

# METAL-CLAD SWITCHGEAR

By

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## I. INTRODUCTION

In the earlier stage of its utility, the Metal-clad Switchgear was applied mainly for a unit substation. In the recent days, however, the switchgear of this type has remarkably been developed to spread its applicable scope over the fields of steam or water power stations, iron and steel manufacturing, chemical industry, and so forth, as it has those characteristics and advantageous points which will be referred to in the following paragraph. The Fuji Denki Seizo K.K., having been quick to start in the development and designing of this metal-clad switchgear, has already supplied the consumers with great many lots of it and is manufacturing. In the following section, outline of the characteristics, rating, dimensions, and construction, etc. of our metal-clad switchgear is to be given.

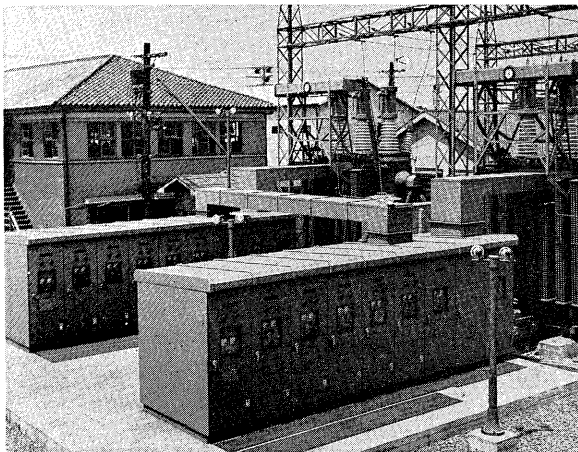


Fig. 1. Metal-clad switchgear installed in Kansai Electric Power Co., Ltd.

## II. CHARACTERISTICS OF OUR PRODUCT

The characteristics and advantageous points of our metal-clad switchgear are as follows:

### 1. Easy planning, designing and short period of manufacturing

As the standardization of its various types has already been completed for each type of the switch-

gear, the combination of certain standard units can be applied to the electric facilities of miscellaneous purposes. Therefore, the planning of manufacture may be made in an easy way, the designing can be almost completed by combination of the standardized types of the unit components, and the manufacturing period can be shortened by accumulating or storing of the common parts, standardizing of manufacturing, and good maintenance of jigs, etc. In other words, this type of the switchgear may be completed in a short period of manufacturing.

### 2. Cost of installation is to be reduced

As this type of switchgear is constructed in a small size, the required area of the site for the outdoor use and of the building for the indoor use is sufficient with only the narrow and small ones. Therefore, the cost of installation is to be curtailed.

### 3. Short period and small cost of its installation

The metal-clad switchgear is delivered in an assembled unit, because its assembly may be completed by assembling and connecting each unit of the

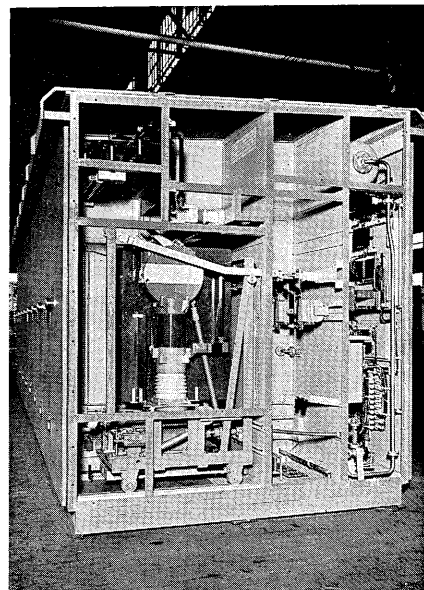


Fig. 2. Sectional view of metal-clad switchgear

necessary parts and components onto the basic foundation. Besides, the inner wiring has already been finished among the relative apparatuses with one another, so that the whole and entire wiring may be completed only by connecting the required out-going wiring. For this reason, the required period of installation can be made short, and its cost will be reduced.

#### **4. Short period of service interruption and improved service**

As this type of switchgear has an enclosed construction, there will be small quantity of dusts accumulated onto it. Moreover, there is little occurrence of various accidents, as no foreign substance comes into the equipment. Because the busbar, circuit breaker and transformer, etc. as well as any other high tension apparatus are isolated, any accident would be limited within a comparatively small range and it might be recovered within a very short period of time, even when it should happen. Furthermore, as this circuit breaker is of interchangeable assembling, the exchange of a spare circuit breaker with any fault one is made possible. Thus, there is little accident for this type of the equipment, which can be recovered within a short period of time, so that the service interruption may not occur very often but the improved service may be realized for the customers.

#### **5. Safe maintenance**

This switchgear is of an enclosed construction, and both the high tension and low tension circuits are perfectly isolated, so that neither confused nor disordered contact may happen and that the safety on its operation may be secured.

#### **6. Single and easy maintenance**

The circuit breaker is of a removable type, so that the inspection may be carried out in an easy way. Besides, the breaker is provided with such interlocks that drawing-out and pushing-in of the circuit breaker can not be carried out if the disconnecting switch is closed. Therefore, there might occur no erroneous operation in this case. In other words, maintenance can be done in a simple and easy way.

#### **7. There will be no fire**

Because it is unnecessary to fear the occurrence of fire, the so-called oilless type of this device, employing the water circuit breaker for our type of the circuit breaker and the dry type for current transformer, potential transformer and the station service transformer might be recommended for the urban sub-station. However, as it costs a considerable expense for manufacturing this type, our Company also makes such equipments as with oil circuit breaker or oil immersed transformer incased.

#### **8. Other characteristics**

In addition to the abovementioned points, the metal-clad switchgear has the following advantageous points:

- (1) As there is little accident, the period of its life is comparatively long.
- (2) As its maintenance is carried out in a safe and easy way, the maintenance expense is rather of a small amount.
- (3) As its standardization has been completed and the transportation in an assembled unit is possible, the removal and the extension of the equipment can be made with easyness.

### **III. SIZE AND FORM OF A METAL-ENCLOSED SWITCHGEAR**

In an earlier stage, the metal-clad switchgear in Japan was manufactured by order in accordance with the NEMA Standards. However, it was found that, in many cases, its specification did not require strict accordance with such a high level as of the NEMA Standards, as the result of its practical use. For this reason, various types of the switchgear have been required to manufacture, and the Japan Electrical Manufacturers Association has recently established a certain classification in this sort of equipment in accordance with the characteristics of assembly for the purposes of making its specification more understandable and of encouraging its standardization still further. The Association has also an intention, from now on, of not calling this type of the equipments a metal-clad switchgear but giving the name of A to G types of the Metal-enclosed Switchgear to this equipment.

According to the Table 1, the G type of the switchgear is made in accordance with the NEMA Standards, while the F and G types of it will be called the Metal-clad Switchgear in Japan. In the present situation, particularly, the electric power companies are inclined to make the E type of this device a standardized one, as the F and G types cost them rather much money and will cause them to pay a great amount of expenses for installment of their electric equipments, in comparison with the case of the E type. In any way, this trend will become prevailing in any other field of our industry. The Fuji Denki Seizo K.K. is making every type, A to G, of this device by the customer's order, but this Article is only to give a brief description on the F and G types in accordance with the requirements of the JEM 1114, and explanation on any other type than the abovementioned is omitted. However, the author hopes that all of the readers will be able to understand the omitted parts by parity of reasoning about its each requirements.

Table 1. List of JEM 1114 Metal-enclosed Switchgear

Types for Metal-enclosed Switchgear							Construction Requirements
A	B	C	D	E	F	G	
○	○	○	○	○	○	○	1. All parts for each unit circuit should be enclosed within a grounded metal enclosure.
—	○	○	○	○	○	○	2. Major parts of the primary circuit should be isolated from the monitoring control board by grounded metal barriers.
—	—	○	○	○	○	○	3. Interlocks should be provided to prevent the disconnecting switch from being operated while the breaker is closed.
—	—	—	○	○	○	○	4. The power circuit breaker and the apparatus mounted thereon should be so constructed as to be extractable.
—	—	—	—	○	○	○	5. The breaker should be of the removable type, equipped with self-coupling type primary and control disconnecting contact.
—	—	—	—	—	○	○	6. Major part of the main circuit should be isolated from each other by grounded metal barriers, or by insulated barriers.
—	—	—	—	—	—	○	7. Conduction parts (buses, connections and joints) should be totally insulated.

IV. OUTSIDE CONSTRUCTION

There are two kinds, for the indoor use and the outdoor use, of the metal-clad switchgear. In many cases of the urban area, the indoor type is applied for the installation, where the transformer and the switchgear are arranged in three dimensions; because the land prices are high, the wide area for installation is very hard to obtain, and the outside appearance must be beautifully harmonized with the surrounding conditions, etc. Of course, the outdoor type is employed in any other site than that of the abovementioned restrictions. And the difference between the outdoor type and the indoor type lies only in its weather-proofing construction. The former type, in itself, costs more expenses than the latter type, but the total expense of installation becomes rather less for the former one than the latter, because it does not require any housing or building for its accommodation. Our Company can offer both types for the customers by order.

Several points for taking into considerations about the outside construction of this equipment are, weather-proof, heat-proof, damp-resistant, dust-tight, vermin-proof and sufficient ventilation, etc. As having been mentioned above, there are two types of use in this switchgear, of which outside construction is different from each other. The outdoor type is required the more severe and higher qualifications

for its effective usage than the indoor type, so that it may be necessary for the former to take into consideration the all of the abovementioned requirements in a perfect way, while the latter appears to be sufficient with consideration only for the damp-resisting, vermin-proof and the satisfactory ventilation to its practical operation. The short description is to be given on each item of the foregoing requirements in the following lines:

1. Weather-proofing

There are two methods or systems; applying the packing materials and not applying such materials. It is quite impossible to make this packing system secure its effects for a considerable length of time, and it is also troublesome to secure a perfectly tight seal by locking up with one or two handles the large-size door. Therefore, it is much better to be able to complete the rain-and-snow-proofing without any packing materials. Our staffs have found, with strenuous efforts in the tests, that ordinary falls of rain or snow might be prevented without packing materials in this type of switchgear, and the Company makes this non-packing system one of the standards in general. On the other hand, packing materials are employed where it is impossible to keep the housing from such snow-drifts invading with the blow of storm as in the cold districts of snowstorm.

In the metal-clad switchgear, the rain or snow might come into the housing through the door and the joint or seam of it. In the Fig. 4, seams of roofing, and of the front and back-side surfaces are shown by the sections A—B and C—D, respectively. As illustrated in Fig. 4, the seam and joint of the roofing surface are made of such structure that both ends of the roofing sheet are bent upwards, on which a close plate of plug system is placed.

As for the front and back-sides of the housing,

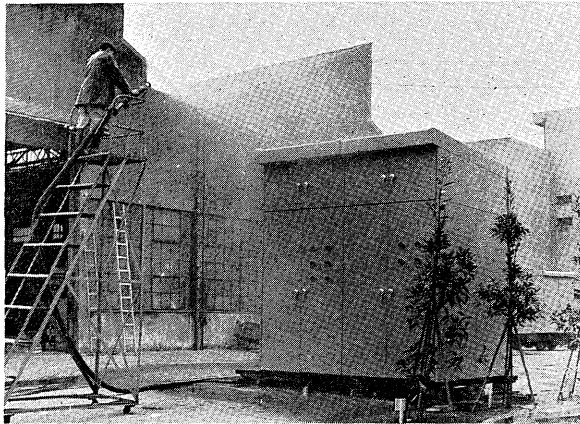


Fig. 3. Spray test

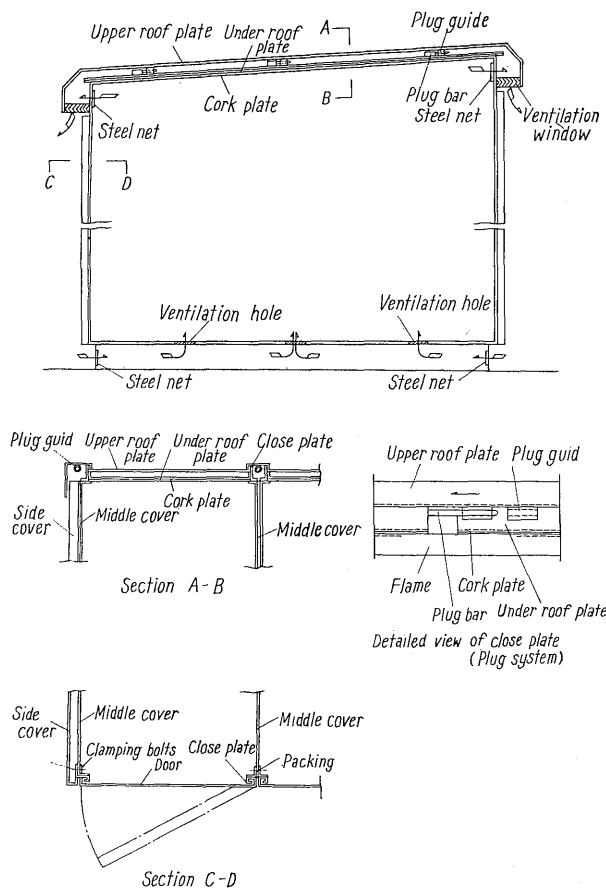


Fig. 4. Rain proof, heat proof and ventilation device

the filling or packing materials are inserted among the seams of their frames. If the head of clamping bolts for outside covering were exposed out of door, water might come through into the inside of housing, so these bolts are welded inside or placed at such positions as the rain or snow might not come up to them.

As far as the door of housing is concerned, the same figure shows that the wedge slot is fixed to the frame and flashing is provided inside the door.

Rain or snow invading can be perfectly prevented with the abovementioned structures. The Fig. 3 shows the actual scene of the spray test carried out by our Company. Particularly, for those districts of cold weather, this equipment is made of the above-mentioned construction plus such filling or packing processings as the foregoing in almost all cases.

## 2. Heat-proofing

The temperature inside the housing rises with the direct projection of the sunlight, and it brings limitation of the load power. So, this is one of the factors to be prevented. As the radiated heat from the sunlight becomes the maximum when the sun takes a position just right above the housing, so the heat-proof consideration is taken into mainly for the roofing surface from the construction standpoint.

As shown in the Fig. 4, the heat-preventing construction of our housing is made such that the ceiling is of double paneled system with the inside panel folded both the iron plate and cork sheet with each other, and that the heat insulation is made between the outside and the inside of its housing. So, little heat may be conducted to the inside of housing even when the temperature rises outside the housing. For these reasons, the temperature would not rise very much inside the housing, even with the direct projection of the sunlight.

## 3. Damp-resisting

As will be explained in the following lines, the ventilation is necessary requirement for heat derived by any electric devices. In such a case, however, the moisture of air fed into the housing might be condensated by the drastic reduction of the atmospheric temperature, sticking to the apparatuses and conductors to cause the dielectric breakdown and sticking to the surface of the supervising window of various meters to make supervising difficult by its clouding. This phenomenon happens very often particularly in the rainy season. Therefore, special consideration must be taken against the damp or moisture from the standpoint of effective and safe operations.

As the water particles come from the moisture in the air by the abrupt reduction of the temper-

ature, it may be prevented by keeping the temperature inside the housing higher than a certain level. For this purpose, an adequate heater is provided for inside the housing, and it is of such a type that the two or three stages of its change-over can be made as its heat must be adjusted in accordance with the length of time to be applied or with the every day condition of weather. As having been illustrated, the switchgear is put into practical use within the condition of elevated temperature inside the housing, so that special attention shall be paid not to allow water coming into the housing because the water at the bottom of the housing would evaporate to increase the humidity inside the housing. Even if the heater increases the temperature inside the housing, the water particles stick to the back sides of the front- and rear-side doors and the supervising window of the housing from an drastic falling of the temperature of the outside atmospheres. The water particles or drops sticking to the doors of front- and rear-side are only sliding down along the surfaces of the doors without much influence to its function. While, the supervising window glass is made of the double paneled type with fistular space between the two glasses to insulate the heat for securing the prevention of its clouding.

As having been described under the paragraph of the heat-proofing, the roofing of our housing is made of the double paneled construction, particularly with its inside panel folded the iron plate and cork sheet with each other to insulate the heat between the outside and inside of the housing. Therefore, water particles hardly stick to the inside surface of the ceiling.

#### 4. Ventilation

As the various apparatuses and conductors produce heat inside the housing, the ventilation must be carried out to cool off the inside of the housing. Aiming at protecting a bottom of the housing from invasion of water and at eliminating the fear of water coming into the housing through the ventilation hole of the door, if it were fitted, we have established a certain base beneath the housing to elevate it and providing its front and back sides with the ventilation holes. Also, other holes are opened in the steel cover plates, at such positions as of the highest cooling effects, for the purpose of ventilation. The wind blows into the base through the holes provided on the rear-side and front-side surfaces, coming up into the housing through its bottom plate and goes out of the housing through the ventilation windows after passing by each compartment of the housing.

#### 5. Vermin-proofing

The wire nets are fitted to each of the inlet of

ventilation air on the front and rear surface of the base, of the ventilation windows on the roofing plate and of the water outlets placed at a proper position of the housing, in order to prevent any vermin coming into the housing.

### V. LOW TENSION APPARATUSES AND LOW TENSION WIRING

Prevention of any confused or disordered contact between the high tension parts and low tension parts is one of the important items requiring particular attention about the low tension apparatuses and low tension wiring. Furthermore, special precaution should be taken in order to avoid any accident by any means at all the possible times, because particular low tension wiring may sometimes be installed at such parts or positions as with difficulty to check it up.

As far as the installation of the low tension apparatuses is concerned, our Company makes it rule to make a complete isolation between the low tension part and the high tension part by locking with the screws the steel plate cover between the low tension apparatus chamber and the high tension apparatus chamber.

There may be found several differences of the installing system of the meters, relays and control switches, etc. for the indoor use from those for the outdoor use. As for the indoor use, almost of all low tension apparatuses are fitted to the front door by inlaying them; while, as for the outdoor use, it is impossible for those apparatuses to be fixed in such a simple way as for the indoor case, because the apparatuses of outdoor type are exposed to the rain and snow falls. So, the installation of the outdoor type is to be made as follows:

In case of this outdoor type, it can not be done without supervising or controlling, because of the bad weather. However, it is to go quite wrong, with rain or snow coming into the housing, to open the door of this housing to carry out the supervision or control under the bad weather.

For these seasons, the meters are fixed onto a swing type panel provided on the back-side of the supervising window and the control switch is fitted in the hollow with a cover which is made on the door. This is shown in the Fig. 5. In case of operating the control switch, the opened cover makes a small pent roof to prevent snow or rain. As having explained in the foregoing lines, this type is made to carry on the supervision and controlling regardless to any condition of weather.

Because there is no need of supervising the relays at all times, they are fixed in the housing. In an ordinary case, the relay is fixed onto the swing type panel, but it is not preferable because

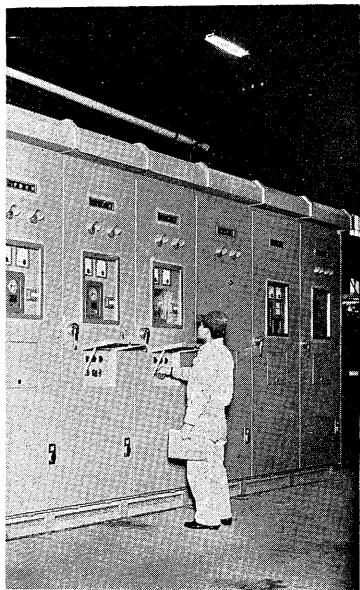


Fig. 5. Front view of metal-clad switchgear

the relay is given vibration. Besides, there is fear of damage in the wiring, as it becomes complicated and its checking is not easy without removing the panel. For this reason, our Company has made the relay of the front connection type to apply the front wiring system by providing it onto the steel panel between the high-voltage chamber and the low-voltage chamber.

The low tension wiring employs the polyvinyl chloride wires. As this polyvinyl chloride is soft, metal supporting of the wires is to break the covering of the polyvinyl chloride to cause the grounding or short-circuit very often. In order to avoid these inconveniences, our Company has applied the clamp

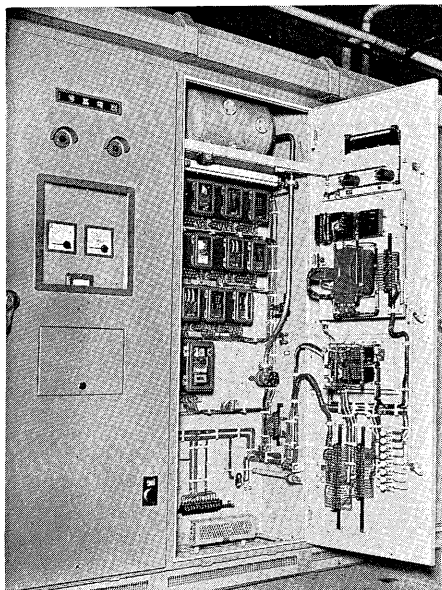


Fig. 6. Inside view of relay of front connection

of an organic insulator, being illustrated in the Fig. 7, with which the wires are not closely sticking to the steel plate and they are not broken into by the supports of insulator as those of metal thrusting into the wires. Even if they should thrust into the wires, they do never cause to either grounding or short-circuit. Furthermore, the steel plate is fixed to cover the low tension circuits being wired in the high tension chamber, shown as in the Fig. 7, and this circuit is earthed, both in order to prevent from confused and disordered contact between high tension and low tension.

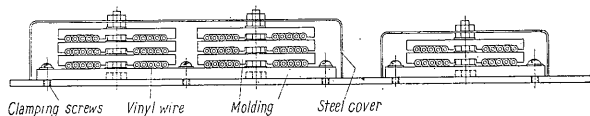


Fig. 7. Vinyl wire clamp

**VI. INTERLOCKING OF CIRCUIT BREAKER AND OF DISCONNECTING SWITCH**

Removing of the circuit breaker, while keeping it closed, is to mean that load is imposed or interrupted through the disconnecting switch as it is of a plug type. Therefore, this circuit breaker should be of such a structure as being impossible to remove it by any means while it is kept closed. As understood by the Fig. 8, a lever with its one end being bent as much as 90° is fitted to the operating shaft of this circuit breaker, and this lever is made to keep in a horizontal direction when the circuit breaker is closed, and to hold it in a vertical direction when opened. In other words, the drawing-out of the circuit breaker or the pushing-in of it while keeping it closed, will be interlocked by such system that the bent part of the lever touches to the stopper "A" or "B" of

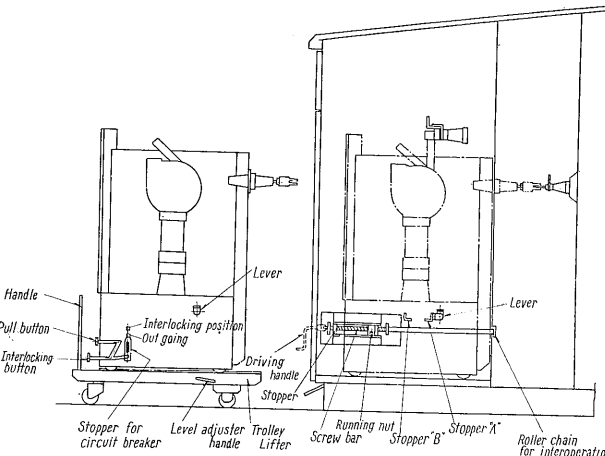


Fig. 8. Draw-out mechanism of circuit breaker

the fixed frame, respectively. In case of the circuit breaker being kept opened, however, the lever holds in the vertical direction and its bent part does not touch either of the stoppers "A" and "B", so that the removing of this circuit breaker may be carried out quite freely. Thus, our Company's type of the circuit breaker applies such a system that its removing can not be done while it is closed. And this is to be more rational than any other ordinary type of it which is made, in general, of such structure that removing of the circuit breaker are possible even when it is closed and that it is released in case of its removal.

## VII. DRAW-OUT MECHANISM OF CIRCUIT BREAKER

The circuit breaker of removable construction has such advantageous points that its housing is satisfactory with a small size and that its checking and maintenance works can be made in the quick and safe way. The draw-out mechanism of the circuit breaker is to be illustrated in the following lines.

### 1. Fixing of the circuit breaker

Either the circuit breaker is closed or opened, it should not be removed from its designated position. As our type of this apparatus is fixed with the movable nuts of the draw-out mechanism which will be described afterwards, the circuit breaker does never move from its designated position in any case, unless the draw-out mechanism would be operated. (As the abovementioned movable nuts are combined with the screw bar, they are not removed without turning the screw bar).

### 2. Draw-out mechanism of circuit breaker

There are two types, vertical and horizontal, of the draw-out method of the circuit breaker.

The vertical draw-out type of it is to be operated by pushing up the breaker itself against its weight and with a considerably heavy feeling. If we make this feeling lighter, the gear ratio must be increased and the operation time is required to be prolonged. Therefore, the motor lift system is applied for this type of the device. However, our Company makes the horizontal draw-out type as the standard, as the vertical draw-out type becomes complicated in its mechanism and costs much expenses. The method of our Company consists of the combination of the screw bar and the movable nuts which are made to be moved in parallel by turning the screw bar. And the stopper of the circuit breaker is bitten by these movable nuts.

According to the Fig. 8, by inserting the driving handle into the screw bar and turning it into the right side, the movable nuts are to move forwards

so that the circuit breaker may be drawn out forwards to open the plug type disconnecting switch. After it is drawn out for a certain distance, it is interlocked by the stopper. And, at this position, the high tension disconnecting switch and another disconnecting device of the low tension control circuit is opened. This position is called the test position. Then, by pulling the pull button fixed to the frame of the circuit breaker, the stopper of it comes down to release the locking of the draw-out mechanism, so that the circuit breaker may be drawn out of the housing quite freely. In case of pulling it in, the circuit breaker comes into the test position just once, at which position it stopps. In the next stage, the circuit breaker and the draw-out mechanism are interlocked by pulling the locking button. After then, by inserting the driving handle into it and turning to the left side, the circuit breaker is pulled into a certain position to close completely the disconnecting switch. These operations can be made in a light and easy way, as the ball bearing is employed for the wheel of the circuit breaker.

### 3. Shutter of circuit breaker

If the primary circuit are exposed in the circuit breaker chamber after the drawing-out of it, this is dangerous and is to cause very often the accident, so that the shutter is provided to isolate them in an automatic way.

In the Fig. 9, as the roller fitted to the frame of the circuit breaker is to move to the left side when the breaker is drawn-out, the lever for operating the shutter loses its supporting point to drop by its self-weight and the shutter can be perfectly

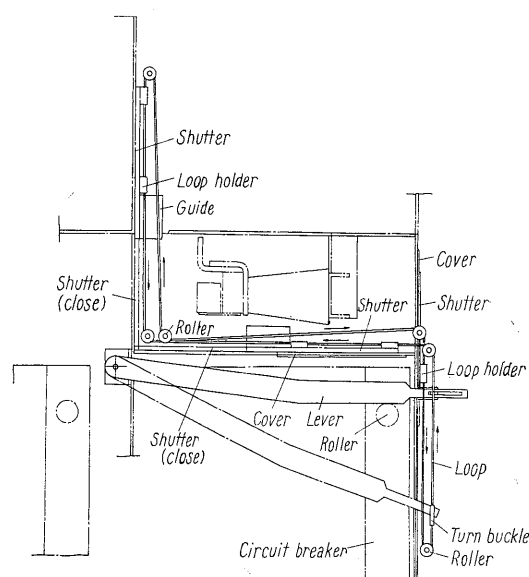


Fig. 9. Shutter mechanism

closed after the breaker is drawn out of the housing. As being understood by this figure, the shutter is composed of three panels which can be interoperated because they are connected with the rope with one another, and both the opening and closing are to be simultaneously carried out for the bus side and load side.

## VIII. PRIMARY AND SECONDARY PLUG TYPE DISCONNECTING DEVICES

The circuit breaker has a self-coupling plug type disconnecting devices in each of the primary circuit and secondary control circuit. In general, the former is called the primary plug type disconnecting devices; and the latter, the secondary plug type disconnecting devices.

### 1. Primary plug type disconnecting devices

One of the important items for the plug type disconnecting contact is to hold a good contact condition at all times with no occurrence of the overheat accident. While, because one end of the plug type disconnecting contact is fixed to the moving frame and because there is manufacturing error of the moving frame by the state of condition of it when pulled in or when applied after interchanged with each other, the relative position of its moving contact to its fixed contact is to be slightly slid in the upward, downward, right and left directions, if any. Therefore, the plug type must be made with no loose contact even if the relative position between the fixed contact and the moving contact should be slid, and it must also be of such construction as causing no mechanical overstrain or excessiveness in case of the drawing-out and pushing-in operations.

The Fig. 10 illustrates the construction of the primary plug type disconnecting devices. In this figure the fixed contact, the contact piece, the spring, the shunt and the terminal are indicated by putting to them the numbers, 1, 2, 3, 4, and 5, respectively. Several contact pieces of movable contact are connected in parallel and their number applied is properly adjusted according to the electric current. Just as clearly shown in the Fig. 10, these pieces are divided as mentioned above, the contact area of each one contact piece is very small, and every piece is forced to touch to the fixed contact by separate spring; so that there may not occur any loose contact in any part on the contact surface.

As the current is not conducted through the spring but through the shunt, the spring is not annealed but holds a constant contact pressure at all the times. These contact pieces are made with no obstacle even by their movement for  $\pm 3$  mm. The blade of the plug type disconnecting device is

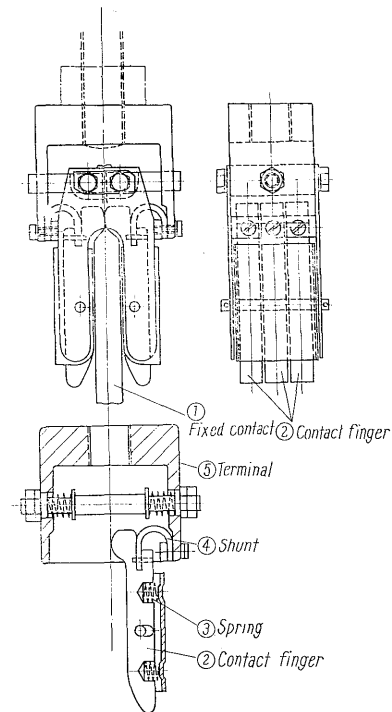


Fig. 10. Plug type disconnecting device for 1 ry circuit

made of the larger width than that of the above-mentioned flexible contact, so that there may not happen any accident even if the moving frame should move for  $\pm 3$  mm in each of the upward, downward, left and right directions. The special consideration has been taken on the designing and manufacturing the frame so that its precision or accuracy may be within the abovementioned ranges.

The blade of the plug type disconnecting contact is of a simple form and does not need any maintenance work, so this is fixed to the fixed frame, while, the flexible contact is of the more complex structure than that of the blade so that it may be fitted to the moving frame and its checking and maintenance can be carried out when the drawing-out of the frame is made.

### 2. Secondary plug type disconnecting devices

The characteristics of this devices are of low voltage, of small current and of great many numbers, etc. Just as the primary plug type disconnecting devices, this secondary ones must have such requirements satisfied as of a good contact state and of causing no mechanical excessiveness or overstrain for the relative position of the moving frame. In order to keep the contact state good and satisfactory, it is necessary for the disconnecting device to be of a highly-qualified construction in itself and to be connected at the proper and adequate position. Our Company applies the banana type contact fitting a guide metal to it in order to secure the contacting of it at the right position.



In case of drawing out the circuit breaker, the secondary plug type disconnecting contact is automatically opened to make the operation and function of the circuit breaker impossible and to prevent any danger being expected during the circuit breaker is moving.

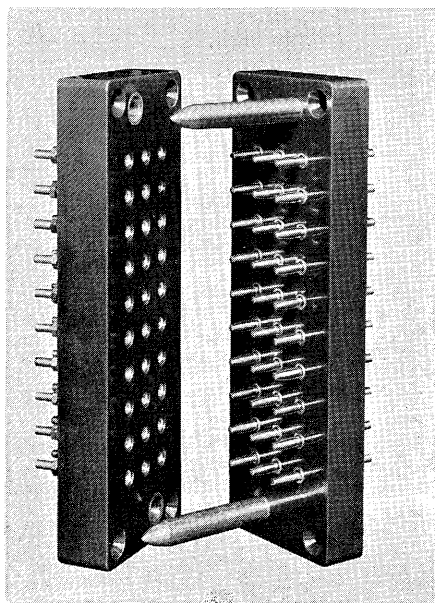


Fig. 11. 2 ry contact

The circuit breaker can be put to the test in the dead load condition, by closing once again the secondary disconnecting devices, after drawing out the circuit breaker to the testing position. In case of resetting the circuit breaker from its testing position to its operating position, the secondary disconnecting contacts is again closed in an automatic way at its operating position, by opening the secondary disconnecting device and then pulling the circuit breaker into its operating position.

The moving part of the secondary disconnecting device is fixed to the lower part of the moving frame. As it is supported in such a system as allowing slight interval of spaces in each of the upward, downward, right and left directions, no mechanical overstrain nor excessiveness might be imposed upon the secondary plug type disconnecting device even if the relative position of the moving frame should happen to slide only a little to that of the fixed frame.

## IX. ISOLATING OF PRIMARY APPARATUSES

The busbar, the circuit breaker, the potential transformer and the cable head, etc. are all isolated by the grounded metal barriers lest any partial accident should affect its influence over the other faultless part.

## X. INSULATION SYSTEM OF PRIMARY CIRCUIT

We employ the two systems for the insulation of primary circuits, one of which is to support the bare conductors with the porcelain insulators and the other is to support the insulated conductors, live parts of which are entirely insulated, with the porcelain insulators or the organic insulating plates. In the latter system, our Company makes it a rule to coat the straight-lined part with the sheath taped by the phenol-resin paper and to wind up the insulating tape upon the bent parts. In case of too many bent parts, we apply for them the butyl rubber insulated and neoprene sheathed cable, because the application of the abovementioned insulating tape costs too much money. And the latter is made with the less expenses and the more secure insulation may be expected.

At the joints between the main and branch parts of the busbar, we coat the cover of such molded insulation of phenol-resin as shown in the Fig. 12, and fill the insulation compounds into the inside of this cover.

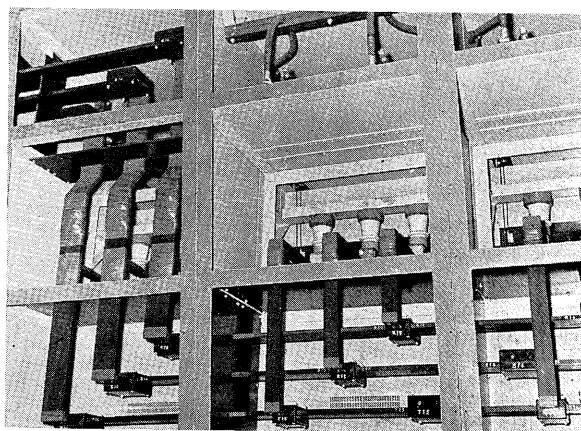


Fig. 12. Insulated busbar

The opinion of our Company is given about the abovementioned two systems in the following lines. The main objects of the system making an entire insulation coating over the high tension conducting parts and securing another insulation support in addition are consisting in the prevention of danger when touching to its primary parts and in the prevention of any accident from its dielectric breakdown. In the case of the metal-clad switchgear, however, the primary circuit are closed by the metal barriers which is earthed, so that the dielectric breakdown might hardly occur if any, because there is little danger of touching to it and little dust or foreign substance comes into the housing. In other words, this system only costs us

too much money and there is little need for its practical utility. Besides, it has a fear of producing corona phenomenon in the gap or space of the conductor supporting points. For these reasons, we recommend all of the concerned to apply the other system of supporting the bare conductor with the porcelain insulator as this is of no secular change but of a high reliability.

XI. TRANSPORT TRUCK

In order to carry out the maintenance work for the circuit breaker and the station service transformer, etc., it is necessary to take out those apparatuses out of the housing.

The transport truck is provided to the convenience of its performance. The requirements of this transport truck are such that it can be used for any of the miscellaneous apparatuses in a common way, that its level can be adjusted at any height above the ground surface, that the converting of its steering direction can be made in a free way, and that any apparatus loaded on can be securely fixed, etc.

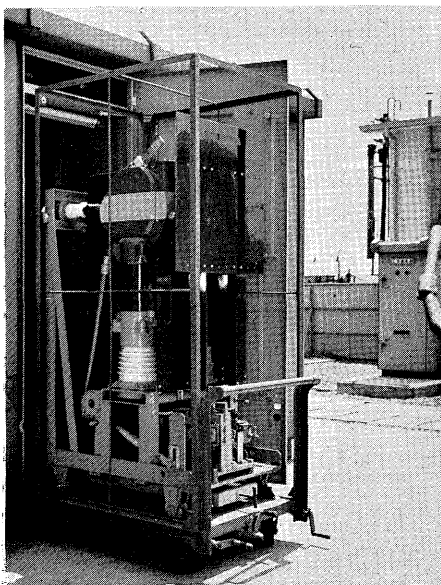


Fig. 13. Trolley lifter

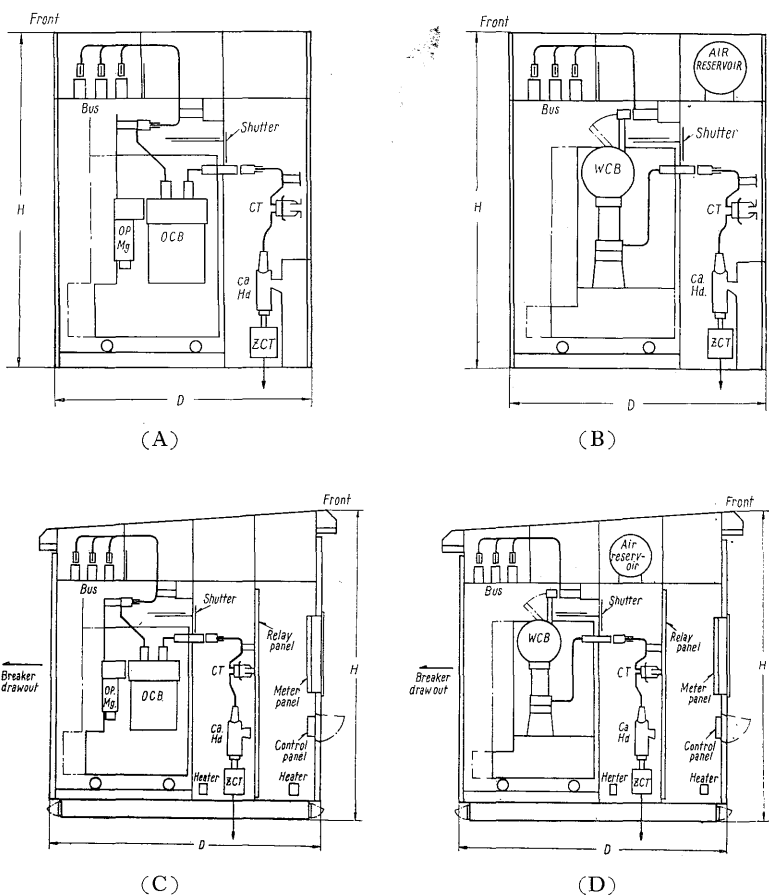


Fig. 14. Dimensions

In order to fulfill the abovementioned items of requirements, the transport truck of our Company is made of such a construction that the all wheels of the apparatuses to be loaded on it have the same width and interval entirely, that the adjusting device of level or height above the ground is provided, that the front wheels are of such structure as its steering directions being able to be shifted in a free way, and that those apparatuses may be easily fixed on the truck by function of the special lever.

XII. CONCLUSION

In the foregoing paragraphs, the outline of the metal-clad switchgear has been illustrated with a brief description, with which all of the readers of this Artile are requested to understand the general outline of it. For further details, any reference directly to the author or to the Company shall be welcome at any time with our great pleasure.

Table 2. Rating Standards and Dimensional Data of Fuji Metal-clad Switchgear

i) In case of Oil Circuit Breaker    See Fig. 14 (A, C)

Voltage ratings (V)	Type	Momentary and interrupting ratings (A)	Current ratings (A)	Type of circuit breaker	Indoor use (mm)			Outdoor use (mm)		
					Width W	Height H	Depth D	Width W	Height H	Depth D
3.450	S 850AG/50-3	8000	200, 400, 600	RF 28/6	650	2400	1870	650	2550	2290
	S 850AG/150-3	24100	200, 400, 600 800	RF 412 a/6	650	2400	1870	650	2550	2290
	S 850AG/250-3	40100	200, 400, 600 800, 1200	RF 412 b/6	700	2700	1970	700	2850	2390
			1500, 2000, 3000	RF 412 c/6	900	2700	1970	900	2850	2390
6.900	S 850AG/50-6	4000	200, 400, 600	RF 28/6	650	2400	1870	650	2550	2290
	S 850AG/150-6	12000	200, 400, 600 800	RF 412 a/6	650	2400	1870	650	2550	2290
	S 850AG/250-6	20000	200, 400, 600 800, 1200	RF 412 b/6	700	2700	1970	700	2850	2390
	S 850AG/350-6	28000	200, 400, 600 800, 1200, 1500 2000, 3000	RF 412 c/6	900	2700	1970	900	2850	2390

ii) In case of Water Circuit Breaker    See Fig. 14 (B, D)

Voltage ratings (V)	Type	Momentary and interrupting ratings (A)	Current ratings (A)	Type of circuit breaker	Indoor use (mm)			Outdoor use (mm)		
					Width W	Height H	Depth D	Width W	Height H	Depth D
3.450	S 855AG/100-3	8000	200, 400, 600 800, 1200	HF 624b/106	800	2550	1930	800	2700	2390
	S 855AG/200-3	16000	200, 400, 600 800, 1200, 1500 2000	HF 624c/106	900	2700	1980	900	2850	2390
	S 855AG/300-3	24100	200, 400, 600 800, 1200, 1500 2000	HF 624g/106	1000	2700	2080	1000	2850	2390
6.900	S 855AG/200-3	16000	200, 400, 600 800, 1200	HF 624b/106	800	2550	1930	800	2700	2390
	S 855AG/400-3	32100	200, 400, 600 800, 1200, 1500 2000	HF 624c/106	900	2700	1980	900	2850	2390
	S 855AG/600-3	48200	200, 400, 600 800, 1200, 1500 2000	HF 624g/106	1000	2700	2080	1000	2850	2390