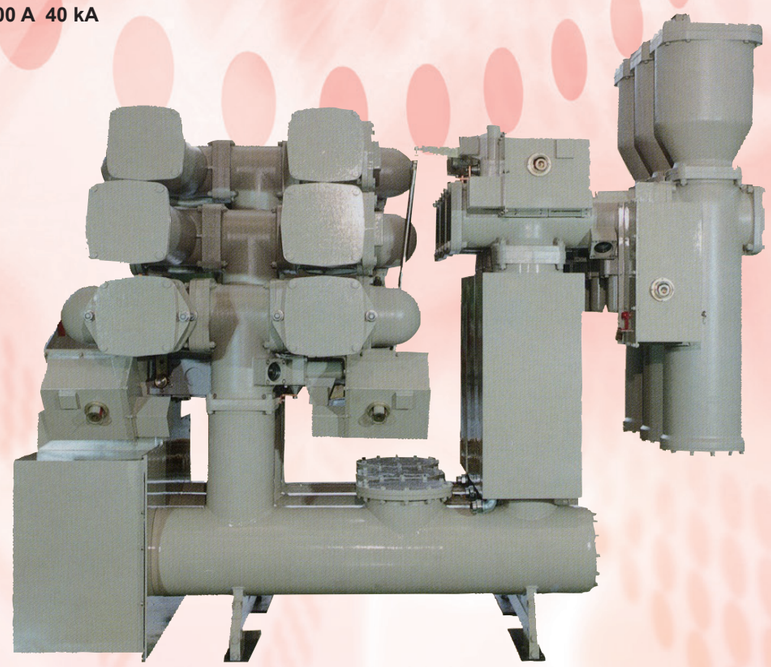
Small Space Requirement & High Reliability

The number of application for SF_6 gas insulated switchgear has been tremendously growing all over the world, because it has many advantageous features as below:

- **Small space requirement**
- **High reliability**
- **Safety**
- **Good harmony with environment**
- **Long maintenance intervals**
- **Short erection period at site**

Fuji started the development of SF_6 gas insulated switchgear (GIS) in 1966.
The first 72.5 kV GIS, which was of the phase segregated type, was put into operation in 1970.
Since then Fuji also developed three phase encapsulated type GIS in addition to phase segregated one as our standard series of GIS.
Based on these experiences with high technology, Fuji has successfully developed as a standard series which realizes a quite compact and very reliable construction of phase segregated type GIS.
The 72.5 kV and above GIS is being manufactured in our substation equipment factory located in Chiba prefecture, Japan. The substation equipment factory has been recognized to be in accordance with the requirements of the quality standards ISO 9001.

SDA514 145 kV 2000 A 40 kA



Characteristic Features

Small overall dimensions make for minimum space requirements.
Therefore, the costs of foundations and buildings can be minimized.

Long service life of the switchgear can be realized due to nonoxidizing of SF_6 gas in enclosure and oil in electro-hydraulic operating mechanism.

The modular design principle applied realizes the standardization of components and parts.
This makes possible the large quantity production way which increases the reliability of components and parts with their easy stock control.

The fully earthed enclosure protects operators not to touch live parts directly, prevents from radio interference, and realizes no atmospheric pollution.

Technical data

Rated voltage	[kV]	IEC	72.5	100	123	145
		ANSI	72.5	—	121	145
		JEC	72	—	120	—
Rated power frequency withstand voltage	[kV]	IEC	140	185	230	275
		ANSI	160	—	260	310
		JEC	140	—	230	—
Rated lightning impulse withstand voltage	[kV]	IEC	325	450	550	650
		ANSI	350	—	550	650
		JEC	350	—	550	—
Rated normal current	[A]	Busbar	2000, 3150			
		Others	1250, 2000, 3000			
Rated short-circuit breaking current		[kA]	31.5, 40			
Rated short-time withstand current (3 sec.)		[kA]	31.5, 40			
Rated peak withstand current	[kA]	IEC, JEC	80, 100			
		ANSI	85, 108			
Rated SF_6 gas pressure, gauge (at 20 ℃)	[MPa]	Switchgear	0.6			
		Circuit breaker	0.6			
Rated break time of circuit breaker		[cycles]	3			
Rated operating sequence of circuit breaker (standard)		IEC	O-3 min-CO-3 min-CO, CO-15 s-CO, O-0.3 s-CO-3 min-CO			
		ANSI	CO-15 s-CO, O-20 cycles-CO			
		JEC	O-1 min-CO-3 min-CO, CO-15 s-CO, O-0.35 s-CO-1 min-CO			

Section of a Cable Feeder Bay with Double Busbar

Fig.1 Sectional view of a cable feeder bay with double busbar

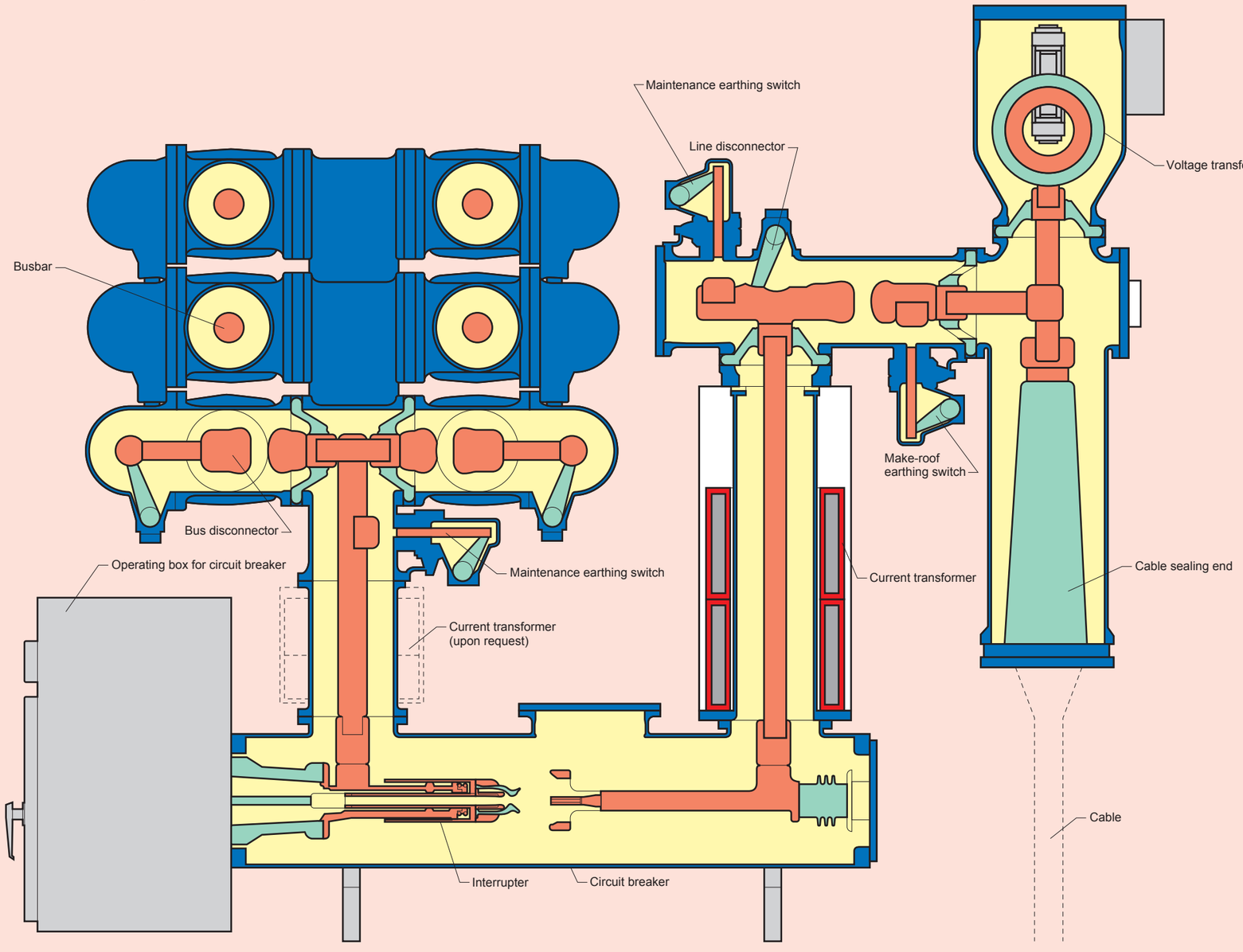
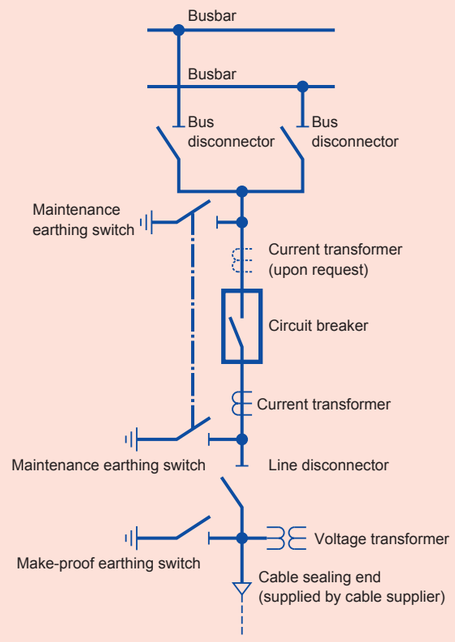


Fig.2 Single line diagram of double cable feeder bay with double busbar



Components and Construction

Circuit breaker

Thousands of Fuji SF_6 circuit breakers with hydraulic operating mechanism were delivered into all over the world and have been in satisfactory operation since 1973.
The SF_6 switchgear is equipped with the single pressure puffer type gas circuit breaker with hydraulic operating mechanism which is used uniformly also for outdoor circuit breakers.
Fuji SF_6 circuit breakers have the advantages:

- **Low noise level during operation**
- **Excellent interruption performance**
- **Long maintenance intervals**
- **Individual energy supply, no air-compressor necessary**

The earthed metal housing accommodates single pole interrupter fixed on insulating mount and support insulator for each phase.
At the front of the circuit breaker, the operating box is arranged, which accommodates hydraulic operating mechanism and monitoring unit for the circuit breakers. The interrupter has a double-flow system and the compressed SF_6 gas which is produced by the movement of the puffer cylinder at opening, flows into both directions in order to distinguish effectively the generated at arcing contacts. The moving section is composed of nozzle, moving contact and puffer cylinder connected to hydraulic operating mechanism through insulating rod and operating links mechanically.
The current path is composed of fixed contact support, fixed contact, moving contact and moving contact support.
This inspection and replacement of nozzle and arcing contacts can be carried out by removing the access cover.

Fig.3 Section of SF_6 circuit breaker

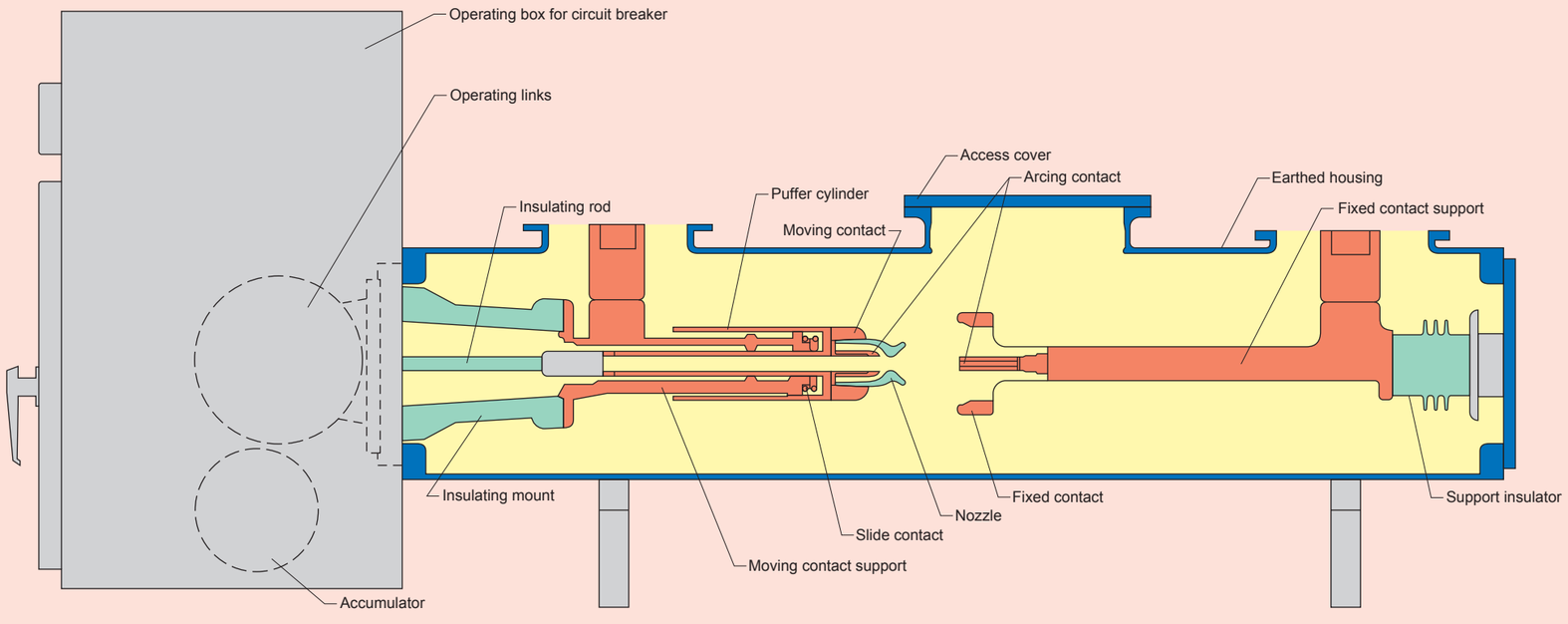
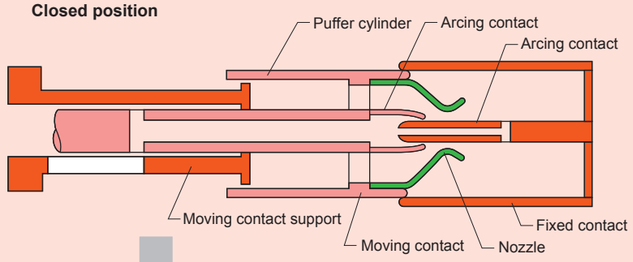


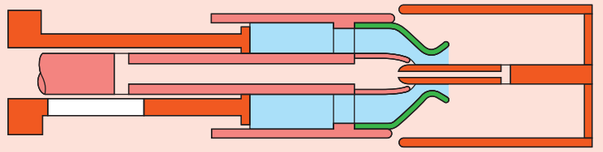
Fig.4 Principle of arc quenching

Closed position



Opening (priming)

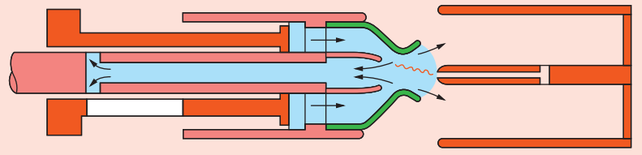
SF_6 gas in the puffer cylinder is being compressed.



When trip commences, the puffer cylinder is driven towards the moving contact support.
The SF_6 gas trapped in the enclosed space is thereby compressed.

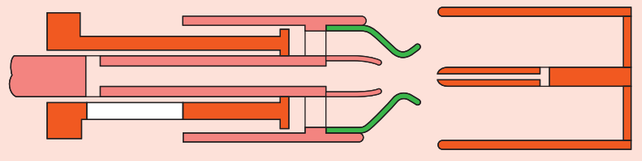
Opening (arc quenching)

SF_6 gas flows during arc quenching



As soon as the arcing contacts separate, the compressed SF_6 gas flows into both directions through the arc quenching nozzle and extinguishes the arc.

Open position

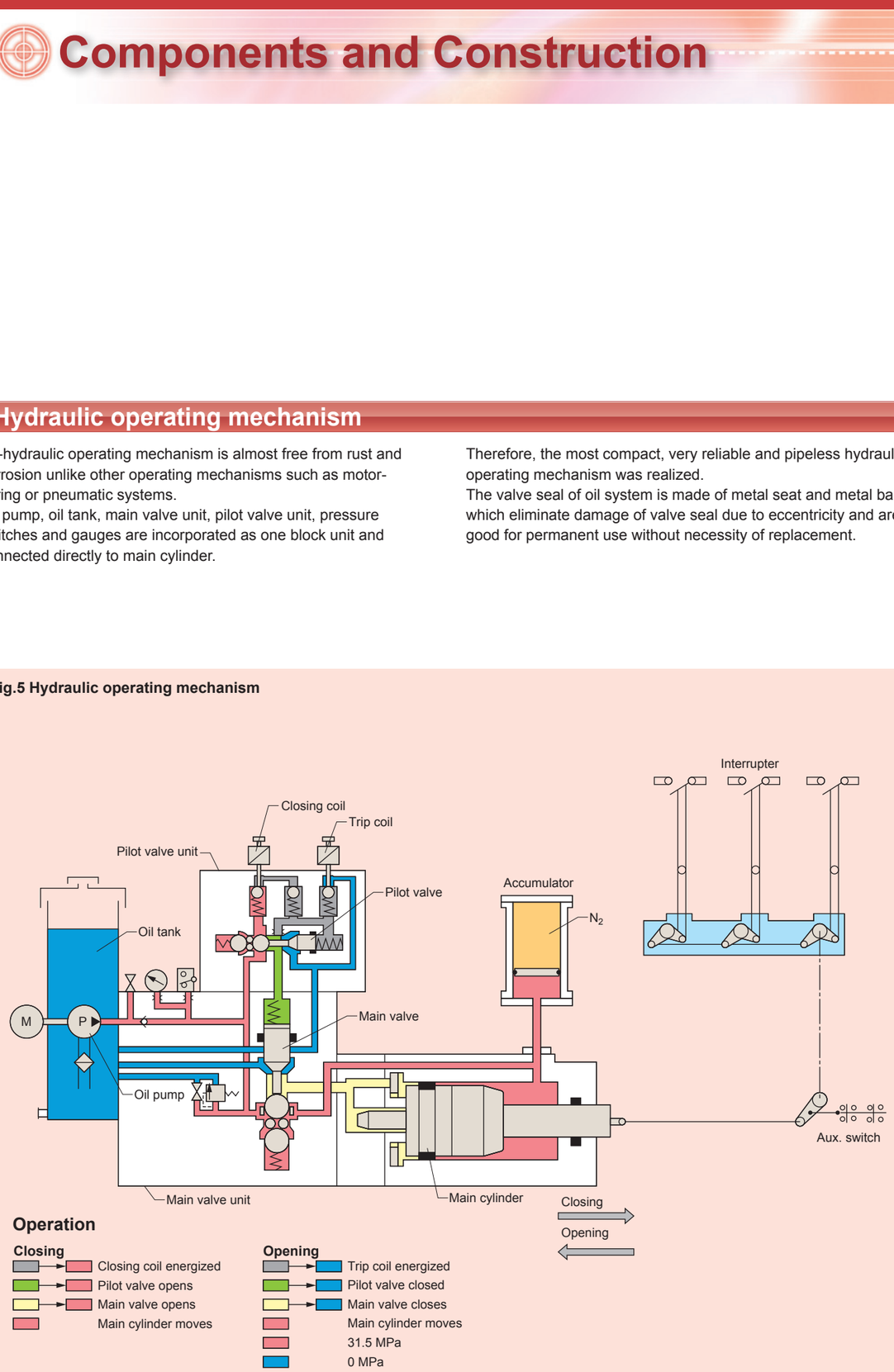


Hydraulic operating mechanism

Oil-hydraulic operating mechanism is almost free from rust and corrosion unlike other operating mechanisms such as motor-spring or pneumatic systems.
Oil pump, oil tank, main valve unit, pilot valve unit, pressure switches and gauges are incorporated as one block unit and connected directly to main cylinder.

Therefore, the most compact, very reliable and pipeless hydraulic operating mechanism was realized.
The valve seal of oil system is made of metal seat and metal ball, which eliminate damage of valve seal due to eccentricity and are good for permanent use without necessity of replacement.

Fig.5 Hydraulic operating mechanism



Busbar

The single-phase conductor made of aluminum or copper, depending on the current rating, is supported by the gas tight insulators.

Disconnectors and earthing switches

Line disconnector is incorporated together with earthing switches in one housing as a combined disconnectors/earthing switch.
Bus disconnector is assembled in each bus enclosure.
Disconnectors are normally motor or manual-operated. Earthing switches are normally manual-operated.
The disconnectors have a switching capability of bus-transfer current, small current as charging current and transformer magnetizing current, if required.
The make-proof earthing switch is provided with the motor-charged spring mechanism.
Maintenance earthing switches on the both sides of the circuit breaker are linked together by a operating rod and operated by the common operating mechanism.
Earthed side of the earthing switch is brought out from the earthed metal housing and earthed to it through a removable bolted link for primary injection test.

Current transformer

The current transformer is of foil-insulated bushing type with ring cores mounted in a CT housing.
The cable through type current transformer is also used for cable feeder unit, if necessary.

Voltage transformer

The voltage transformer is of the inductive type. SF_6 gas provides the high-voltage insulation.
The high-voltage winding discs are well insulated by plastic foils.

Surge arrester

The surge arrester consists of zinc oxide (ZnO) element with excellent low residual voltage characteristics and long service life.

Fig.6 Line disconnector and earthing switches

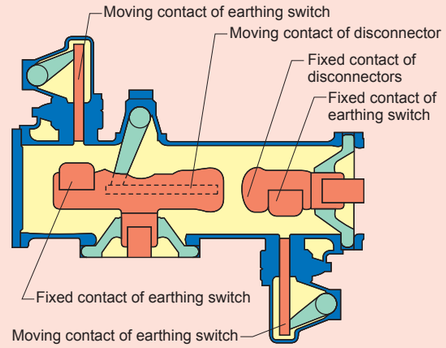


Fig.7 Current transformer

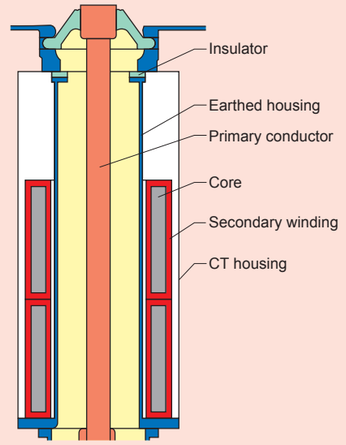
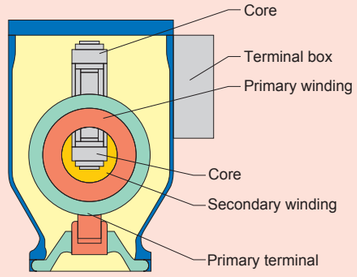


Fig.8 Voltage transformer



Components and Construction

SF_6 gas system

Rated SF_6 gas pressure is unified at 0.6 MPa, gauge for all components. SF_6 gas pressure changes depending on the ambient temperature as shown in Fig.9 pressure-temperature characteristic curve. The monitoring of SF_6 gas is carried out by means of temperature compensated pressure switches in the manner as tabled below.

[at 20 ℃]

Components	Rated SF_6 gas pressure [MPa]	Low alarm pressure [MPa]	Operation lockout pressure [MPa]
Circuit breakers	0.6	0.55	0.5
Disconnector and earthing switches	0.6	0.55	Note
Other components	0.6	0.55	—

Note: Operation lockout at 0.5 MPa (at 20 ℃) is upon request.

Fig.9 Pressure-temperature characteristic curve of SF_6 gas

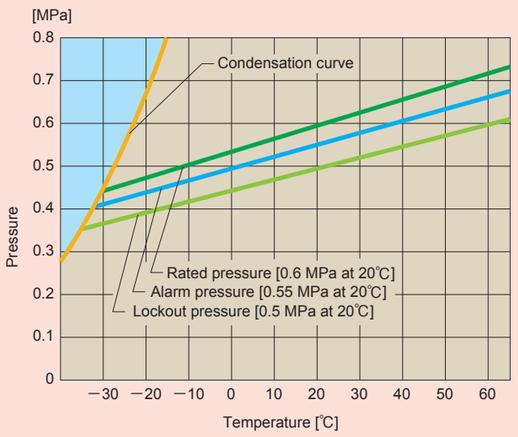
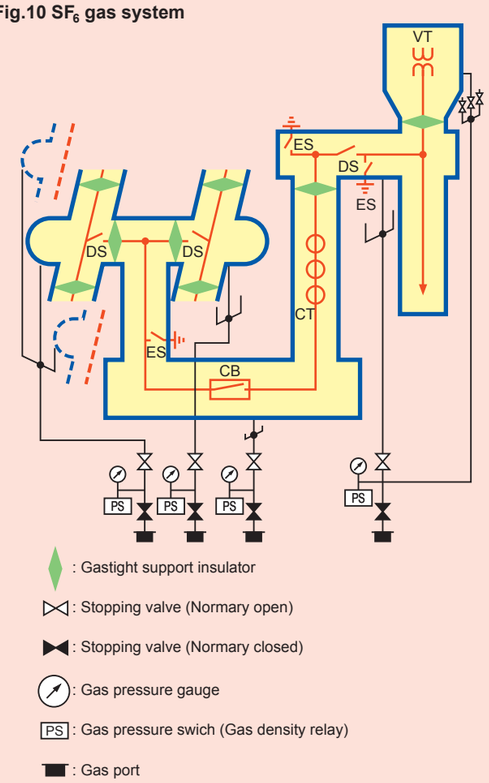


Fig.10 shows the typical gas zones and gas monitoring system.
The SF_6 gas filled disconnectors/bus chamber is sealed off from the adjacent unit by gastight and arc-proof insulators.
A similar insulator seals off this chamber from the circuit breaker.
All gas zones are monitored by gas density relays.
Three phase circuit elements are monitored in common.
The switchgear has a very low gas leakage rate.
Guaranteed gas loss is less than 0.5% per annum.

Fig.10 SF_6 gas system

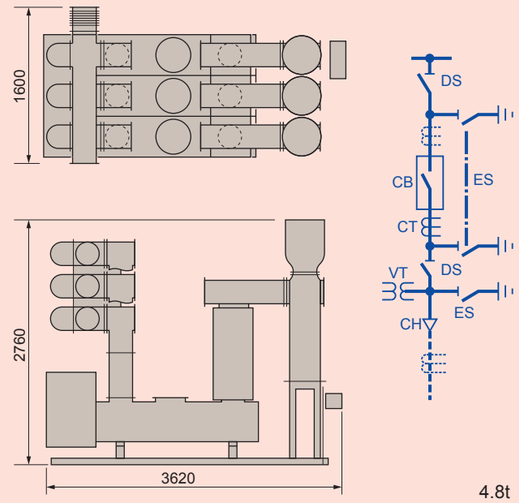


Typical Arrangement

Note 1: Fuji also has 1800 mm of width between bays as our standard.
Note 2: Fig.11 to 14 show minimum height of GIS on each pattern.
Height will depend upon CT requirement.

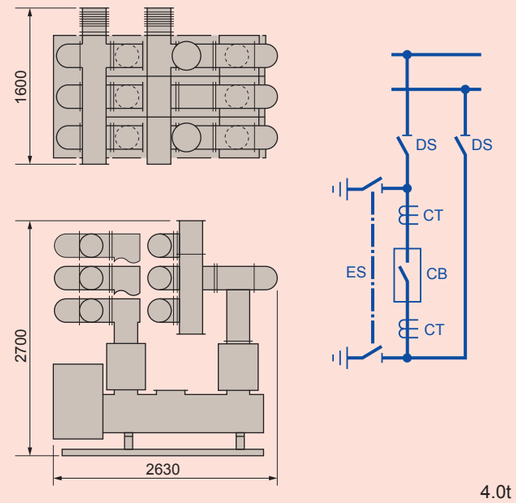
[Unit: mm]

Fig.11 Cable feeder bay with single busbar (72.5 to 145 kV)



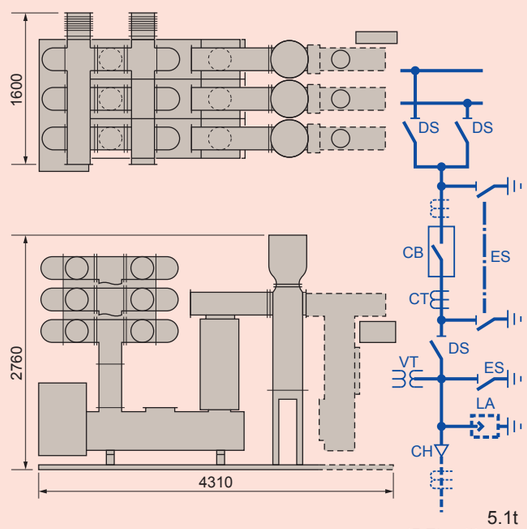
4.8t

Fig.12 Bus coupler bay (72.5 to 145 kV)



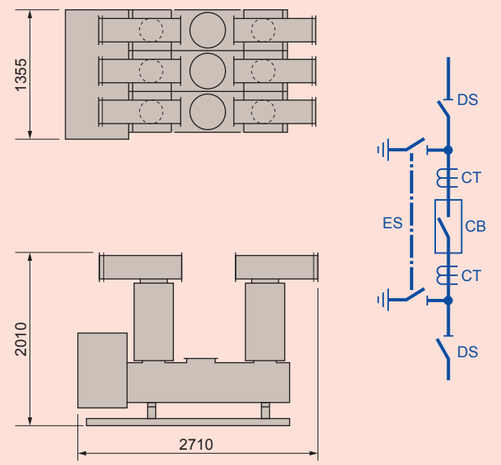
4.0t

Fig.13 Cable feeder bay with double busbar (72.5 to 145 kV)



5.1t
(5.7t: with LA)

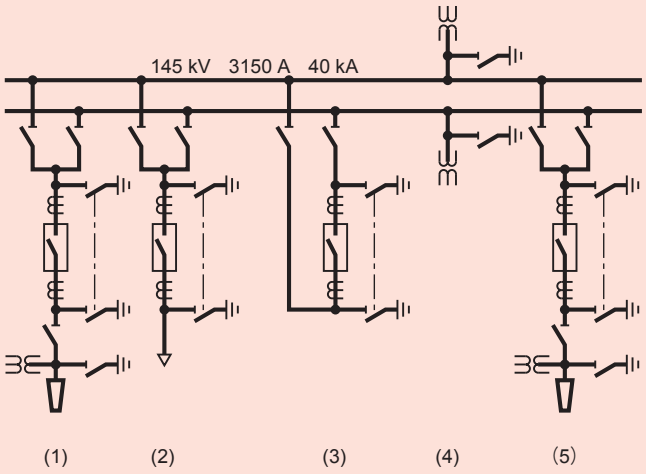
Fig. 14 Bus section bay for single busbar (72.5 to 145 kV)

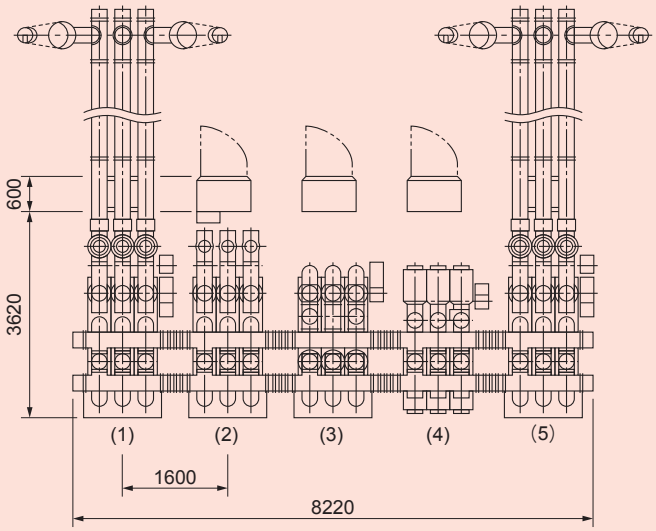


3.4t

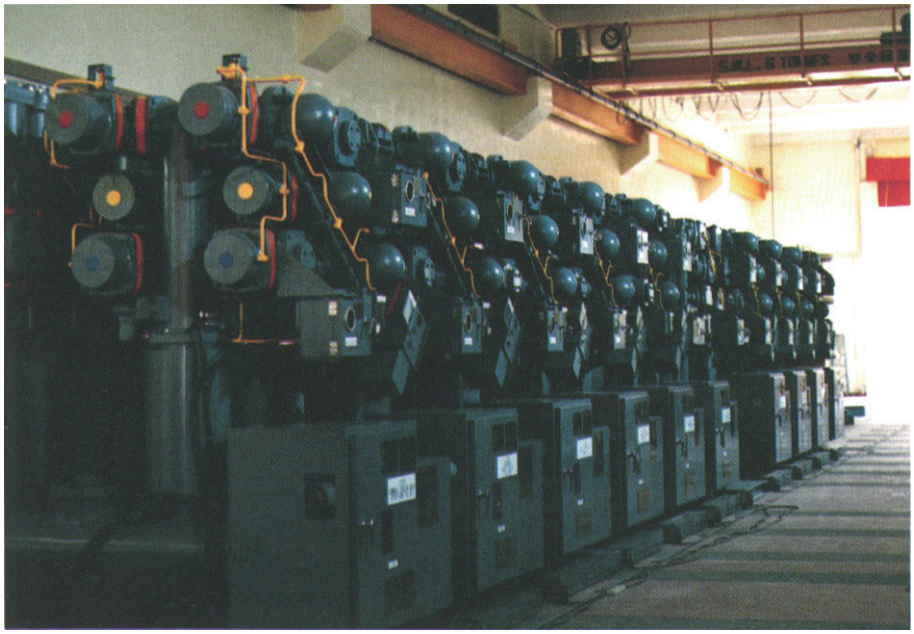
Typical Layout

[Unit: mm]





Example of GIS



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