

# CONTROL CENTER

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## I. INTRODUCTION

The recent trend toward larger industrial plants and thermal power plants has brought about a more extensive use of low tension motors and the arrangement of switches and protecting devices for these low tension motors is a problem of great importance from the point of control and maintenance. In the past, motor starting device for this purpose was usually installed in the vicinity of the motor or other machinery and power was transmitted from a power source located at some distance; consequently, there was inconvenience from the point of centralized supervision and maintenance inspection.

The Control Center consists of combinations of switches and protecting devices for motors not exceeding 600 V placed into one compact unit of standard dimensions. These units are so designed that each unit is separate and removable. These Control Centers can be combined for specific blocks of motors and can be conveniently arranged for easy control and maintenance. The abovementioned drawbacks have been eliminated. The Control Center can be used with great advantage for centralized supervision and easy maintenance.

Fuji Denki's Control Center has already been installed at many thermal power plants and steel mills with the most satisfactory results.

The following is a brief description of the distinctive features, construction and circuit of Fuji Denki Control Center.

## II. DISTINCTIVE FEATURES

Fig. 1 shows one example of Fuji Denki Control Center. This Control Center has the following distinctive features:

1. The Control Center is neat and compact and makes it possible to arrange many control center units vertically on one panel; consequently, it requires small space and can be conveniently arranged for easy centralized control and maintenance.

2. Each unit is equipped with a no-fuse breaker of large rupturing capacity for short circuit protection and thermal relay for over-load protection. Thus, the motors can be properly protected.

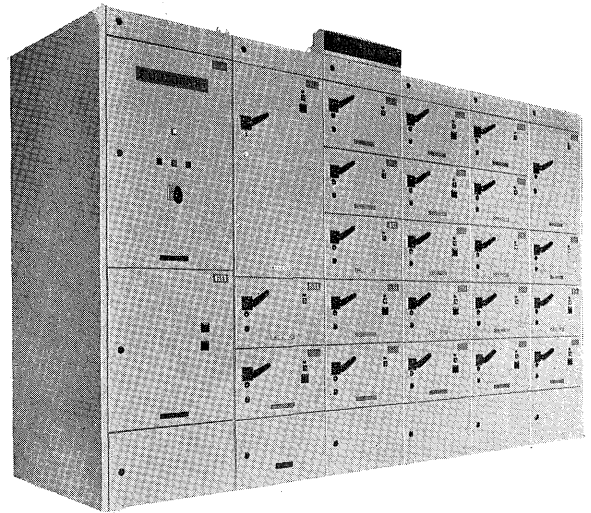


Fig. 1. Control Center

3. The incoming terminal of each unit is designed for self-coupling; therefore, it can be easily drawn out. This makes it possible to remove or replace a unit without stopping the operation of other motors connected to the same power source. Also, by keeping a spare unit, damaged unit can be easily and speedily replaced.

4. Since each unit is completely standardized, designing can be easily conducted.

5. No live parts are exposed. There is no danger since all operation can be done from the outside.

6. The external appearance is neat and compact.

## III. APPLICATION

Control Center can be used with great advantage in the thermal and hydraulic power plants and steel mills for control of auxiliary motors and at the textile, paper and food plants for control of various motors. The advantages of Control Center are particularly noticeable in industrial plants using many motors.

Recently, in the large capacity thermal power plants, high tension metal-clad switchgear, low tension load center and Control Center as switchgear for auxiliary motors are used according to voltage and capacity of motors. Fig. 2 shows the typical

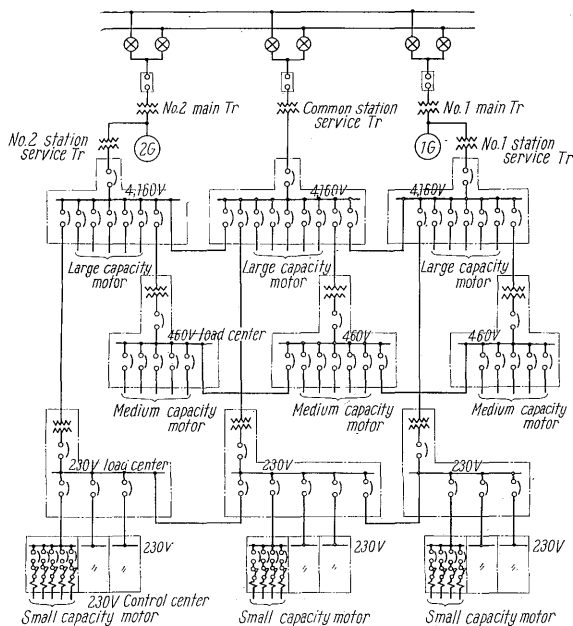


Fig. 2. Typical skeleton diagram of steam power station

skeleton diagram of a 125,000 kW class thermal power station. As can be readily seen from this diagram, the load center is used for the medium capacity auxiliary motors, and Control Center is for the auxiliary motor group located at the system terminal. The low tension circuit voltage of these load center and Control Center is 400 V and 200 V. Since low tension switches are manufactured for use for 600 V, the rated current of the switch and the circuit rupturing current can be fixed at one half when system voltage is changed from 200V to 400V. For example, at 200 V the 11 kW Control Center unit can be used without changes for 22 kW at 400 V.

At present, 400 V is used for medium capacity motors of the thermal power plants while 200 V is used mainly for small capacity motors. However, the recent trend at the large power plants and in the U.S. is to use 400 V for even small capacity motors and to limit 200 V to miniature motors and electric light source.

Fuji Denki's Control Centers are manufactured for standard 200V and 400V and the applicable capacity of the motor when using Control Center is as follows :

200 V	40 kW (cage rotor type)
	50 kW (wound rotor type)
400 V	80 kW (cage rotor type)
	100 kW (wound rotor type)

For medium capacity motors, exceeding the above capacity load centers using ACB (air circuit breaker) are recommended.

## IV. COMPOSITION AND CONSTRUCTION

Control Center is composed of the Control Center unit and the cabinet to house the Control Center unit.

### 1. Control Center Unit

This is the main part of the Control Center. It consists mainly of switch and protecting devices, composed of the following fittings :

#### 1) Clip

This is the incoming terminal of the unit.

#### 2) No-fuse breaker

This is for short circuit protection. Rupturing capacity is determined according to short circuit capacity of line. Generally, 100 A frame and over is used and this has capacity of rupturing current of 15,000 A.

#### 3) Magnetic contactor

Compact and highly efficient RC 3631 series magnetic contactor is used. This contactor has efficiency guarantee of A-1-1 of JIS (Japanese Industrial Standard) C8325.

#### 4) Thermal relay

As a usual, close attention must be given when there is difference of temperature inside the Control Center and vicinity of motor. But, because Fuji Denki's thermal relays have been adjusted for thermal compensation, there is no incorrect operation even when temperature difference occurs.

#### 5) Auxiliary relay

This relay is used to reset thermal relay and for fault indication.

These parts are properly arranged in a container without front and light side. Together with the compact and efficient magnetic contactor, it forms an extremely compact unit.

Fig. 3 is a typical one of the Control Center unit for 220 V 11 kW motor.

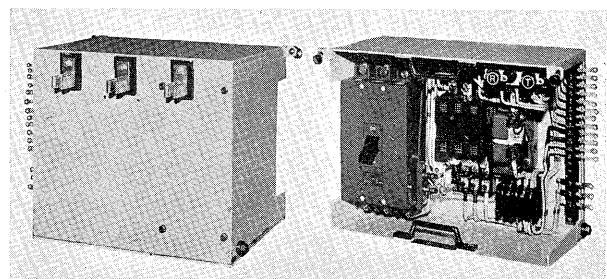


Fig. 3. Control Center unit, front and back view

All unit are of draw-out construction so that parts can be easily replaced by inserting it in the cabinet. Namely, the incoming terminal of the main circuit forms self-coupling, and draw-out wheels and handles are attached to each unit. As can be

seen from Fig. 3, a clip is attached on the back of unit and this clip can be connected with the vertical bus which is vertically arranged on the back side of the unit. (See Fig. 4). Silver plating is treated on all contact points.

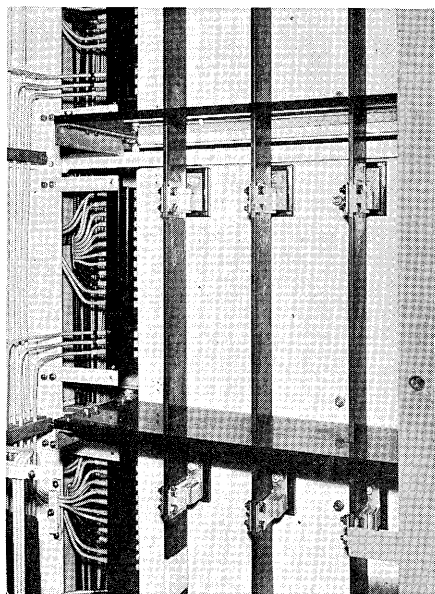


Fig. 4. Vertical bus structure and clip

The bottom of the unit is slanted to facilitate drawing out and inserting operation. To insert unit, slightly slant unit as shown in Fig. 5 and push handle when the wheels fit into the groove. The clip automatically connects with the bus. The control circuit and load circuit are then connected and the entire operation is completed. Do the reverse to draw out a unit.

The right side of the unit which is opened is used when connecting wires with the outside. The wire clamp is on the right end of the unit and the terminal block is attached to the frame side. Therefore, there is no need to bend the wire when

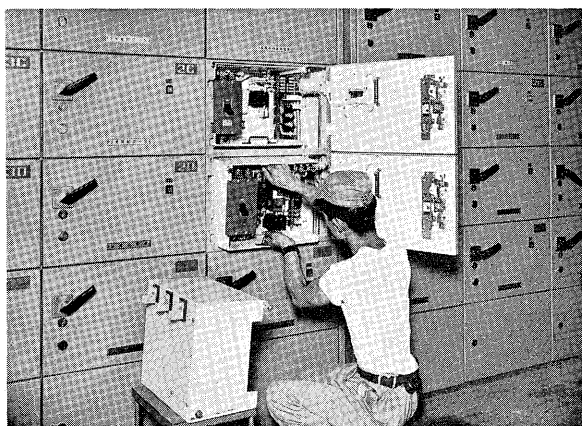


Fig. 5. Control Center unit is being removed

detaching the unit and the wires will not fall apart when detached.

The dimensions of the Control Center unit differ according to the component parts; however, the depth and the width are always fixed while the height is double or treble the standard height. This means that a unit with twice the height of the standard unit will fit into the space open for two standard height units. The height of the standard unit is 360 mm and this value is selected to get the efficient space factor when using a large number of motors.

The parts of the Fuji Denki Control Center Unit are properly arranged so that the height of the unit is limited to the minimum. It is also easy to handle. Since weight and height increase too much to handle easily when 4 rows units are used the unit size is limited to three rows. Fig. 6 shows Control Center units arranged in three rows. Table 1 shows the types and ratings of Fuji Denki standard Control Center units. The dimensions listed in this table are the panel area of the units inserted in the cabinet.

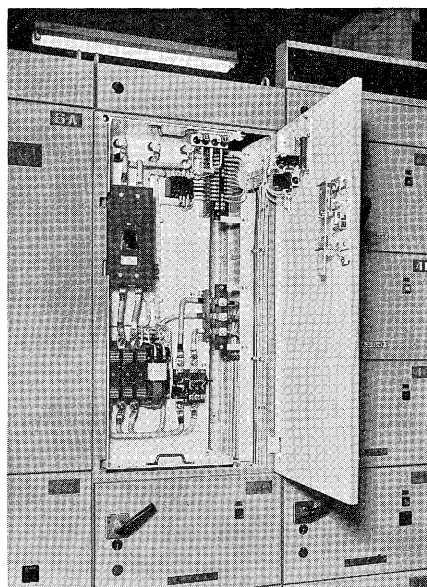


Fig. 6. Largest Control Center unit

## 2. Cabinet

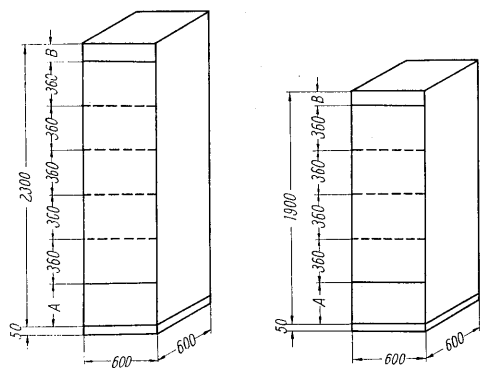
This is the external frame of the Control Center. It houses the Control Center unit and forms the control center.

Fig. 7 gives the standard outline dimensions of the Fuji Denki Control Center. As can be seen from this figure, width is 600 mm, depth, 600 mm and height, 2,300 mm or 1,900 mm. Both the outgoing load cable and control cable are connected in the lower part in the standard type but, when

Table 1. List of types and ratings of standard Control Center unit

Type	Working load		Current	Rupturing current of circuit	Apparatuses mounted on unit			Dimension of unit (Panel area)	Applica- bility
	220 V	440 V			N.F.B.	Magnetic contactor	Thermal relay		
U 51- I	3.7kW	3kW	16A	5kA	K 53	R C 3631-5-1	R C 3737-4H	600×360 ( I )	Non- reversible
U101- I	3.7	3	16	15	K103	R C 3631-5-1	R C 3737-4H	600×360 ( I )	“
U 52- I	5.5	7.5 (11)	25	5	K 53	R C 3631-2	R C 3737-4	600×360 ( I )	“
U102- I	5.5	7.5 (11)	25	15	K103	R C 3631-2	R C 3737-4	600×360 ( I )	“
U104- I	11	22	50	15	K103	R C 3631-4	R C 3737-4	600×360 ( I )	“
U106- II	15	30	75	15	K103	R C 3631×-6	R C 3737-10	600×720 ( II )	“
U206- II	20	(40)	75	15 (600 V) 20 (250 V)	K203	R C 3631×-6	R C 3737-10	600×720 ( II )	“
U210- III	40 (50)	80 (100)	150	15 (600 V) 20 (250 V)	K203	R C 3631-10	R C 3737-20	600×1080 ( III )	“
UR 51- I	3.7	3	16	5	K 53	2× R C 3631-5-1	R C 3737-4H	600×360 ( I )	Reversible
UR101- I	3.7	3	16	15	K103	2× R C 3631-5-1	R C 3737-4H	600×360 ( I )	“
UR 52- II	5.5	7.5 (11)	25	5	K 53	2× R C 3631-2	R C 3737-4	360×720 ( II )	“
UR102- II	5.5	7.5 (11)	25	15	K103	2× R C 3631-2	R C 3737-4	600×720 ( II )	“
UR104- II	11	22	50	15	K103	2× R C 3631-4	R C 3737-4	600×720 ( II )	“
UP 51- II	3.7	3	16	5	K 53	3× R C 3631-5-1	2× R C 3737-4H	600×720 ( II )	Polechange
UP101- II	3.7	3	16	15	K103	3× R C 3631-5-1	2× R C 3737-4H	600×720 ( II )	“
UN100- I	—	—	100	15	K103	—	—	600×360 ( I )	N.F.B.
UN200- II	—	—	200	15 (600 V) 20 (250 V)	K203	—	—	600×720 ( II )	“

Remarks 1. Working load: Cage motor ( ): Wound-rotor type motor  
2. R C 3631-2+ R C 3737-4 are R C 3931-2  
R C 3631-4+ R C 3737-4 are R C 3931-4  
2× R C 3631-2+ R C 3737-4 are R C 3931-2+ R C 3631-2  
2× R C 3631-4+ R C 3737-4 are R C 3931-4+ R C 3631-4



Remark: Parts of A & B are bus duct and terminal room  
Fig. 7. Standard outline dimensions of Fuji Denki Control Center

needed, all combinations of lower and upper connecting system are available.  
The cabinet is composed of the space for containing the units and the horizontal and vertical busses. Shape steel to partition the unit chamber and rail are fixed in the unit chamber. The horizontal bus is a common bus for all units. The vertical bus

branches off from the horizontal bus and is used for supplying power to the every units of one panel. It is so designed that the clips of the units can be directly connected. (See Fig. 4). All busses have continuous current capacity of 600 A and is so designed to withstand short-circuit current.  
One part of the vertical bus chamber is used to mount accessories not installed in the Control Center unit, such as, for example, auxiliary relay, current transformer.  
The back side is fitted with a cover that is divided into two parts so that the unit can be inspected from the back side. Particularly, when the back side must be placed against a wall, all parts that require inspection, such as auxiliary relays, can be installed together in one unit space for easier maintenance and inspection.  
The front side of the cabinet is fitted with a door of the same size as the respective unit. The door is attached to the frame with hinges and is separated from the unit. The door may be kept closed even when unit is not installed.

The followings are placed on the door :

- a. No-fuse breaker operating handle
- b. Fault indicating lamp
- c. Push button switch for thermal relay reset
- d. Name plate and unit number plate
- e. Operating push button switch
- f. Indicating lamp

(e) and (f) may be omitted.

When the door is closed, the outer operating handle and handle of the no-fuse breaker are mechanically connected so that the no-fuse breaker can be operated by turning the outer operating handle 60 degrees. This handle is also used for opening and closing the door ; however, it is interlocked so that the door cannot be opened unless the no-fuse breaker is in "off" condition. There is a device, too, to release the interlocking so that the door can be opened for emergency inspection even when the breaker is in "on" condition. The no-fuse breaker operating handle can be locked so that visitors or other persons cannot operate the breaker and that the door cannot be opened.

## V. METHOD OF WIRING

The method of wiring of Control Center is classified into A, B and C by U.S. NEMA specifications ICI-22.02 (1954).

### A Method

A terminal block for outer connection is not installed in the unit and the terminals of the various appliances in the unit are directly connected with the outside wiring.

### B Method

Each unit is equipped with a terminal block but there is no upper or lower terminal for each cabinet, so the outside wiring must be connected at the terminal block of each unit.

### C Method

Each unit is equipped with a terminal block similar to that described in B. Also, the outgoing wiring terminals are bunched at the bottom or upper section of each cabinet, and connected with the abovementioned terminal block through inner wirings.

Of the above three methods C is the most satisfactory method. Fuji Denki Control Centers are designed with C method.

The terminal block for outgoing cable is installed in the lower or upper space. The control circuit terminal block is installed in the front while the load circuit terminal block is at the back. Thus, the wiring is in good order and easy to inspect and maintain.

## VI. CIRCUIT

As has been explained, the Control Center consists of a combination of no-fuse breaker and magnetic switch. The circuit as well as the construction are standardized.

The units of Control Center are interchangeable ; consequently, the unit circuit is uniform and such appliances which makes the standard circuit are only used. Consequently, it is so designed that the additional apparatus that is not in the standard circuit is installed in the back of each unit. All connections in the interior of the unit are standardized ; consequently, some connections in certain units appear superfluous or unnecessary ; however, it results to save time for planning and design.

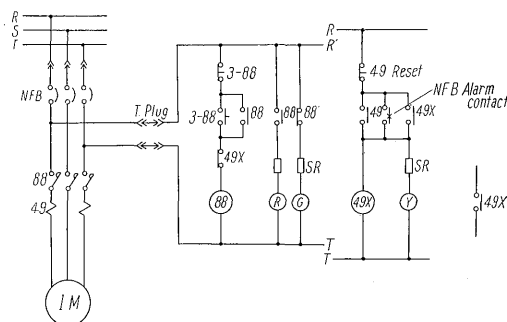


Fig. 8. Standard circuit

Fig. 8 shows standard circuit for Control Center. All parts except 3-38, 49 reset and signal lamps are contained in the unit. This standard circuit is believed to be applicable to almost all motors. This circuit permits the operation at the surface of the door ; therefore, it is very convenient and easy to use.

Appliances that cannot be installed inside the unit are mounted outside the unit and these include those listed in table 2. (1) and (2) are installed in all standard units but (3) and (4) are optional. Normally, control switches of this type are operated from the control panel near the motor and it is unusual to control the switch at the Control Center. In standard types, the current transformer (5) and ammeter (6) are not installed except when needed. The ammeter was so far installed for the purpose of reading the motor current ; however, this is impossible when so many motors are used as in the case at present. It is more reasonable to use the fault indicator instead of the ammeter. Recently, it is trend not to install the ammeter at thermal power plants.

The changing-over switch (7) is used, for example, for changing-over of automatic and manual operation.

VII. CONCLUSION

The foregoing has been a brief explanation of Fuji Denki Control Center. It is believed that a wide variety of Control Centers will come to be used extensively. Fuji Denki will continue research and further standardize construction and circuit for greater efficiency.

Table 2. Additional apparatus that  
can be installed out of unit

	Apparatus	Set out position
1	Fault indicating lamp	Door
2	Push-button switch for thermal relay reset	"
3	Indicating lamp	"
4	Operating push-button switch	"
5	Current transformer	Back of unit
6	Ammeter	Door
7	Change-over switch	"