

# FUJI POWER-USE LIGHTNING ARRESTER

## TYPE HF410 RATED 4.2 AND 8.4 kV

The Lightning Arrester rated 4.2 and 8.4 kV, on which a brief introduction is to be given in this Article, has been completed by our Company in compliance with the Lightning Arrester Standard JEC-131 of Institute of Electrical Engineers of Japan. In Japan, the arrester of this voltage rating is employed for the isolated neutral system and the high-impedance grounded system under 3 kV and 6 kV of the nominal voltage, respectively. Besides, on taking into account a state of its system, we might attain our object even when it would be applied for any other systems than those of our country.

### I. SPECIAL FEATURES

- ① As an auto-blast electrode is applied for this arrester, its spark-over characteristics might not be changed even after its working or functioning.
- ② Excellent state of protection can be expected, because of its moderate impulse spark-over voltage characteristic and of its low discharge voltage.
- ③ As its small size and light weight, this arrester is particularly good and adequate to installation of it in the cubicle.
- ④ A special explosion-proof device is fitted on behalf of its safety.
- ⑤ Consideration for anti-contamination is paid to the insulator.

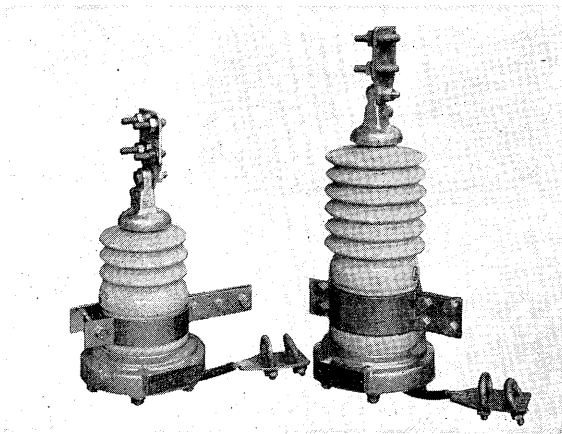


Fig. 1. Outer view of lightning arrester HF 410  
left: 4.2 kV      right: 8.4 kV

### II. CONSTRUCTION

Both figures, namely Fig. 1 and Fig. 2, give the outside appearance and the inside construction of this arrester, respectively. In general, this arrester has such a construction that the series gap, the characteristic elements and other components are set and assembled into the anti-contamination insulator; that the explosion-proof device is fitted on the bottom surface of the insulator; and that the hanger is provided for its installation.

The Fig. 3 illustrates, in a form of its model, an operational principle of the auto-blast gap, or a characteristic component of this arrester. That is, as the electrode of this gap has an indenting part in its center fronting to the gap spacer, the spark-over with the impression of an impulse voltage oc-

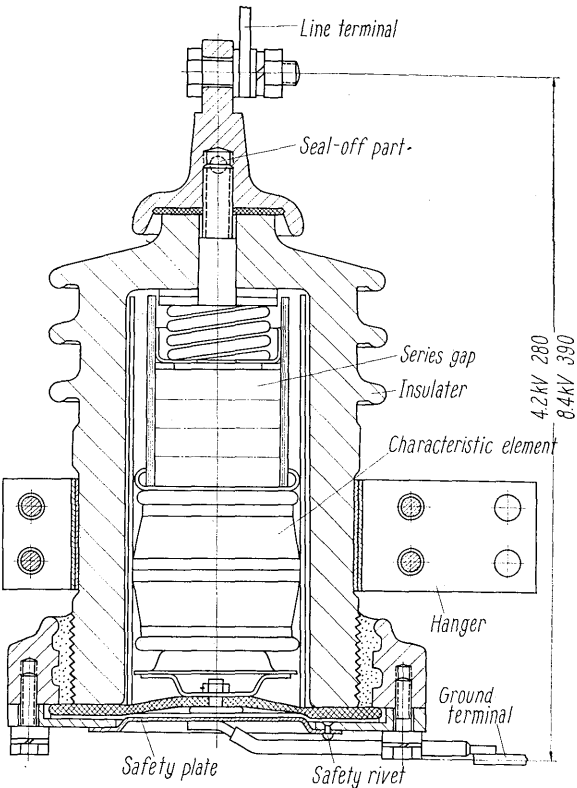


Fig. 2. Interior construction

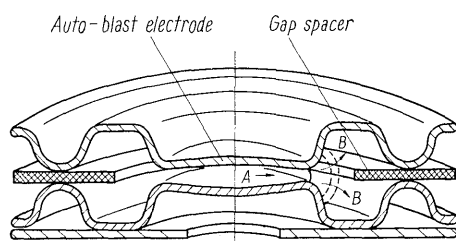


Fig. 3. Principle of auto-blast gap

curs on a certain constant circle; and, as the space within this circle is smaller in its volume than that outside of it, the pressure within this circle rises abruptly with heat of the follow current arc in the period of the follow current to blast the arc outside in a direction of its radius, so its cathode and anode spots on the arc quenching are always to be removed to such a position as irrelative to subsequent spark-over. As have been described, the auto-blast electrode has such an effect as driving the arc, its arc quenching ability is large and its spark-over characteristic is unchangeable, too.

A special packing is provided for the purpose of making the state of sealing mainly to secure both the weather-proof property and the low permeability, and such a construction is given as each product having no difference in its packing effects. After completion of its assembling, heating and evacuation are processed; and as the nitrogen gas of a high purity and of a low humidity is sealed in the arrester, the dew point can never be attained even in the lower temperature than  $-40^{\circ}\text{C}$ .

The explosion-proof device consists of both the safety rivets and the safety plate. The former,

which is illustrated in the Fig. 2, is cut by inner pressure when the arrester is made in a short-circuit state after its working for an excessive duty over its guaranteed capacity. While, the latter is opened by the former and it may be clearly seen from the outside.

The 4.2 kV-rated arrester weighs 7.7 kg/pole and the 8.4 kV-rated arrester weighs 11.8 kg/pole, respectively.

### III. CHARACTERISTICS

Both tables No. 1 and No. 2 provide the guaranteed capacity of the arrester and some examples of the test results.

The duty-cycle test, in compliance with the Standard JEC-131, was carried out in the following ways:

a) Such a power source as with a symmetrical r.m.s. short-circuit current more than 700 A in the

Table 1. Guaranteed characteristics

Voltage ratings (kV)		4.2	8.4
Power frequency spark-over voltage (kV)		Above 8	Above 16
Impulse spark-over voltage $1 \times 40 \mu\text{s}$ wave, at $2 \mu\text{s}$ (kV)		Below 15	Below 30
Discharge voltage (kV)	1,500 A	Below 13	Below 26
	5,000 A	Below 14.5	Below 29
Discharge current withstand test		$10 \times 20 \mu\text{s}$ wave 20kA, above 5 times	

Table 2. Example of test results

Voltage ratings	Arrester number		Power frequency spark-over voltage (V)			Impulse spark-over voltage (V), $1 \times 40 \mu\text{s}$ , at $2 \mu\text{s}$		Discharge voltage (V) $10 \times 20 \mu\text{s}$ 5,000 A	Duty-cycle test
			Dry	Wet 2)	Contamination 1)	Dry	Wet 2)		
4.2 kV	P	Before duty test	8,020	—	—	10,400	—	12,700	Terminal voltage 4.2 kV Follow current about 80 A
		After duty test	8,060	8,140	—	11,400	11,700	13,100	
	Q	Before duty test	8,460	—	—	11,600	—	13,100	Terminal voltage 4.5 kV Follow current about 90~100 A
		After duty test	8,726	8,850	8,200	11,900	12,000	13,100	
8.4 kV	T	Before duty test	18,510	18,700	16,700	24,000	24,000	27,800	Terminal voltage 9 kV Follow current about 100 A
		After duty test	18,124	—	—	—	—	27,800	

Note: 1) Degree of contamination. A solution which contains 48.8 grammes kaoline and 1.626 grammes NaCl in one litre water

2) Horizontal precipitation 3.4 mm/min.  
Vertical precipitation 3.2 mm/min.  
Specific resistivity 8,200 $\Omega$ -cm at  $20^{\circ}\text{C}$

state of arrester short-circuited is employed for this test with impression of the rated voltage.

b) The impulse current of the half-crest value duration time of more than 15 s and the crest value of 3,000 A is superposed in the course of a-c voltage build-up, within the range of  $\pi/4 \sim \pi/2$ , five times the same phase to a-c voltage and in the opposite phase respectively.

In this test, the arrester interrupted each follow current about 100 A with a sufficient superfluity, just as shown in the Table 2, even when impressing a voltage as much as approximately 110% of its rated voltage.

As have already been mentioned, in our country, this arrester might be applied for such lines as bearing the nominal voltages of 3 kV or 6 kV, and the rated voltage of the arrester itself has been decided at 1.4 times as high as the above voltage of the proposed lines. Thus all readers will find this test very strict, without difficulty.

This test is also to be continued under such voltages as much higher than the rating, until the arrester is destroyed.

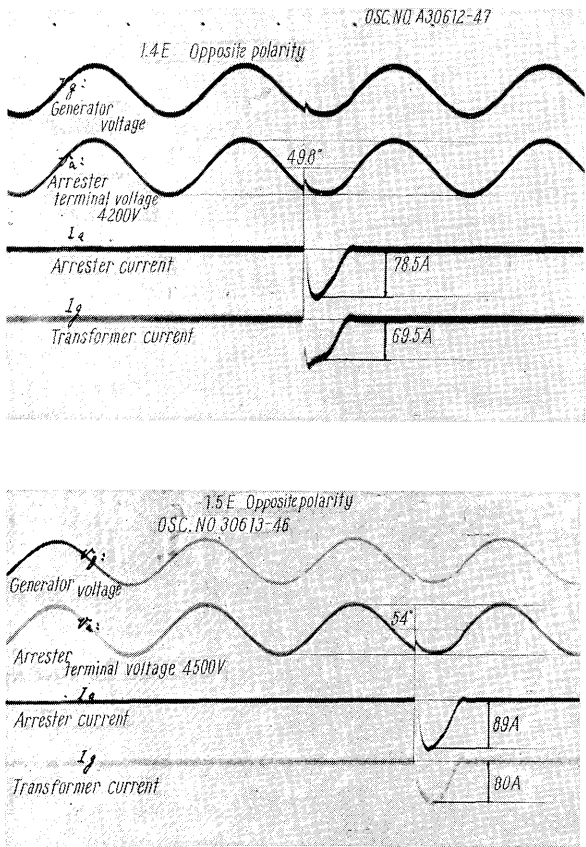


Fig. 4. Oscillograms of operating duty-cycle test of arrester rated 4.2 kV

From up to down; Generator voltage, arrester terminal voltage, arrester current and transformer current

Fig. 4 shows some examples of results of the duty-cycle test, under which the follow current is interrupted within a half cycle. According to the Table 2, very little variation in its spark-over characteristic may be clearly recognized before and after the test. This fact reveals nothing other than the very effects of the auto-blast electrode.

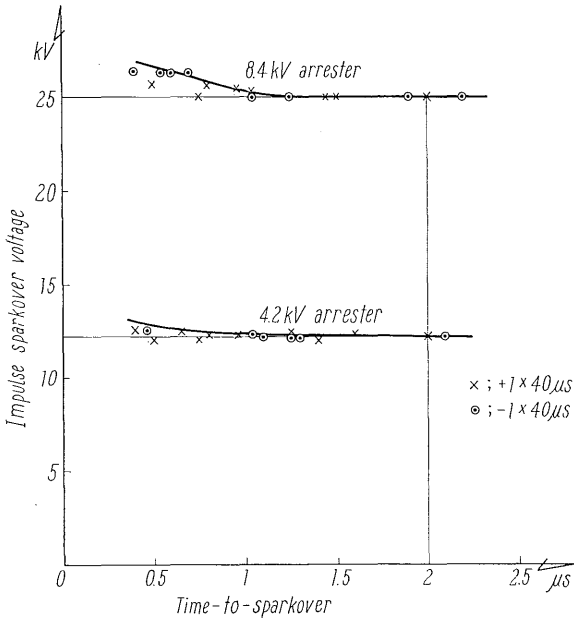


Fig. 5. Impulse spark-over volt—time characteristic

Fig. 5 gives the impulse spark-over volt—time characteristic. With thin gap spacer between the two electrodes, its preionization effect appears so emphatically that a time delay in the spark-over is little, that its characteristic curve is flat and that the impulse ratio at 2  $\mu$ s is approximately 1.0.

The discharge current withstand quantity of this characteristic element is so large for the small size of  $67\phi \times 27$  that it may withstand not only the requirements of 20 kA and 3 times under the Standard JEC-131, but also those of 70~80 kA of the half-crest-value duration time of 20~30  $\mu$ s and 3 times.

Also, in the course of its type test, each finished arrester is put under an air-tight test by cooling and heating repeatedly in order to scrutinize variation in its characteristic; while, in a course of its production, an another air-tight test is carried out in a strict way.

Furthermore, the vibration test is also undergone under the condition of acceleration about 6 g by taking into account its vibration on its delivery and earthquakes, so that the arrester may stand sufficiently against any earthquake and vibration.

(By Keiji Edamoto and Shigenobu Kimura, Physical Research Div., Research Dep't.)

## Outline of Our Products

### (I) Heavy Current Equipment

- a) Generators :  
Synchronous generators up to 100,000kVA.  
Direct current generators up to 5,000 kW.  
Other all kinds of generator.
- b) Condenser :  
Synchronous condenser up to 50,000kVA.  
Static Condenser up to 200kVA.
- c) Motors :  
3-phase synchronous motors up to 10,000 HP.  
3-phase induction motors up to 10,000 HP.  
3-phase commutator motors up to 200 HP.  
Direct current motors up to 10,000 HP.  
Other all kinds of motor.
- d) Standard motors (for general use):  
3-phase induction motors from  $\frac{1}{2}$ HP to 100HP.  
Squirrel cage motors from  $\frac{1}{2}$ HP to 100 HP.  
Split phase start 1-phase ind. motors 100 & 200 W.  
Repulsion start 1-phase ind. motors for 200 & 750 W.
- e) Special motors :  
Loom, card, mule, ring-motor and pot-motor for textile industries.  
All other kinds of special use motor.
- f) Rotary converters with transformer up to 3,000 kW, 1,500 V.
- g) Transformers :  
Power transformers up to 200MVA, 287 kV.  
Furnace transformers with on-load tap changer up to 50 MVA, 140kV.  
Measuring transformers up to 287 kV.  
Other all kinds of transformer.
- h) Standard transformers (for general use):  
1-phase & 3-phase distribution transformers from 3kVA to 200kVA.
- i) Induction voltage regulators up to 1,000kVA.
- j) Iron vessel mercury arc rectifiers :  
Singleanode or multianode type, water cool or air cool type and with pump or without pump type up to 6,000 A, 100k V.
- k) Contact converters up to 12,000 A, 500 V.
- l) Selenium rectifiers up to 10,000 A, 100 kV.
- m) Regulating apparatus :  
Motor starters, controllers, speed regulators, voltage regulators and other regulating apparatus for all kinds of service.
- n) Circuit breakers :  
Expansion circuit breakers from 60 kV up to 287 kV.  
Oil circuit breakers up to 70 kV.  
Air circuit breakers up to 3,000 V.  
High speed air circuit breakers up to 3,000V.
- o) Switch equipment :  
Disconnecting switches up to 287 kV.  
Knife switches, magnetic switches and other all kinds of switch equipment.
- p) Switchboards :  
Sheet iron made switchboard for all kinds of service.
- q) Relays :  
All kinds of relays for power and industry use.

### (II) Machines

- a) Water turbines :  
Francis type, Pelton type and Kaplan type turbines up to 100,000 HP completed with necessary regulating accessories.
- b) Steam turbines up to 50,000 kW.
- c) Gas turbines :  
Closed circuit type up to 30,000 HP.
- d) Water pumps :  
Turbine pumps up to 1,000 HP.  
Centrifugal pumps from 2".
- e) Fans :  
Propeller fans.  
Centrifugal (Sirocco) fans.
- f) Mine hoists :  
Cage or skip type shaft winder.

### (III) Railway and Ship Equipment

- a) Traction motors of all kinds.
- b) Mine locomotives of all kinds with electric equipment.
- c) Cargo winches for 3 tons and 5 tons with electric equipment.
- d) Steering engines of all kinds with electric equipment.

### (IV) Weak Current Equipment

- a) Integrating watt-meters (watt-hour meters):  
1-phase W.H.M. for low tension circuit use.  
3-phase W.H.M. for low tension and high tension circuit use.
- b) Electric measuring instruments :  
Switchboard meters, portable type meters, precision meters, recording meters, insulation testers, tele-metering equipment.
- c) Industrial measuring instruments :  
Electric thermometers, pyrometers, psychrometer, flow meters for water, steam, gas and air.  
Gas analyser, pressure gauges, vacuum meters  
pH meters, level meters, electronic recorders, salinometer.
- d) Automatic controlling equipment :  
Automatic combustion controlling equipment for steam boilers and various furnaces.  
Pneumatic controllers for temperature, pressure, flow and liquid level.  
Ratio controllers for gas and liquid mixing.  
Rollers, electrical indicating controllers with on-off contacts.

### (V) Domestic Equipment

- a) Electric table fans of, 8" 12" and 16".  
Electric pedestal fans of 16".
- b) Electric room heaters.
- c) Electric washers for  $\frac{1}{4}$  HP.
- d) Electric refrigerators for  $\frac{1}{4}$  HP.
- e) Razor blade sharpener (for double edge).
- f) Dry battery & flash light.
- g) Juicer, electric clock.
- h) Electric iron.
- i) Toaster.
- j) Centrifugal dehydrating machine.
- k) Electric bulbs & Fluorescent lamp & illuminating app.