

NEW TYPE AIR CIRCUIT BREAKER

I. PREFACE

We have recently completed a new series of air circuit breakers of rated current from 200 A to 6,000 A for low voltage.

This new series is aimed at not only improving their qualities but also making the breakers particularly smaller in size and lighter in weight. These breakers may be roughly classified into three groups; namely, the RF 913 type (for alternating current), the RF 914 type (for direct current) for rated current of more than 600 A and the RF 921 type (for both the alternating and the direct current) to be applied for rated current of less than 400 A.

In the following paragraphs of this article, we would like to introduce several characteristic features about the each above-mentioned type, as a guide for selecting these apparatus.

II. SPECIAL FEATURES

1. RF 913 type and RF 914 type

1) These types have large interrupting abilities and their interrupting time is short, therefore they may particularly be suitable for protecting both the machines and the circuits in those systems of large short-circuit capacity.

In order to let these breakers have the above-mentioned features, the special consideration has been taken in the structure of these breakers as follows:

- (1) The moment of inertia of their movable parts is made as small as possible.
- (2) The arc-quenching contact of these breakers are made so as to open very quickly.
- (3) The arc chamber is made of such a deionization structure as containing many arc-quenching iron plates in itself.

2) These types are of the small size, the light weight, the box-type form and a so-called draw-out type structure; so that they may be sufficiently placed in a small space and a narrow front area, and that they may be properly mounted in the cubicle.

Especially, they are the most adequate types for locating a lot of breakers in several vertical layers.

And, the originative shapes of various components and special materials are applied for these breakers in order to compose these breakers of such a form and shape as above-mentioned.

3) The main contact part is made of a silver contact to increase its current-carrying capacity, while the arc-quenching contact is protected by an arc-resisting metal to minimize the consumption. This arc-quenching contact is designed so as to cancel effectively the electromagnetic repellent force.

4) The arc chamber is mounted on the back side of the air circuit breaker to spout the electric arc in a direction opposite to its operating device, so that there may be no danger, even if the breaker is erroneously operated in any accident.

5) As these types of air circuit breaker may be equipped with the short-time delay over current tripping device, so the selective tripping can be effectively carried out. Also, they can delay their non-voltage tripping action so that any unnecessary tripping may be prevented sufficiently. Furthermore, these types of the breaker may be designed so as not to make their reclosing action possible without particular pushing of the "reset" button after automatic tripping at the short-circuit.

6) The consumption of the arc-quenching contact can accurately be estimated only by removing the arc extinction chamber from the breaker. And, the arc-quenching contact can be replaced with a new one in a simple way.

7) Special metals are adopted for main parts of the operating mechanism and device of these types of the breakers, and all the forms or shapes of the components are equilibrated, so that all of them may stand satisfactorily any severe utilization, including that under the states of shock and vibration.

8) The universal type of the motor, being able to be applied equally for both the alternating and the direct current, is adopted for the motor-driven operating device of the breakers; the shifting from the DC operation to the AC operation, or vice versa may be effectuated very simply.

2. RF 921 type

1) This type of air circuit breaker is made of such small size and light weight that it may be

mounted both in a hanging type and in a draw-out type. Its arc-quenching chamber is designed of a nozzle type in order to minimize the spouting volume of electric arc so that it may be installed in a narrow space and be properly placed in a cubicle.

2) Because of its simple structure and of its easy checking and maintenance, it may be utilized without difficulty.

3) The contact parts are made of a silver alloy in order to increase its current-carrying capacity and to minimize its consumption.

4) As this type of air circuit breaker may be provided with the short-time delay over-current tripping device, so the selective tripping can be effectively carried out. This type of the air circuit breaker can also delay its no-voltage tripping action, so that any unnecessary tripping may be effectively prevented. Besides, it can be designed of such a structure as being unable to make its reclosing action without pushing particularly the "reset" button after automatic tripping at the short-circuit.

5) Its operating mechanism is designed in such a way as minimizing the weight of its movable parts and as taking balance in the shape or form, so that it may stand satisfactorily against any severe utilization including that under the states of shock and vibration.

6) The universal type of the motor, which can be equally applied for both direct current and alternating current, is applied for the motor-driven operating device of the breaker; so that the shifting from the direct current operation to the alternating current operation, or vice versa, may be effectuated very easily.

3. Equipped devices for over-current tripping

Both the instantaneous and inverse-time over-current tripping devices are to be provided to each type of the air circuit breakers. As for the short-time delay over-current tripping device, it may be provided at the request of customers.

1) Instantaneous over-current tripping device

The tripping action may be effectuated with the current as much as 100% of the adjusted scale value. This scale value is adjustable.

2) Inverse-time over-current tripping device

This device can not act with the current as much as 105% of the adjusted scale value but can with the current as much as 120% of it. The scale value is adjustable in all types.

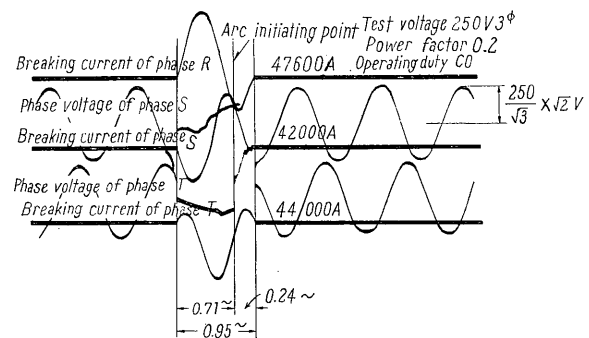


Fig. 1. Oscillogram of short-circuit test of air circuit breaker, type RF 913-1,000

III. RATINGS AND PERFORMANCE, ETC. OF BREAKERS

1. Types and ratings

Table 1 is to describe on the types and ratings of this new series of air circuit breakers. The various items of ability and performance of these breakers are to comply with the requirements of the Japanese Standard of the Air Circuit Breaker, JEC-91.

2. Total rupturing time and closing time

Table 2 is to show the various approximate values of both the total rupturing time and the closing time required in the case of motor-driven operating device. Both Fig. 1 and Fig. 2 are to illustrate an example of the interrupting performances, respectively.

Both the RF 913 type and the RF 914 type are equipped with the thermal relay and which effectuates the tripping through the voltage tripping device. On the other hand, the RF 921 type is made of such a mechanism that tripping at the over-current is effectuated directly in a certain mechanical way. This thermal relay is mounted to the upper part

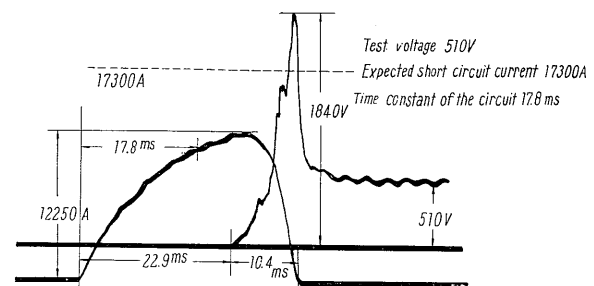


Fig. 2. Oscillogram of short-circuit test of air circuit breaker, type RF 914-3,000

of the air circuit breaker itself in case of the RF 913 type, while the relay is located at a proper position separately from the breaker itself in case of the RF 914 type. Besides, a temperature-compensating device is fitted to all types.

Table 1. List of types and ratings of new type air circuit breakers

| Air circuit breaker for alternating current | | | | | |
|---|----------------------|----------------------|---|--|-----------------------|
| Type | Rated voltage (V) | Rated current (A) | Rated rupturing capacity (kA) (at 600A) | | Number of poles |
| R F 921- 200 | 250 | 200 | 10 | | 2 |
| R F 921- 400 | | 400 | 20 | | |
| R F 913-1,000 | | 1,000 | 40 | | |
| R F 913-2,000 | 600 | 2,000 | 50 | | or |
| R F 913-3,000 | | 3,000 | 50 | | 3 |
| R F 913-4,000 | | 4,000 | 70 | | |
| R F 913-6,000 | | 6,000 | 70 | | |

| Air circuit breakers for direct current | | | | | |
|---|----------------------|----------------------|----------------------------------|---------|-----------------------|
| Type | Rated voltage (V) | Rated current (A) | Rated rupturing capacity (kA) | | Number of poles |
| | | | at 600V | at 750V | |
| R F 921- 200 | 600 | 200 | 10 | — | 2 |
| R F 921- 400 | | 400 | 20 | — | |
| R F 914-1,000 | 250 | 1,000 | 40 | 20 | |
| R F 914-2,000 | | 2,000 | 50 | 30 | |
| R F 914-3,000 | | 3,000 | 50 | 30 | |
| R F 914-4,000 | 600 | 4,000 | 70 | 35 | |
| R F 914-6,000 | 750 | 6,000 | 70 | 35 | |

Table 2. Total rupturing time and closing time (at motor-driven operating device)

| Type | Total rupturing time | Closing time |
|-------------------|-------------------------|----------------|
| RF 921 | approx. 2 c/s | approx. 15 c/s |
| RF 913 and RF 914 | approx. 2 c/s | approx. 10 c/s |

3) Short-time delay over-current tripping device

The breaker may be equipped with this device in case of the particular request of the customers. The time to be delayed is adjustable within the range of 0~0.5 second.

4. Voltage tripping device

There are two types of this device, namely the voltage tripping type and the no-voltage tripping type. Either of the two types shall be equipped.

This tripping action can be delayed within 0.4~ 1 second, in case where the request is made for the no-voltage tripping device in order to prevent the device from any unnecessary tripping action, at such a time of temporary drop of voltage as that of starting of the motor.

5. Auxiliary switches fitted to the breaker

As for the auxiliary switches, the breaker is provided with both the four contacts which can open or close in the same manner along with the opening or closing of main contact, and another four contacts which may open or close in such a manner as opposite or contrary to the opening or closing of main contact, as a standard type. The current-carrying capacity is as much as 15A approximately in both the RF 913 type and the RF 914 type, while it is as much as 5A approximately in the RF 921 type.

6. Operating device

Each type of air circuit breakers may be provided with the manually operating device as well as the motor-driven operating device, the compressed-air driven operating device and the lever operating device for remote control.

As for each type of the breakers, the rated voltage of the motor-driven operating device is 100/110V or 200/220V in both alternating current and direct current; and the rated operating pressure of the compressed-air driven operating device is 5 kg/cm².

IV. OUTLINE OF STRUCTURE OF VARIOUS TYPES OF BREAKER

1. RF 913 type and RF 914 type

Both Fig. 3 and Fig. 4 are to illustrate the appearance of the air circuit breakers, the RF 913 type and the RF 914 type, respectively.

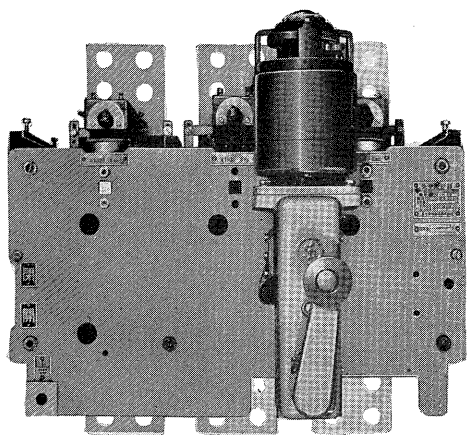


Fig. 3. Air circuit breaker, type RF 913-3,000

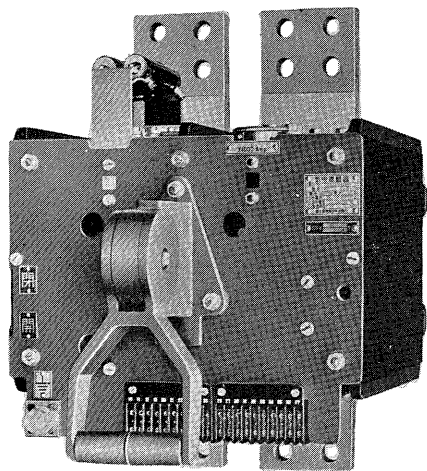


Fig. 4. Air circuit breaker, type RF 914-3,000

These air circuit breakers are composed by connecting with three bolts those side walls and shield walls which are made of the moulded insulating material of large mechanical strength, and by placing among these walls the equal number of the conducting part, of such a structure as shown in Fig. 5, to that of the electric pole.

As clearly seen by Fig. 5, the contact part consists of both the upper and the lower fixed contact and the roller-type contact, and it is of such a structure that the turning of main shaft is to open the state of bridge by the roller and that the insulating support is simultaneously to knock the movable arc-quenching contact to open the circuit.

In the front side of the breaker, the front board is fitted to support both the side walls and the shield walls.

The operating device and the auxiliary circuit terminals, etc. are to be fitted to the front board.

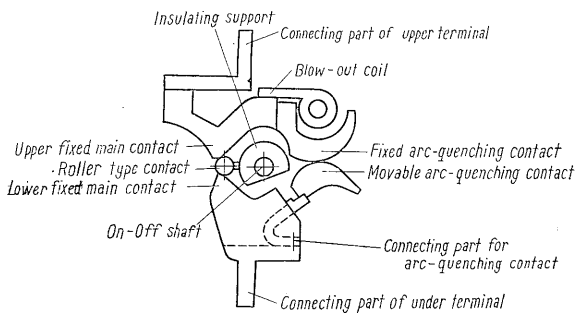


Fig. 5. Construction of contact part of breaker, type RF 914

The operating or functioning mechanism of the breaker is located in the hollow space of the right and left side walls of the body. The arc-quenching chamber is made of such a deionization structure as containing the arc-quenching iron plate in the chamber, which is mounted on the back side of the breaker.

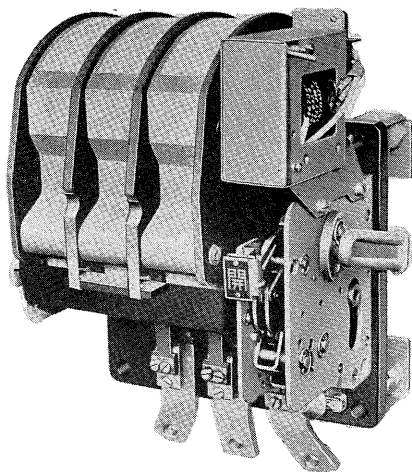


Fig. 6. Air circuit breaker, type RF 921-200

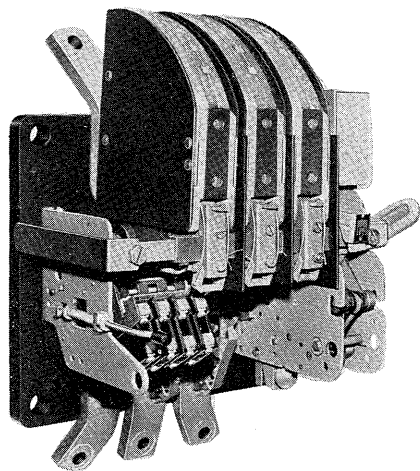


Fig. 7. Air circuit breaker, type RF 921-400

2. RF 921 type

Both Fig. 6 and Fig. 7 are to show the photographed appearance of the air circuit breakers, the RF 921-200 type and the RF 921-400 type, respectively. These types of breakers are of such a very simple construction as placing the conducting parts in parallel, corresponding in the number of electric pole, on the base of the insulating board, mounting the arc-quenching chamber to the upper part of the breaker and collecting the operating mechanism only in the right side of the breaker.

As for the breakers for direct current, the arc-

quenching chamber is of a nozzle-type structure with a narrow head of it; while the chamber is made of a deionization structure containing the arc-quenching iron plate in the breaker for alternating current.

The main contact is made of a silver alloy, both for the 200A type and the 400A type.

V. OUTLINE DIMENSIONS

Several examples of the outline dimensions of the air circuit breakers, types RF 913, RF 914, and RF 921, all in case of the manual operation, are illustrated in those Fig. 8~13, respectively.

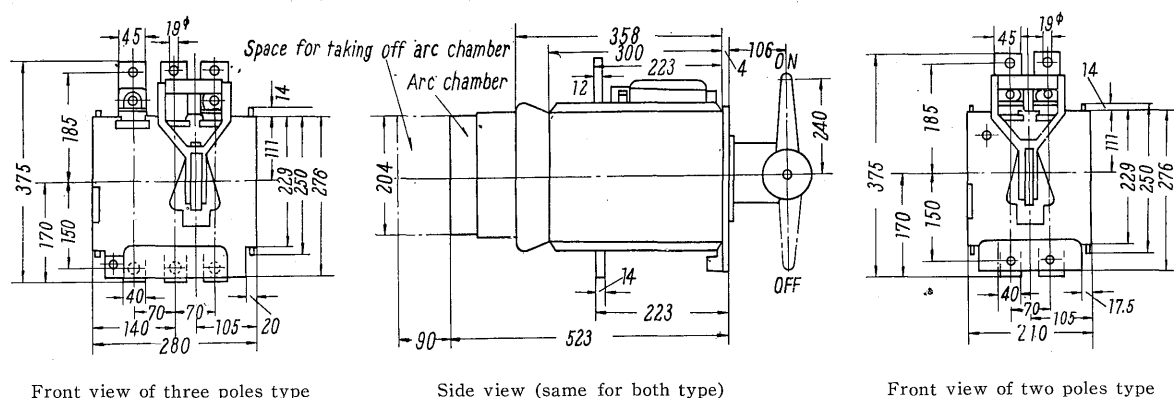


Fig. 8. Outline drawing of air circuit breaker, type RF 913-1,000

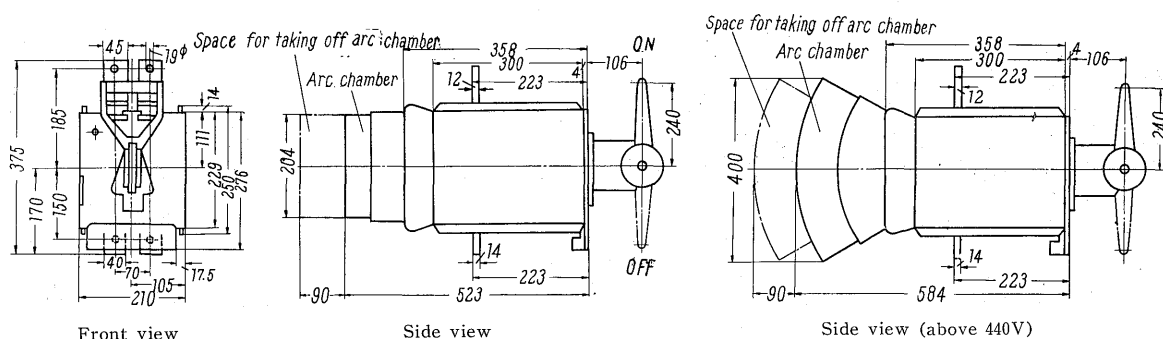


Fig. 9. Outline drawing of air circuit breaker, type RF 914-1,000

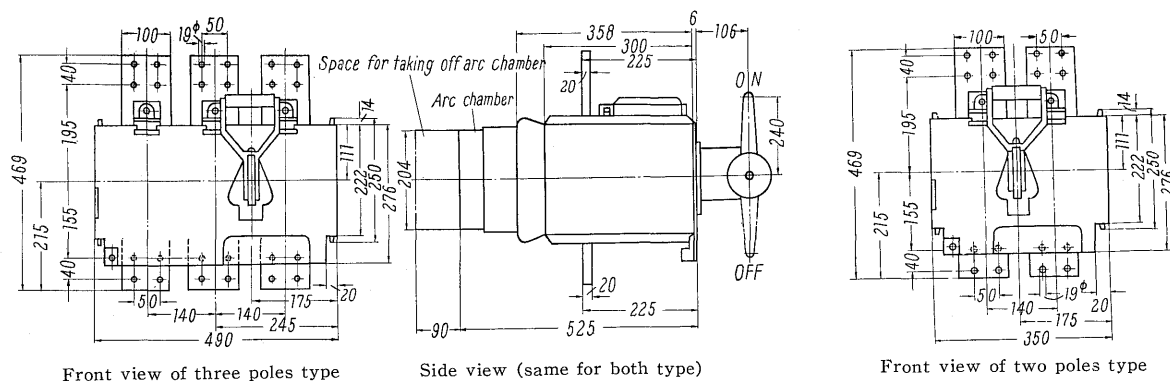


Fig. 10. Outline drawing of air circuit breaker, type RF 913-3,000

VI. CONCLUSION

As having been described in the foregoing paragraphs, a brief introduction has been made as to the new series of the air circuit breakers. In the

last part of this article, the author of this article sincerely hope that all readers would utilize or select the air circuit breakers by making the best of each item of special features of these types of the breaker made by the Fuji Denki Seizo K.K.

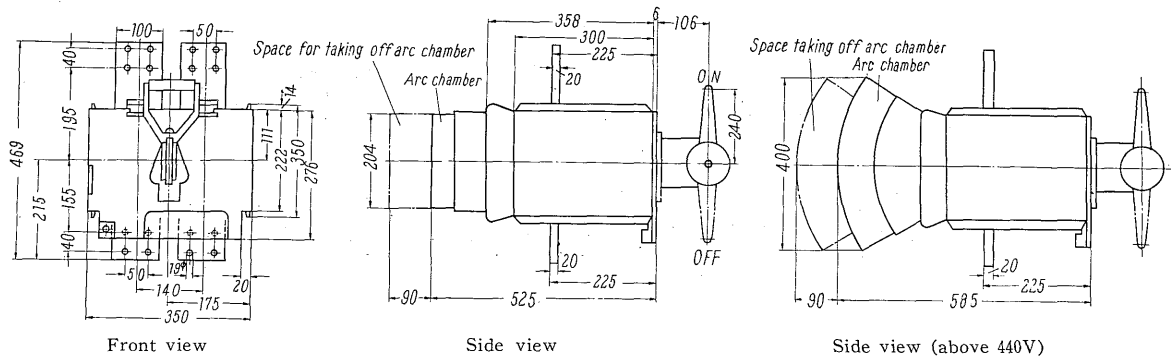


Fig. 11. Outline drawing of air circuit breaker, type RF 914-3000

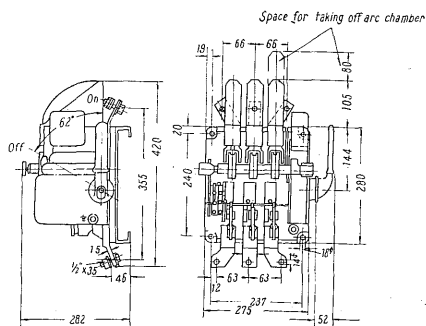


Fig. 12. Outline drawing of AC breaker, type RF 921-400

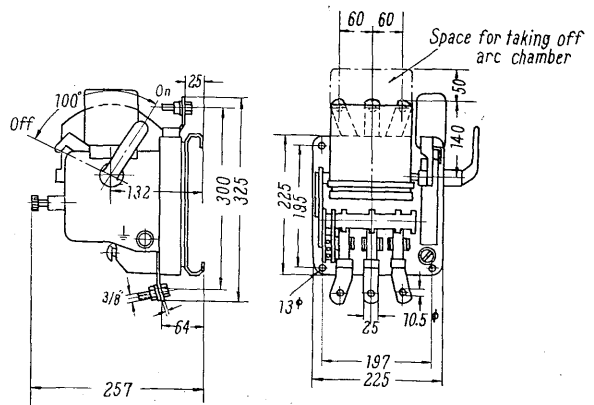


Fig. 13. Outline drawing of AC breaker, type RF 921-200

(By Teiji Sanjo, Apparatus
Div., Design Dep't.)

Outline of Our Products

(I) Heavy Current Equipment

- a) Generators :
Synchronous generators up to 100,000kVA.
Direct current generators up to 10,000 kW.
Other all kinds of generators.
- b) Synchronous condenser up to 75,000kVA.
- c) Motors :
3-phase synchronous motors up to 10,000 kW.
3-phase induction motors up to 10,000 kW.
3-phase commutator motors up to 300 kW.
Direct current motors up to 10,000 kW.
Other all kinds of motors.
- d) Standard motors (for general use):
3-phase squirrel cage motor from 0.4 kW to 75 kW.
3-phase wound motor from 20 kW to 75 kW.
1-phase split phase start ind. motor, 100 & 200 W.
1-phase repulsion start ind. motor, 200 & 750 W.
- e) Special motors :
Loom, card, mule, ring-motor and pot-motor for textile industries.
All other kinds of special use motors.
- f) Transformers :
Power transformers up to 300MVA, 287 kV.
Furnace transformers with on-load tap changer up to 60 MVA, 140kV.
Measuring transformers up to 287 kV.
Other all kinds of transformers.
- g) Standard transformers (for general use):
1-phase & 3-phase distribution transformers from 3kVA to 1,000kVA.
- h) Induction voltage regulators up to 1,000kVA.
- i) Mercury arc rectifiers :
Single-anode or multi-anode type, water cool or air cool type and with pump or without pump type up to 6,000 A.
- j) Contact converters up to 20,000 A.
- k) Selenium rectifiers and silicon rectifiers.
- l) Regulating apparatuses :
Motor starters, controllers, speed regulators, voltage regulators and other regulating apparatus for all kinds of service.
- m) Circuit breakers :
Expansion circuit breakers up to 287 kV.
Oil circuit breakers up to 154 kV.
Air circuit breakers up to 3,000 V.
High speed air circuit breakers up to 3,000V.
- n) Switch equipments :
Disconnecting switches up to 287 kV.
Knife switches, magnetic switches and other all kinds of switch equipment.
- o) Switchboards :
Sheet iron made switchboard for all kinds of service.
- p) 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 kW.
- b) Steam turbines up to 150,000 kW.
- c) Gas turbines :
Closed circuit type up to 50,000 kW.
- d) Ventilating fan for radial and axial type.
- e) Mine winder set for vertical shaft and inclined shaft.

(III) Railway and Ship Equipment

- a) Traction motors of all kinds.
- b) Electric locomotives of all kinds.
- c) Winches for cargo ship use.
- d) Steering engines for ship use.

(IV) Atomic Energy Applying Equipment and Nucleus Testing Equipment

- a) Atomic reactor
- b) Nucleus accelerators of all kinds.

(V) 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, tele-metering equipment.
- c) Industrial measuring instruments :
Electric thermometers, pyrometers, psychrometers, flow meters for water, steam, gas and air gas analysers, pressure gauges, vacuum meters, pH meters, level meters, electronic recorders, salinometers, etc.
- d) Automatic controlling equipment :
Automatic combustion controlling equipment for steam boilers and various furnaces.
Pneumatic controllers, electro-pneumatic controllers, electrical indicating controllers for temperature, pressure, flow and liquid level, etc.

(VI) Domestic Equipment

- a) Electric table and pedestal fans of all kinds.
- b) Electric room heaters of all kinds.
- c) Electric washers of all kinds.
- d) Electric refrigerators of all kinds.
- e) Centrifugal dehydrator.
- f) Dry batteries & flash lights of all kinds.
- g) Juicer and toaster.
- h) Electric iron of all kinds.
- i) Electric bulbs & fluorescent lamps & illuminating apparatus of all kinds.
- j) Television sets and Transistor radios.
- k) Room coolers.