

## NEW TYPE AC LOW-TENSION SWITCH AND CONTROLGEAR

### I. INTRODUCTION

Low-tension switch and controlgear are regarded vitally important for the normal function of any plant. The controlgear plays a major role in a whole plant and is mainly responsible for keeping the plant in operation. Many long and unnecessary delays have occurred during production because of the failure of the controlgear. In order to counteract this, our company has spent many years in the researching and experimenting of developing a more precise type of switch and controlgear.

After many years of hardships, we were able to develop a more precise type of switch and controlgear, and are now prepared to write the outline on this apparatus, here.

### II. MAGNETIC CONTACTORS

The magnetic contactor is the most important device in the field of low-tension switchgear. It can be safely said that the ability of the control equipment largely depends on that of the magnetic contactors. We are in technical co-operation with Siemens Schuckeltwerke AG in Germany and with their technical assistance, we were able to develop RC 3631 series magnetic contactors suitable for the service required here in Japan. This Series is now widely known for their superiority in the industrial field in Japan. Fig. 1 shows the photo of this Series. With the recent development of automatic controls, magnetic contactors have come to face the following severe demands:

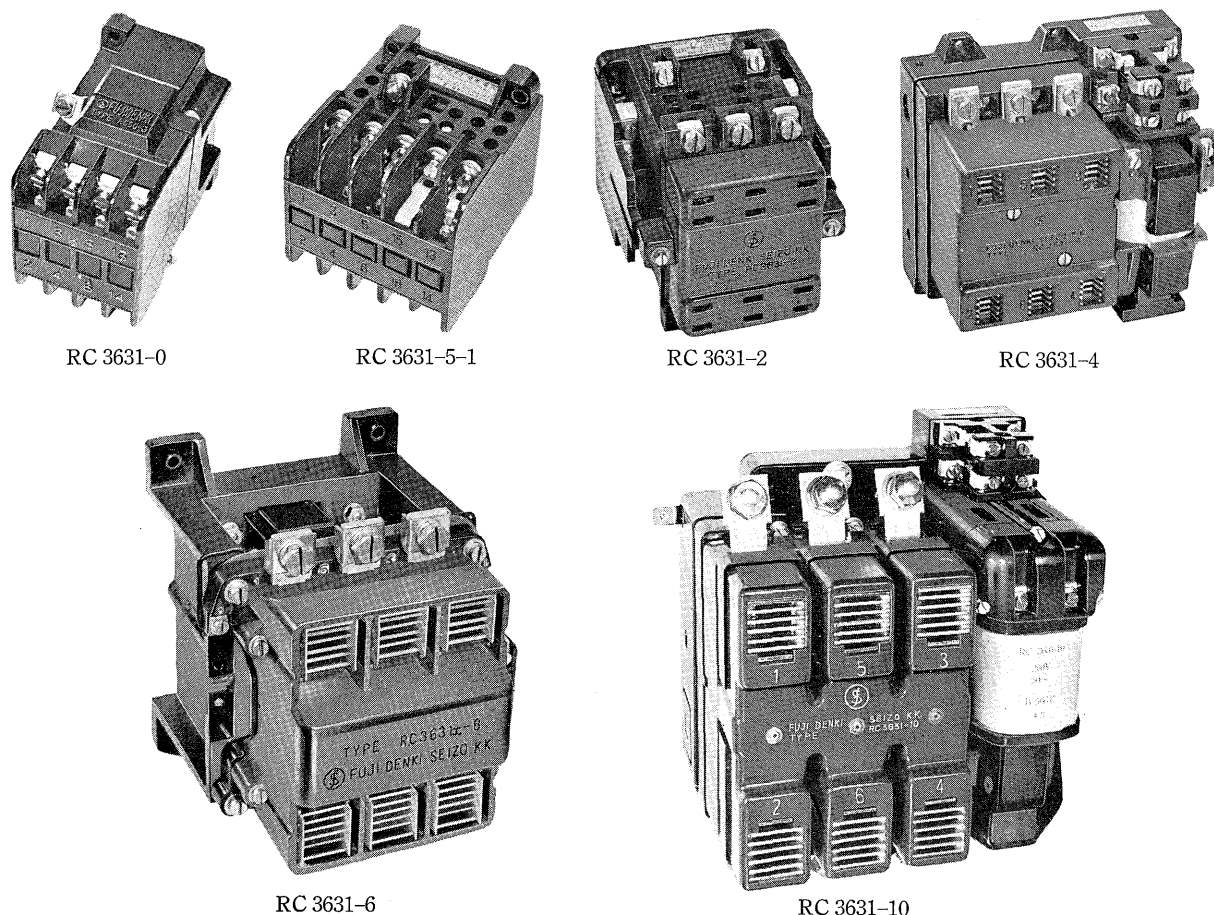


Fig. 1. Fuji magnetic contactors

- 1) Large switching cycles per hour.
- 2) Large closing and breaking capacity.
- 3) Compact in size, light in weight and with less mounting space.
- 4) Quick and easy maintenance.
- 5) Exchangeable parts, etc.

We made every effort to make a contactor which would be capable of matching the above mentioned severe conditions and after many difficulties we succeeded in completing RC 3631 Series contactors whose technical level far surpasses the highest level ruled in JIS C 8325-1959 A-1-1.

In general, the so-called bouncing or chattering of contact is the fated defect of magnetic contactor and have the following faults: If the contacts chatter on closing motor circuit they are to switch on and off repeatedly the rush current several times the motor rated current, which impairs, cause to strain the contacts and so shortens the life of the contacts. In our contactors, see Fig. 2, the moving contacts

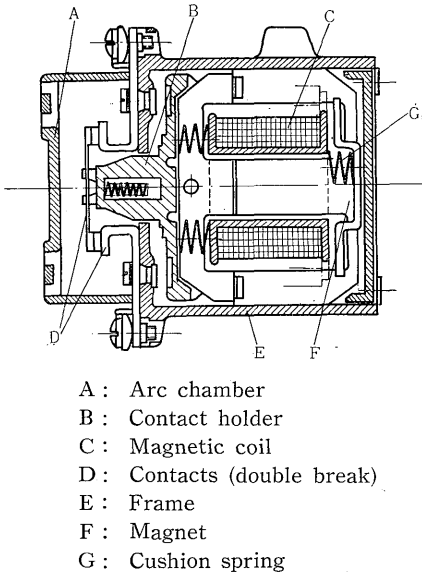


Fig. 2. Cross-section of air-break contactor type RC 3631-2

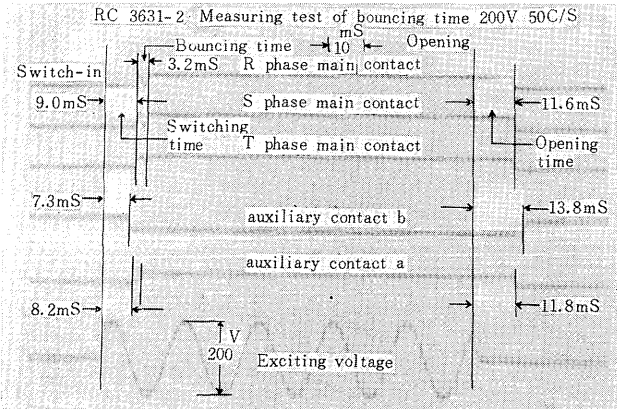


Fig. 3. Oscillogram of bouncing

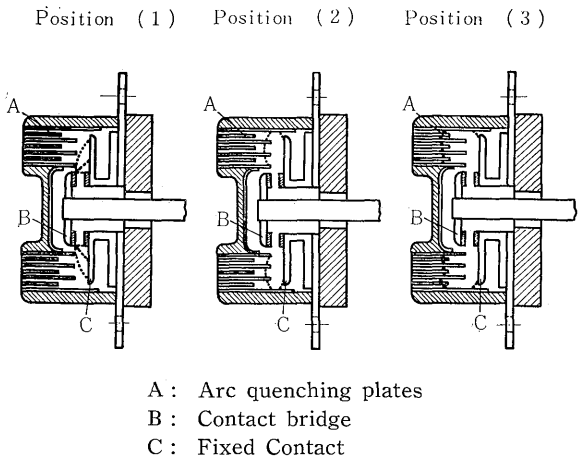


Fig. 4. Two-stage quenching chamber

are made lighter, and the cushion springs are arranged effectively. Thus, the bouncing or chattering is reduced and the shock to the magnet is lessened as shown in Fig. 3. How to maintain the long life of contacts? This is possible by reducing the arcing time during interruption. These contactors are built to adopt the double breaking system. On a large type, arc-quenching plates are attached to the contactor as shown in Fig. 4, for the purpose of quick arc-quenching.

When the contacts are opened as shown in position 1, the arc between the moving and fixed contacts will shift simultaneously to the arc horn, position 2 shows arc entering the gaps of the arc-quenching plates, and as shown in position 3, the arc is completely divided into many parts by means of being driven into the gaps of the arc-quenching plates. By this method, the electric life of the contacts can be extended considerably. Mechanical damage can also be minimized by absorbing the shock at closing of the magnet. Because the friction parts are made of resin and metal, wear of these parts without oiling can be markedly reduced. By adopting the above two methods surprising long mechanical life was obtained. As shown in Fig. 5, most of these parts are made with materials of high accuracy press molding. Molded phenol-resin is used for the frame and mechanical parts. For these reasons, the contactors were able to be manufactured for easy assembly, space saving and for making simple exchanges possible.

We had to over-come many difficulties in designing magnetic contactors because of the special circumstances of power system in Japan, i.e. we have 50 c/s in some regions and 60 c/s in others. Taking the above fact into consideration and for the convenience of user, we tried and accomplished to make the magnetic coil which can be applied to either 50 c/s or 60 c/s source. Thus, our magnetic contactors for the motor, relatively small and most

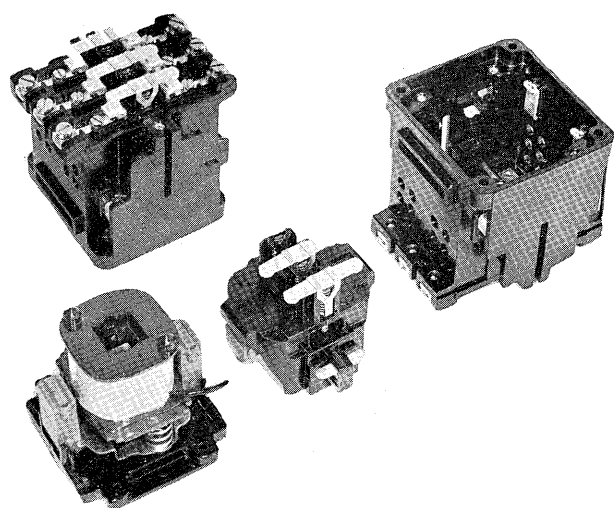


Fig. 5. Fuji magnetic contactor type RC 3631-2

widely used, whose out put is below 5.5 kW, 200 V are applicable to either 50 c/s or 60 c/s.

As RC 3631-4 used for motor the out put of which is up to and including 11 kW, 200 V has a special coil with additional terminal, the contactor can be applied to either 50 c/s or 60 c/s source by means of changing connection to the terminal.

To the terminal of this type of contactors, special consideration is paid in simplifying the connection.

As shown in Fig. 6, using our special washer eliminates the old method of twisting the wire when it is connected to the terminal. The connection can be made by ; remove the outer insulator of the wire loosening the terminal screw slip the wire end between the washer and the terminal without bending the wire, and retighten the terminal screw.

The output specified in Table 1 is utilized for conventional motors, but for special application. For instance, if frequent inching or plugging for quick stopping is required, it will cause the electric life of the contactor to be greatly reduced and impaired.

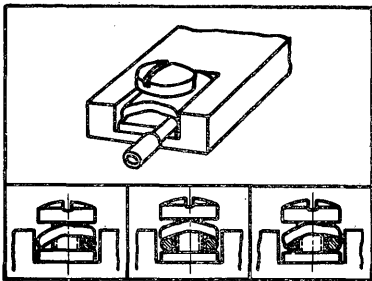


Fig. 6. Straight-end wire terminal with curved washer

Now in order to alter this, it is requested that a magnetic contactor whose applicable output is one or two sizes larger than that of one you may use for a normal application. Please ask for our advice regarding the right sizes for correct application.

This Series also includes various protection type contactors constructed for use in different fields. Not just the open type, as shown in Fig. 1, but also the dust proof type which can be used in industrial plants, just as the corrosion proof type may be used in a chemical factory, where corrosive gas is present and the explosion proof type, for use in a chemical factory where explosive gas is generated.

III. AUXILIARY RELAYS

The abovementioned RC 3631-0 and RC 3631-5-1 are not used just for switching on and off the motor circuit, but also as an auxiliary relay. The following RC 50-3, RC 50-4 and RC 50-4 F types are to be used only as an auxiliary relay and improved locally upon the magnetic contactor. As the control elements of the automation, these auxiliary relays command a general admiration from the point of high character of a large switching cycle and long life. The dimensions of RC 50-3 and RC 50-4 are the same as RC 3631-0 and RC 3631-5-1 in Fig. 1, but

Table 1. Rated capacity of Fuji AC magnetic contactors

Type	Max. permissible continuous current (A)	Max. permissible rated output of 3 phase induction motor							
		For Cage rotor				For Wound rotor			
		110V	220V	440V	550V	110V	220V	440V	550V
RC 3631-0	6	0.55	1.1	—	—	0.55	1.1	—	—
RC 3631-5-1	18	1.9	3.7	3	2.2	1.9	3.7	3	2.2
RC 3631-2	28	3	5.5	7.5	7.5	3	5.5	11	13
RC 3631-4	55	5.5	11	22	28	5.5	11	22	28
RC 3631-6	83	10	20	30	37	10	20	40	50
RC 3631-10	220	20	40	80	100	25	50	100	120

Table 2. Ratings of Fuji AC aux. relay

Type	Numbers of contact	Max. permissible continuous current (A)	Voltage (AC) (V)	Rated making capacity (VA)	Rated breaking capacity (VA)
R C 3631-0	4a	6	24	360	72
R C 3631-0	3a-1b		110	1,650	330
R C 50-3	2a-2b		220	3,300	660
R C 3631-5-1	5a, 4a-1b 3a-2b	10	24	720	240 (240)
			110	3,300	440 (220)
R C 50-4	3a-3b, 1a-4b 5b		220	6,600	880 (150)
			440	13,200	1,760 (120)
R C 50-4F	5a-5b		550	16,500	2,200 (110)

A figure in ( ) can be applied for type RC 50-4 F auxiliary contact when potentials between a and b contact in the same barrier are different.

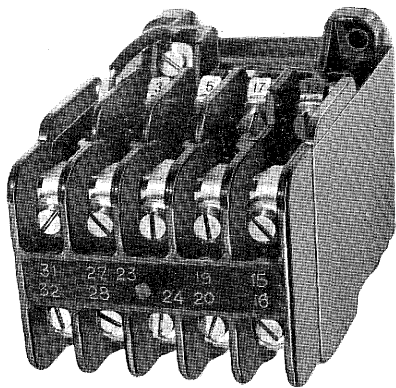


Fig. 7. Aux. relay type RC 50-4 F

RC 50-4F is different from RC 3631-5-1, as shown in Fig. 7. Table 2 shows the number of contacts for these auxiliary relays and rated capacity.

IV. THERMAL RELAYS

This relay is used for the over load protection of electrical equipment, especially of motors. Bending of bimetal because of temperature rise will cause the small contacts to be switched off, and in so doing, operate the operating coil of the magnetic contactor or the low voltage coil of a circuit breaker. Thus the main circuit can be opened.

The operating elements of a thermal relay consist of a bimetal and a heater right near the bimetal. The bimetal is heated by the heater in which motor current flows. Tripping characteristic which is the most important thing of relay is influenced by the

heat capacity, heat radiation-coefficient and thermal relation between the heater and bimetal. According to the starting characteristics of a motor, suitable characteristics of a relay should be selected. Because the thermal relay acts on the basis of temperature, it will be influenced and affected by ambient temperature. The relay not having a temperature compensation, will act faster in summer and slower in winter. Though the abovementioned fact seems to be reasonable for the motor is initially hot in summer and cold in winter, it is completely incorrect. Because it is not always the case to install the motor and relay in the same room or to be kept at definite temperature. It is not also reasonable to believe that an over load is permissible only in winter. Permissible output for an equipment should be kept constant in either winter or summer. The fine points of using an accurate relay with temperature compensation is that, with it, equipment failure and single phase operation, can be quickly stopped and checked. Because of its great merit, a relay having a temperature compensation should be used. There are two ways to reset a relay after tripping, i.e., manual and automatic reset. Generally, as the tripping of relay is due to some accidents, it is safe to adopt the manual reset type of a relay. But if the relay is mounted on a place where the resetting is complicated or required from the view of a circuit construction, an automatic reset system may be used. If this is the case, special attention must be paid to the control circuit, making sure the motor cannot start again, when the relay is automatically reset. Otherwise, an operator may be injured or motor windings will be over heated unexpectedly because of it. So please make sure.

Our thermal relay of the RC 3737 Series, based on abovementioned view point, has the most ideal

protection characteristics and the application of the Series is shown in Table 3.

Every relay is accompanied with a perfect temperature compensation and is strictly adjusted. RC 3737-1 type can be used up to and including a maximum current of 16 amperes and though the manual reset type is our standard the automatic reset type is also offered by request. RC 3737-4 type may be used up to and including a maximum current of 50 amperes and has a contact system which can be easily changed into either automatic or manual reset type by turning a screw, (see Fig. 10.) RC 3737-II type as shown in Fig. 8 (C) has a time lagging characteristics and is suitable for a heavy starting motor. Because this relay is of the manual reset type, it can be of anti-vibration type and displays its ability for marine use.

Special consideration must be given to relays that are to be used for motors having long starting time, and also used for stopping or starting frequently repeated. Please ask our advice regarding this matter, because each choice must be considered individually.

**Table 3. Fuji thermal overload relay**

Type	Setting range of thermal overload relay A						Numbers of contact	Reset
R C 3737-1	0.125~0.25 1~2 8~16	0.25~0.5 2~4	0.5~1.0 4~8				1b	Manual (standard) Automatic (by request)
R C 3737-4	0.125~0.25 1.0~2 8~16	0.25~0.5 2~4 15~30	0.5~1.0 4~6 30~50				1c	Manual & auto- matic (adjustable)
R Ca3737-II	0.5 3 10 40 135	0.75 3.5 12.5 50 170	1 4 16 60 ±20%	1.5 5 20 70	2 6.5 25 90	2.4 8 30 110	1c	Manual

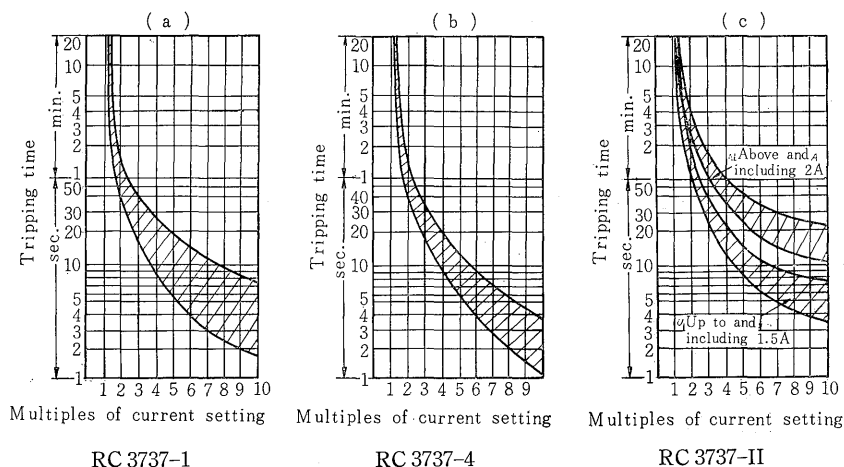


Fig. 8. Tripping characteristics of Fuji thermal relays

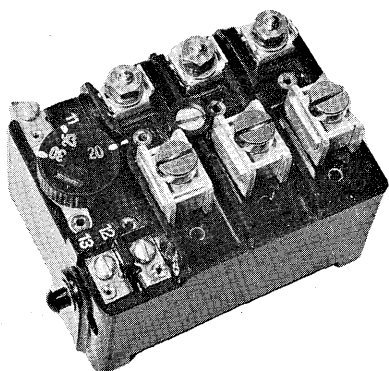


Fig. 9. Thermal relay  
type RC 3737-4

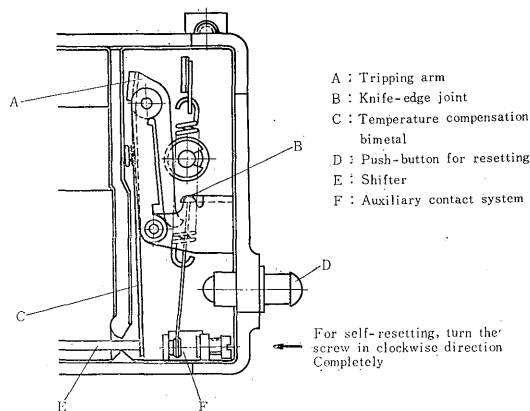


Fig. 10. View of tripping system of thermal relay type RC 3737-4 (as seen from rear)

## V. MAGNETIC SWITCH BOX

According to the JIS C 8325-1959, the magnetic

switch box is to be constructed with a magnetic contactor and a overload relay, assembled together in a case, and to be mainly used as a motor switch.

Table 4. Fuji magnetic switch box

Type	Combined together	
	Mag. contactor	Thermal relay
R C 3931-0	R C 3631-0	R C 3737-0
R C 3931-5-1	R C 3631-5-1	R C 3737-1
R C 3931-2	R C 3631-2	R C 3737-4
R C 3931-4	R C 3631-4	R C 3737-4
R C 3931-6	R C 3631-6	R Ca3737-II
R C 3931-10	R C 3631-10	R Ca3737-II

The fundamental construction and the internal apparatus are shown in Table 4. It is not necessary to state the superior quality of this switch box, because our switch box consists of RC 3631 Series contactor and RC 3737 Series relay whose excellence was previously acknowledged. Fig. 12 shows the internal construction of magnetic switch RC 3931-4, and Fig. 13 shows that of a reversible magnetic switch box RC 3938-4 R.

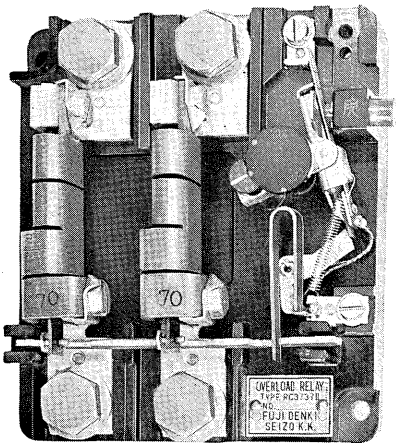


Fig. 11. Thermal relay type RC 3737-II

RC 3938-5-1, -2, -4, -6 and -10 consist of two RC 3631-5-1, -2, -4, -6 and -10 respectively, and may be utilized for reversing operation of the motor. All protection type switches are made as follows, the ammeter type as shown in Fig. 14, the dust proof type as in Fig. 15, gas proof type as in Fig. 16, and explosion proof type as in Fig. 16.

VI. CONTROL SWITCH

This is a new switch of manual operation type available for direct control of AC motor up to and including 220 V 3.7 kW (type ; K 138-2) and 220 V 15 kW (type ; K 138-6). The control switch is mainly applied to machine tools and flush, enclosed, water proof and explosion proof type are to be offered. The most distinctive feature of this type of which is, it is easy to assemble than most control switches and many other forms of switch can be made easily by using the suitable switch elements as shown in Fig. 18. (There are two other elements of different construction of contacts in addition to the elements in Fig. 18).

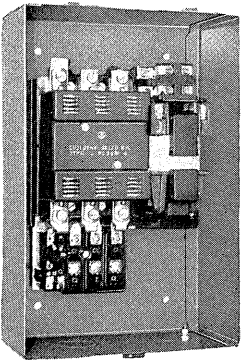


Fig. 12. Mag. sw. box type RC 3931-4

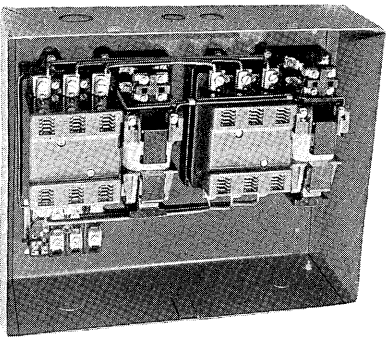


Fig. 13. Reversible mag. sw. box type RC 3938-4R

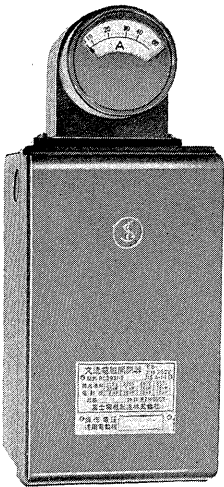


Fig. 14. Mag. sw. box with ammeter

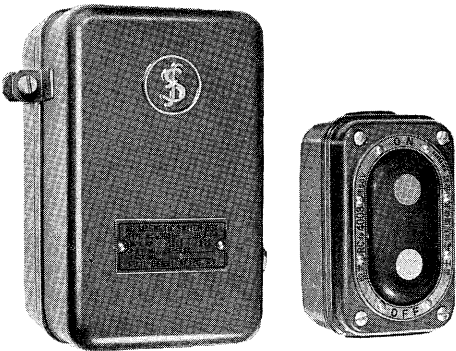


Fig. 15. Dust proof type mag. sw. box

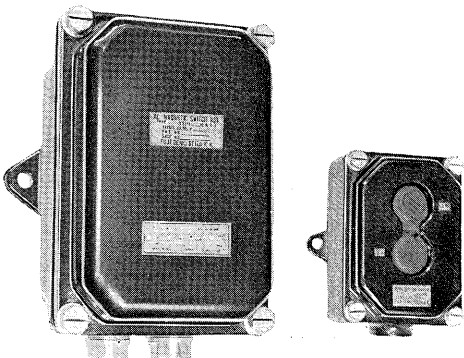


Fig. 16. Gas proof type mag. sw. box

Table 5. Standard application of control switch

Application	K138-2					K138-6		
	Current (A)	Max. permissible rated out put of 3 $\phi$ induction motor (kW)				Current (A)	Max. permissible rated out put of motor	
		110V	220V	440V	550V		110V	220V
Line starting switch	15	2.2	3.7	3	3	60	7.5	15
Reversing switch								
Star-delta switch		3.7	7.5	10	10			
Reversing $\Upsilon$ - $\Delta$ switch								
Pole changing switch	15	2.2	3.7	3	3	60	7.5	15
Reversing pole change switch								

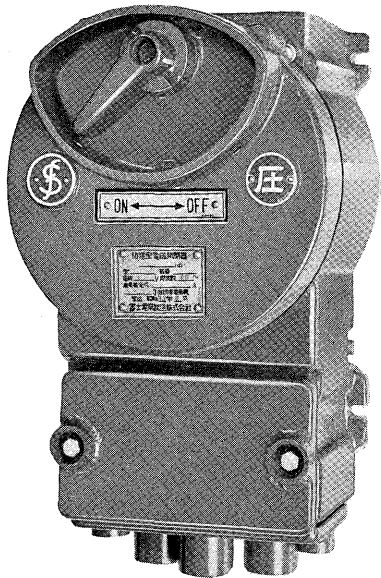


Fig. 17. Explosion proof type mag. switch box

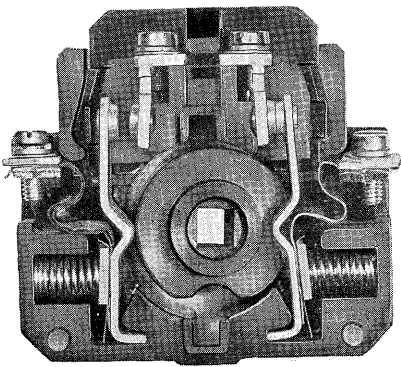


Fig. 18. Switch element

These typical applications and the applicable motor capacities are listed in Table 5. This control switch can be used as either direct control or master control switch.

Based on many long hours of research, our company has finally found a method to make a control

switch far lighter and more compact than before. Contacts, springs, etc., are assembled together in a bakelite mould frame. The space for the arc quenching has been reduced, making for a better, lighter and a more compact control switch.

The main part (the frame that is) as shown in Fig. 18, is made of accurate phenol-resin. Movement is done by using a cum. Therefore, the switch can be used for various applications, depending on the size and shape of the cum. The operation angle of this switch per one notch is only 45 degrees and the maximum numbers of notches is eight. It is one of good examples to explain the strong assembling ability of this switch that it can be used for either a reversing star-delta switch or a reversing pole change switch. Using silver contacts is one of the big features for its long life, and the switch has the electrical characteristics as shown in Fig. 19.

Fig. 20 and 21 show line starting switch K 138x-2 and star-delta switch K 138x-6 SD, cover removed respectively, and Fig. 22 shows pole change switch K 138c-2-12 which is used, as flush type, for machine tools. Fig. 23 shows reversing line

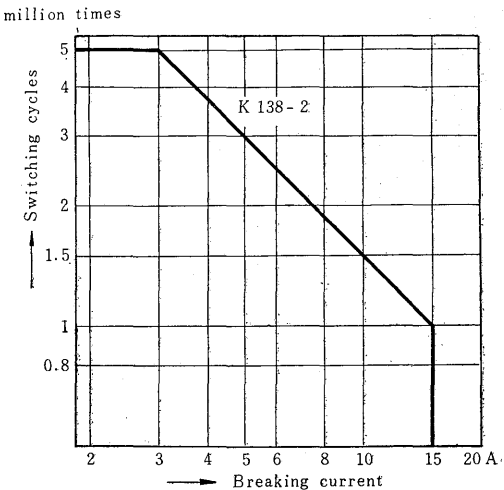


Fig. 19. Characteristic curve of life of contacts



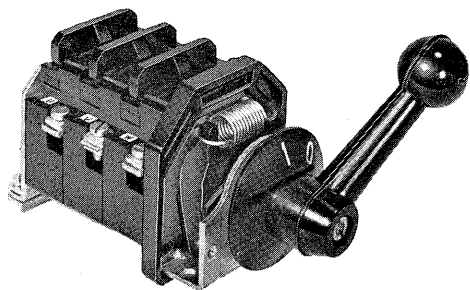


Fig. 20. Line starting switch  
type K 138x-2

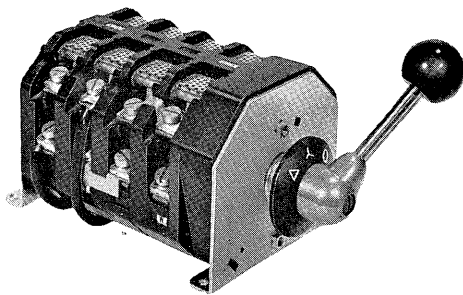


Fig. 21. Star delta switch  
type K 138x-65 D

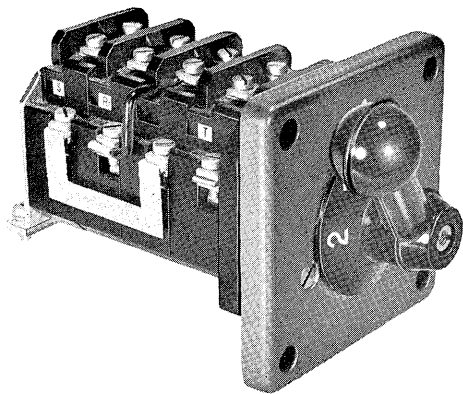


Fig. 22. Pole changing switch  
type K 138e-2-12

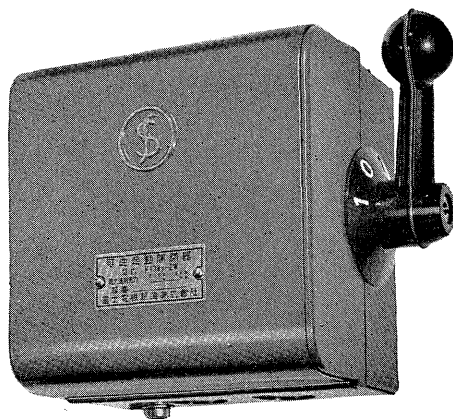


Fig. 23. Reversing switch  
type K 138g-2 W

starting switch K 138 g-2W protected with a steel iron case and cover.

The connection of the lead wire is easy and the same as for magnetic contactors using a special washer (see Fig. 6).

As our standard we offer the ball type operating handle, but only for type K 138-2, knob or stick type can also be made, if required by the user. The ball handle is so constructed that the direction of the mounting angle can be changed freely but only 22.5 degrees at a time and is extremely convenient when the mounting space is limited.

VII. END LIMIT SWITCH

End limit switch K 244-2 is applied to an automatic operation or a sequence control in all fields of industrial machines, such as machine tools, printing machines and textile machines, etc.

The most remarkable facility of this switch is its high switching cycle i.e. 600 switchings per hour at continuous use, or 3,000 switchings for short time use. And the life of the switch is definitely longer than 500 million switchings on condition that switched current is AC 1 ampere. The main body of the switch is set compactly inside the frame which is made of Phenol-resin mould (see Fig. 25) and covered with a simple plastic cover as occasion may demand (see

Fig. 26). We are also in the position to offer perfect protection type. This is done by setting the switch inside a case and cover made of Silumin die-casting (see Fig. 27). In the case of a Silumin case, the roller system is largely adopted, and can be classified into three types, right hinge type (left hinge type is of course offered) as shown in Fig. 28, and front hinge type as shown in Fig. 29.

Table 6 shows the rated capacity of just the switch element of K 244-2. Standard operation of end limit switch is such as A contact will close after B contact opens, moreover, there are also two

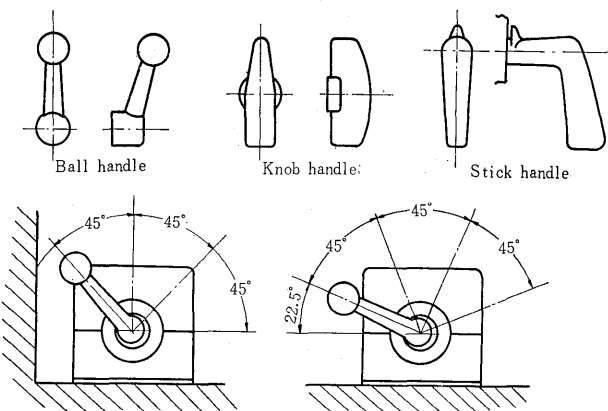


Fig. 24. Shape of handle and examples  
of installation



Table 6. Rated capacity of K244 type end limit switch

Max. per- missible continuous current (A)	AC $\cos \phi=0.3\sim 1$			DC			
	Voltage (V)	Rated making capacity (V A)	Rated breaking capacity (V A)	Voltage (V)	Rated making capacity (W)	Rated breaking capacity	
						Non inductive (W)	Mag. coil (W)
10	24	350	150	24	150	150	50
	110	1,600	500	110	500	200	50
	220	3,300	1,000	220	500	200	60
	440	6,000	1,200	440	500	150	70
	500	7,500	1,500	600	500	120	85

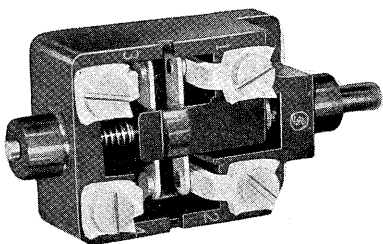


Fig. 25. Limit switch element type K 244x-2



Fig. 26. Limit switch with plastic cover type K 244x P-2



Fig. 27. Limit switch with silumin case and cover type K 244g-2

kinds of switches ; in over-lap type K 244x-2U A-contact will close before B-contact opens, longstroke type K 244x-2V, for this type, after B-contact has opened, A-contact will close after a slight time

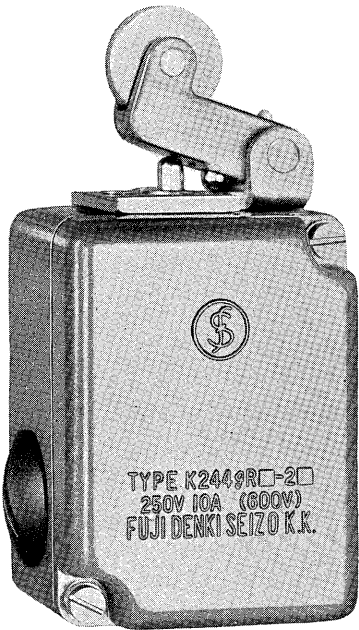
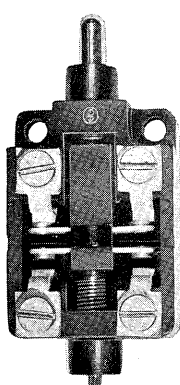


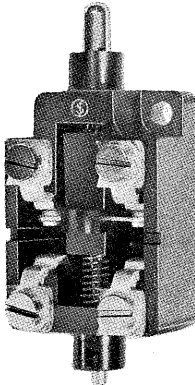
Fig. 28. End limit switch type K 244g R-2



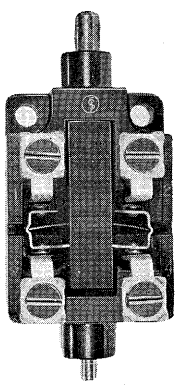
Fig. 29. End limit switch type K 244g Rf-2



(a) Over-lap type



(b) Long stroke type



(c) Snap type

Fig. 30. Switch elements of limit switch type K 244-2

delay. A new type K 244x-2S having snap action has been developed. The internal construction of these switches are shown in Fig. 30.

The stroke of the K 244x-2S type being very short, this type of switch makes it possible to insert a proper packing between the operating rod and the case. And K 244x-2S with the packing is able to be used as the oil tight one.

## VIII. PUSH BUTTON SWITCH

There are various types of push button switches, some types are used for the operation of a magnetic switch, some are made into oil tight switches for the control device of machine tools and a flush type for switchboard use.

Fig. 31 and 32 show the outline of 2 point push button switch RCb 4008 II used for the operation of RC 3931 type magnetic switch and 3 point push button switch RCa 4001 III used for the operation of RC 3938 type reversing switch respectively.

Fig. 33 shows RC 470 type push button switches for machine tools. The push button switch used for machine tools is mounted directly to various types of machine tools i.e., milling machine, grinding machine, etc., or on the surface of a control panel. This switch is made oil tight and sturdy in consideration of severe operation. The contacts are made of silver and have sufficient breaking and making capacity. There are various kinds of operation part; button, knob, key type in form and red, black, dark

green and yellow in colour. The contact can be made from 1A-1B up to 4A-4B, by assembling the 1A-1B element.

Fig. 34 shows the flush type push button switch to be mounted on a switchboard. These switches are RCa 4001-Ie, IIe and IIIe having one, two and three push buttons respectively. As our standard, the button colour is red or green for RCa 4001-Ie; green and red for RCa 4001-IIe; and green, red and green for RCa 4001-IIIa push button switch. Combination of contacts is 1A-1B per a push button.

Fig. 35 shows the push button switch No 1043 which is used for switchboards and is of higher class than the switches mentioned above. The figure shows only 1-point push button switch, but we have also a 2-point one. The contact is made of silver and is so designed that it has sufficient breaking and making capacity. 1A-1B contact per one push button is standardized but 2A-2B is to be offered by request. The button colour is red or green for 1-point and red and green for 2-point push button switch as our standard. This push button switch has a window for inserting the name plate, making change of the card possible.

## IX. PUSH BUTTON TYPE STATING SWITCH

It goes without saying that magnetic switch is the most superior among all switches for motor. However, simple push button type starting switch may

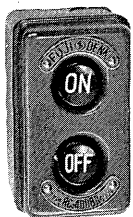


Fig. 31. 2 point push button switch type RCb 4008 II



Fig. 32. 3 point push button switch type RCa 4001 III

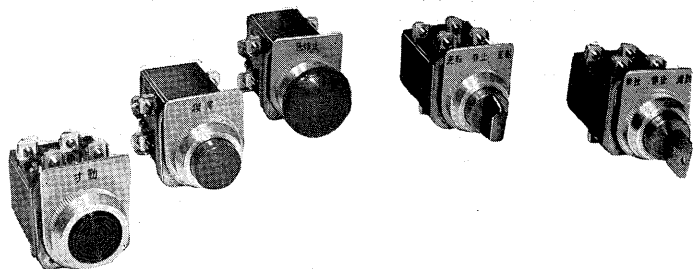


Fig. 33. Push button switches for machine tools type RC 470

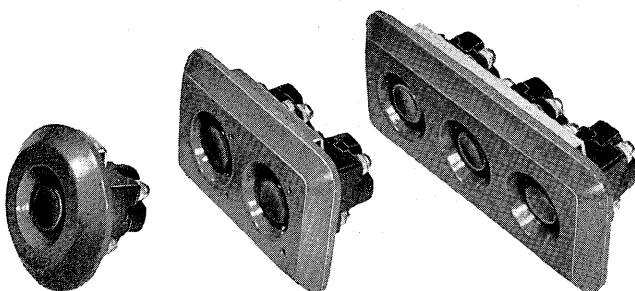


Fig. 34. Push button switch type RCa 4001-e

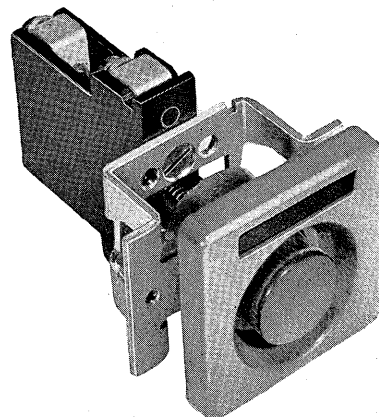


Fig. 35. Push button switch type Na 1043

take the place of magnetic switch when no severe demands are required. Our RC 480-2 push button type starting switch was manufactured for the purpose of being used in such a case. The switch can be used for direct starting and stopping of motor, the capacity of which is listed in Table 7....(Fig. 36.)

As the switch has silver contact and its tripping mechanism is of stout build the long life is guaranteed despite its simple construction.

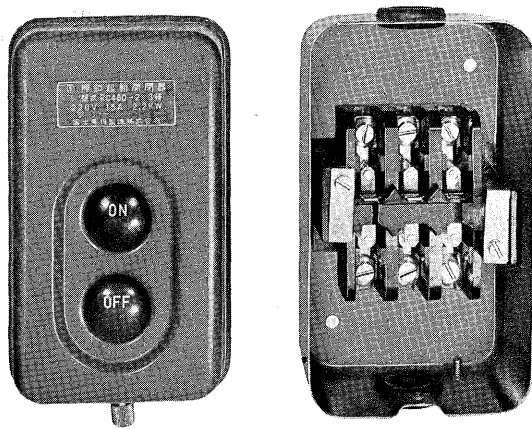


Fig. 36. Push button type starting switch type RC 480-2

X. KNIFE SWITCH

Until recently the knife switch of 250 V class was capable of interrupting completely a load current, but most of 500 V class were used only as a disconnecting switch and were not capable of interrupting load current. But even if the knife switch is used as a disconnecting switch, an operator might by mistake, switch off the circuit in which current flows. In this case, a phase short circuit may occur or an operator might be injured by a long arc caused by opening live circuit. From this point, we developed new types of knife switches R 1266

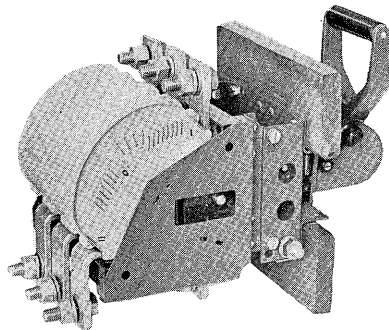


Fig. 37. Knife switch type R 1267 III/600

Table 7. Rated capacity of starting switch Type RC480-2

Type	Maximum Volts & Amps.	Phase	Maximum permissible rated out put of induction motor		Weight (kg)
			110 V	220 V	
R C 480-2	AC 250 V 15A	Single	0.4	0.75	0.6
		Three	1.1	2.2	

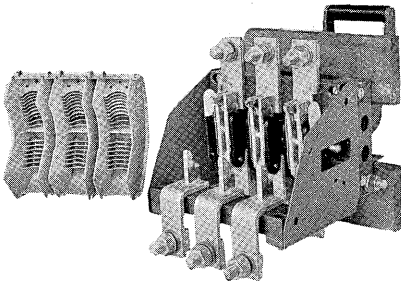


Fig. 38. Knife switch type R 1267 III/600

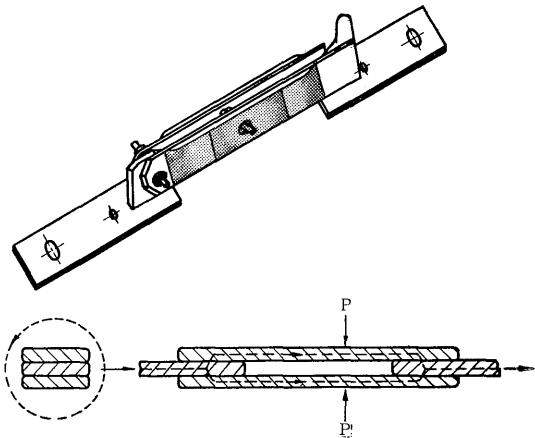


Fig. 39. Automatic compensation of lifting force by mean of divided current bars

and R 1267 which can be used up to circuit of 500 V, and can safely and completely break the load current by arc quenching chamber attached to the switch. Rated current is from 100 A up to 1,000 A, number of poles are 2, 3 and 4, and single and double through type are standard. R 1266 and R 1267 are of single and double through type respectively.

Fig. 37 shows the outer view of type 1267 III/600, Fig. 38 shows the contact parts without an arc chamber. This knife switch has two big features in the construction as follows, one of them, as shown in Fig. 39, is that a magnetic force is utilized effectively for compensation of contact pressure which is reduced by occurring short circuit; and melting contact or injury will not occur. And the second feature is the mechanism of the double through handle. As shown in Fig. 40 in detail, the contact

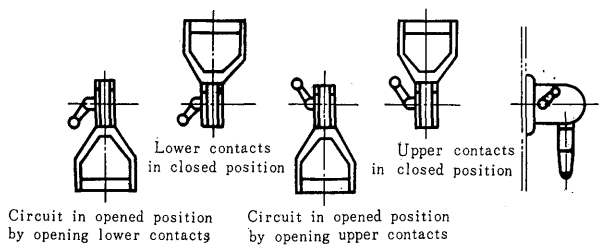


Fig. 40. Handle positions of knife switch type R 1267

will close by throwing in the main handle, and open by pulling down on it. And the direction of change-over can be selected by the auxiliary handle attached the side of the main handle. That is, after the auxiliary handle has been thrown in, the upper fixed contact and the moving contact will make a circuit close by throwing in the main handle. By

pulling down the auxiliary handle, it will close the circuit at the lower contact by throwing in the main handle. The above are considered for safe and correct operation and the purpose of preventing from quick changing-over.

## XI. CONCLUSION

The above is the general explanation regarding the new type AC low tension switch and controlgear. We regret to inform you that the overall reference had to be condensed because of space limitations. For further details, please do not hesitate to write, we are always glad to be at your service. We shall always be grateful for any help, information or advice that you may offer for our guidance.

(By Satoru Iwata, Designing Sect., Fukiage Factory)

# Outline of Our Products

## ( I ) Heavy Current Equipment

- a) Generators :  
Synchronous generators up to 100,000 kVA.  
Direct current generators up to 10,000 kW.  
Other all kinds of generators.
- b) Synchronous condenser up to 75,000 kVA.
- 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 300 MVA, 287 kV.  
Furnace transformers with on-load tap changer up to 60 MVA, 140 kV.  
Measuring transformers up to 287 kV.  
Other all kinds of transformers.
- g) Standard transformers (for general use):  
1-phase & 3-phase distribution transformers from 3 kVA to 1,000 kVA.
- h) Induction voltage regulators up to 1,000 kVA.
- 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 3,000 V.
- 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.