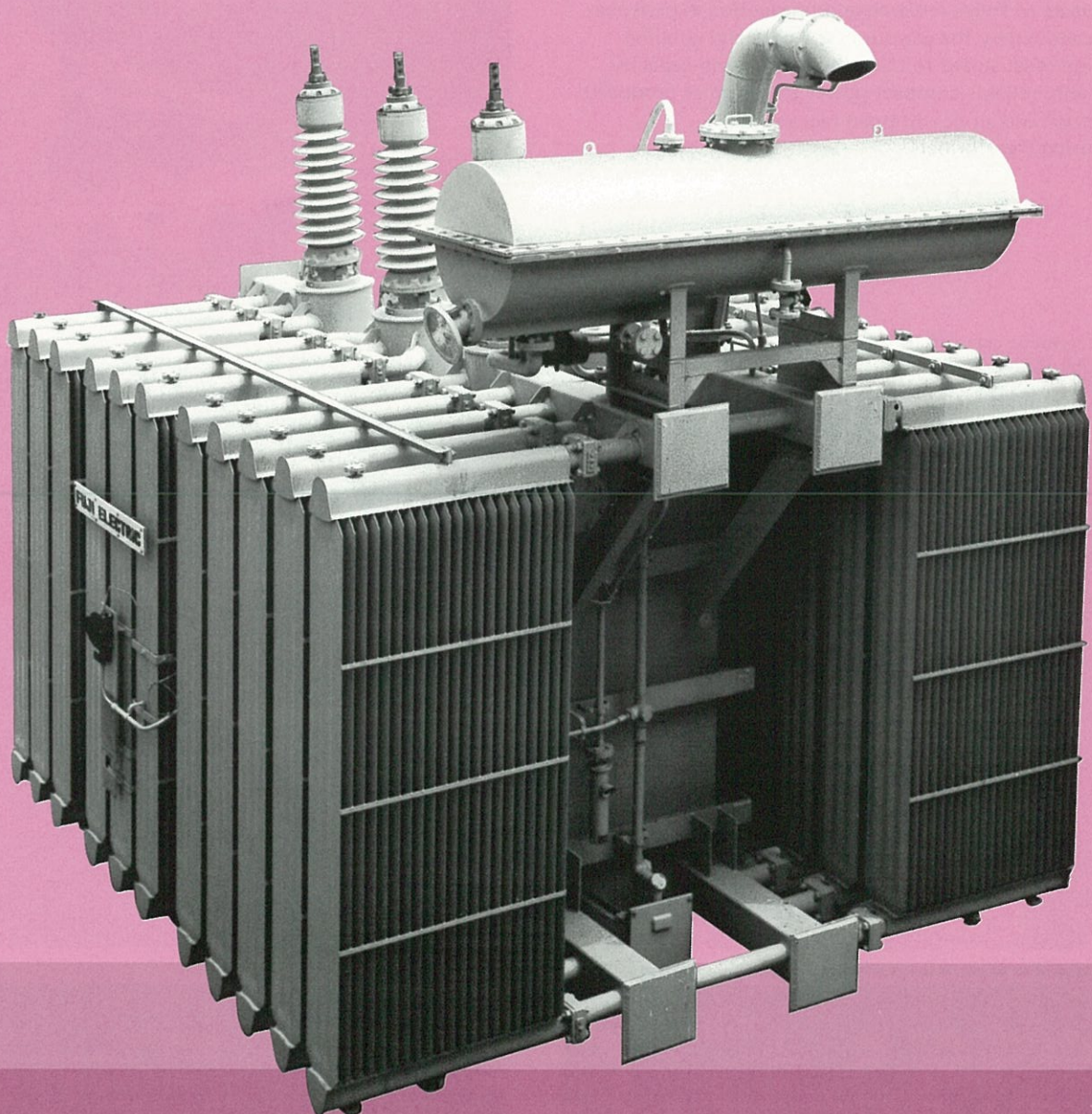


Standard Transformers FL-82

Three-phase/11-154kV/6-45MVA



Fuji's standard transformer FL-82 has been developed based on many years of Fuji's research and production experience. It is characterized by the adoption of a core and winding construction most suited to the given voltage and capacity, and is a highly reliable compact power transformer produced in a dustproof and air-conditioned factory solely manufacturing transformers.

Photo 3 Winding work in the dustproof, air-conditioned room N89-1465-5

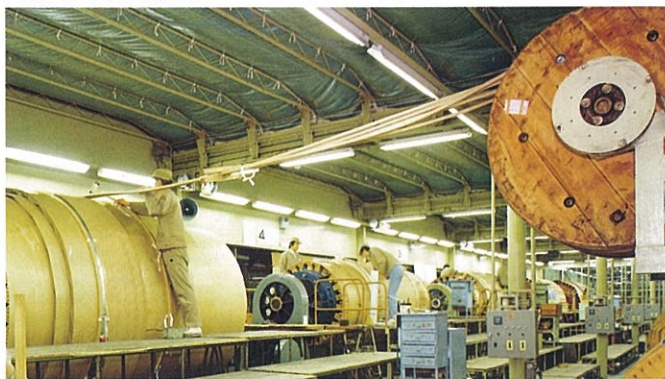


Photo 1 Automatic core cutting line

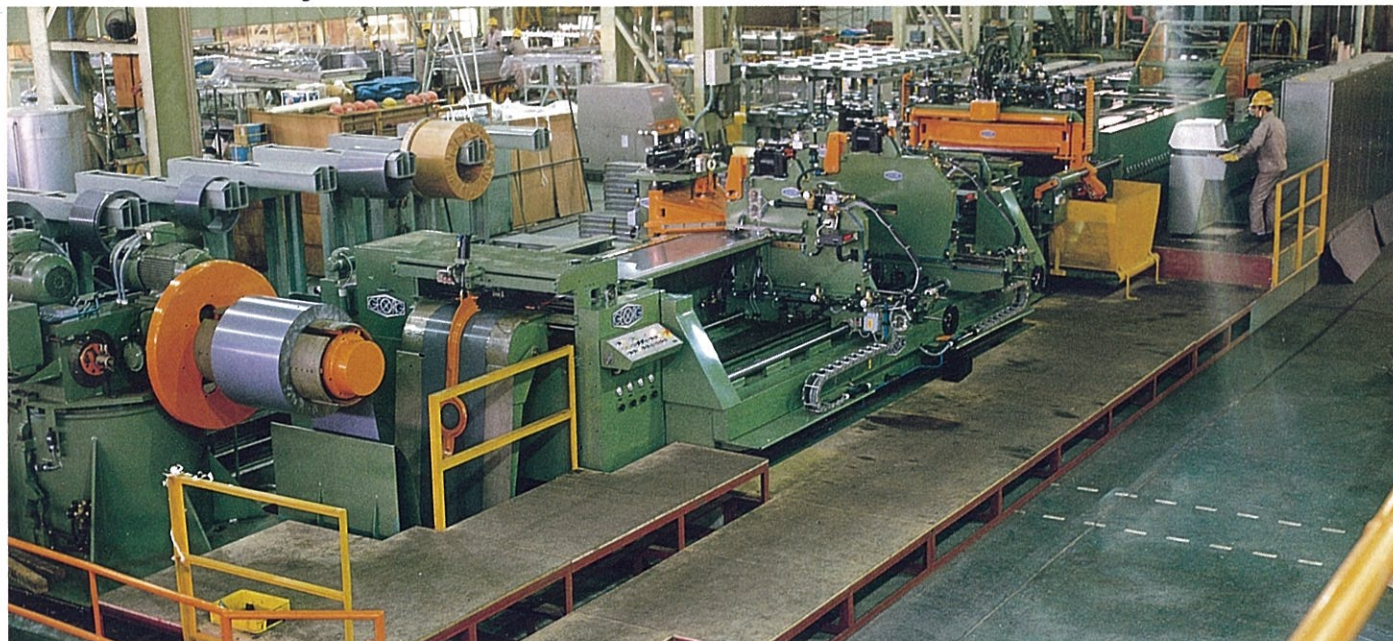
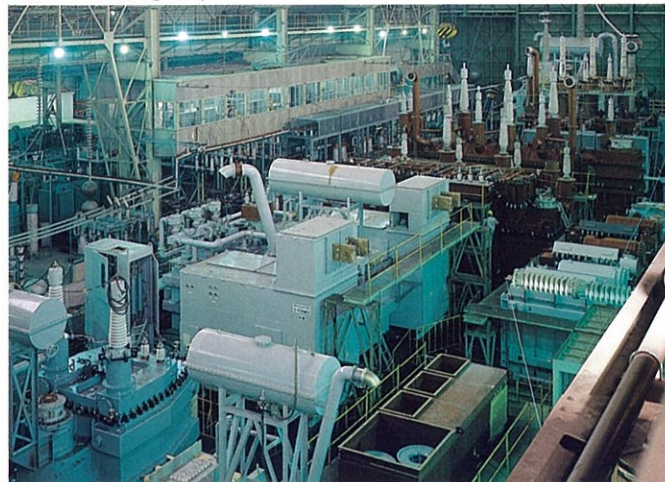


Photo 2 Assembly work in the dustproof, air-conditioned room



Photo 4 Testing shop



Features

Photo 5 Core standing-up equipment

AC291508

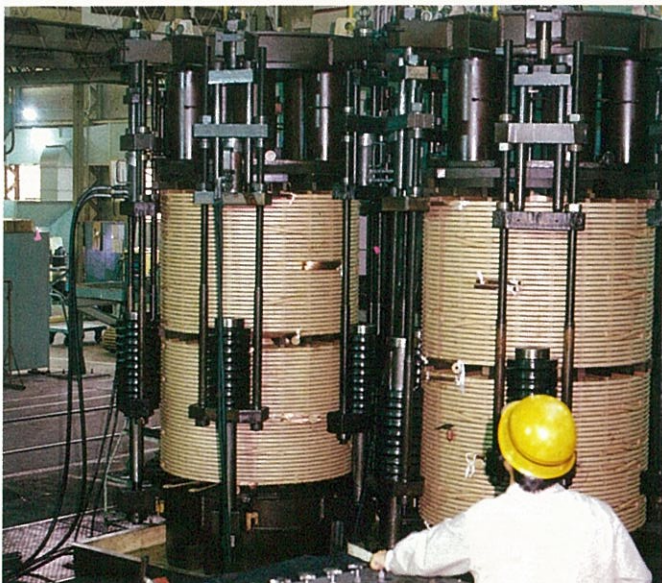


■ Rationalized core construction

Highest quality directional silicon steel sheets with exciting magnetic characteristics (such as no-load loss, excitation current and magnetic strain) are used for the core, and a 45° lap joint is adopted to fully utilize these excellent characteristics. Thus, the core has been made small in size and light in weight with low noise level.

Photo 6 Winding prepressing equipment

AC 327602



■ High ability of short-circuit withstand strength

The winding is rationally designed to endure the electromagnetic and mechanical forces caused by external short-circuit which has been precisely calculated by computer system using empirical data obtained through various experiments on short-circuit forces. The winding is also subjected to prepressing with the forces corresponding to the short-circuit mechanical forces, and fastened further in the final process. Therefore, a sufficient durability to withstand a short-circuit is maintained over many years.

Photo 7 Computer room

N89-2649-7

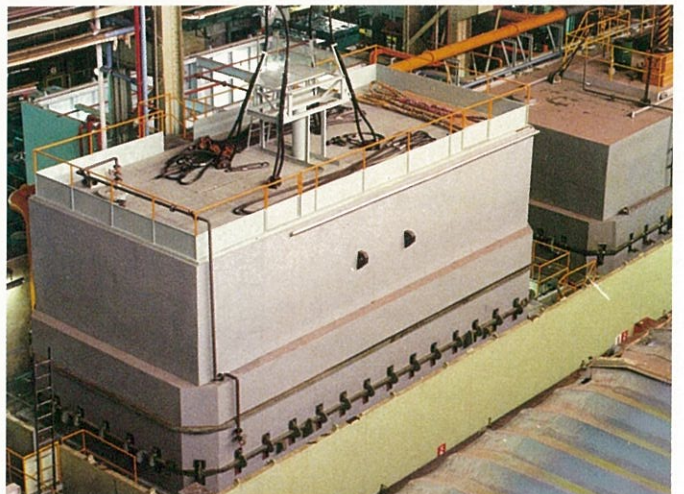


■ Winding construction with high insulation reliability

The insulation within the winding and against other windings and grounds has been structured with high reliability based on various fundamental experiments and by computer aided analysis of the potential distribution. Depending on the insulation class and capacity, partial discharge tests are also performed to improve stability of quality and to improve the reliability.

Photo 8 Large size vapor-phase drying system

AC 351719



■ Transformer with high quality and reliability

Prevention of moisture absorption and dust collection during the components assembly process is very important for ensuring high insulation reliability. For this purpose, the processes of insulation materials, windings and assembly are carried out in a dustproof air-conditioned room. Furthermore, the work environment is always kept clean by preventing dust fall from the ceiling cranes and by use of vacuum cleaners to produce transformers with high quality and reliability. After the completion of the assembly, a high vacuum drying oven is used for processing high level drying and vacuum oil impregnation.

Structure

1. General Structure

The general structure of Fuji's standard transformer FL-82 is shown in Fig. 1.

2. Core

Basic construction of the core is as follows:

Material . . . Directional silicon steel sheets
Joint 45° lap joint

Silicon steel sheets are sheared and punched in automatic press lines. Then, the strain from processing is removed in a continuous annealing furnace to obtain cores with high performance characteristics and stable quality.

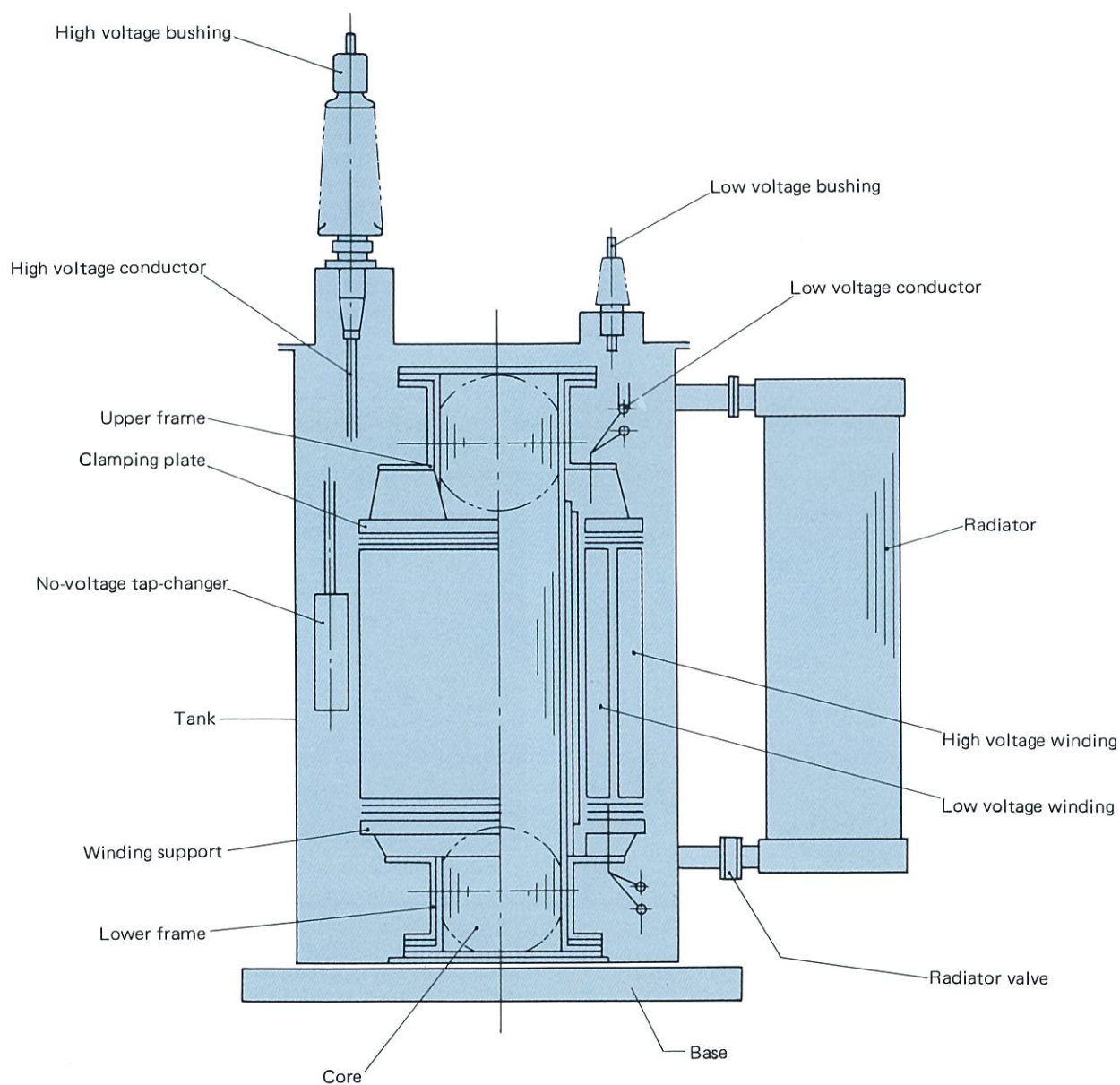


Fig. 1 Structural view of the FL-82 type standard transformer

3. Winding

Windings are arranged in concentric structure with the high voltage portion outer and the low voltage portion inner. The optimum type is selected from the following in accordance with the given voltage and capacity.

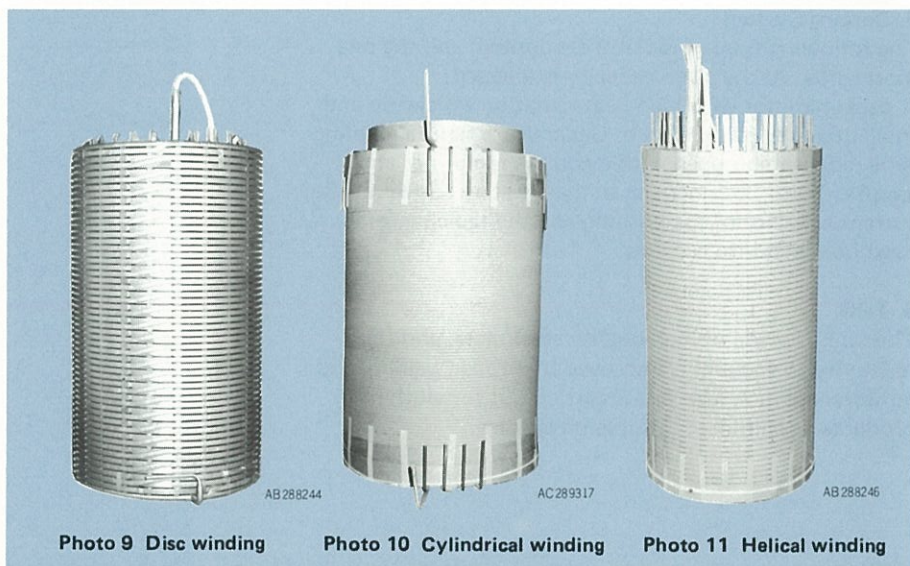
High voltage, small current

Disc or cylindrical winding is generally used.

Low voltage, large current

Helical or cylindrical winding is generally used.

These windings are all of continuous type without any intermediate connection. When more than 2 parallel conductors are used, proper transposition is provided to eliminate the circulating currents between conductors.



4. Oil Preservation System

• Diaphragm type conservator

A synthetic rubber diaphragm is provided on top of the oil in the conservator to prevent the oil from contacting the air. Thus, the oil is constantly in degassed condition. The upper case serves to protect the diaphragm. (Even if the diaphragm should break, the conservator can continue to be used as open type since it has an oil sealed structure.)

• Nitrogen-sealed type

Inert seal gas (nitrogen gas) is sealed in the upper portion of the transformer or the conservator to prevent oxidization of the oil. The nitrogen gas pressure varies in a certain range by the expansion or the contraction of the oil.

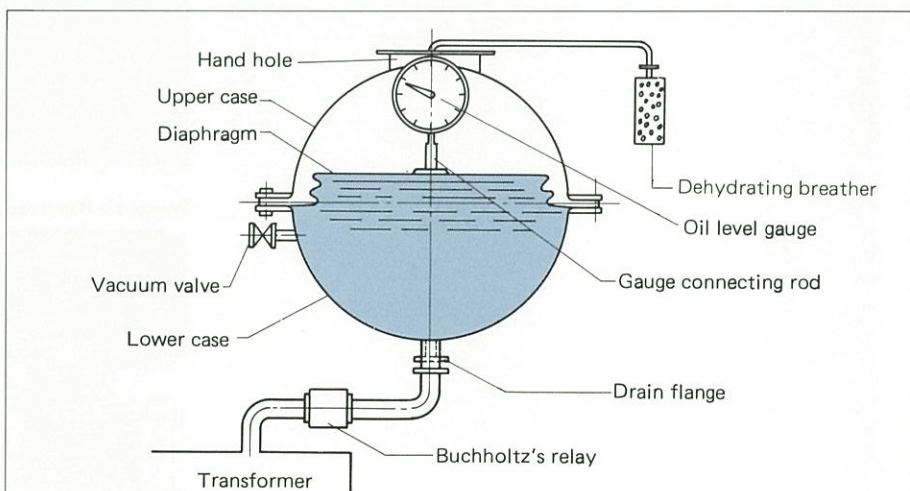


Fig. 2 Oil preservation system with diaphragm type conservator

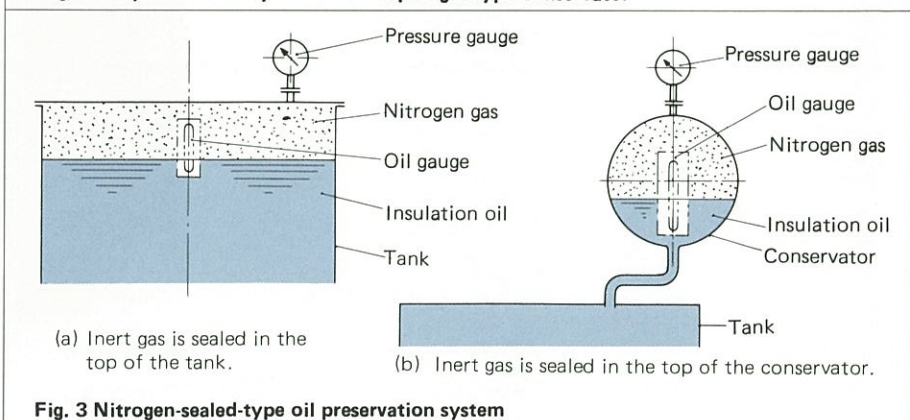


Fig. 3 Nitrogen-sealed-type oil preservation system

5. Cooling System

The following type of radiator is adopted, and the one most suited to the given capacity is selected.

A panel radiator with high heat radiation efficiency and small quantity of oil is used. Generally, a natural cooling type radiator equipped with a cooling fan brings about approx. 20 to 25% increase in the capacity. However, the current capacity of the bushing and the tap-changer must be taken into account.

6. Tank

The tank is made of high quality steel plate, and the resistivity to vacuum is improved by proper welding and reinforcement. A leak test is carried out for all the products to eliminate possible oil leakage.

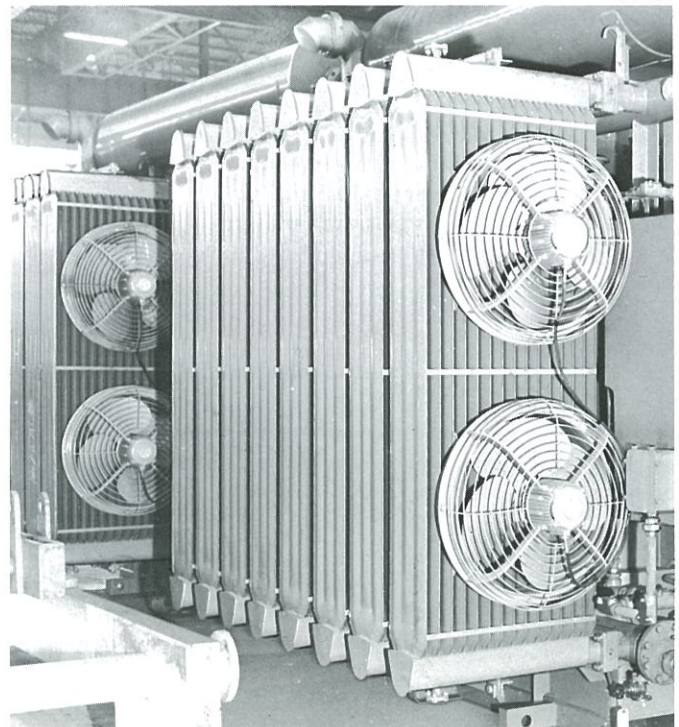
Photo 12 Panel radiator

AB 288247



Photo 13 Panel radiator with cooling fans

A 101589



Standard Specifications

■ General Specifications

Type	Outdoor use oil-immersed, double winding
No. of phases	Three phase
Frequency [Hz]	50 or 60
Applied standard	JEC 2200 (1995)

■ Standard Impedance and Application of Oil Preservation System

		Standard impedance [%] and oil preservation system (Classified by color)						
Standard capacity Primary insulation level [Class]	Standard capacity [MVA]	6	7.5	10	15	20	30	45
		7.5	7.5	7.5	7.5	8.5	—	—
10		7.5	7.5	7.5	7.5	8.5	—	—
20		7.5	7.5	7.5	7.5	8.5	—	—
30		7.5	7.5	7.5	7.5	8.5	—	—
60		7.5	7.5	7.5	7.5	8.5	8.5	9.5
70		7.5	7.5	7.5	7.5	8.5	8.5	9.5
100<60>		—	—	—	—	—	9.5	9.5
140<80>		—	—	—	—	—	9.5	9.5
Cooling system	ONAN	○	○	○	○	○	○	—
	ONAF	—	—	—	—	○	○	○

- Notes 1) The mark < > shows neutral insulation level.
2) The classification by color indication of the oil preservation system is as follows.

Standard:	Nitrogen-sealed type
Quasi-standard:	With diaphragm type conservator
Standard:	With diaphragm type conservator
Quasi-standard:	Nitrogen-sealed type
	With diaphragm type conservator

■ Standard Voltage and Connections

Items	No-voltage tap changing			On-load tap changing				
	Primary tap voltages [kV]	Secondary voltage [kV]	Connections	Primary voltages [kV]			Secondary voltage [kV]	Connections
				Tap voltages	Step voltage	Number of taps		
10	11.5 ^F —11 ^R —10.5 ^F —10 ^F	3.45 (3.3)	△/△	—	—	—	—	—
20	23 ^F —22 ^R —21 ^F —20 ^F							
30	34.5 ^F —33 ^R —31.5 ^F —30 ^F							
60	69 ^F —66 ^R —63 ^F —60 ^F	6.9 (6.6)	△/△ (less than 20MVA) △/△ (20MVA or more)	69 ^F ~66 ^R ~60 ^F	0.75	13 (17)	3.45 (3.3)	△/△
70	80.5 ^F —77 ^R —73.5 ^F —70 ^F	11		80.5 ^F ~77 ^R ~70 ^F	0.875		6.9 (6.6)	
100(60)	115 ^F —110 ^R —105 ^F	22	△/△	115 ^F ~110 ^R ~100 ^F	1.25		11	△/△
140(80)	161 ^F —154 ^R —147 ^F			161 ^F ~154 ^R ~140 ^F	1.75		22	

- Notes 1) The mark [] shows neutral insulation level.
2) The mark () shows quasi-standard specifications.

Special Types

The following special types are available in addition to the standard types :

1. Elephant Type Transformer

(Transformer with cable junction box)

The elephant type has a structure where the live portions are concealed by direct connection of the bushing and cable within the cable junction box. It is characterized by virtually no damage from salt or dust, and it provides high safety.

[Variety of elephant types]

● Air-insulated elephant type

Cable duct type

Cable head is not needed.

(For 3, 6 or 10kV class)

Air-insulated elephant type

Cable head is used.

(For 10, 20 or 30 kV class)

● Oil-immersed elephant type

Cable head is used.

(For 60kV class or above)

2. Transformer with Bus-duct Flange

This transformer is constructed for connection to the cubicle with a bus-duct. The bushings are mounted on either the top or the side, considering the shape of duct with the relative position of transformer and cubicle.

Photo 14 6kV elephant type transformer (cable duct type)

DK0289



Photo 15 60kV oil-immersed elephant type transformer

DK0290



3. Transformer Directly Coupled to Cubicle

This type is directly coupled to a 60 to 140kV cubicle, and is provided with horizontal bushings.

Since the transformer is located outdoors while indoor bushings are used, it is suited to use in a salty atmosphere. Contamination inside the cubicle varies with the airtightness and installation conditions, but in ordinary airtight conditions at an indoor switchgear station near the seashore, it is reported that the annual rate of adherence of salt component is $0.03\text{mg}/\text{cm}^2$ or less.

4. Low Noise Type Transformer

Generally, the sound level of a transformer is reduced by a sound-barrier around the tank. The sound-barrier types are basically categorized into the two types described below, between which the proper one is selected in accordance with the desired sound reduction level.

- (a) Steel plate sound-barrier
(double tank type) (see photo 16)
- (b) Concrete panel sound-barrier

5. Transformer Directly Coupled to SF₆ Gas Insulated Switchgear (GIS)

This transformer is designed to reduce the size of a substation with an SF₆ gas insulated switchgear and its structure allows direct coupling to an SF₆ gas insulated switchgear as illustrated in photo 17.

Photo 16 Transformer directly coupled to a cubicle
(low-noise type transformer with sound-barrier)

N93-436-2

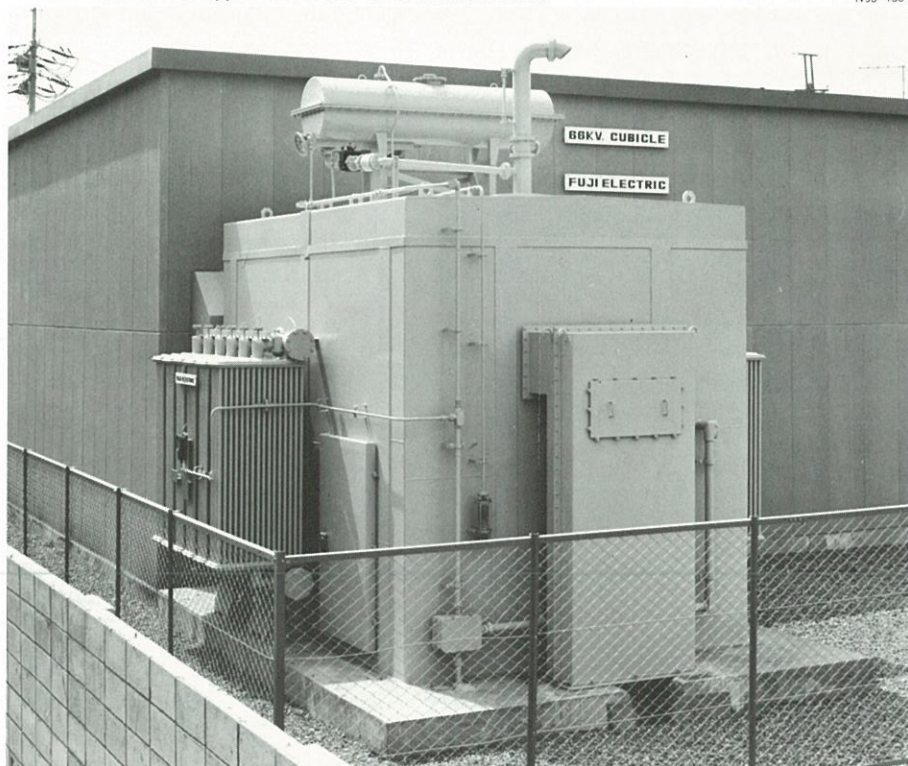


Photo 17 Transformer directly coupled to SF₆ gas insulated switchgear

N99-908-13



Standard accessories are shown in Table 1 classified by the oil preservation system.

Table 1. List of standard accessories

(Mark ○: Attached)

Accessories	Oil preservation system	Diaphragm type conservator system	Nitrogen gas sealed system	Remarks
Name plate		●	●	
Radiator		●	●	
Radiator valve		●	●	Only lower part attached
Conservator		●	●	
Dehydrating breather		●		
Pressure-relief device		●	●	With contact
Dial type thermometer		●	●	With maximum indicator and contact
Oil gauge			●	
Dial type oil indicator		●		With contact
Buchholtz's relay		●		with alarm and trip contacts
Pressure gauge			●	
Nitrogen gas seal valve			●	
Terminal box for aux. circuit		●	●	
Bushing		●	●	
Earthing terminal		●	●	Clamping type (38 to 60mm ²)
Drain and filter valve		●	●	
Lifting lug		●	●	
Foundation bolt		●	●	
No-voltage or on-load tap changer		●	●	

Also attached as requested are the following accessories.

- Bank number plate
- Ladder
- Cooling fan
- Thermometer
- Safety flap
- Bus duct flange
- Resistance bulb
- Bushing current transformer
- Cable junction box (elephant head)
- Sudden gas pressure relay
- Connection terminal for main circuit

Sufficient surface and anti-corrosion treatments are carried out before the painting process considering the environmental conditions of the location for installation.

Standard painting color:

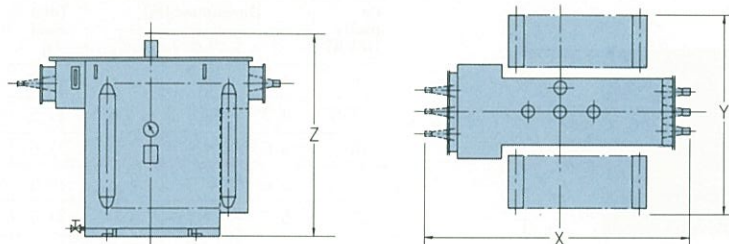
Outdoor use Munsell N7

Indoor use Munsell 7.5 BG 6/1.5

Dimensions

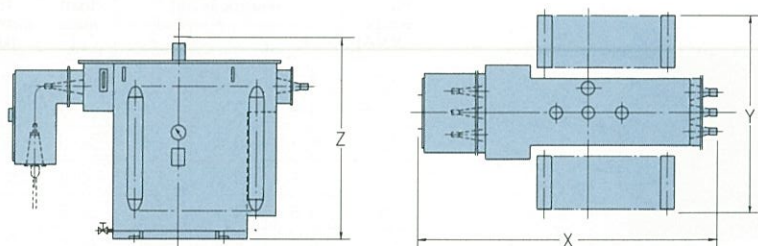
1. Three-phase, 10 or 20kV/ 3 or 6kV Class, 6 to 20 MVA, 50Hz No-voltage Tap Changing, Nitrogen sealed Type, Oil-immersed Natural Cooling System

(1) Primary, secondary: Bus-duct flange



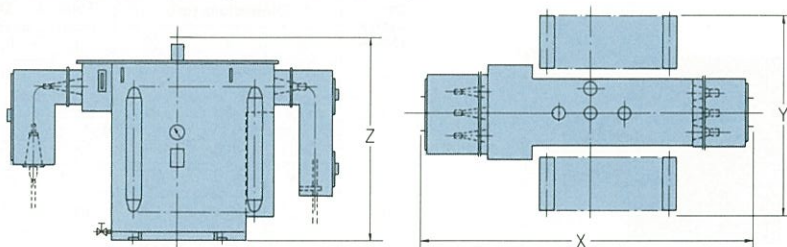
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	3.9	3.1	3.4	16.0	4.4
7.5	4.0	3.5	3.5	18.5	5.0
10	4.4	3.6	3.5	22.5	5.7
15	4.6	4.0	3.6	28.0	7.0
20	4.8	4.3	3.9	33.0	8.1

(2) Primary: Air-insulated elephant Secondary: Bus-duct flange



Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	4.5	3.1	3.4	16.5	4.4
7.5	4.6	3.5	3.5	19.0	5.0
10	5.0	3.6	3.5	23.0	5.7
15	5.3	4.0	3.6	28.5	7.0
20	5.5	4.3	3.9	33.5	8.1

(3) Primary: Air-insulated elephant type Secondary: Cable duct type air insulated elephant

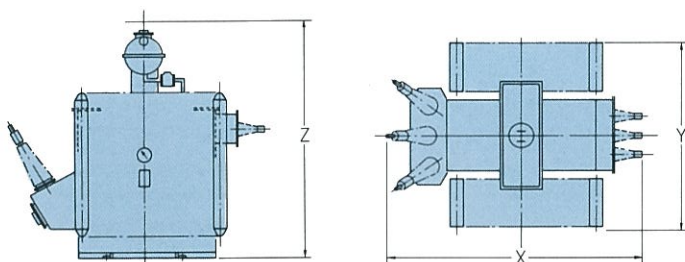


Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	4.9	3.1	3.4	17.0	4.4
7.5	5.0	3.5	3.5	19.5	5.0
10	5.5	3.6	3.5	23.5	5.7
15	5.8	4.0	3.6	29.0	7.0
20	6.1	4.3	3.9	34.0	8.1

2. Three-phase, 60 or 70kV/ 3 or 6kV Class, 6 to 30MVA, 50Hz

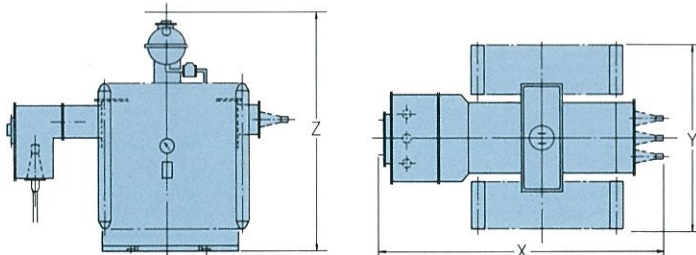
No-voltage Tap Changing, Diaphragm Type Conservator System, Oil-immersed Natural Cooling System

- (1) Primary: Side bushing
Secondary: Bus-duct flange



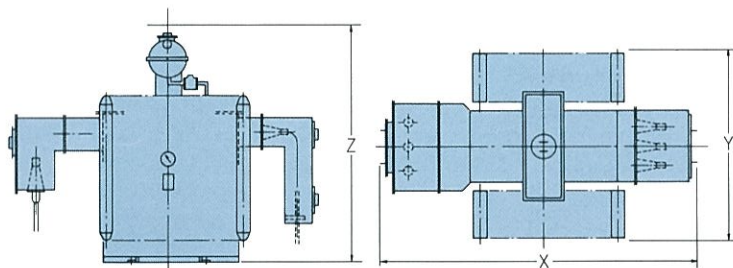
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	4.1	3.4	3.7	17.0	4.8
7.5	4.3	3.6	3.8	19.5	5.4
10	4.6	3.8	4.0	23.5	6.4
15	5.0	3.9	4.2	30.5	8.2
20	5.2	4.1	4.5	37.0	9.7
30	5.6	4.4	5.0	48.0	12.3

- (2) Primary: Oil-immersed elephant
Secondary: Bus-duct flange



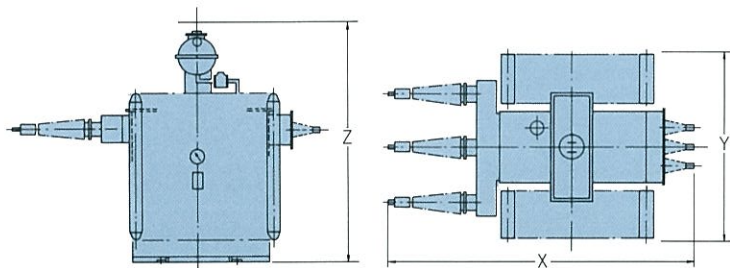
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	4.7	3.4	3.7	19.5	6.8
7.5	4.9	3.6	3.8	22.0	7.4
10	5.2	3.8	4.0	26.0	8.4
15	5.6	3.9	4.2	33.0	10.2
20	5.8	4.1	4.5	39.5	11.7
30	6.3	4.4	5.0	50.5	14.3

- (3) Primary: Oil-immersed elephant
Secondary: Cable-duct type, air insulated elephant



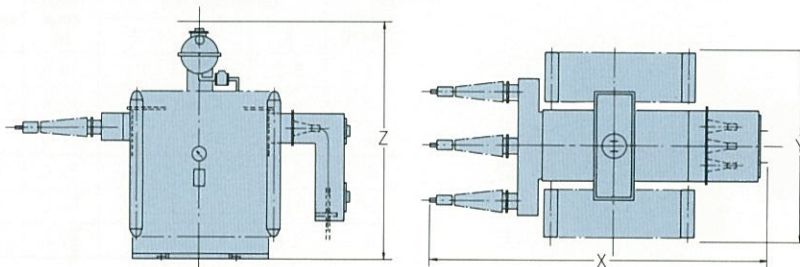
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	5.1	3.4	3.7	20.0	6.8
7.5	5.3	3.6	3.8	22.5	7.4
10	5.6	3.8	4.0	26.5	8.4
15	6.0	3.9	4.2	33.5	10.2
20	6.2	4.1	4.5	40.0	11.7
30	6.8	4.4	5.0	51.0	14.3

- (4) Primary: Horizontal type
Secondary: Bus-duct flange



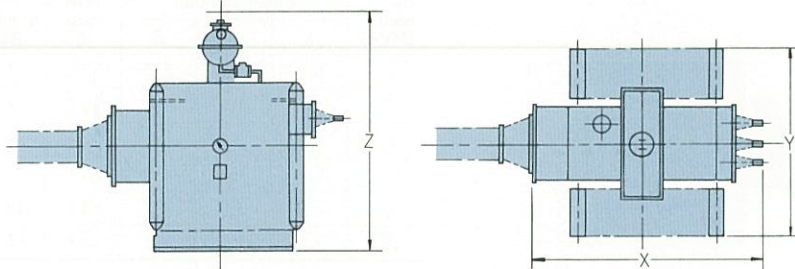
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	5.0	3.4	3.7	17.0	4.8
7.5	5.2	3.6	3.8	19.5	5.4
10	5.5	3.8	4.0	23.5	6.4
15	5.9	3.9	4.2	30.5	8.2
20	6.1	4.1	4.5	37.0	9.7
30	6.7	4.4	5.0	48.0	12.3

(5) Primary: Horizontal type
Secondary: Cable-duct type, air insulated elephant



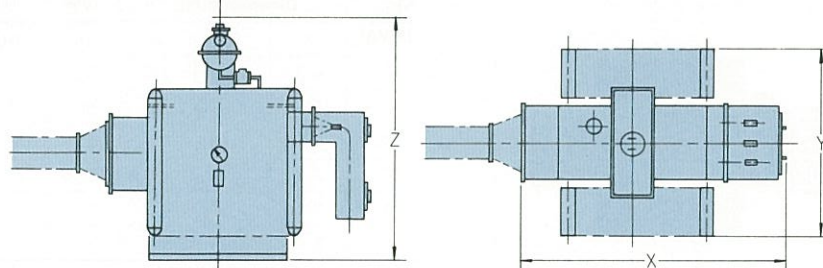
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	5.4	3.4	3.7	17.5	4.8
7.5	5.6	3.6	3.8	20.0	5.4
10	5.9	3.8	4.0	24.0	6.4
15	6.3	3.9	4.2	31.0	8.2
20	6.5	4.1	4.5	37.5	9.7
30	7.2	4.4	5.0	48.5	12.3

(6) Primary: GIS directly coupled
Secondary: Bus-duct flange



Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	4.4	3.4	3.7	19.5	7.0
7.5	4.6	3.6	3.8	22.0	7.6
10	4.8	3.8	4.0	26.0	8.6
15	5.3	3.9	4.2	33.0	10.4
20	5.5	4.1	4.5	39.5	11.9
30	5.9	4.4	5.0	50.5	14.5

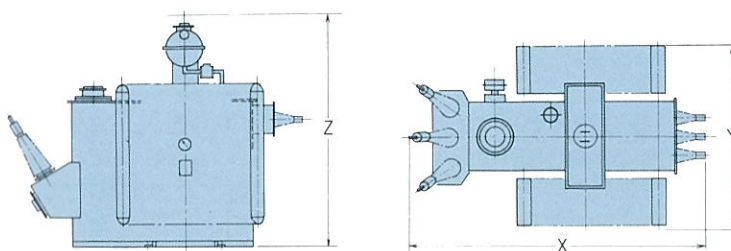
(7) Primary: GIS directly coupled
Secondary: Cable-duct type, air insulated elephant



Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	4.8	3.4	3.7	20.0	7.0
7.5	5.0	3.6	3.8	22.5	7.6
10	5.2	3.8	4.0	26.5	8.6
15	5.7	3.9	4.2	33.5	10.4
20	5.9	4.1	4.5	40.0	11.9
30	6.4	4.4	5.0	51.0	14.5

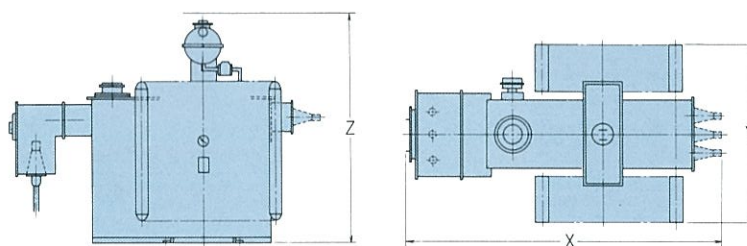
3. Three-phase, 60 or 70kV / 3 or 6kV Class, 6 to 30MVA, 50Hz
On-load Tap Changing, Diaphragm Type Conservator System, Oil-immersed Natural Cooling System

(1) Primary: Side bushing
Secondary: Bus-duct flange



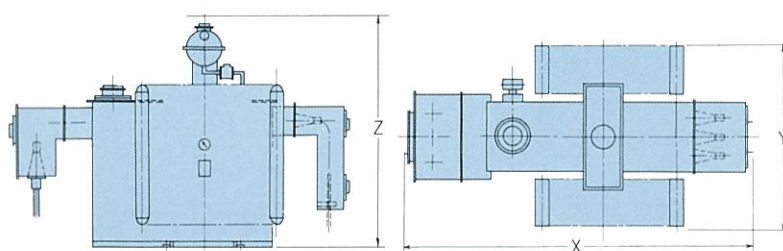
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	5.2	3.3	3.7	19.5	5.8
7.5	5.4	3.4	3.8	22.5	6.4
10	5.7	3.6	4.1	27.0	7.4
15	6.1	3.7	4.5	33.5	10.2
20	6.3	3.9	4.7	40.5	11.7
30	6.8	4.1	5.2	52.0	14.8

(2) Primary: Oil-immersed elephant
Secondary: Bus-duct flange



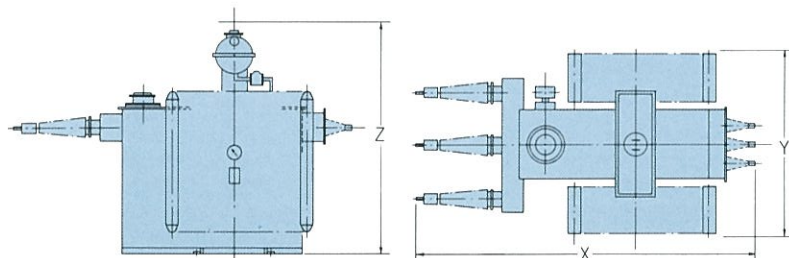
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	5.9	3.3	3.7	22.0	7.8
7.5	6.1	3.4	3.8	25.0	8.4
10	6.3	3.6	4.1	29.5	9.4
15	6.8	3.7	4.5	36.0	12.2
20	7.0	3.9	4.7	43.0	13.7
30	7.5	4.1	5.2	54.5	16.8

(3) Primary: Oil-immersed elephant
Secondary: Cable-duct type, air insulated elephant



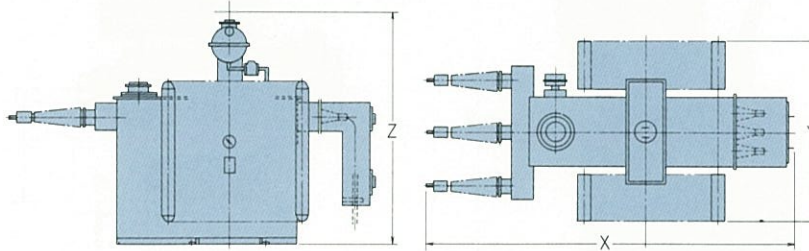
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	6.3	3.3	3.7	22.5	7.8
7.5	6.5	3.4	3.8	25.5	8.4
10	6.8	3.6	4.1	30.0	9.4
15	7.2	3.7	4.5	36.5	12.2
20	7.4	3.9	4.7	43.5	13.7
30	8.0	4.1	5.2	55.0	16.8

(4) Primary: Horizontal type
Secondary: Bus-duct flange



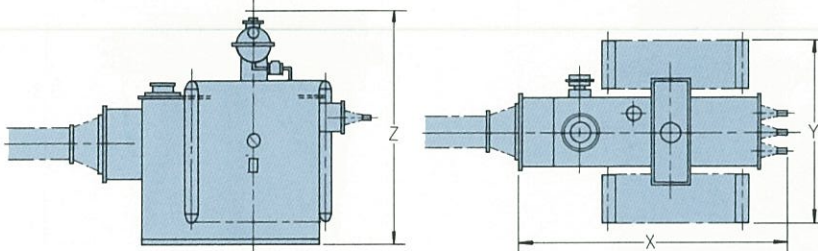
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	6.1	3.3	3.7	19.5	5.8
7.5	6.3	3.4	3.8	22.5	6.4
10	6.6	3.6	4.1	27.0	7.4
15	7.0	3.7	4.5	33.5	10.2
20	7.2	3.9	4.7	40.5	11.7
30	7.9	4.1	5.2	52.0	14.8

(5) Primary: Horizontal type
Secondary: Cable-duct type, air insulated elephant



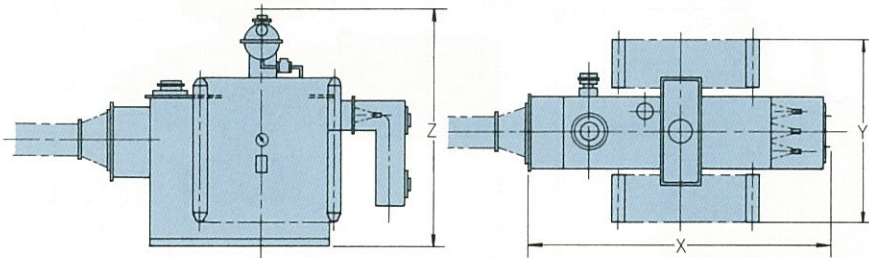
Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	6.5	3.3	3.7	20.0	5.8
7.5	6.7	3.4	3.8	23.0	6.4
10	7.0	3.6	4.1	27.5	7.4
15	7.4	3.7	4.5	34.0	10.2
20	7.6	3.9	4.7	41.0	11.7
30	8.4	4.1	5.2	52.5	14.8

(6) Primary: GIS directly coupled
Secondary: Bus-duct flange



Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	5.5	3.3	3.7	22.0	8.0
7.5	5.7	3.4	3.8	25.0	8.6
10	5.9	3.6	4.1	29.5	9.6
15	6.4	3.7	4.5	36.0	12.4
20	6.6	3.9	4.7	43.0	13.9
30	7.1	4.1	5.2	54.5	17.0

(7) Primary: GIS directly coupled
Secondary: Cable-duct type, air insulated elephant

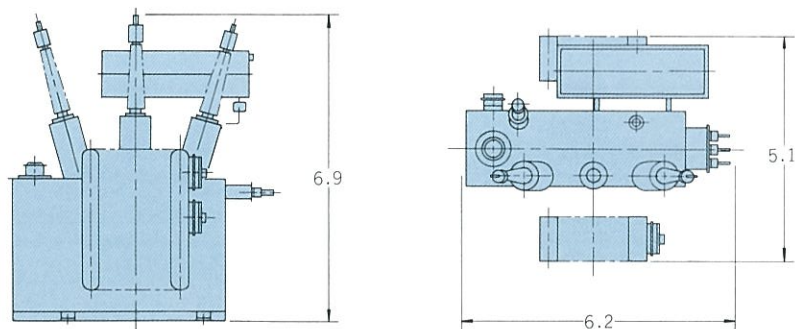


Ca- pacity [MVA]	Dimensions [m]			Total mass [t]	Oil quantity [kL]
	X	Y	Z		
6	5.9	3.3	3.7	22.5	8.0
7.5	6.1	3.4	3.8	25.5	8.6
10	6.3	3.6	4.1	30.0	9.6
15	6.8	3.7	4.5	36.5	12.4
20	7.0	3.9	4.7	43.5	13.9
30	7.6	4.1	5.2	55.0	17.0

4. Three-phase, 140kV/20kV Class, 45MVA, 50Hz
On-load Tap Changing, Diaphragm Type Conservator System, Oil-immersed Forced-air Cooling System

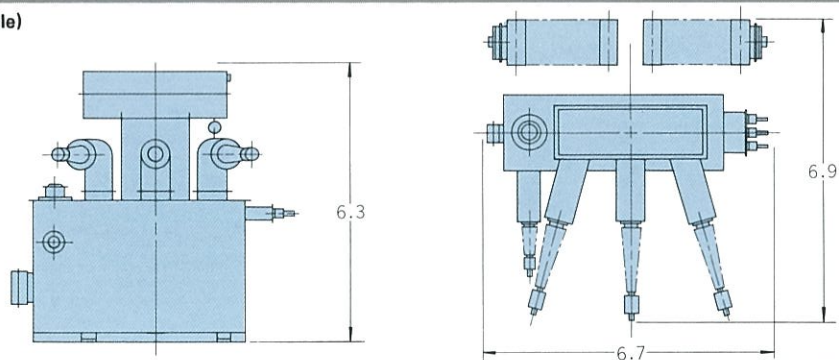
(1) Primary: Vertical type
Secondary: Bus-duct flange

Total mass: 69t
Oil quantity: 20kL



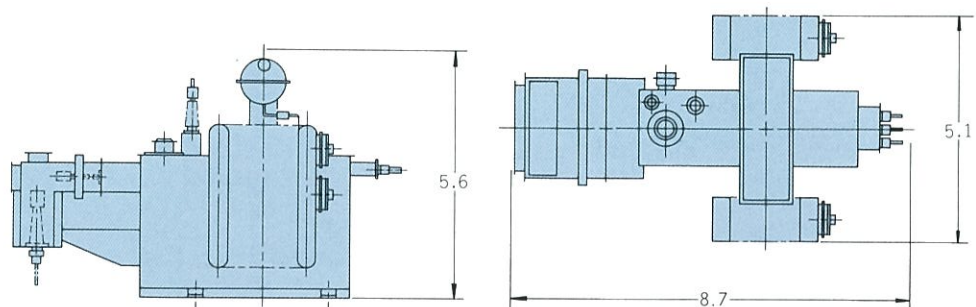
(2) Primary: Horizontal type (directly coupled to cubicle)
Secondary: Bus-duct flange

Total mass: 70t
Oil quantity: 20.8kL



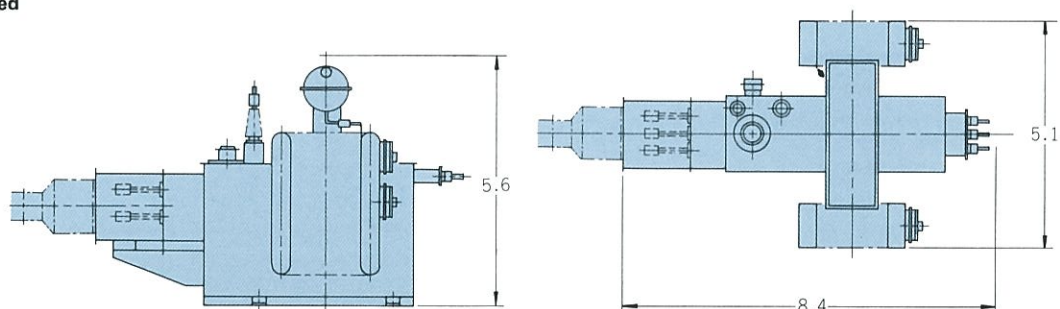
(3) Primary: Oil-immersed elephant
Secondary: Bus-duct flange

Total mass: 75t
Oil quantity: 24.1kL



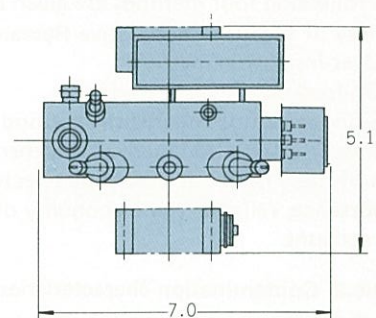
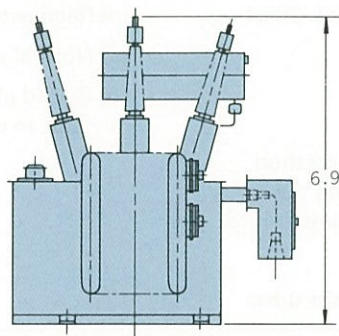
(4) Primary: GIS directly coupled
Secondary: Bus-duct flange

Total mass: 73.5t
Oil quantity: 22kL



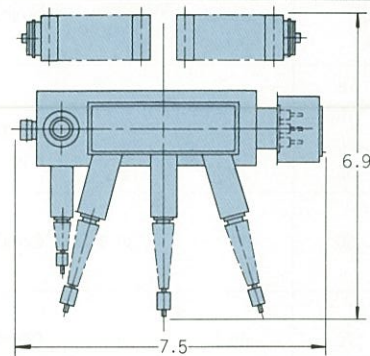
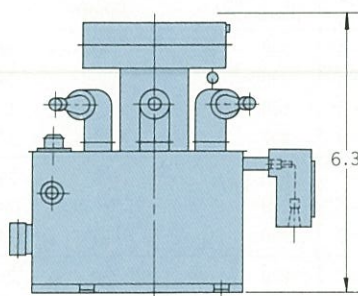
(5) Primary: Vertical type
Secondary: Air insulated elephant type

Total mass: 69.5t
Oil quantity: 20kL



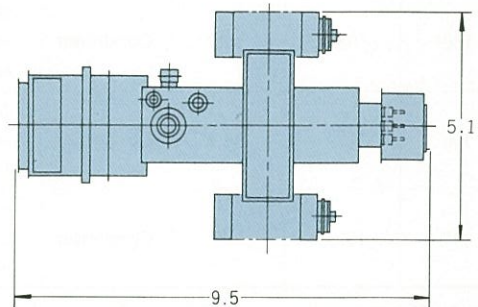
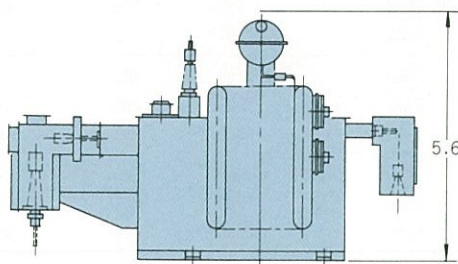
(6) Primary: Horizontal type (directly coupled to cubicle)
Secondary: Air insulated elephant type

Total mass: 70.5t
Oil quantity: 20.8kL



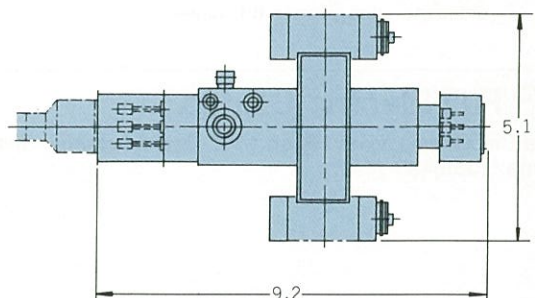
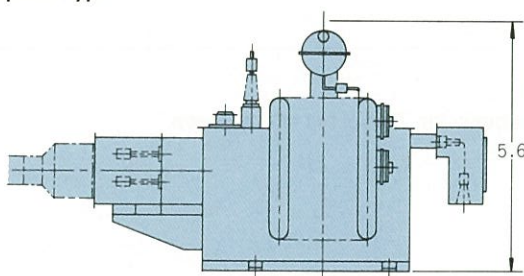
(7) Primary: Oil-immersed elephant
Secondary: Air insulated elephant type

Total mass: 75.5t
Oil quantity: 24.1kL



(8) Primary: GIS directly coupled
Secondary: Air insulated elephant type

Total mass: 74t
Oil quantity: 22kL



For Reference

With regard to bushings

■ Types of bushings

● Solid bushing

The solid bushing uses a porcelain tube as a main insulation, and the standard insulation class is 30 [kV] or below.

● Condenser bushing

The condenser bushing has a number of concentric cylindrical electrodes arranged in the internal insulating material and is formed into a condenser cone. The potential distribution is kept uniform within it. One of the following two types is selected according to the purpose of use. The standard insulation class is No. 60 or higher.

a) Synthetic-resin-bonded paper-insulated condenser bushing

The main part of internal insulation is composed of synthetic resin paper.

b) Oil impregnated paper-insulated condenser bushing

The main part of the internal insulation is composed of oil-impregnated paper.

■ Countermeasure of salt-pollution

● Countermeasure of salt-pollution

The following four methods are given in No. 2, Vol. 20 of Society of Electric Cooperative Research.

a) Over-insulation method

b) On-load cleaning method

c) Silicone compound coating method

d) Indoor installation method or other shielding method

One of these methods should be selected by taking the importance, reliability and economy of the equipment into full account.

● Types of porcelain tubes

The following three types of porcelain tubes are available for bushings used in the atmosphere, which should be selected according to the degree of salt-resistance needed.

(Applicable standard: JEC-183)

c) No. 2 Porcelain tube . . . For ordinary place.

b) No. 1 Porcelain tube . . . Has a long creepage distance and effective length for use at places where they are subjected to damage by salt.

c) No. 2 Porcelain tube . . . Has an extra-long and effective length for use surface leak at places where they are subjected to damage by salt.

● Contamination characteristics of porcelain tube

The contamination characteristics of the porcelain tube are shown in Table 2. The contamination withstand voltage is determined according to the importance of the equipment composing the system, though the value mentioned in (b) below is generally utilized.

Ineffective earthing system (154kV or less)

(a) Normal voltage to ground (max. circuit voltage $\times \frac{1}{\sqrt{3}}$)

(b) Sound phase max-voltage to ground in case of ground fault in one line (max. circuit voltage)

Table 2 Contamination characteristics of porcelain tubes

Insulation class [No.]	Rated voltage [kV]	Normal voltage to ground [kV]	Types of bushings	Porcelain tube designation	Porcelain tube dimensions [mm]			Contamination withstand voltage [kV]			
					Creepage distance	Effective length	Average	Salt contamination [mg/cm ²]			
								0.01	0.03	0.06	0.12
6	6.9	3.98	Solid	6-0	220	110	140	10.8	8.3	7	6.1
10	11.5	6.64		11-0	330	160	140	15.9	12.6	10.7	9
20	23	13.3		22-0	590	270	155	28.2	22.2	19	15.8
30	34.5	19.9		33-0	850	370	170	40.5	31.5	27	22
60	69	39.8	Condenser	66-0	1660	650	250	72	54	—	—
				66-1	2070	750	245	90	69	57	48
				66-2	2490	900	245	110	83	69	56
70	80.5	46.5	Condenser	77-0	1870	750	250	82	62	—	—
				77-1	2490	900	245	111	84	69	56
				77-2	3080	1100	245	137	102	85	71
(80)	(92)	(53.2)	Condenser	88-0	2080	850	280	86	63	—	—
				88-1	2670	950	275	113	85	70	57
				88-2	3100	1100	275	134	99	81	66
100	115	66.5	Condenser	110-0	2780	1100	300	115	82	—	—
				110-1	3500	1250	295	149	108	89	73
				110-2	4410	1540	295	190	138	113	92
140	161	93	Condenser	154-0	3750	1500	325	148	108	—	—
				154-1	5100	1800	320	210	154	125	102
				154-2	6330	2210	320	260	189	152	126

Note 1) The contamination withstand voltage (equivalent to 5% flashover voltage in fog) given in this table is the value versus outdoor contamination, and follows Electric Power Standard B-302 (A) curve.

2) When the bushing is covered with a cubicle, duct or the like or is installed indoors, the contamination withstand voltage becomes about 1.3 times the value given in this table.

Printed on recycled paper

F Fuji Electric Co., Ltd.

Gate City Ohsaki, East Tower, 11-2, Osaki 1-chome, Shinagawa-ku, Tokyo 141-0032, Japan
Phone : (03)5435-7111