

NEW CONTROL CENTER TYPE SM-2200

Junji Kobayashi

Masaei Yamashita

Fukiage Factory

I. INTRODUCTION

In the recent years, the demand for control centers have remarkably increased as a control device for low tension motor groups, etc. It is considered as one of the reasons that the practical application of 400 V class distribution system has been popularized, however the main reason will be in the fact that extremely safe and highly reliable and yet compact control device can be supplied at a low cost and in a short delivery time as compared with the conventional grouped magnetic control panels.

Fuji Electric has been manufacturing the control centers since fifteen years in response to the requirements of users in various industries, and now we have recently developed a control center type SM-2200 which is designed extraordinarily compact under the new idea based on his accumulated experience.

Herewith, the outline of this new type control center will be introduced.

II. FEATURES

The external view of the control center type SM-2200 is illustrated in *Fig. 1*.

The special features for the control center will be as follows.

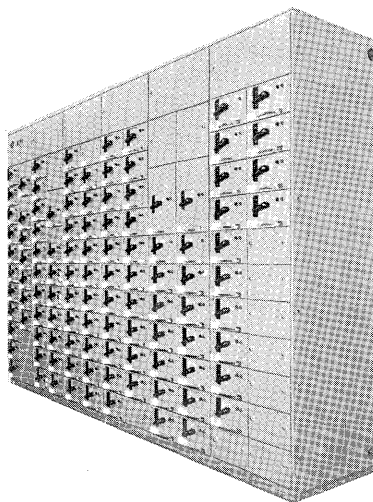


Fig. 1 Control center type SM-2200

1. Extremely Economized Installation Area

22 units each designed extraordinarily compact under the new idea can be contained in one cabinet having a width of 600 mm. Therefore, as compared with the conventional types the installation area can be curtailed to 1/2-1/3 depending on the load capacity of the equipment, thereby economizing largely the installation cost.

2. Increased Safety

The circuit breaker, main circuit apparatus, and auxiliary apparatus, being divided into 3 groups, are contained in each unit shielded every circuit, so that other equipment is free from danger due to arc of circuit breaker and also direct touching to the charging portion of unit is completely avoided because the unit front surface is made of a stationary panel type instead of the door type.

3. High Reliability

By the combination of Fuji Auto-breaker and current limiting fuses both having a great breaking current capacity and also Fuji magnetic switch having an established reputation reliable and sure circuit protection is assured.

4. Abundant Kinds of Circuit Compositions

The unit may be applied to the optimum circuit composition of unit such as for direct starting, Υ - Δ starting with time limit release, or that with earth leakage release according to each load. Moreover, the unit can be effectively applied with ease for various kinds of circuit systems such as so-called cascade protection system which performs back-up protection for the small breaking capacity units at the load side by the provision of a large breaking capacity circuit breaker on the branch of vertical bus branched from the horizontal bus within the cabinet, group sectionized feed system which sectionizes a plurality of units by insertion switch, and so on.

5. Easy Operation

Each unit is not provided with operating switch is usually used and when in need this is collectively

arranged in the center of cabinet, therefore operation is very easy.

III. COMPOSITION AND CONSTRUCTION

Of the types and classification in the standards of control center JEM-1195 only the single faced type is employed because this type can provide by far more units than the conventional double faced type by the rational construction.

With respect to the kinds, protection, construction, etc. in the above standards those to satisfy all items prescribed therein can be manufactured.

The external wire connection system B type which has great economical merits is made as standard. In the following the details will be explained with reference to respective components of the control center.

1. Cabinet

The cabinet is divided into unit receiving chamber, operating switch door, horizontal bus portion, external wire junction portion at the rear side, and vertical bus portion. The side plates, top plates, lower frames and unit receiving chambers which compose these sections are all assembled with set screws and respective parts are designed suitable for uniformization of quality and mass-production.

The standard dimensions and specification are shown in Table 1.

1) Unit chamber

The unit chamber can be made up in free even in case the large and small capacity units and also special units are mixed in use by suitable combination of unit tables and intermediate partition panels, thereby enabling the cabinet to accommodate the units in high density. This is a combination of divisions into 1-2 for 600 mm in the widthwise direction of cabinet and a unit minimum height of 120 mm with a pitch of 60 mm in the vertical direction.

Table 1 Standard dimension of cabinet

Cabinet	Height (mm)	Width (mm)	Depth (mm)	External connection terminal
Single face type	2,320	600	730 930	JEM-1195 B

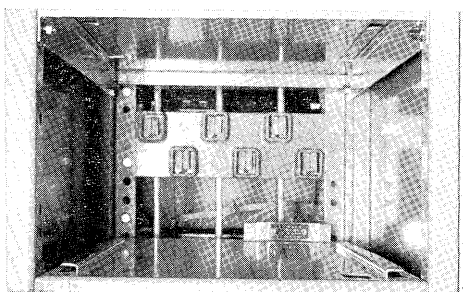


Fig. 2 Unit room

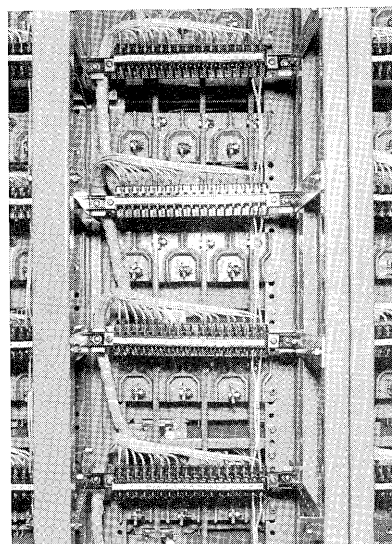


Fig. 3 Back view

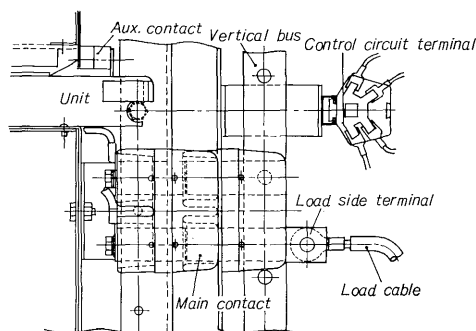


Fig. 4 External wiring and vertical bus

With a minimum unit size 300×180 mm for a motor, one cabinet can include 22-units, and also for a circuit composition divided in comparatively small number of groups with small capacity in which the horizontal bus bars are not required and further direct-operation is to be carried out on the control center, the cabinet is able to contain up to 24-units.

2) Operating switch door and horizontal bus bars

When direct operation (operating switch, change-over switch etc. are attached to each unit circuit) is made on the control center, these switches are collectively mounted on the central portion of the cabinet for facilities of operation.

3) External junction chamber and vertical bus bars (Fig. 3 in a back view.)

The vertical bus bars are connected and fixed to the unit power supply and stationary side power supply plugs corresponding to the load side clips through the supporting bolts with fixing holes at 60 mm pitches and extend upwards and downwards.

As above, one end of the stationary plugs is used for supporting the vertical bus bars and the other end (the female side) is inserted on the unit side. Therefore, since this is not a directly plug-in construction into the vertical bus bars, even though the vertical bus bars get bending due to any reason no

wrong effect will be given to the contact of main circuit at all. The external main circuit wiring can be easily connected directly to the stationary plug load side terminals.

The external terminal blocks for control are provided with plug type terminals (4 wires are possible to connect per terminal) for the convenience of connection and moreover looseness and falling off can be completely prevented by the absence of screws. Fig. 4 is a sectional view showing these relations.

2. Unit

The unit plays an important role in changing the entire configuration of control center depending on the idea of composition. As shown in Fig. 5, the unit has employed such a construction as to curtail the width and extend the depth as compared with the conventional types and the space in the unit is roughly divided into 3 sections where the main cir-

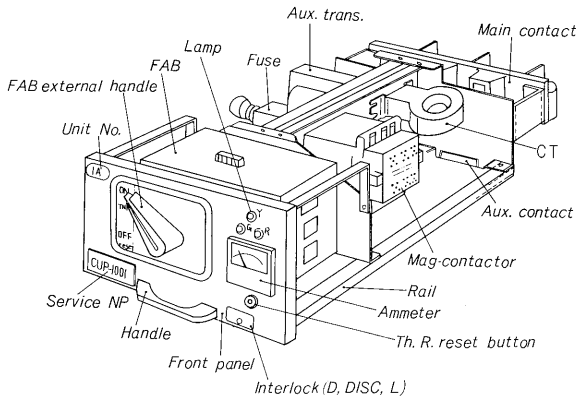


Fig. 5 Unit

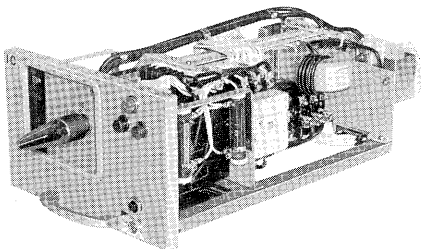


Fig. 6 Unit 30 kW at 400 V

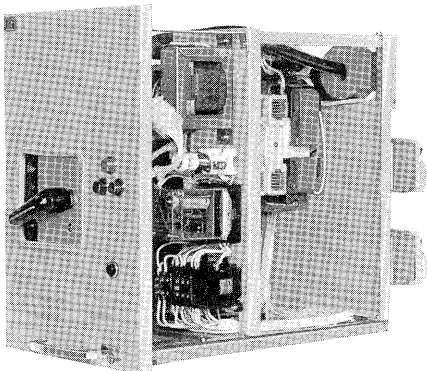


Fig. 7 Unit 110 kW at 400 V

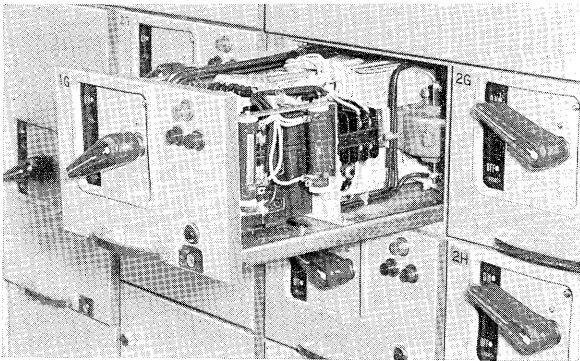


Fig. 8 Pushing-in of unit

cuit breaker, main circuit equipment and auxiliary circuit equipment are arranged respectively and further the main circuit plugs (load side of power supply) are provided at the rear side and also the auxiliary circuit plugs at the lower side. Fig. 7 and 8 show various kinds of unit and Fig. 8 shows a plug-in view of unit.

Table 2 Unit size

No. of unit tiers	Height (mm)	Width (mm)
* 1	120	300 or 600
1.5	180	
2	240	
2.5	300	
3	360	
3.5	420	
4	480	

* The first tier is used for relay unit and not used as starter

Table 3 Standard rating

Item	Ratings	
Application	AC	600 V or less
Rated voltage (V)	Main circuit	440, 400, (380), 220, 200
	Control circuit	220, 200, (110, 100)
Rated frequency (Hz)	50/60	
Bus rating (A)	Vertical bus	Aluminum 300 600 (Flat copper 500 1000)
	Horizontal bus	Aluminum 600, 1000, 1500, 2000 (Flat copper 800, 1000, 1500, 2000, 2500, 3000)
Breaking current capacity (unit)	F.A.B.	70 kA at 220 V ※ 40 kA at 460 V ("O" one time)
	Fuse	100 kA at 600 V

- Note: 1. Flat aluminum is the standard for vertical and horizontal bus bars.
2. "O" one time with ※ mark means one time breaking. Fuji Auto-breakers are guaranteed for the following breaking current capacities.
- L102, 103.....40 kA at 460 V
 - L202, 203.....60 kA at 460 V
 - L402, 403.....70 kA at 460 V
3. Ratings parenthesized are not standard.

Table 4 Application chart

200/220 V 50/60 Hz

Capacity (kW)	Main circuit apparatus											
	F	A	B	F U S E		Magnetic switch 200/220 V 50/60 Hz	Thermal relay		CT ※ (A)	Ammeter KSS-7a ※ (A)		
	Type	Current (A)		Type	Current (A)		Type	Current (A)				
0.1	1× L33 I/K 70 kA	10		3× AFC-30 100 kA	3	SRC3631-5-1F 2A+2B	1× TH-1	0.5-0.9	1/1	0-1-2		
0.2		16			5			1-1.8	2/1	0-2-4		
0.4		20			10			1.7-3.1	3/1	0-3-6		
0.75		40			15			3-5.4	5/1	0-5-10		
1.5	1× L103 I/K 70 kA	40-80		3× AFC-60 100 kA	30			5-9	10/1	0 -10-20		
2.2		80-160			30			7.5-13.5	15/1	0 -15-30		
3.7		160-320			40			11-16	30/1	0 -30-60		
5.5		160-320		60	SRC3631-2 2A+2B	15-30	40/1	0 -40-80				
7.5		380-580		75								
11		480-720		3× FNH-1H 100 kA	100	SRC3631-3 2A+2B	30-50	75/1	0 -75-150			
15		480-720			100					50-60	100/1	0-100-200
18.5		720-1,100			150	SRC3631-4	65-100	100/1	0-100-200			
22		720-1,100			150	SRC3631-4T				65-100	150/1	0-150-300
30		1,000-2,400			200	SRC3631-6						
37	1× L203 I/K 100 kA	1,000-2,400		200	SRC3631-8 2A+2B	120-155	200/1	0-200-400				
40		1,000-2,400		200					140-170	300/1	0-300-600	
55		1,300-3,000		300	SRC3631-10 2A+2B							
60	1× L403 I/K 100 kA	1,500-3,600		3× FNH-2H 100 kA	300	SRC3631-12 2A+2B	1× RC3737-30N	120-240	300/1	0-300-600		
80		2,100-5,000			400			150-300	300/1	0-300-600		
90		2,100-5,000			400			180-350	400/1	0-400-800		
110	1×L603 I/K	2,400-6,000		3×FNH-3H	500	SRC3631-14 4A+4B	1× RC3737-60N	300-600	500/1	0-500-1,000		
150	1×L803 I/K	3,200-8,000		3×FNH-4H	700			300-600	750/1	0-750-1,500		

380-400/440 V 50/60 Hz

Capacity (kW)	Main circuit apparatus									
	F	A	B	F U S E		Magnetic switch 200/400 V 50/60 Hz	Thermal relay		CT ※ (A)	Ammeter KSS-7a ※ (A)
	Type	Current (A)		Type	Current (A)		Type	Current (A)		
0.2	1× L33 I/K 35 kVA	10		3× AFC-30 100 kA	3	SRC3631-5-1F 2A+2B	1× TH-1	0.5-0.9	1/1	0-1-2
0.4		16			5			1-1.8	2/1	0-2-4
0.75		20			7			1.4-2.6	3/1	0-3-6
1.5		40			15			3-5.4	5/1	0-5-10
2.2		40-80			15			3-5.4	7.5/1	0-7.5-15
3.7		80-160			30			5-9	15/1	0-15-30
5.5	1× L1031/K 30 kA (1TIME 40 kA)	80-160		3× AFC-60 100 kA	40	SRC3631-5-1BF 2A+2B	1× RC3737-4H	7.3-13.5	20/1	0-20-40
7.5		160-320		40	SRC3631-2 2A+2B	8-16		30/1	0-30-60	
11		260-480		60		15-30		40/1	0-40-80	
15		380-580		3× AFC-100 100 kA	75	SRC3631-3 2A+2B		25-35	50/1	0-50-100
18.5		380-580		100	30-50			75/1	0-75-150	
22		480-720		100	30-50			75/1	0-75-150	
30		720-1,100		3× FNH-1H 100 kA	100	SRC3631-4 2A+2B		50-60	100/1	0-100-200
37		720-1,100			150			50-80	100/1	0-100-200
40		720-1,100			150	SRC3631-6 2A+2B		65-100	150/1	0-150-300
55		1,000-2,400			150			SRC3631-8 2A×2B	80-120	150/1
60	1× L203 I/K 50 kA (1TIME 60 kA)	1,000-2,400		200	80-120	150/1	0-150-300			
80		1,000-2,400		200	140-170	200/1	0-200-400			
90		1,000-2,400		300	SRC3631-10 2A+2B	120-240	300/1	0-300-600		
110		1,300-3,000		300		120-240	300/1	0-300-600		
150	1× L403 I/K 50 kA (1TIME 70 kA)	2,100-5,000		400	SRC3631-12 2A+2B	1× RC3737-30N	150-300	400/1	0-400-800	
180		2,100-5,000		400			180-360	500/1	0-500-1,000	
250	1× L603 I/K 70 kA (1TIME 80 kA)	2,400-6,000		3× FNH-4H 100 kA	800	SRC3631-14 4A+4B	1× RC3737-60N	300-600	750/1	0-750-1,500

- Note: 1. Apparatus marked ※ are not attached as standard.
 2. 200 V unit exceeding 55 kW are not made of drawout type.
 400 V units exceeding 110 kW are not made of drawout type.

On the front of unit there are arranged nameplates, equipment, etc. which are suitably selected according to the service object and use.

In respect to fixing, disconnection, and drawing-out of the unit, there is provided an operating unit of interlocks for these three operations on the lower-right corner of unit and the unit can be easily fixed on or drawn out from the cabinet by handling this operating unit. This operating unit is located within a round hole installed on the unit front panel and provided with a shaft which has a slit on the end for turning by use of a minus driver. Around the periphery of round hole there is attached a nameplate showing the interlock conditions. This nameplate is indicated with 3 conditions, that is, "D" (Draw-out) from the left side facing the round hole, "Disc." (Disconnection) turned by 90° clock-wise from "D" (just at the top of round hole), and "L" (lock) further turned by 90° clockwise.

And when inserting into or drawing out from the cabinet the indicating mark of shaft in the round hole must be set at the position "D" of nameplate. Further, to fix the unit when it is completely inserted into the cabinet, tee indicating mark of shaft shall be turned clockwise so as to come to the position "L" of nameplate.

On "Disc." position the unit main circuit and auxiliary circuit plugs can be disconnected from respective receptacles by drawing out the unit by 30 mm from position "L" to your side. If the shaft interlock is turned to position "L" under such condition (as drawn out to your side) the unit is made fixed in the disconnected condition being permitted neither drawn out from the cabinet nor

inserted inversely into the running position (completely inserted position)

The main object for such interlock is to secure the absolute safety in the case of inspection and maintenance for the load side lines. The unit dimensions are shown in *Table 2*.

IV. RATINGS AND SPECIFICATIONS

The general ratings and specification of control center and standard specification of unit are shown below.

1. Standard Ratings (Table 3)

2. Specification of Unit

Table 4 is a standard application table for different motor capacities and voltages, and *Table 5* shows standard apparatus for various systems of operations and other attachable apparatus. *Table 6* shows the number of units for various kinds of the composed unit capacities.

V. CIRCUIT COMPOSITION

1. Examples of Various Kinds of Bus Bar Arrangements

The horizontal bus bars and vertical bus bars are available for various kinds of main circuit compositions with ease. These examples are shown in *Fig. 9*.

1) (A) and (B) show the horizontal bus bars are provided in the intermediate portion of cabinet and either the upper or lower unit receiving portion of

Table 5 Application chart

Control system	Control source	Main specification	Attachable apparatus as standard											Extra order	
			88X	Control circuit fuse	Transf. for lamp	Running lamp R	Stop lamp G	Fault lamp Y	49X	Reset button	CT	Am-meter	Trans-former	Re-closing relay	Earth leakage relay
A	Common	Standard	⊙	⊙	⊙	⊙	⊙	⊙	×	×	×	×	×	⊙	⊙
		With CT	⊙	⊙	⊙	⊙	⊙	⊙	×	×	⊙	×	×	○	○
		With AM & CT	⊙	⊙	⊙	⊙	⊙	⊙	×	×	⊙	⊙	×	○	○
	Individual	Standard	⊙	⊙	⊙	⊙	⊙	⊙	×	×	×	×	⊙	○	○
		With CT	⊙	⊙	⊙	⊙	⊙	⊙	×	×	⊙	×	⊙	×	×
		With AM & CT	⊙	⊙	⊙	⊙	⊙	⊙	×	×	⊙	⊙	⊙	×	×
B	Common	Standard	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	×	×	×	⊙	⊙
		With CT	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	×	×	○	○
		With AM & CT	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	×	○	○
	Individual	Standard	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	×	×	⊙	○	○
		With CT	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	×	⊙	×	×
		With AM & CT	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	×	×

⊙ Attachable apparatus

○ Either one is attachable

×

Table 6 Application chart

FAB control center		Fuse control center							
Dimension (mm)	Size	Unit capacity 200 V/400 V (kW)				Unit capacity 200 V/400 V (kW)			
		300 Wide		600 Wide		300 Wide		600 Wide	
		Direct start	Reversible	Direct start	Reversible	Direct start	Reversible	Direct start	Reversible
120	1 tier								
130	1.5 tier	15/30	7.5/11	—	—	55/11	55/11	—	—
240	2 tier	—	15/30	—	—	15/30	15/30	—	—
300	2.5 tier	22/37	—	—	/40	22/37	—	—	—/60
360	3 tier	—/40	22/37	—	—	30/60	22/37	—	40/80
420	3.5 tier	40/80	—	—	55/110	40/80	—	—	55/110
480	4 tier	55/110	—	—	—	55/110	—	—	—

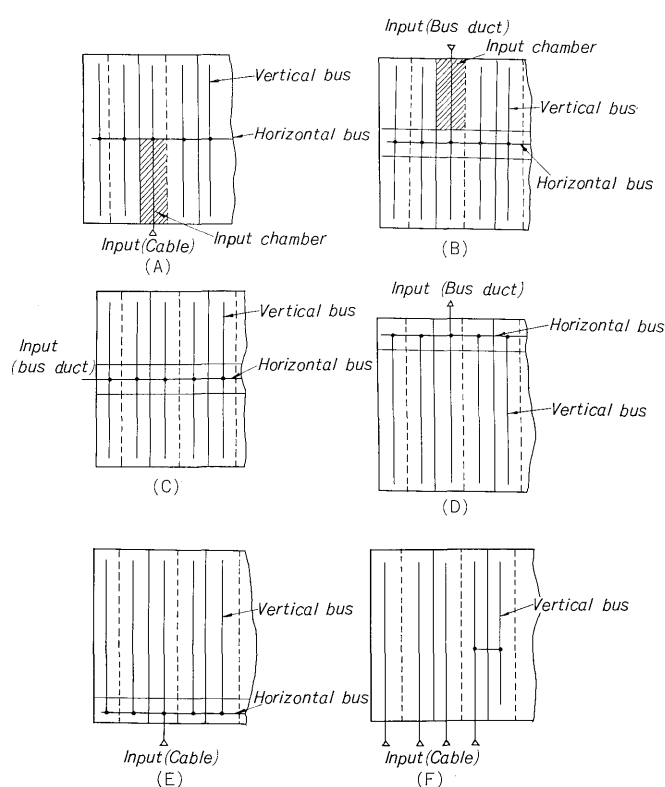


Fig. 9 Bus bar arrangement

any of two rows in one cabinet is used for bus bar incoming.

- 2) (C) shows the bus bars are directly led-in from the bus duct in the traverse direction.
- 3) (D) and (E) show the horizontal bus bars are arranged in the upper portion and the lower portion.
- 4) (F) shows comparatively small capacity power supplies are separated every group. As above described, the application range is very wide.

2. Various Applications of Circuit Protection Systems

As the circuit protection system, there are roughly classified into 2 systems by the circuit breaker selected, the full capacity interruption system and back-up interruption system. In the former, no

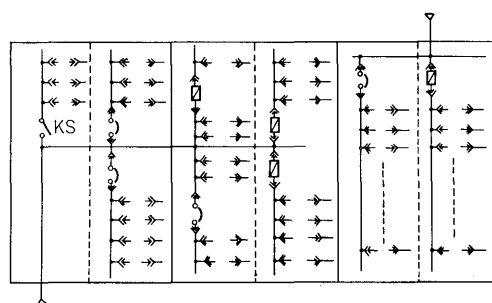


Fig. 10 Arrangement of back up system

problem arises particularly to the unit arrangement as the control center, and in the latter the bus bar arrangement has so far been extremely disadvantageous in the space factor for the conventional types because of a small number of units contained in the cabinet. But now, as will be understood in the preceeding item the modification for the above has been easily made possible. This example is shown in Fig. 10.

3. Unit

1) Unit protection system

The motor protection is performed by the combination of molded Fuji Auto Breaker FAB, fuses, and magnetic switch.

Small current range: The magnetic switch is to be surely released by action of thermal relay against over load during motor running.

Middle current range: Mistrup of thermal relay, FAB or fuses is to be perfectly prevented at starting of motor.

Large current range: When a short-circuit has happened in the line, the line must of course be interrupted by the main circuit breaker and moreover it is desirable that the equipment connected in series with the main circuit breaker (cables, wires, magnetic contactor, thermal relay, and so on) is applied with the minimum or no thermal and mechanical stress thereby.

It is a fact that a different result is obtained by

FAB or fuses due to a difference in the current limiting characteristics between both, however the equipment is suitably selected taking the co-ordination for protection over these entire ranges into consideration.

2) Fault indication system

The fault indication system provides the following 2 kinds as standard.

- (1) A System: The thermal relay is of hand reset type and does not give any indication particularly.
- (2) B System: The thermal relay is of auto self-reset type. The fault condition is sustained by an auxiliary relay which is actuated by the circuit breaker and thermal relay, and thereby a fault indicating lamp lights on or off and the thermal relay is electrically reset by a push button.

4. Control Power Supply

The installation system of control power supply transformer provides the following 2 kinds.

- 1) Individual system: A control transformer is provided for each unit and the control power supply is obtained from the main circuit within the unit. (Refer to Fig. 11)
- 2) Common system: A control transformer is provided for every group which to compose the control center, and control power is supplied from common bus bars. (Refer to Fig. 12)

As will be clear from Table 5, an auxiliary relay (88X) for main magnet switch (88) is attached on each unit as standard. The coil of 88 is connected to the main circuit voltage irrespective as to whether the individual system or common system, and only the auxiliary relay 88X will be loaded on the control power supply. (Refer to Figs. 11 and 12) Besides the above, DC control power supply system is available upon request.

VI. STANDARD CONNECTION DIAGRAM

The control center provides the interchangeability for unit, so that all the circuits of units in one plant

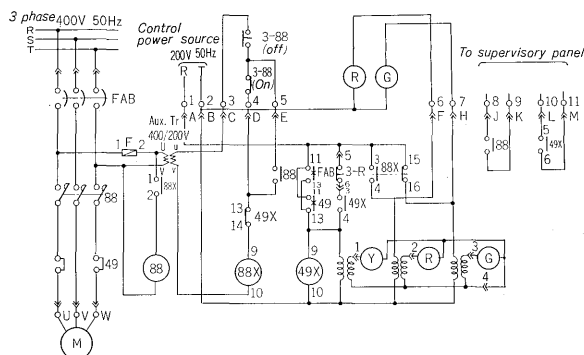


Fig. 11 Standard connection diagram
(Type B)

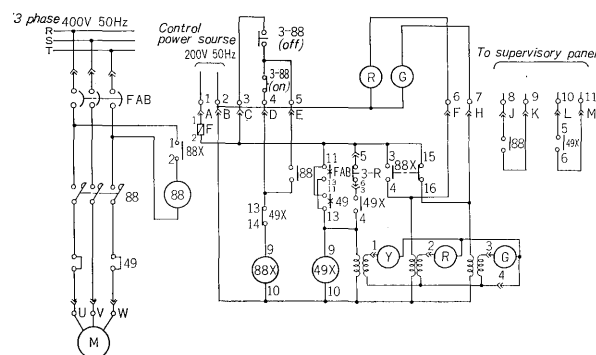


Fig. 12 Standard connection diagram
(Type B without Tr)

are desirable to be identical. Accordingly, it must be considered that some blank unit chambers are reserved for mounting the apparatus other than the standard attachable apparatus in Table 5. The typical connection diagrams are shown in Figs. 11 and 12.

VII. CONCLUSION

In the above, Fuji control center type SM-2200, newly developed has been introduced with respect to the outline of construction and it is hoped that this will serve to any reference for your projection and application of the same equipment.