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METAL-CLAD SWITCHGEAR FOR FUJI T-TYPE CIRCUIT BREAKERS

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I. INTRODUCTION

The demand for electric power has increased in step with the recent growth of various modern industries. The modernization and rationalization of electric power facilities is keeping pace with the construction of increasingly modern power substations, industrial plants, and buildings.

Metal-clad switchgear is employed for the switching of power facilities in these modern installations and the demand for this type of switchgear is constantly increasing. For some time, efforts at Fuji Electric have been directed toward both the improvement of actual metal-clad switchgear performance and greater compactness. Fuji Electric has now completed new 3/6 kv stacked, compact, metal-clad switchgear which accommodates Fuji T-type circuit breakers. The Fuji T-type metal-clad switchgear takes advantage of the high performance and economy of the Fuji T-type circuit breaker and is the most suitable for such fields as power plants, power distribution substations, factories, and buildings. Different configurations, besides the stacked construction, are possible with this switchergear and Fuji hopes to announce them in future issues. An outline of the metal-clad switchgear for use with Fuji T-type circuit breakers follows.

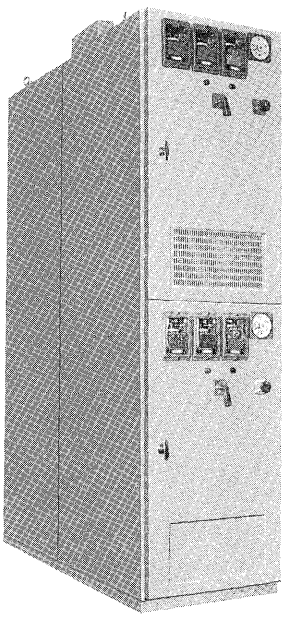

Fig. 1 Metal-clad switchgear for Fuji T-type circuit breakers

II. SPECIAL FEATURES

The metal-clad switchgear for use with Fuji T-type circuit breakers is shown in *Fig. 1*. This switchgear has the following special features.

(1) The installation space required for this switchgear is approximately half that required for past equipment. Consequently, savings in both floor space and construction expenditures are possible.
(2) Since Fuji T-type circuit breakers are small and lightweight, they can be handled as easily as the Type LD load center drawout type air circuit breaker.
(3) The parts of the Fuji T-type circuit breaker are conveniently located to facilitate inspection and maintenance of the contacts, arc extinguishing chamber, and insulation oil.
(4) The interior of the switchgear is completly segregated from the T-type circuit breaker, bus, and CT and cable compartments by grounded metal barriers. This provides protection during maintenance and inspection. This metal barrier also prevents other compartments from being affected when a breakdown occurs in another part of the equipment.
(5) Interlock equipped to eliminate the possibitity of incorrect operation.
(6) Since a special connection method can be adopted for stacked construction, an increase in the reliability of the electric power supply is possible.

III. OUTLINE

1. Ratings

The ratings of the metal-clad switchgear are listed in *Table 1* and those of the T-type drawout circuit breakers are listed in *Table 2*.

The rated current of the T-type drawout circuit breaker, even when it is incorporated into the metal-

Table 1 **Metal-Clad Switchgear Ratings**

Rated Voltage (kv)	Insulation Level	Rated Current (amp)	Rated Bus Current (amp)	Rated Short-Time Current (ka)
3.45	6 A	600	600	12.0
6.9		1200	1200	20.0
			2000*	24.1

Note) *: Two sets of 1200 amp buses are used

Table 2 **T-type Drawout Circuit Breaker Ratings**

Type	Rated Voltage (kv)	Insulation Level	Rated Current (amp)	Rated Breaking Capacity (Mva)
HF515-10M/600-150	7.2	6	600	150
HF515-10M/600-250	7.2	6	600	250
	3.6	6	600	150
HF515-10M/1200-250	7.2	6	1200	250
	3.6	6	1200	150

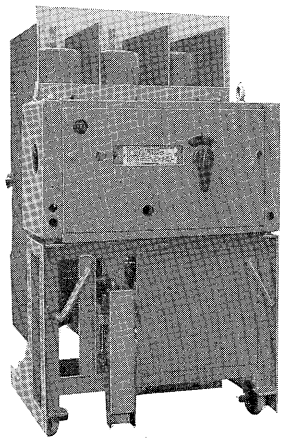

Fig. 2 Front view of T-type drawout circuit breaker

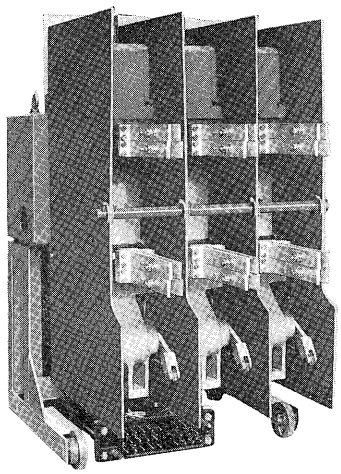

Fig. 3 Rear view of T-type drawout circuit breaker

clad switchgear, is the value of the continuous current. The external dimensions of the three types of Fuji T-type drawout circuit breakers are the same.

Figs. 2 and *3* show the front and rear views, respectively, of the T-type drawout circuit breaker.

2. Specifications of the Metal-Clad Switchgear

This switchgear satisfies the conditions of the "JEM 1114 F-type metal-clad switchgear".

The standard construction is of the indoor type, however, outdoor type construction is also available. Alminum is used as the standard conductor for the main circuit. (The technical problems associated with aluminum conductors have already been solved and Fuji Electric is now fully utilizing aluminum conductors.)

IV. CONSTRUCTION

1. Construction Outline

The metal-clad switchgear for use with the Fuji T-type circuit breaker is composed of the stationary housing and T-type drawout circuit breaker. The stationary housing (*Fig. 4*) is divided into the T-type breaker, bus, and CT and cable compartments. These are all segregated from each other by grounded

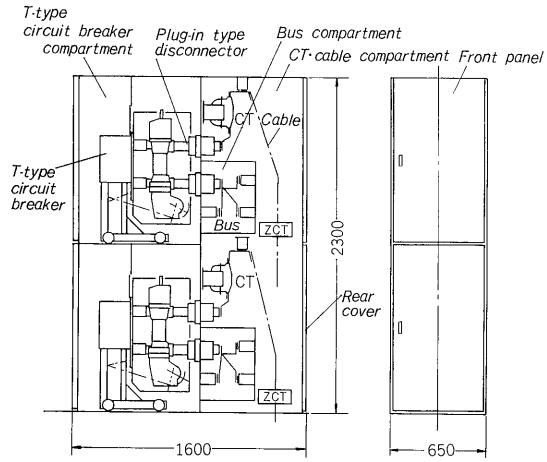

Fig. 4 Structure of metal-clad switchgear for Fuji T-type circuit breaker

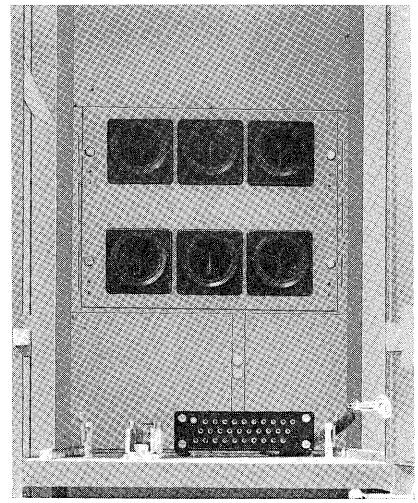

Fig. 5 T-type circuit breaker compartment

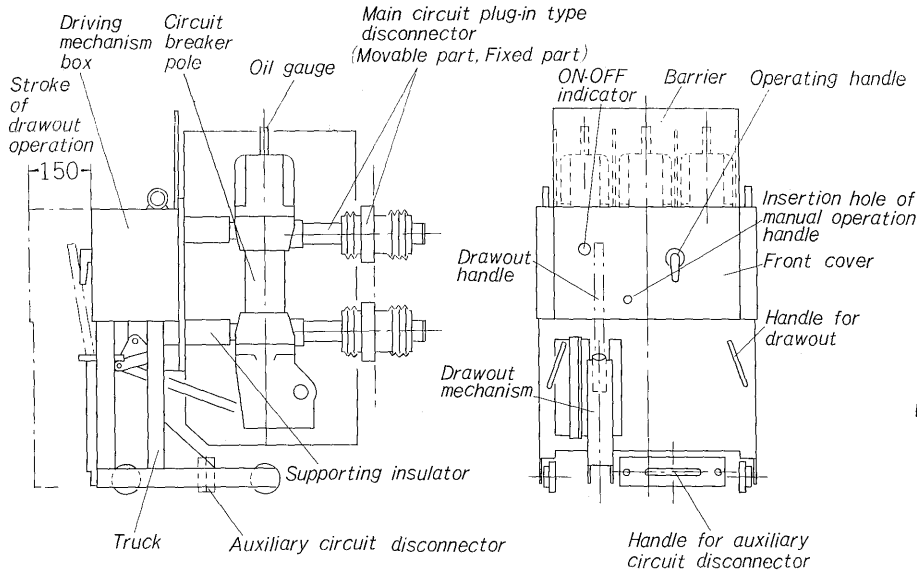

Fig. 6 Structure of T-Type drawout circuit breaker

metal barriers. Both the compartments and instruments are rationally arranged to reduce the external dimensions.

The upper and lower circuit breaker compartments are completely independent from each other. The fixed part of the plug-in type main circuit disconnectors, the drawout mechanism, and the fixed part of the control circuit disconnector are arranged in the T-type circuit breaker compartment. The fixed contact is imbedded in a special bushing made of epoxy resin and facilitates separation of the circuit breaker compartments from the other compartments. *Fig. 5* shows the T-type circuit breaker compartment. The front door is divided into an upper and lower section, with respect to the circuit breaker compartments. The necessary meters, relays, control switches, signal lamps, etc., are mounted in each unit.

Two sets of buses are used, one for the upper unit and the other for the lower unit. These buses are generally connected in auxiliary switchgear, and are used as single bus system. However, it is also possible to use them as mutually independent buses. When they are used as two independent buses, the selection of a convenient main circuit connection system is possible. This connection system was not possible with the metal-clad switchgear used in the past. More details of this type of main circuit connection system will be discussed in VI.

The rear of the CT and cable compartment is provided with two separate upper and lower covers.

2. Construction of the T-Type Drawout Circuit Breaker

The T-type drawout circuit breaker is shown in *Fig. 6*. The driving mechanism box is located on the front. The three circuit breaker poles which accommodate the extinguishing arc chambers and the contacts are supported by epoxy resin insulators behind the driving mechanism box. The contact arm of the movable portion of the main circuit plug-in type disconnector is directly mounted to the upper and lower terminal of the circuit breaker pole with bolts.

The truck, drawout mechanism, and auxiliary circuit disconnector are mounted to the bottom of the driving mechanism box. The interior of the driving mechanism box can be easily inspected by merely removing the front cover.

3. Main Circuit Plug-in Type Disconnector

The newly designed wedge type disconnector is used in the T-type drawout circuit breaker (refer to *Fig. 3*). A compression spring is used to obtain the contact pressure in the contact area at the tip of the contact arm. The contact arm forms two parallel conductors and the magnetic force produced between them when a short-circuit current flows boosts the contact pressure. For this reason, there is more than ample margin against contact fusion caused by short-circuit current (24.1 ka for 2 sec), regardless of the fact that the spring force is comparatively weak. The fixed contacts of the disconnector are imbedded in a special epoxy resin bushing.

4. Drawout Interlock Mechanism

The drawout interlock mechanism must fulfill the following two conditions:

(1) When the circuit breaker is closed, pulling out or pushing in of the circuit breaker should be impossible.

(2) The circuit breaker should not be closed whenever the compartment is either being pulled out or pushed back in.

The equipment required to satisfy these conditions is fitted into the circuit breaker truck as an additional part of the drawout mechanism.

5. Front Panel Fixtures

Meters, relays, signal lamps, control switches, etc. are mounted on the front panel.

The fixtures are somewhat limited because only the space on the upper portion of the panel can be used. *Fig. 7* is an example of arrangement of the fixtures mounted on the front panel.

Relays which are not necessary for normal supervision and control can be installed by using an auxiliary panel on the upper portion of the rear cover.

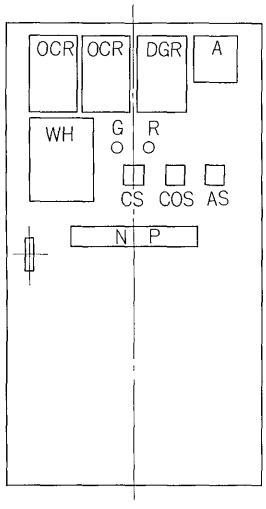

Fig. 7 Example of apparatus arrangement

V. TEST RESULTS

The metal-clad switchgear for use with the Fuji T-type circuit breaker underwent the following tests:

(1) Dielectric test, interruption test, and short-time current test.

No abnormalities in the ratings of interest appeared during these tests and a sufficient margin with respect to the standard values was assured.

(2) Temperature rise test

The upper T-type circuit breaker unit has a rating of 1200 and the lower unit a rating of 600 amp. The temperature rise test was performed by simultaneously passing current through both units. A sufficient margin with respect to the standard values was assured. The temperature rise in the major parts of the switchgear are shown in *Fig. 8*.

VI. MAIN CIRCUIT CONNECTION

A very convenient main circuit connection system, besides the usual main circuit connection system which has a single bus, can be selected in the stacked metal-clad switchgear. This was impractical with the metal-clad switchgear used in the past. A few examples of these systems will now be given.

1. Modified Double Bus System

This is the connection shown in *Fig. 9*. With this system of connection, the power source and feeder circuits can be interchanged and arbitrarily connected to either one of the buses. This connection is similar to the usual main circuit connection system which has a double bus.

This metal-clad switchgear connection system has almost the same construction as that of the single bus system, the only difference being in the assembly of the fixtures in the CT and cable compartment.

2. Modified Single Bus Connection

This connection appears in *Fig. 10*. This is an example of when there are two banks of transformers. The upper and lower buses are used as independent single bsues of the respective banks. This connection system differs from the general connection.

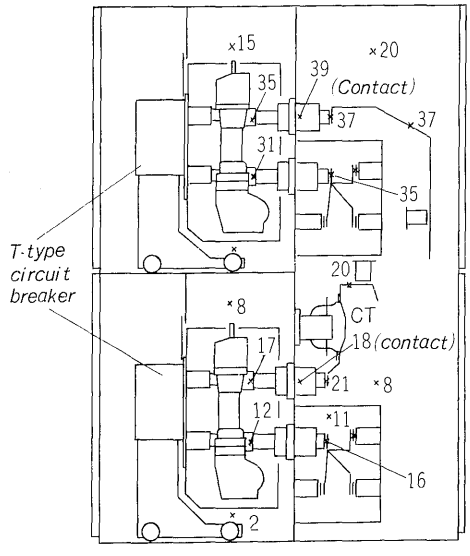

Fig. 8 Result of tempereture rise test

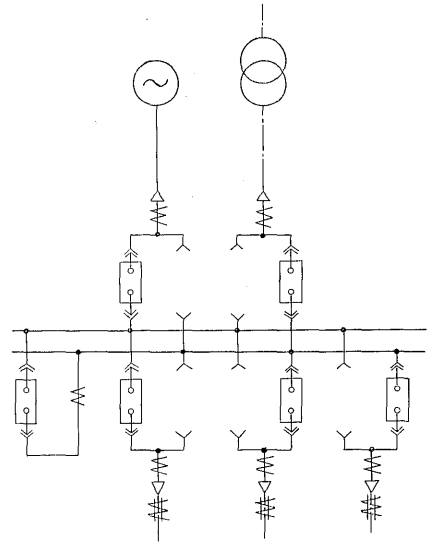

Fig. 9 Main circuit connection with modified double bus system

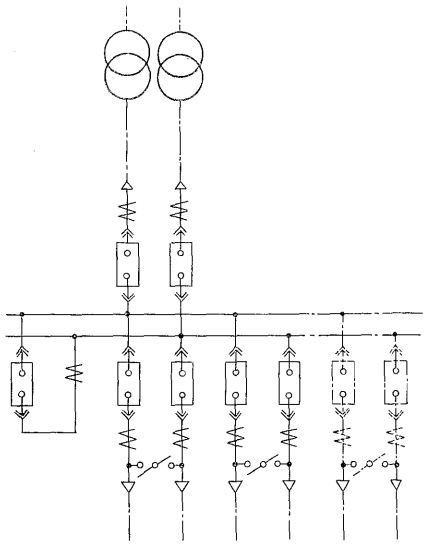

Fig. 10 Main circuit connection with modified single bus system

A tie disconnector is employed at the exit of the upper and lower feeders, This tie disconnector is normally opened, but by operating it the following special applications are possible.

(1) The circuit breaker can be removed from the circuit for inspection without cutting the feeder power supply.
(2) One side of the bus can be brought to zero voltage and inspected without cutting the supply of power to all feeders.
(3) One side of the bus can be brought to the zero voltage level and work can be done to increase the number of feeders without cutting the supply of power two all the feeders.

These advantages are the same as those of the transfer bus connection system. A special rotary disconnector most suitable for this stacked, metal-clad switchgear was developed by Fuji Electric, permitting the manufacture of extremely compact switchgear equipment. *Fig. 11* is a cross-sectional view of the stacked, metal-clad switchgear employing the above connection system. This connection system can also be employed when there is only one power supply system.

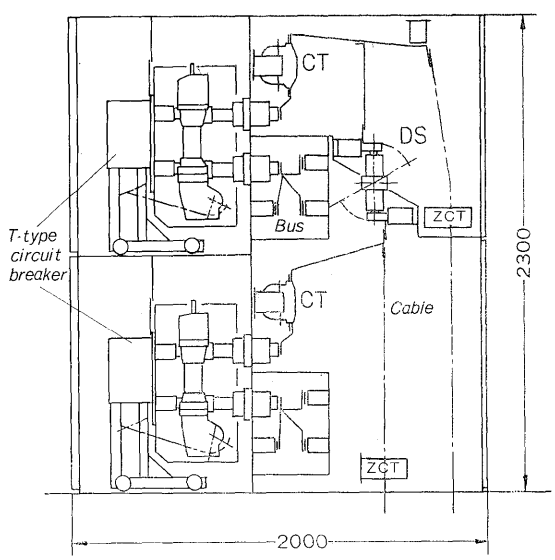

Fig. 11 Stacked metal-clad switchgear with modified single bus system

VII. EXAMPLE OF A PLAN EMPLOYING THE T-TYPE METAL-CLAD SWITCHGEAR

Fig. 12 is an assembly outline of the T-type metal-clad switchgear described above. The external dimensions have been greatly reduced as compared to those of the metal-clad switchgear used in the past.

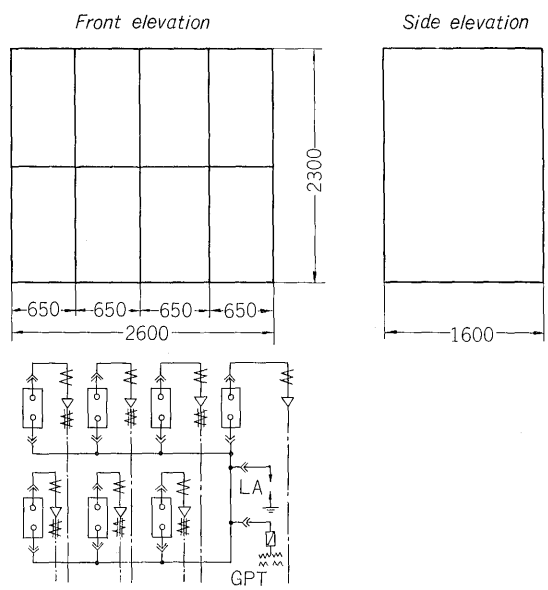

Fig. 12 An assembly outline of T-type metal-clad switchgear

VIII. CONCLUSION

The above article has been a brief description of the stacked, metal-clad switchgear used with the Fuji T-type circuit breaker. We sincerely hope that it will be useful in the planning, rationalization, and size reduction of 3/6 kv switchgear.