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LD LOAD CENTER

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I. INTRODUCTION

Nearly ten years have elapsed since the commencement of domestic use of what is generally called a load center, in which the air circuit breaker is accommodated upright in the enclosed switchgear. During this decade, applications of the load center have increased, along with an increase in various types of demands by users. In response to these demands, Fuji Electric has improved many aspects of the load center so far manufactured.

Given in the following is a general description of the new type LD load center.

II. FEATURES

An external view of the LD load center is shown in *Fig. 1*. It has the following features:

1) With the highly reliable Fuji air circuit breaker used, accurate operation and circuit protection is insured.
2) The arc chute of the Fuji air circuit breaker is installed at the rear, thus ejecting the arc to the rear upon breaking. This guarantees utmost safety.

   With a wide space provided for the arc ejection, breaking performance is efficient and accurate.
3) No exposure of the live part and complete interlocking permit extreme safety.
4) The air circuit breaker is of the draw out type, permitting smooth withdrawal and insertion, simply by turning the crank handle. Needless to say, air circuit breakers of the same series are perfectly interchangeable.
5) Simple construction of the mechanical units, such as the draw out mechanism, permits easy understanding of the construction and high reliability.
6) The terminals have been thoughtfully arranged for easy connection of the power cable.

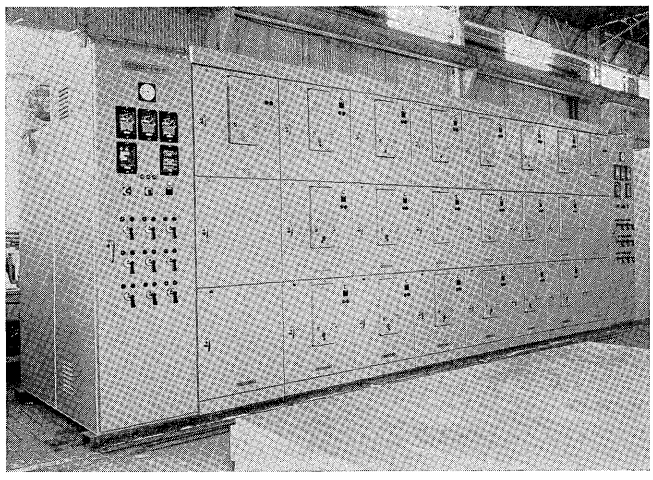


Fig. 1 LD load center

III. DRAW OUT TYPE AIR CIRCUIT BREAKER

This is an air circuit breaker specially designed to be accommodated in the load center, small in size and easy to handle.

1. Types and Ratings

Table 1 shows the types and ratings of a draw out type air circuit breaker, illustrating ac, three-phase circuit equipment with rated current less than 2000 amp. However, Fuji Electric is prepared to manufacture equipment with larger rated current, as well as for dc circuits.

Figs. 2 and *3* are external views of the motor drive and hand drive draw out type air circuit breakers.

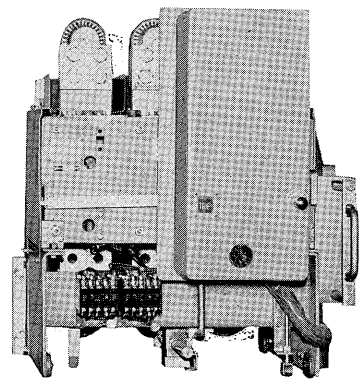


Fig. 2 Motor drive draw out type air circuit breaker

Table 1 **Types and Ratings of Draw Out Type Air Circuit Breaker**

Control System	Type of Control Circuit Plug	Rated Voltage (v)	Rated Rupturing Current (ka)	Rated Current (amp)	Air Circuit Breaker Models
Motor Drive	Plug-in type connector	250 600	40	800 1000	RFb 913Ⅲ/ 800M-L2 RFb 913Ⅲ/1000M-L2
			50	1600 2000	RFb 913Ⅲ/1600M-L2 RFb 913Ⅲ/2000M-L2
	Automatic coupling connector		40	800 1000	RFb 913Ⅲ/ 800M-L1 RFb 913Ⅲ/1000M-L1
			50	1600 2000	RFb 913Ⅲ/1600M-L1 RFb 913Ⅲ/2000M-L1
Hand Drive	Plug-in type connector		40	800 1000	RFb 913Ⅲ/ 800-L2 RFb 913Ⅲ/1000-L2
			50	1600 2000	RFb 913Ⅲ/1600-L2 RFb 913Ⅲ/2000-L2
	Automatic coupling connector		40	800 1000	RFb 913Ⅲ/ 800-L1 RFb 913Ⅲ/1000-L1
			50	1600 2000	RFb 913Ⅲ/1600-L1 RFb 913Ⅲ/2000-L1

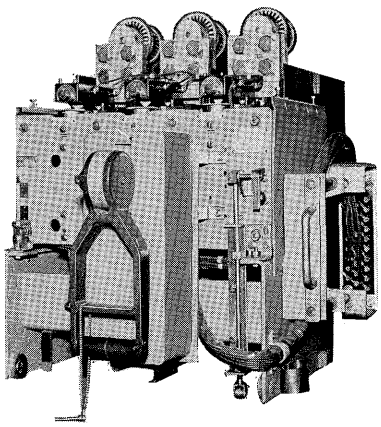
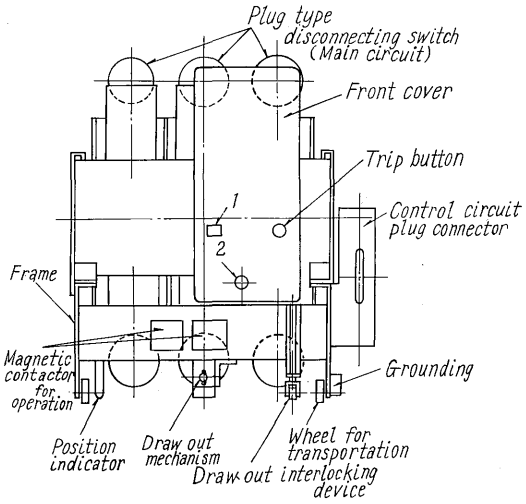


Fig. 3 Hand drive draw out type air circuit breaker

2. Construction

Fig. 4 is a structural diagram of a draw out type air circuit breaker (the moter drive type only). As *Figs. 2* through *4* clearly show, the air circuit breaker, draw out mechanism and associated units are all functionally compact.



① Mechanical on-off indicator
② Window through which adjusting on-off handle is inserted

Fig. 4 Front view of draw out type motor drive ACB

1) Plug type disconnecting switch of the main circuit

The plug type disconnecting switch of the main circuit uses a tulip type contact, newly designed for low voltage high current circuits.

Consideration has particularly been given to avoid melting by short time over current. The contact for 1000 amp can withstand up to 40 ka, while the contact for 2000 amp can withstand up to 50 ka, for a period of two seconds.

2) Control circuit plug connector

There are two types of control circuit plug connector, the manual coupling connector and automatic coupling connector; the former is standardly used. Five 6-prong plugs are used for plug-in type connector.

Many of these plug-in type connectors are in satisfactory service at the Fuji Electric CN type control center.

The automatic coupling type connectors are 30-point type connectors which have been employed for a long period of time in Fuji Electric metal clad switchgear.

3) Draw out interlocking device

This is a device which prevents the air circuit breaker from being drawn out as long as the switch is closed. The LD load center is constructed to trip the breaker automatically when the air circuit breaker is accidentally drawn out with the switch closed. This construction eliminates concern over erroneous switching of the load current by the plug type disconnecting switch. Furthermore, it cannot be turned on while the circuit breaker is being drawn out or inserted, thus providing utmost safety in operation.

4) Draw out mechanism

This mechanism permits easy drawing out of the draw out type air circuit breaker, as described in detail in Section IV.

5) Position indicator

This indicates clearly whether the draw out type air circuit breaker inside the cabinet is in

the operation or test position.

6) Front cover

The front cover protrudes from the surface of the door when the unit door of the cabinet is closed. In the case of the motor drive type, the front cover is provided with a mechanical on-off indicator, trip button, and a window through which the adjusting on-off handle is inserted. In the case of the hand drive type, it is provided with a operating handle.

7) Mechanical on-off indicator

This indicates mechanically the on-off condition of the contact of the air circuit breaker; it indicates on, off, and tripped condition.

8) Trip button

In the case of the motor drive type, this button may be pressed for tripping the air circuit breaker without the necessity of opening the unit door. Since this button protrudes from the surface of the door, care should be taken not to operate it erroneously or carelessly touch it. However, Fuji Electric has arranged so that when the trip button has been turned 90° clock-wise, it does not operate even if accidentally pressed.

In the case of inspection of the motor or when there is danger of the circuit breaker being closed, the trip button may be pressed and turned 90° clockwise, thereby locking the breaker from being closed.

9) Window through which adjusting on-off handle is inserted

When inspecting wear of the contact points in the case of the motor drive type, the handle is inserted through this window for turning on or off the air circuit breaker by hand drive for test purposes.

3. Draw Out Type Disconnecting Switch

The switch is constructed with a short bar, instead of an air circuit breaker, connected to a frame of a type similar to the draw out type air circuit breaker. This is also called a dummy disconnecting switch. *Fig. 5* is an outer view of a draw out type disconnecting switch.

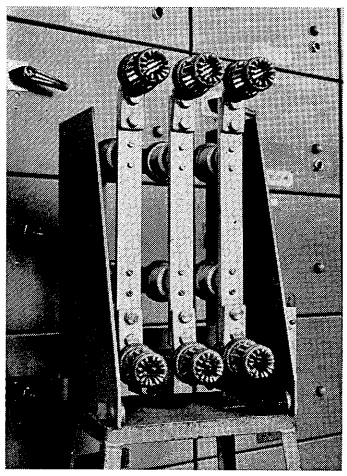


Fig. 5 Draw out type disconnecting switch

This draw out type disconnecting switch is provided with functions identical to an ordinary type of disconnecting switch, plus availability of future replacement by the air circuit breaker for utmost convenience.

IV. CABINET

This is a three-shelf cabinet which accommodates the draw out type air circuit breaker.

The cabinet is designed with emphasis placed on function, with attractive external appearance as well.

1. Types and Ratings

Types and ratings of the cabinet are as shown in *Table 3.*

2. Standard Dimensions of Cabinet

The cabinet is available with dimensions shown in *Table 2* or *Fig. 6,* depending upon the type of the air circuit breaker which the cabinet accommodates.

3. Construction of Cabinet

The cabinet consists of a breaker chamber which accommodates the draw out type air circuit breaker, a cable chamber which accommodates the bus bar and an external cable.

In the air circuit breaker compartment are the draw out mechanism of the draw out type air circuit breaker, the fixed side of the plug type disconnecting switch of the main circuit, the fixed side of the

Table 2 **Standard Dimensions of Cabinets**

Type of Air Circuit Breaker to be Accommodated	Cabinet Dimensions		
	Width (mm)	Height (mm)	Depth (mm)
RFb 913III/800, 1000 -L1, L2 RFb 913III/800, 1000 M-L1, L2	550	2400	1800
RFb 913III/1600, 2000 -L1, L2 RFb 913III/1600, 2000 M-L1, L2	700	2400	1800

Table 3 **Types and Ratings of Cabinets**

Control System of Air Circuit Breaker	Types of Control Circuit Plug	Type of Cabinet	Ratings
Motor Drive	Plug in type connector	LD 2M	Rated voltage: 250, 600 v ac Bus rated current: 600, 1000, 1600, 2000, 3000 amp Rated frequency: 50, 60 cps Short-circuit strength: 40, 50 ka
	Automatic coupling connector	LD 1M	
Hand Drive	Plug in type connector	LD 2H	
	Automatic coupling connector	LD 1H	

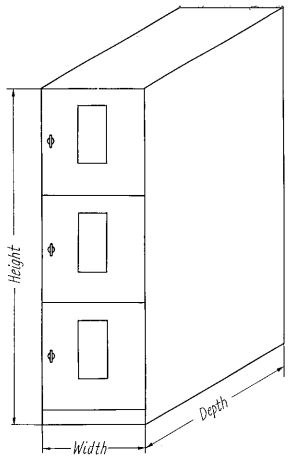


Fig. 6 Outline sketch of cabinet

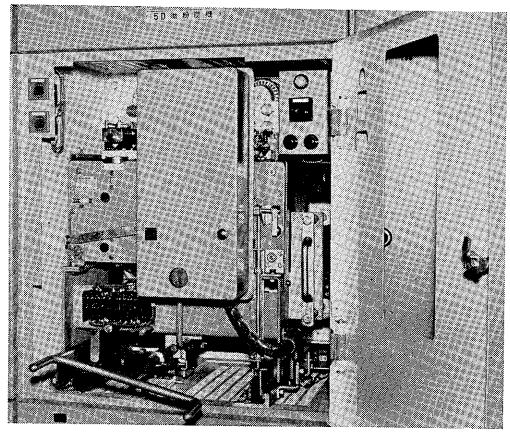


Fig. 8 Load center unit (with door opened)

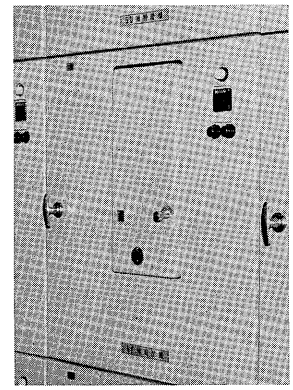


Fig. 9 Load center unit

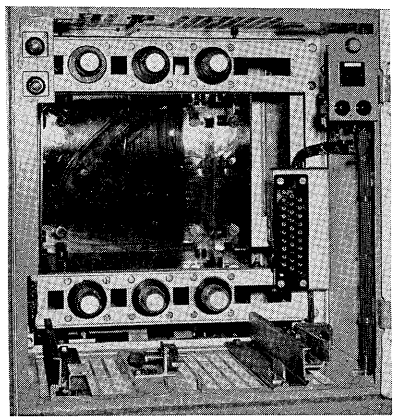


Fig. 7 ACB compartment

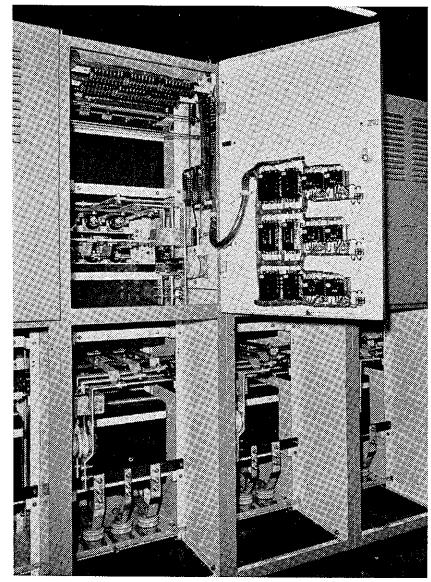


Fig. 10 Bus and cable compartment

control circuit plug connector, and a limit switch which detects the operation and test positions. *Fig. 7* shows the air circuit breaker compartment, while *Figs. 8* and *9* show the air circuit breaker accommodated.

Careful consideration was given to the arrangement of the conductors of the bus and cable compartment for providing utmost convenience for connection of the external cable.

A suspended type cover, divided into two sections, upper and lower, may be fitted to the rear side where the bus and cable compartment is located. In the case where a number of auxiliary units, such as no-fuse breakers and auxiliary relays, are installed in the load center, a door may be installed instead of the upper cover, on the rear side of which these units may be installed (Refer to *Fig. 10*).

4. Operation, Test, and Disconnecting Positions

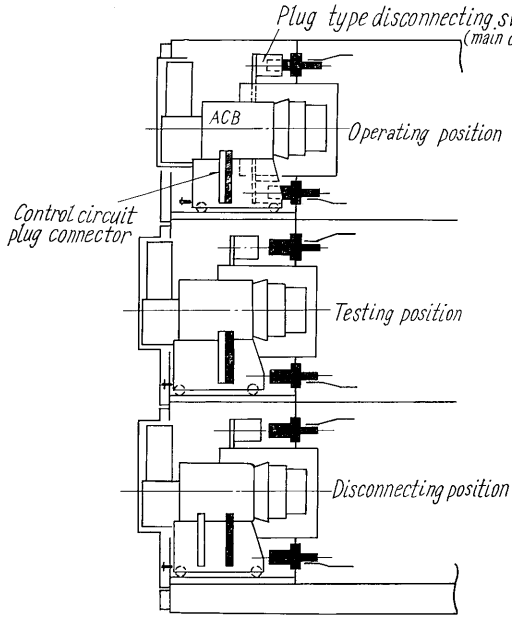
In the draw out type air circuit breaker, there are three positions, as in the case of the metal clad switchgear circuit breaker; these are operation, test, and disconnection positions. *Fig. 11* illustrates each of these three positions. As for the Fuji Electric load center, the test position is where the draw out type air circuit breaker stops as it is drawn out from the operation position. At this position the control circuit plug connector may be pulled out manually for the disconnecting position.

The testing on-off control of the air circuit breaker may be performed by means of the test on-off special pushbutton switch, as shown in the left upper position of *Fig. 8*.

As for the LD load center, whether the air circuit breaker is of the motor drive type or hand drive type, the door may be set to open or close at either the test or the disconnecting position. This provides convenience when a stand-by circuit breaker is required to remain disconnected from the circuit.

5. Draw Out Mechanism

The draw out method is of the horizontal draw out type, and drawing out or insertion may be effected smoothly by means of the crank handle.



Operating position
Position where the air circuit breaker is in the normal operating condition
Main circuit: Closed
Control circuit: Opened

Testing position
Position where the air circuit breaker is set to close or trip for test purposes
Main circuit: Opened
Control circuit: Closed

Disconnecting position
Position where the air circuit breaker is completely disconnected from the circuit
Main circuit; Opened
Control circuit Opened

Fig. 11 Three positions of air circuit breaker

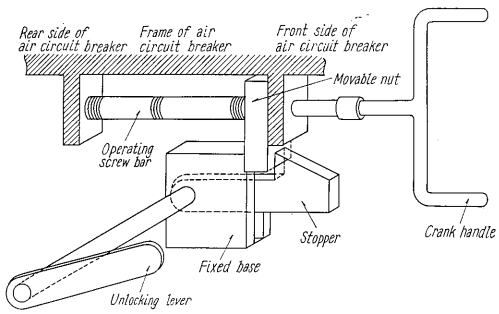


Fig. 12 Draw out mechanism (at operating position)

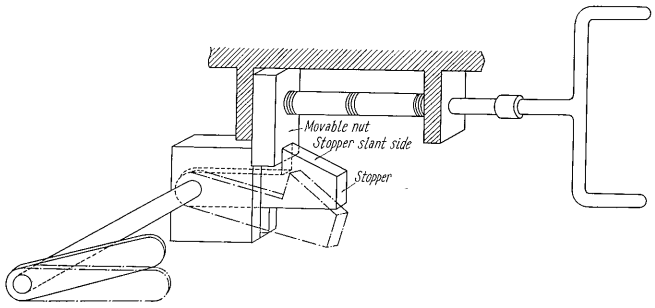


Fig. 13 Draw out mechanism (at testing position)

1) Drawing-out method

Shown in *Figs. 12* and *13* are the operation principles of the draw out mechanism unit. *Fig. 12* illustrates the air circuit breaker in the operating position.

Fit the crank handle to the top end of the operating screw bar, and turn the handle counterclockwise, so that the movable nut shifts to the left, as seen in the figure. Actually, the fixed base and the stopper are installed on the fixed frame and the movable nut does not move as shown, so that the draw out type circuit breaker moves to the right, i.e., is drawn out.

When the handle has been turned by approximately 25 turns, the movable nut moves as far as the position shown in *Fig. 13*, preventing the handle from being turned any further.

This is the testing position. In this condition, the position indicator indicates the "testing" position.

When, at this position, the control circuit plug connector has been removed (in the case of the automatic coupling connector, the handle for the connector may be pulled to the front for easy removal), it will be in the disconnecting position.

When further drawing out the draw out type air circuit breaker from the load center, the special lifter-type transfer truck may be used for easy and safe operation; set the rail of the transfer truck to the rail of the circuit breaker compartment; press down by hand the unlocking lever shown in *Fig. 13* (so that the stopper is disconnected from the moving nut, thus permitting the circuit breaker to move to the right), and pull to the front the draw out handle located under the bottom of the circuit breaker, so that the circuit breaker moves onto the transfer truck. When the circuit breaker has come to the required position on the transfer truck, the latch mechanism is applied, so that the circuit breaker is securely held, as shown in *Fig. 14*. Vertical control of the transfer truck may be performed easily and smoothly by means of the handle.

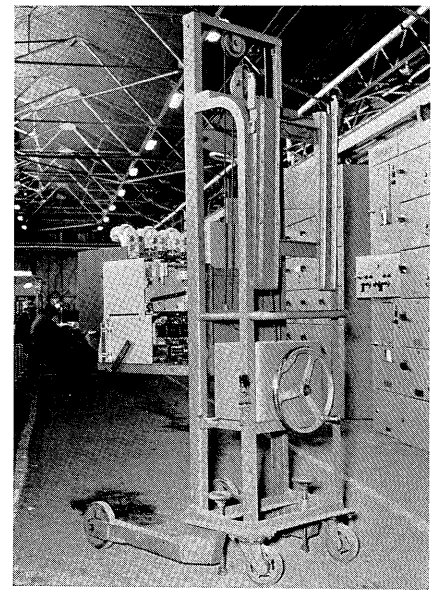


Fig. 14 Lifter type transfer truck

2) Method of insertion

The insertion method is the reverse of the case of drawing out. That is, set the rail of the transfer truck to the rail of the circuit breaker compartment and set the latch unlocking handle of the transfer truck, thus forcing the circuit breaker inside to attain the testing position. (When forcing it from the outside, the movable nut presses the stopper inclined side all the way down; the stopper returns to its original position by spring force, thus holding the circuit breaker securely. This eliminates the need for operating the unlocking lever when forcing from the outside). Fit the handle and turn it clock-wise by approximately 25 turns; the moving nut reaches the position shown in *Fig. 12,* thus preventing the handle from turning any further. This is the operating position. In this condition, the position indicator indicates the "operating" position.

6. Apparatus Installed

In the LD load center, the control apparatus required for operation and control are rationally arranged.

1) Signal lamp

The signal lamp is installed on the frame of the cabinet and protrudes from the surface of the door. This permits confirmation of the indication even when the door is opened, and of course, when the door is closed.

2) Fault indicating lamp, and its resetting pushbutton switch

These are also installed on the side of the frame of the cabinet for control convenience.

3) Pushbutton switch for testing on-off control

This is used for electrical on-off control test of the air circuit breaker in the testing position. In the testing position, the control is available only by means of this switch.

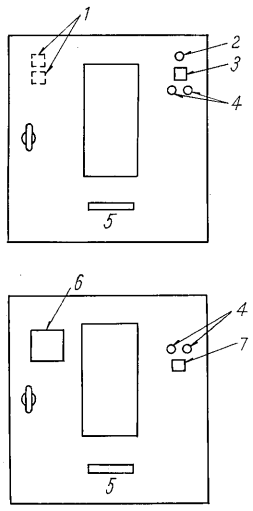
4) Limit switch

This is used for attaining the operating and testing positions; up to four and one limit switch may be installed for the operating and testing positions, respectively.

5) Others

In addition to the above apparatus, there may be installed as required a control switch, change-over switch, auxiliary relay, fuse, control power supply-use no-fuse breaker, measuring instrument-use current transformer, and ammeter.

Such large scale units as a watt-hour meter and measuring instrument-use potential transformer are impossible to mount on any of the units, so that an empty unit is provided where these may be mounted.



① Pushbutton switch for use of test open-close control (installed inside the cabinet)
② Fault indicating lamp
③ Resetting pushbutton switch
④ Signal lamp
⑤ Name plate describing application
⑥ Ammeter
⑦ Control switch

Fig. 15 Examples of apparatus arrangement

V. CIRCUIT CONSTRUCTION

1. Selection of Short-circuit Current and Rupturing Capacity

The air circuit breaker should in general be selected to have greater rupturing capacity than the short-circuit current estimated at its operating point. The standard calculation formula for the short-circuit current is given in the following.

Should the impedance of the power supply side in the circuit as shown in *Fig. 16* be ignored, the following formula may be employed:

Maximum short-circuit current (ka)

$$= \frac{kva \times 100 \times K_1}{v \times \sqrt{3} \times X} + 4.0 \times I_m$$

where,

kva: Power supply transformer capacity
v: Voltage of lower valtage side circuit
X: % impedance of power transformer
K_1: Constant due to dc component
I_m: Addition of motor rated current

The reason for the consideration, in this case, of the constant K_1 and the supply of the short-circuit current from the motor is that the break time of the breaker is extremely short in which to breaking current containing a dc component and the short-circuit current from the induction motor and which attenuates in approximately 1/2 cycle.

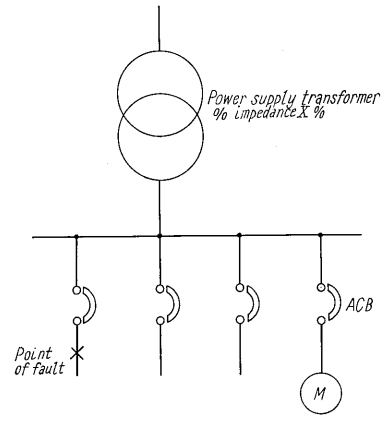


Fig. 16 Explanatory diagram

When the distance from the power supply transformer is great, the short-circuit capacity lowers due to the line impedance, so that it is necessary to add the line constant to the result of the above formula.

2. Protection

The circuit of the Fuji air circuit breaker is completely protected by its built-in instantaneous, reverse time and short time over-current tripping device.

In many cases, the breaker is connected in series with the low tension circuit of the load center or control center; should the over-current protective device characteristics be applied without consideration of the following, power failure may result:

1) The point of failure should be isolated by the breaker located closest to it, thus preventing other circuits from being affected.
2) The over-current protective characteristics of the breaker should not be doubled.
3) When the breaker is cascade connected and backed up by means of the power supply side breaker, the over-current protective characteristics should be brought as close as possible.

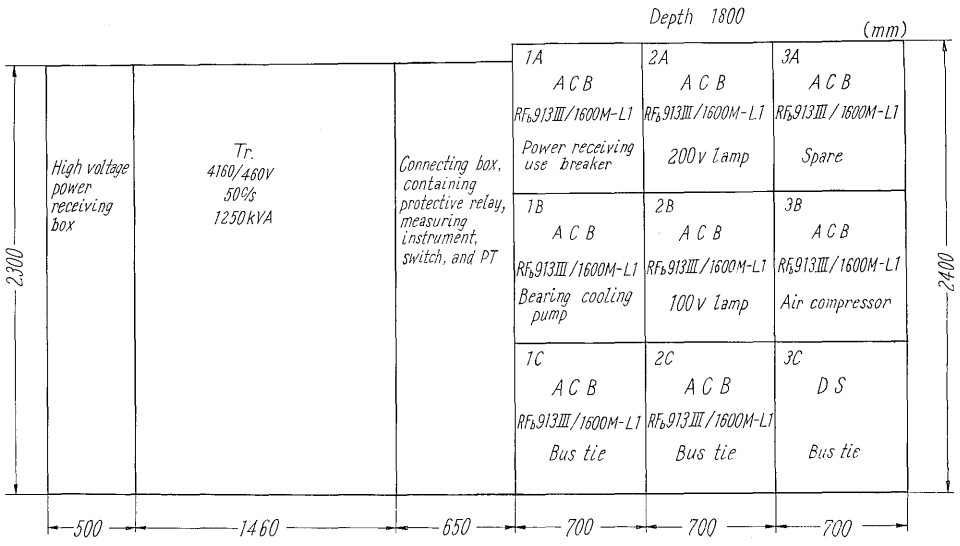


Fig. 18 Outline sketch

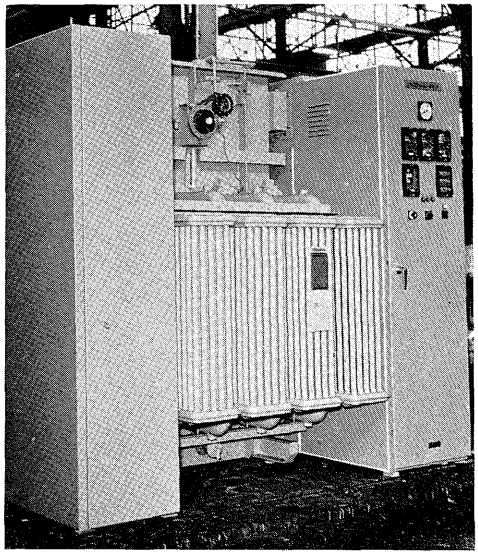


Fig. 19 Load center type transformer

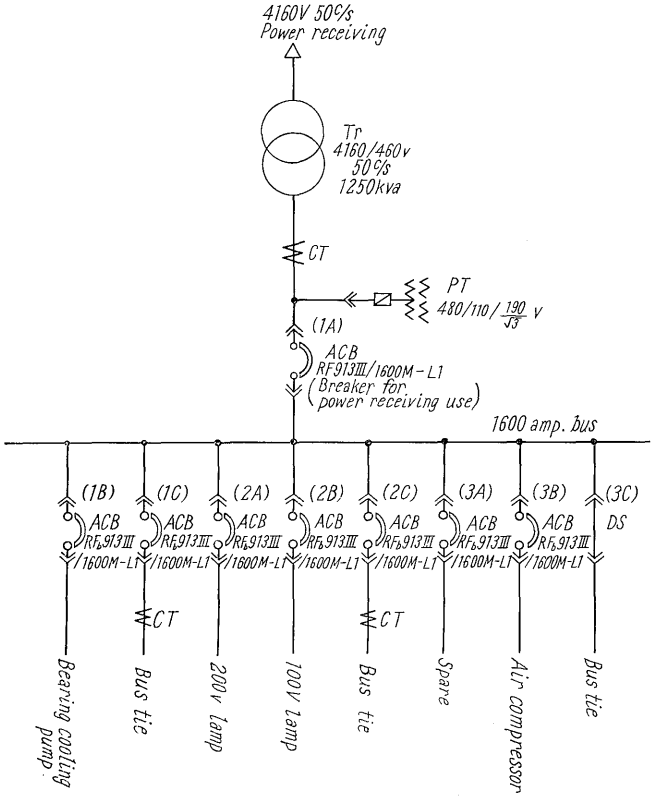


Fig. 17 Skeleton diagram

VI. EXAMPLE OF PLAN

Given in the following is an example of a plan of the above-mentioned load center. The skeleton diagram is given in *Fig. 17*, while its rough outline sketch is illustrated in *Fig. 18*.

The transformer which is combined with the load center is one which is designed specially for the load center where, as shown in *Fig. 19*, the radiating pipes are installed only in the front and the rear, with the bushing protruding horizontally, thus making the load center compact.

The above discussion covers the construction and an example of a proposed plan of the Fuji Electric new type LD load center. The authors hope that this paper will assist engineers in their plan and use of the load center.