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NISSIN ELECTRIC

CAPACITOR

FOR POWER FACTOR IMPROVEMENT AND VOLTAGE REGULATION

General

Nissin Electric Company Ltd. is Japan's largest and one of the world's leading capacitor equipment manufacturers. Nissin has a history of 50 years since it developed an oil-filled "OF" type capacitor for the first time in the world in 1931.

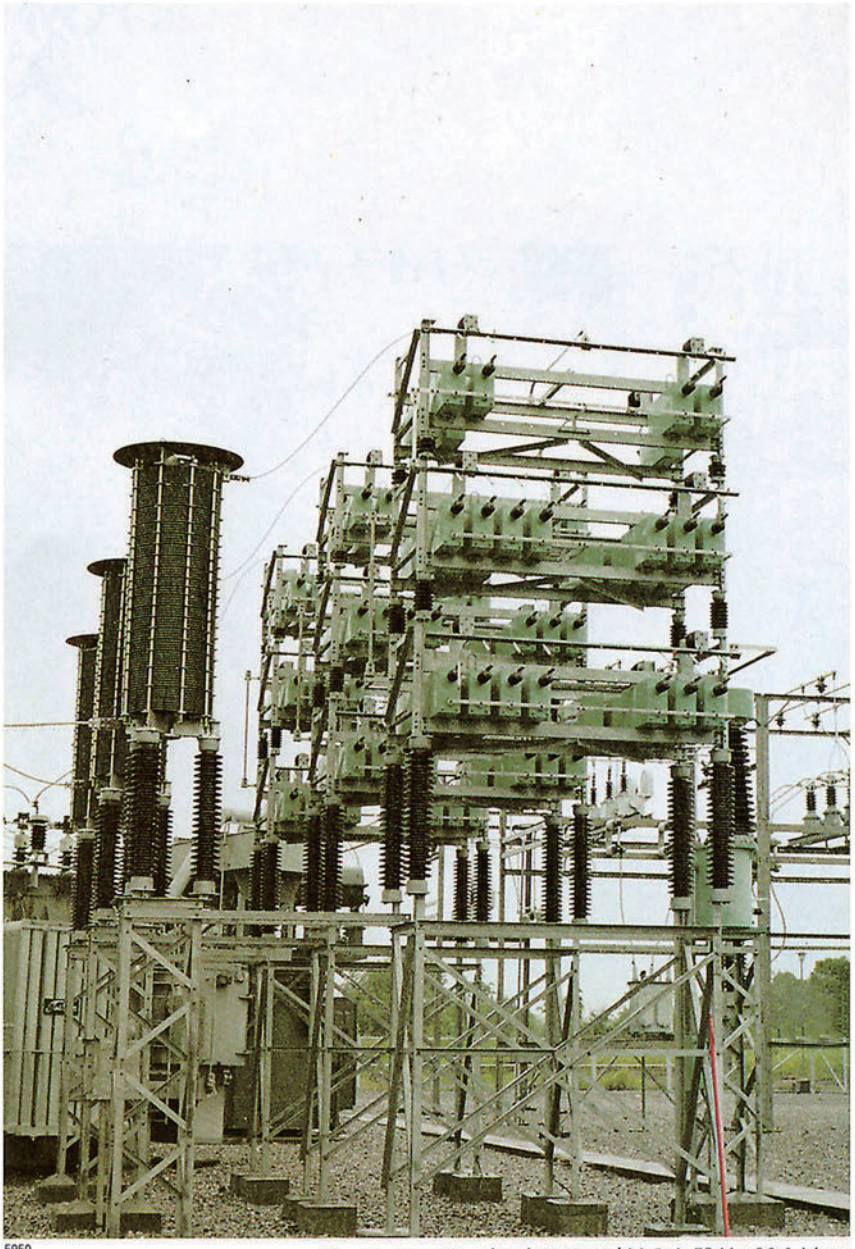
Supply Record

The aggregate of capacity of power capacitors so far built in Japan has exceeded well over 138,000 Mvar. Total production accounted for Nissin Electric Co., Ltd. has exceeded over 125,000 Mvar included those supplied for foreign countries. The concentration of manufacture is particulary kept in high voltage (above 11 kV) capacitors, for in this field, Nissin is responsible for as much as 90% of total production.

(at December of 1992)

Use / Voltage	Shunt Capacitor	Series Capacitor	AC Filter Capacitor	Total
above 11 kV	Mvar 72,578	Mvar 1,929	Mvar 5,269	Mvar 79,776
3.3 or 6.6 kV	37,120	60	444	37,624
Total	109,698	1,989	5,713	117,400

The History of Development



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Shunt capacitor bank 119.48 kV 3 ϕ 50 Hz 30.6 Mvar

- In 1931, the "OF" type capacitor having a rating of 6 kV 7 kvar was developed for the first time in the world.
- In 1938, the 66 kV-class capacitor equipment was delivered for the first time in the world.
- In 1955, the 220 kV 76.5 Mvar series capacitor equipment for power flow control in a looped transmission system was delivered.
- Coupling capacitors for power line carrier telephone communication, telemetering and carrier relay use for 154 kV line were developed in 1934. Also, in 1967, 500 kV use capacitor voltage transformers for line voltage measurement were standardized and delivered not only in Japan but also in various countries in the world.

999

Shunt capacitor bank 66 kV 3 ϕ 50 Hz 10 Mvar

- In 1973, the 154 kV 30 Mvar dead tank type shunt capacitor equipment having a maintenance-free and safety construction was delivered.
- In 1973, 2 banks of 275 kV 49.6 Mvar series capacitor for improving the system stability of long-distance transmission line and increasing the power transmission capability were delivered.
- The frequency converter equipment 300 MW capacity was installed in 1977, 275 kV 132 Mvar AC Filter equipment and 200 Mvar shunt capacitor equipment for this equipment were delivered. In this case, Nissin offered both the hardware and software, thereby proving our high level of technology.
- In 1978, the 187 kV and 275 kV 192 Mvar AC Filter equipment, 180 Mvar shunt capacitor equipment, and 250 kV 3.97 μF DC Filter equipment for DC transmission system were delivered.

NISSIN is the World's Leading Capacitor Manufacturer

- The elaborate research works and experiments carried out by expert engineers have developed various kinds of capacitor for various applications such as series capacitors, AC and DC Filters, power line carrier coupling capacitors, capacitor voltage transformers etc., revolutionizing the techniques for the application of capacitor to various field.
- Nissin's capacitors have been rated, both in performance and reliability, as one of the best in the world market due to production process of high quality control and high level capacitor technology such as analysis of phenomena of capacitor switching, higher harmonics and for application of series capacitor by computer and site test.
- The excellent performance and durability of Nissin's capacitors have created a reputation for the reliability all over the world and resulted in the supply of technical and production know-how to foreign manufacturers under license.

275 kV AC harmonic filter equipment 132 Mvar

C-I-165

275 kV Series capacitor banks 20.4 Ω 49.6 Mvar × 2

C-I-151

69 kV AC filter equipment 3ϕ 60 Hz 176 Mvar

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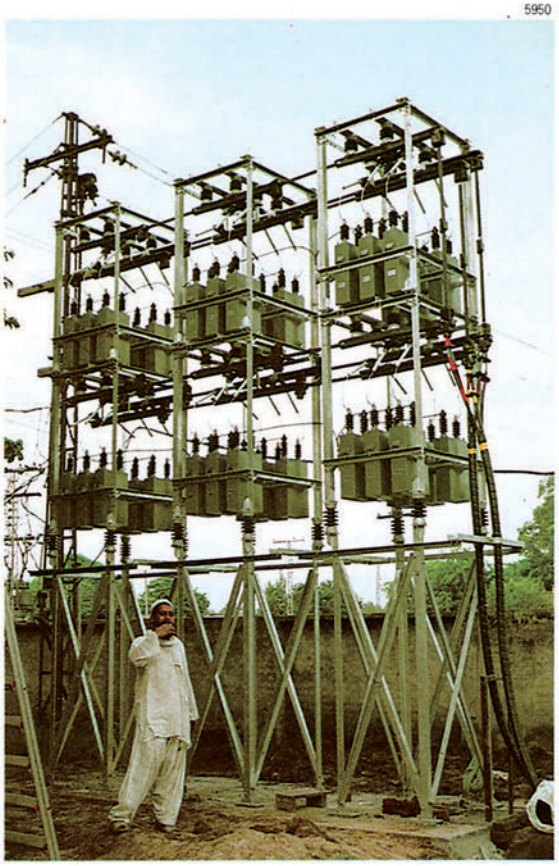
High Voltage Capacitor

Construction

The internal elements of the capacitor unit are made of modified kraft paper and synthetic film or all film as an insulator and the aluminium foil as an electrode, and impregnated with a biodegradable non-toxic aromatic hydrocarbon type synthetic oil. These elements are put in a steel case and hermetically sealed. The change of the oil volume is adjusted by the flexibility of the case wall. The discharge resistors are equipped.

5950



High voltage capacitor bank 11.7 kV 3ϕ 50Hz 7.2 Mvar

Superb Characteristics

Higher reliability and long life

The capacitor equipment has higher reliability and long life, obtained by production process of high quality control and high level technology of capacitor application.

The fault rate of Nissin's "OF" capacitor is very small as proved after many year's service.

Extra lower loss

Watt loss of capacitor is very small, 0.2~0.5 watts per kvar in operation condition.

C-U-179

High voltage capacitor unit

Easy maintenance

Nissin's "OF" capacitor is very easy to maintain.

Fault detecting device

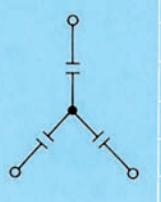
(Pressure Switch)

This Pressure Switch is the unique method developed by Nissin to detect internal failure and to remove capacitor from power circuit.

The internal pressure of capacitor case increases when a fault occurs inside the capacitor (i.e. breakdown).

A kind of Pressure Switch epuiped on the capacitor is turned-on by its pressure rise, and then instantly the faulted capacitor is removed from the circuit by means of the circuit breaker before the capacitor case rupturing.

Unit rating and bank capacity rating

Line voltage (kV)	Connection diagram of capacitor bank	Capacitor unit		Bank capacity to be constructed (kvar) and number of capacitor units used								
		Rated voltage (V)	Rated capacity (kvar)	300	450	600	750	900	1,200	1,350	1,500	1,800
2.4		1,390	100	3		6		9	12		15	18
3.3		1,910	150		3			6		9		12
4.16		2,400	200			3			6			9
4.8		2,770										
6.6		3,810	250				3				6	
7.2		4,160	300					3				6

Note: Other ratings available on request.

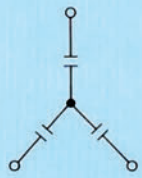
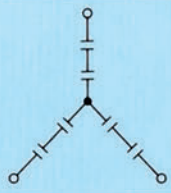
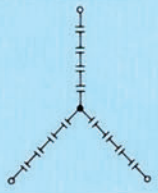
High Voltage Shunt Capacitor Bank for 11kV and above Circuit

Construction

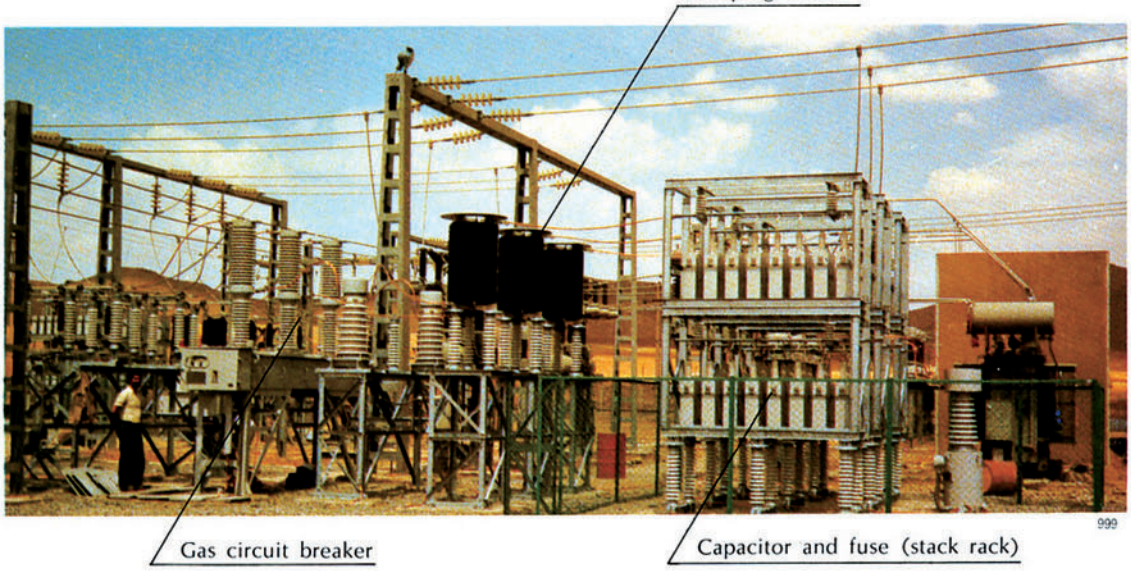
- The shunt capacitor bank is generally subject to star connection, and the neutral point is not grounded in general.
- Each capacitor unit is equipped with an expulsion type protective fuse for detecting internal failure upon a customer's request, and the capacitor units and the fuses are mounted in the open stack rack.

Ratings of Capacitor Bank

Unit rating and bank capacity rating

Line voltage (kV)	Connection diagram of 3 phase capacitor bank	Capacitor unit		Bank capacity to be constructed (kvar) and number of capacitor unit used						
		Rated voltage (V)	Rated capacity (kvar)	2,500	5,000	7,500	10,000	15,000	20,000	30,000
11		6,350	209 (334)	unit 12 (—)	24 (15)	36 (—)	48 (30)	—	—	—
11.5		6,640								
12.47		7,200								
13.2		7,620								
13.8		7,960								
22		12,700								
23		13,280								
33		9,500	209 (334)	—	—	—	48 (—)	72 (—)	96 (60)	—
34.5		9,960								
66		19,000								
69		19,920								
115		16,600	167 (256)	—	—	—	—	—	120 (—)	180 (120)
132		19,000								
154		22,200								

Note: Other ratings available upon request.



Ancillary Apparatus for Shunt Capacitor Equiment

The following apparatus which are necessary for the operation of capacitor banks are also made available by Nissin.

Damping reactor and series reactor

(1) It is quite necessary to suppress excessive inrush current surges at switching capacitor banks in the circuit, especially when switching them into the bus with already energized capacitor banks.

By the use of damping reactors, contact wear of switching equipment can be reduced and overvoltages across current transformer secondaries can be suppressed effectively.

(2) When the capacitor bank is connected to the system, voltage wave form of which contains some amounts of higher harmonics due to non-linear characteristics of transformers, rectifiers, etc., higher harmonic current will flow into the capacitor and the extent of wave form distortion tends to increase. In some particular cases, harmonic currents in capacitor circuit will be increased to such a large extent that operation of capacitor itself might become difficult or hazardous effects will be given on other equipment in the system.

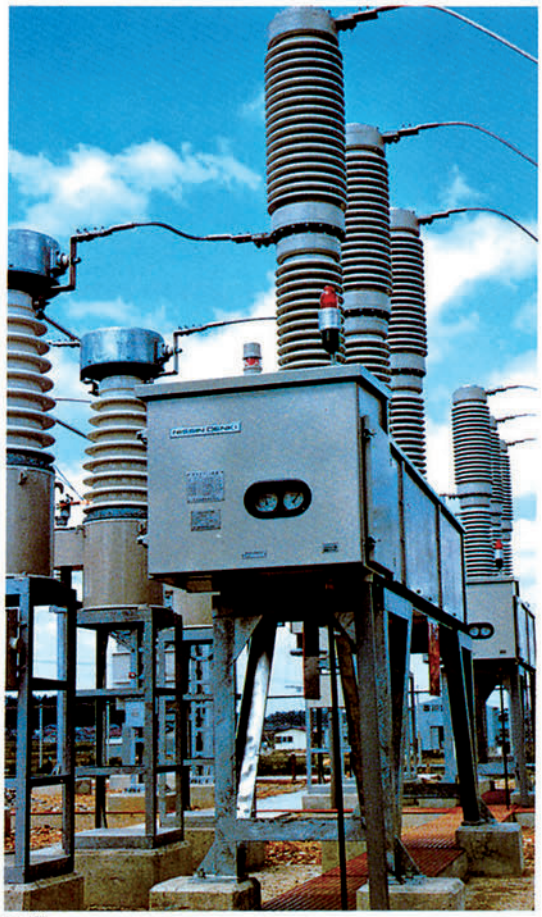
To prevent those effects, series reactors are prevailingly used in Japan.

Switches and circuit breakers

The points to which considerations should be given in the event of switching capacitor banks are as follows.

1) Large inrush current surge
2) High possibilities of restriking
3) Frequent switching operations

Switches and circuit breakers which are "restrike free", "endurable for large inrush current" and "suitable for frequent operation" can be supplied for capacitor switching by Nissin.



S-I-101

Gas circuit breaker 72/84 kV 1,200 A 25 kA

Available switching devices are as follows:

Type of devices	System voltage		
	3.6~7.2 kV	11~33 kV	66 kV and above
Gas circuit breaker	○	○	○
Gas switch	○	○	○
Vacuum circuit breaker	○		
Vacuum switch	○		

Control, metering and protection equipment:

Panels and cubicles for control, metering and protection which may be required for operation of capacitor banks can be also supplied by Nissin.

Low Voltage Capacitor

Construction

Low voltage capacitor is of the "self-healing" type and comprises metallized plastic film or metallized paper and plastic film mixed type elements are put in a flexible case.

Internal elements are impregnated with a biodegradable non-toxic synthetic oil. The discharge resistor and safety device are equipped.

Superb Characteristics

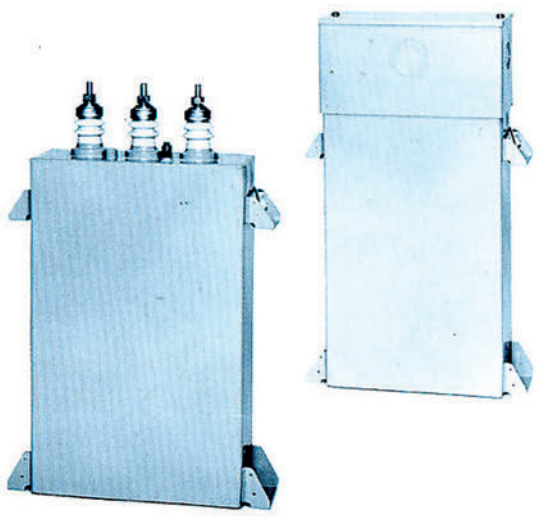
Self healing function and safety device

When an internal failure occurs, a capacitor element heals themselves instantaneously and re-establishes the insulation. In case of no re-establish, as back up protection, the safety device cuts the capacitor off from power source.

Low loss

Watt loss of capacitor is less than 2 watts per kvar.

Small size and light weight



Low voltage capacitor units

56-146

Rating of Capacitor Unit

• 200 V～220 V	10～1,000 μF
	10～50 kvar
• 380 V～460 V	5～600 μF
	10～100 kvar

Ancillary Apparatus

The following apparatus which are necessary for the operation of capacitor are available.

Power fuse

Power fuse protection of short circuit is available.

Power fuse must be rated at 2～3 times nominal capacitor current.

Switch

Switches suitable for frequent operation of capacitor connection are also available.

Automatic-control equipment

Several types of automatic-control equipment can be supplied by Nissin.

Among them, reactive power (Var) control system is widely applied.

Summary of Var-control system is as follows;

The capacitor equipment are switched on or off automatically, according to the variation of the reactive power flow of the main circuit.

Other Capacitor Equipments

57-168

- **Series Capacitor Equipment**
  For transmission line and distribution line

O-398

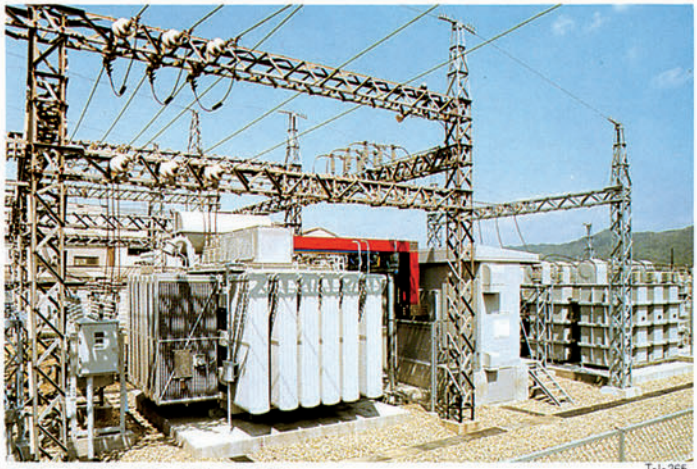
- **AC and DC Filter Equipment**
  For transmission line, distribution line and converter station

C-U-163

- **Shunt Capacitor for Furnace**
  For arc furnace, induction furnace and other

T-I-268

- **Coupling Capacitor and Capacitor Voltage Transformer**
  For power generation, transmission line and distribution line



T-I-265

- **Thyristor Var Controller**
  For compensation of voltage fluctuation

Others

- **Surge Protecting Capacitor**
  For transformer, motor, generator and other
- **Standard Capacitor**
  For testing equipment