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MICROPROCESSOR-BASED MULTIPLE LOW-VOLTAGE INSULATED CASED POWER CIRCUIT BREAKER

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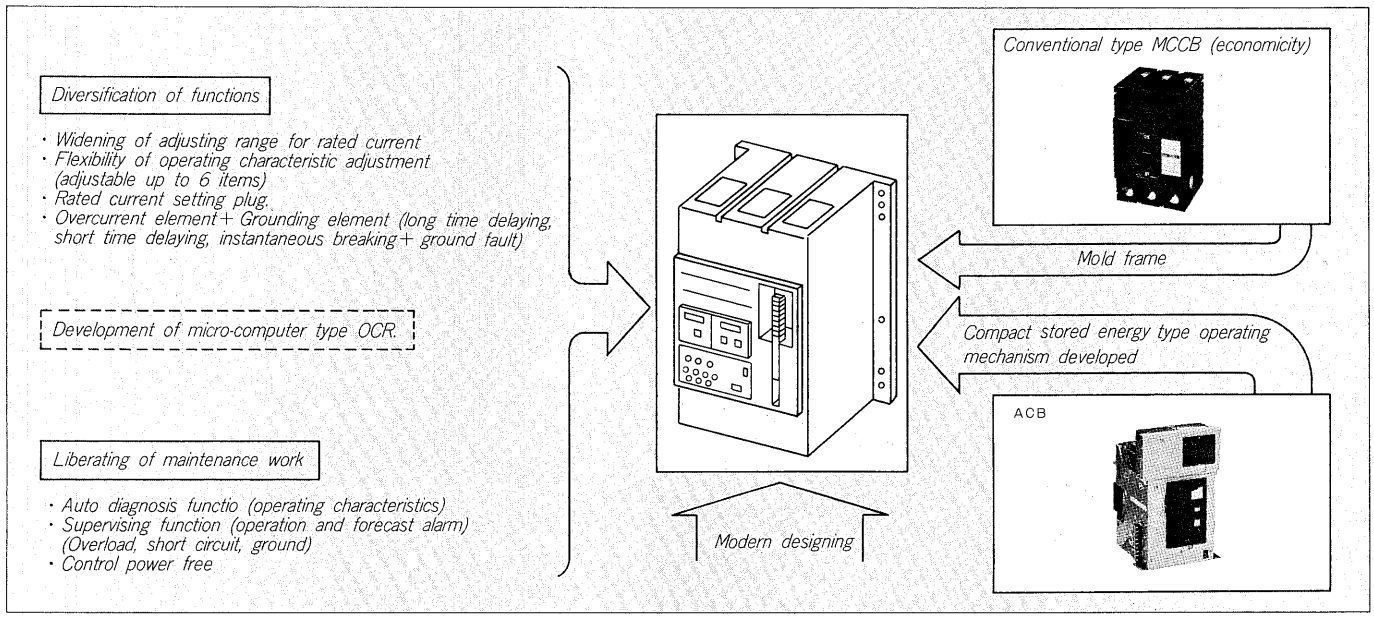
1 INTRODUCTION

Together with diffusion of super-high layered buildings and expansion and higher grading of factory installations, the low-voltage distribution systems also have become larger and diversified, so that higher performance and more diversified functions are demanded for the low-voltage circuit-breakers that protect them, and on the other hand, from the stand point of resources saving and lowering of installation cost, higher degree of economicity also is required. For the large-capacity low-voltage circuit breakers that are used for opening and closing and protecting mains located nearer to the power source for low voltage distribution systems, at present, comparative larger and higher priced metal frame made dead front type "Low-voltage air circuit breaker (ACB)" and comparatively smaller and lower priced mold frame enclosure type "Molded case circuit breakers (MCCB)" are used. However, as the conventional MCCB's aim at economicity while ACB's, at functionality and performance, the truth is that the sufficient measures for planning a protective system for high-performance low-voltage distribution system with emphasis on economicity are not taken up yet to full satisfaction of both manufacturers and users. In order to cope with this problem, Fuji Electric has developed a new type of system circuit breakers and commercialized them with a new concept of improving the reliability of the low-voltage distribution system and enhancement of cost performance. The present report introduces the outline of the features, constructions and applications of the FUJI Power Breakers.

2 FEATURES OF THE POWER BREAKERS

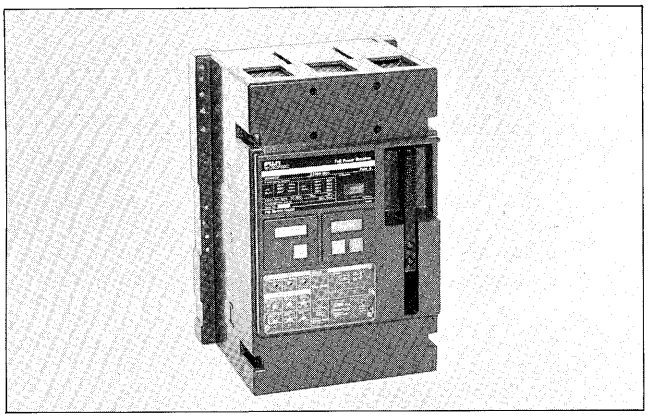
The power breakers are a new type of low-voltage circuit breakers that revolutionalize the concept of conventional MCCB's. *Fig. 1* shows the design concept. *Fig. 2* shows the outer view, and as it is clear from the figure, the control unit (handle can be housed within the case), electronic OCR type setting panel, operation display and name plates are arranged in front of the modern design

Fig. 1 Power breaker development concept



panel face. With this arrangement, improvement of machine interface has been devised, by making the panel operable from outside by cutting the panel in a bay when the breaker is housed in the distribution equipment.

Fig. 2 Power breaker



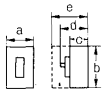
The new power breakers have the following excellent features that have also been the features of conventional MCCB's:

(1) A compact and safe structure by adopting the mold frame.
(2) Economicity in prices.
(3) Flexible terminal structures that can be adopted in most diversified mounting and connecting systems.

Also they are provided with the following features that are all particular to these new power breakers:

(4) Possibility of instant closing and improvement of maneuverability through adoption of stored energy operating system.
(5) Improvement of operational safety and breaking performance through structure separating completely main conductor and breaking part from control mechanism and electronic OCR's.

Table 1 Specifications of power breakers

			3 elements: Electronic micro-computer (plug system)				2 elements: Electronic analog system			
Frame (A)			1,600	2,000	2,500	3,200	1,600	2,000	2,500	3,200
Model			SE1603PD	SE2003PD	SE2503PD	SE3203PD	SE1603PF	SE2003PF	SE2503PF	SE3203PF
No. of poles			3	3	3	3	3	3	3	3
Rated current in (A)			1,400 1,600	1,406, 1,800 1,600, 2,000	1,800, 2,200 2,000, 2,500	2,500, 3,000 2,800, 3,200	1,600	2,000	2,500	3,200
Rated voltage (V)		AC DC	660 (50/60 Hz) –							
Rated interruption capacity (kA) [Rated closing current peak value]	JIS C 8370 AC asym/sym	500V 460V 220V	75/ 65 (143) 100/ 85 (196) 150/125 (313)							
	IEC 157-1-P2 AC sym	660V 500V 380V 220V	42 (88) 65 (143) 85 (187) 125 (275)							
	Short-time dielectric capacity		35kA sym. 1s				–			
Outer dimensions (mm)	 e: With motor control		a = 342 b = 546 c = 305 d = 330 (335)*2 e = 330 (335)*2							
Structure and operation	Control mechanism		Stored energy operating mechanism							
	Display		ON, OFF, Charged, Discharged, Overload, Short-circuit, Ground Tripped, No. of operations (Optional)				ON, OFF, Charged, Discharged, No. of operations (Optional)			
	Protective features	System	Electronic type (micro-computer)				Electronic type (analog)			
		Long-time delay	• (0.6 In ~ 1 In, adjustable)				• (0.67 In ~ 1 In, adjustable)			
		Instantaneous	• (35 kA, fixed)				• (2 In ~ 6 In, adjustable)			
		Short-time delay	• (2 In ~ 8 In, adjustable)				X			
		Grounding	• Option (0.3 1F ~ 0.8 1F, adjustable)				X			
Mounting and connection	Front panel type	–	• (Except 3,200A)							
	Rear panel type	X	•							
	Draw-out type	D	•							
Auxiliary equipment	Alarm switch	K	• (la, external self retaining type)							
	Auxiliary switch	W	• (max. 5a + 5b)							
	Undervoltage trip device	R	•							
	Voltage trip device	F	•							
	Locking device	L_1 ~ L_3	•							
	Key lock device	Q	•							
	Motor control device	M	•							

Notes *1: • Suppliable, X not suppliable *2: Dimensions in ( ) show the extreme values

(6) Improvement in large scale of short-time dielectric capacity and decrease in temperature rise through adoption of multiple-parallel sliding contactor structure.
(7) Improvement of flexibility in pretection characteristics by micro-computer mounted multiple function electronic trip system without control power source.
(8) Improvement of operational safety through development of draw-out device having as high function as that of ACB's and through completion of various types of interlocking systems.

Therefore the power breakers can be adapted not only for fields covered by the conventional MCCB's but also for the scope of application assigned up to now to ACB's such as for spot network, bus-ties, and power source switching, in brief, they can be used as the main circuit breakers.

3 RATINGS AND SPECIFICATIONS

The power breakers are serialized with four frames: that of 3,200AF (ampere frame), 2,500AF, 2,000AF and 1,600AF. They can be system composed on the basis of secure selective interruption compatibility as the main circuit breakers for the maximum capacity of 3,000kVA (AC400V) system transformer and for main circuit breakers for single unit transformer from current rating to the maximum transformer capacity of 2,000kVA/1,000kVA (AC400V/200V) system. *Table 1* shows their types and ratings.

Power breakers are available in 3 types: for the quanty of functions of overcurrent protective characteristics, electronic type OCR; while for multiple functions through micro-computer control, DG type; and for less functions but economic AN type through analog electronic circuit control. DG type permits as an option setting of heavy ground protection characteristic and alarm contact depending on the cause of operation failure. And as for setting of rated current, a combination of rating plug and adjustable dial (DG type) is adopted so that the setting change can be made with simple operating of changing the plugging in of the rating plug. Power breakers are designed so as to fit to both specifications of MCCB and ACB, so that they can constitute a protective system with high functionality and high economicity for the low-voltage electric installations. For the reference, a comparative list of specified performance of MCCB and ACB power breakers is given in *Table 2*.

Table 2 Comparison of power breaker characteristics with that of MCCB/ACB

	Wiring circuit breaker (MCCB)		Power breaker		Air circuit breaker (ACB)
Rated insulating voltage	AC600 V		AC660 V		AC660 V
Frame size	Generally, max. 4,000 A	←	max. 3,200 A		Generally, max. 6,000 A
Rated interruption current	85 kA (sym) at 460 V (With instantaneous tripping)	←	85 kA (sym) at 460 V (With instantaneous tripping)	→	50~85 kA (sym) at 460 V (With instantaneous tripping)
Short-time current	Not indicated		35 kA, 1 sec. (Without overcurrent tripping)	→	35~85 kA, 1 sec. (Without overcurrent tripping device)
Operational duty Useful life	"O" – "CO" Current application: 500 times Current non application: 2,000 times		"O" – "CO" – "CO" Current application: 4,000 times Current non application: 4,000 times	→	"O" – "CO" – "CO" Continuous operation: Current application, 500~100 times Current non application, 2,000~1,900 times
Outer view and operating mechanism	Molded case housing type Operating mechanism is located in the case and charged. (with closing condition)	←	Molded case housing type Though the operating mechanism is housed in the case, it is not charged (with closing state).		Dead front type Operating mechanism is set on outer and is not charged (with closing state).
Closing and control system	Repulsing force of a closing spring Closing spring acts also as interrupting spring.		Stored energy type Provided with closing spring and interrupting spring.	→ →	Stored energy system Provided with closing spring and interrupting spring.
Electric operation (closing)	Standard type is manual. Electric control needs larger dimensions as they have to fix units outside.		As the electric control unit is of internal mounting type, the dimensions will not differ.	→	As electric control unit is of internal mounting type, the dimensions will not differ.
Mounting system	Front panel, rear panel and draw-out types	←	Front panel, rear panel, draw-out type		Fixed type (rear panel), draw-out type
Outer dimensions Occupying volume (estimated by us) 3,200 A Manual Automatic	Generally small in size, as each phase is separated by insulating materials 0.097 (m^3) 0.111 (m^3)	←	Compact in size as each phase is separated by insulating materials. 0.088 (m^3) 0.088 (m^3)		Insulation has parts through gaps, Generally large in size. 0.177 (m^3) 0.177 (m)
Price .	Inexpensive	←	Inexpensive		Insulation has parts through gaps, Generally large in size.
Application	Not flexible for modifications. Used for general applications.	←	Flexible for modifications. Used mains and general applications.	→ →	Flexible for modifications Mainly used for the mains.
Standards	JIS C 8370 IEC 157-1. P1 etc.	← ←	JIS C 8370 JIS C 8372 JEC 160 IEC 157-1. P1. P2 etc.	→ → →	JIS C 8372 JEC 160 IEC 157-1. P2 etc.

4 STRUCTURE OF POWER BREAKERS

Fig. 3 shows the outline structure of the power breaker. A large case made of high-strength low-contraction polyester primics (BMC) material in single block houses power supply unit, arc distinguishing unit, control mechanism unit, electronic OCR, current transformer and motor control unit in a compact form. For composing the above-mentioned parts, a block built structure (in which independent completely finished parts from one another are assembled in a case) is adopted so that they can be delivered within a term as short as that of conventional MCCB's. Besides, they are provided with the following advantages.

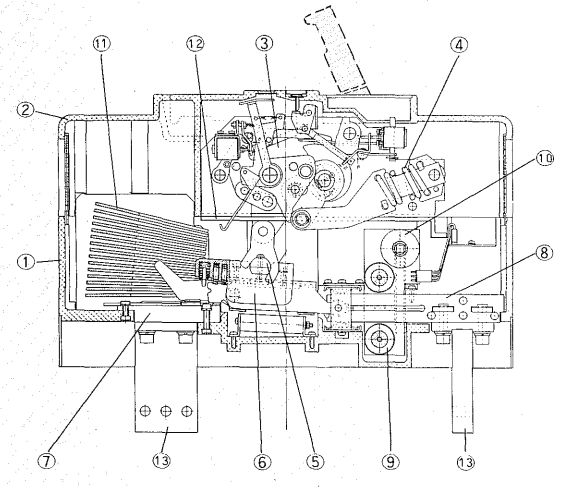
(1) Possibility of reversing the connections through separate structure

By "separator" and conver partition wall that are mold formed, the electronic OCR and control mechanism units are separated from current conducting and arc distinguishing parts, so that no thermal effect is transmitted to the incorporated electronic circuit and operating mechanism as well as no influence due to internally generated gas at the time of interruption should be transmitted to said parts. Consequently, even in the state of reverse mounting of outer connecting conductors to power source side/load side, short-circuit interruption characteristics will not be affected adversely. Also, since the separator is of structure permitting mounting of auxiliary switch and motor control units and others, they can be mounted with ease after the device is mounted to the main body of the circuit breaker. This feature is very helpful for shortening of the time for manufacture and improving of maintainability.

(2) Operating mechanism

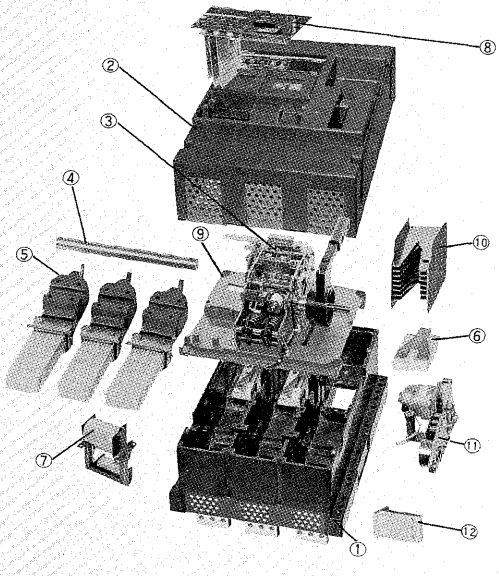
For power breaker closing control system, stoned energy system which is entirely different from that of conventional wiring circuit breakers is adopted. By manual

Fig. 3 Sectional view of power breaker



① *Case*
② *Cover*
③ *Stored energy operating mechanism*
④ *Closing spring*
⑤ *Main shaft*
⑥ *Movable contactor*
⑦ *Fixed contactor*
⑧ *Connecting conductor*
⑨ *Current transformer for sensor*
⑩ *Current transformer for power source*
⑪ *Arc-extinguishing chamber*
⑫ *Separator*
⑬ *Terminal*

Fig. 4 Block build structure



① *Case*
② *Cover*
③ *Stored energy operating mechanism assembly*
④ *Main shaft*
⑤ *Movable contactor assembly*
⑥ *Fixed contactor*
⑦ *Composite current transformer*
⑧ *Electronic OCR*
⑨ *Separator*
⑩ *Arc-extinguishing chamber*
⑪ *Motor control unit*
⑫ *Terminal*

Fig. 5 Charging of closing spring (Manual)

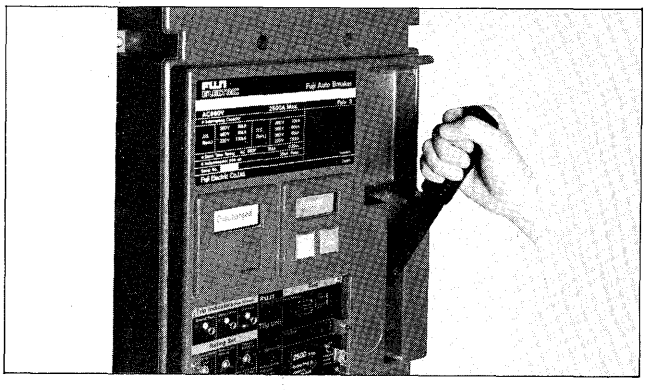
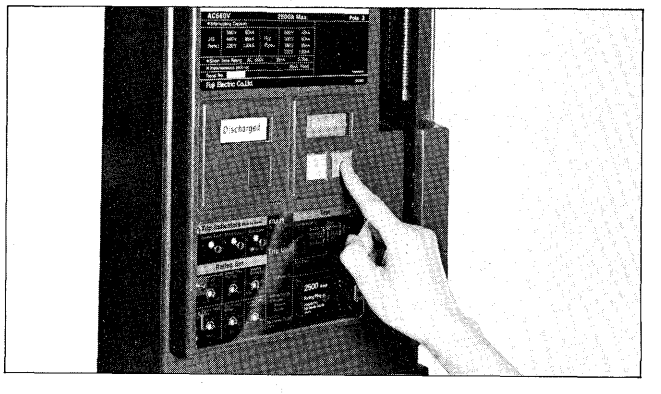


Fig. 6 Closing operation (Manual)



charge handle or electric motor, the cam mechanism located inside will be turned and by extending the closing spring, energy is stored, then by a single operation of push button located on the power breaker front panel, or by applying tension to the solenoid for remote control, the closing spring is triggered and the contactor is closed, in a blow, so that the closing speed is always constant and a large closing force can be obtained. With this, short-circuit closing can also be made securely. Maneuverability is improved in a large scale as its closing force is more than three times and handle operating force, less than 1/5 as compared with those of conventional MCCB's.

Since for the stored energy closing device of the power breakers, a high-speed reclosing system has been adopted for the standard practice (less than 0.3 second), the closing spring can be recharged by putting it to standby state in preparation for the next closing operation when the circuit breaker is in closing state. (For motor controlled devices, the operation can be made automatically when the breaker is closed.) Consequently, the operational sequence as shown in *Fig. 7* is possible and power source switching normal/emergency can be effectuated in high speed.

Closing and opening status of the circuit breaker and stored energy status of the closing spring are clearly displayed by the color-coded display unit. Closing standby status display contact can be called out as necessary. The motor control mechanism of the power breaker is directly coupled to cam mechanism incorporated in the main body of the circuit breaker, so that no large-sized reducing gears are necessary, this accounting for the compactness in size of the apparatus. Therefore, the motor control unit will be housed, as shown in *Fig. 8*, so that the outer view and dimensions have no difference from those of standard type even for motor control type.

(3) Multiple-parallel sliding contact mechanism

In order that the power breaker should have good current conducting performance up to the large current region, and to reduce the contact repulsive force generated when a large current flows to the contacts of the circuit breaker, multiple-parallel contactors (10 parallels per phase, which is the maximum number for this class) are developed and adopted for the device. With this system, the total sum of the contact repulsion could have been reduced to less than 1/2 as compared with that of conventional MCCB's. *Fig. 9* shows movable contactor corresponding to one phase.

The movable contactor has a laminated structure composed of combined units (*Fig. 10*) effectuating sliding contact, inserted into an arm of connecting conductor having a slit which divides the surface into two equal portions, and acts so as to cancel the contact repulsion of the sliding parts with the current absorptive power of the current derived to the arm of the connecting connector, so that a stable contact state can be kept until a large current region. Also thanks to the function of multiple parallel sliding contact mechanism, the current density of movable contactor is reducted (down to about 1/2 of conventional value), and by reduction of skin effect by the derived current and improvement of heat dissipation effect, the internal temperature rise is inhibited low. (Reduction of some 30 to 40% of the value of the conventional MCCB's.)

Fig. 7 Reclosing sequence

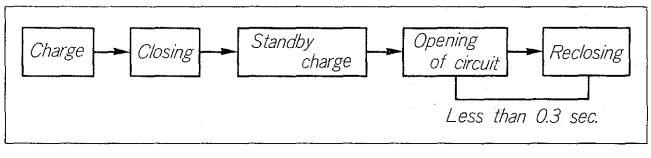
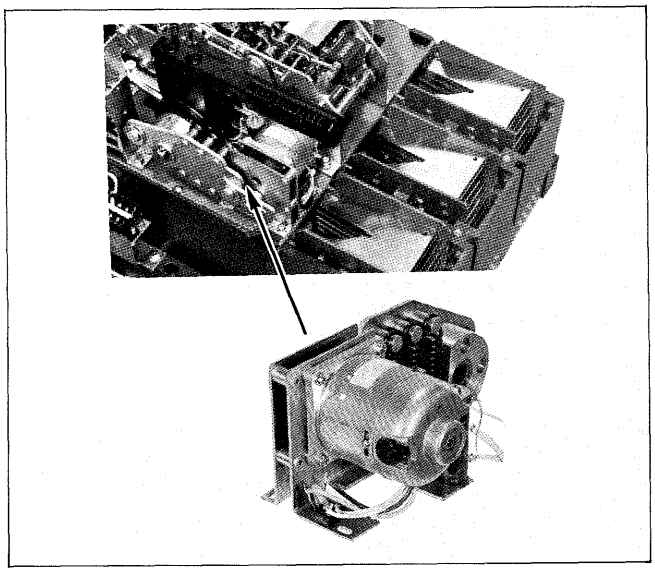


Fig. 8 Mounting of motor control unit



5 ELECTRONIC MULTI-FUNCION OCR

The power breaker is provided with a high-precision stationary type overcurrent tripping device of digital system

Fig. 9 Movable contactor for one phase

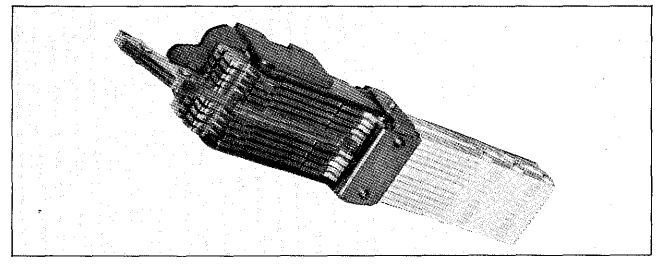
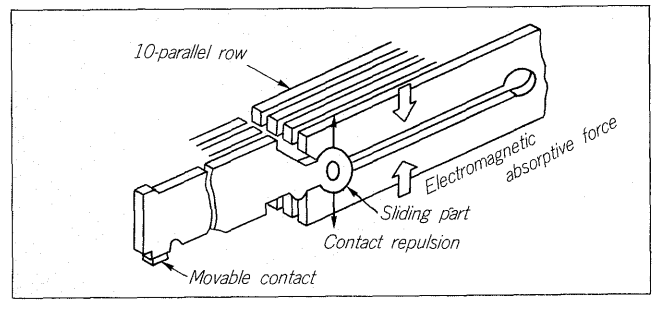


Fig. 10 Sliding contact mechanism of movable contactor



through adoption of micro-computer (DG type). *Fig. 11* shows the outer view of the trip unit. Fuji Electric has developed a self drive system (requiring no external power supply) that can be fed from main circuit current as driving power source, using, at the same time, a micro-computer.

(1) Protective function

The electronic OCR is provided, in DG type, with the following five types of protective elements. *Fig. 12* shows the characteristic curve and *Fig. 13*, a block diagram.

(a) Long-time delayed tripping current/time
(b) Short-time delayed tripping current/time
(c) Instantaneous tripping current
(d) Ground fault tripping current
(e) Pre-trip alarm (long-time delayed trip)

These are set freely as desired and by making combinations, selective compatibility with higher hierarchy and lower hierarchy circuit breakers with ease. *Table 1* shows the specifications of each protective characteristic. As the upper limit value of the continuously applied current can be determined by the rating plug (*Fig. 14*), there is no risk of errorneously setting the operation current to the value higher than the external connecting conductor capacity of the circuit breaker, and secure protection can be obtained. In due consideration of delay due to the rise time of the micro-computer, the instantaneous tripping at the time of short-circuit closing of the circuit breaker, is made to be steady by providing analog instantaneous pick-up circuits in parallel.

(2) Operation display and operation check

Depending on the operation of the circuit breaker, mechanical operation display can be made and contact

Fig. 11 Trip unit

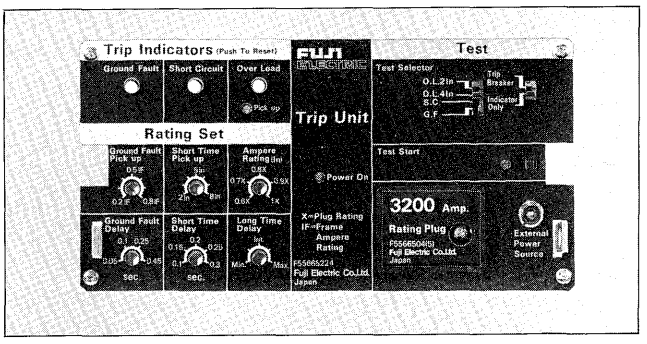


Fig. 12 Power breaker characteristic curves

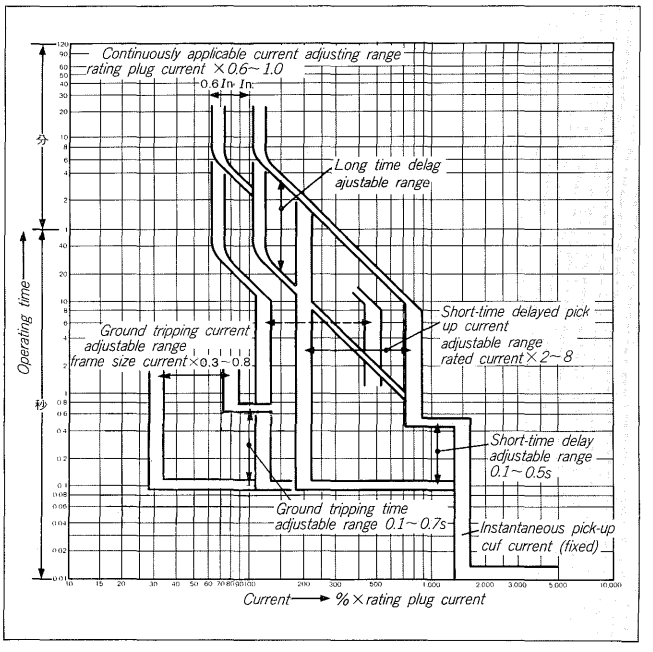


Fig. 13 Electronic OCR block diagram

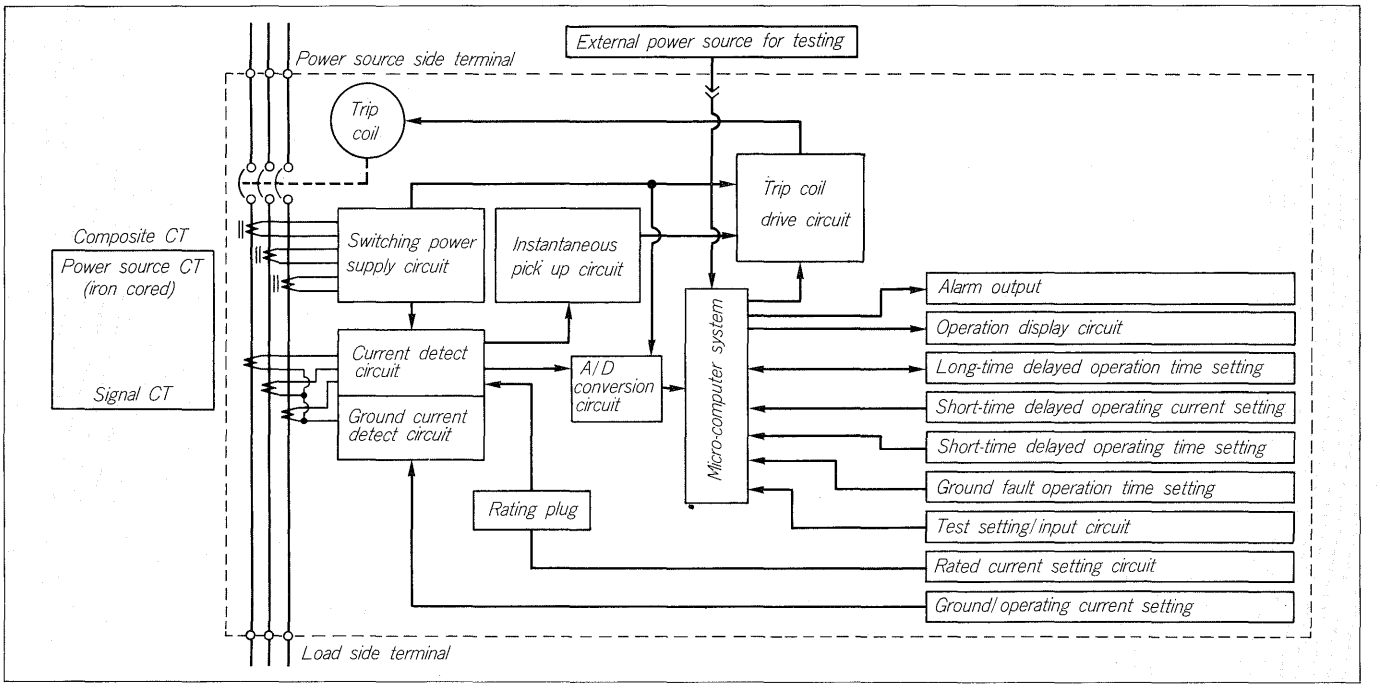


Fig. 14 Rating plug

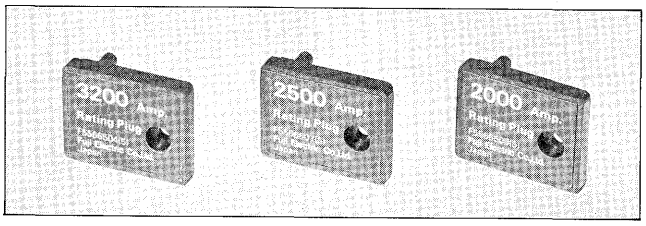


Fig. 15 Explanation on operation display according to accident mode

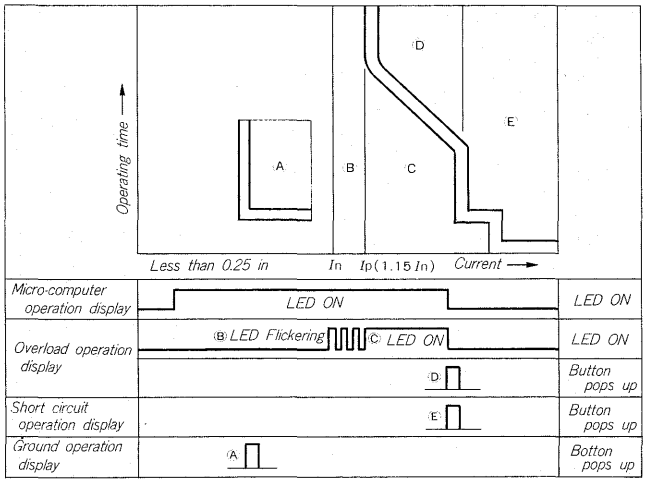
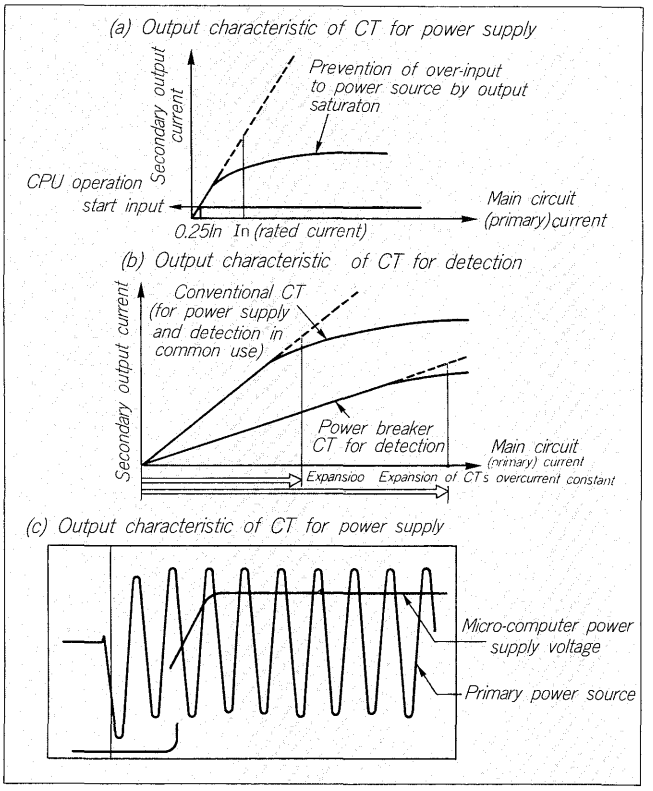


Fig. 16 Composite current transformer of power breaker and power source formation



signal, appeared on the trip unit. By this, the operation of the circuit breaker can be supervised and be known as to what is the actual operation, if it is for overload, short circuit or ground fault. So that a quick countermeasures can be taken up to carry out maintenance and inspection that may be required urgently. Also, depending on the LED lighting condition, the operation display as shown in *Fig. 15* is possible.

After setting Test Selector Mode of the trip unit, by giving test start instruction (push button) only, the micro-computer will check automatically the tripping characteristic. As the checking can be made without operating the circuit breaker even when the main circuit is under current applied condition, (Indicate mode), the maintainability can be much improved.

(3) Composite current transformer

Fuji Electric has developed a new type of current transformer in which two types of current transformers, one for power supply and another for current detection are combined for each phase, and adopted it for the power breaker. In the vicinity of the connecting conductor inside the circuit breaker, air-core coil is provided to be used for current detecting converter. Consequently, this type of power breaker can have an overcurrent constant of two times more than that of conventional electronic MCCB and ACB's CT for current detection, and detects with precision the current up to the large current region.

The micro-computer OCR starts operating with the current less than 0.25 times of the rated current maximum value. Consequently, a high-output power current transformer for power supply is provided separatedly from the converter for current detection. By restricting the sectional area of the iron core of the coil, the output will be saturated in the region higher than the rated current, thus, the over-input is prevented, and, at the same time, by the switching circuit incorporated in OCR, it generates the stable power as shown in *Fig. 16* in a wide range of regions.

6 PERFORMANCE

Power breakers not only confirm with provisions of standards for conventional MCCB, that is JIS C8370, IEC 157-1. P1, NEMA AB-1, etc. but also with standards for ACB, that is, JIS C8372, IEC 175-1. P2, ANCI C 37, 13, JEC 160 etc. so that they can be manufactured in conformity with the standards established and required by users.

(1) Short-circuit interruption function

When a short-circuit accident is produced and short-circuit current flows on the power breaker, the electronic OCR detects the overcurrent and the trip coil plunger retained by a permanent magnet will be excited reversely by the current of the incorporated current transformer, for cancelling the attracting force of the permanent magnet, and by the action of release spring, stopper of the link mechanism is released and this releases abruptly the movable contactor. The arc generated between the arc contacts will be driven into de-iron grid system arc extinguishing chamber and cooled abruptly and extinguished. Power breakers are provided with larger space for the arc-

Fig. 17 Example of interruption test oscillogram

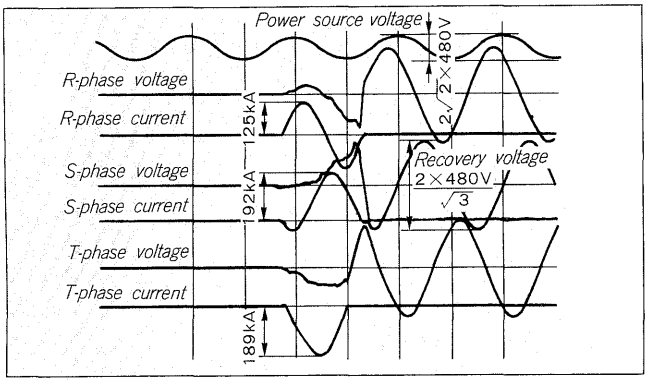
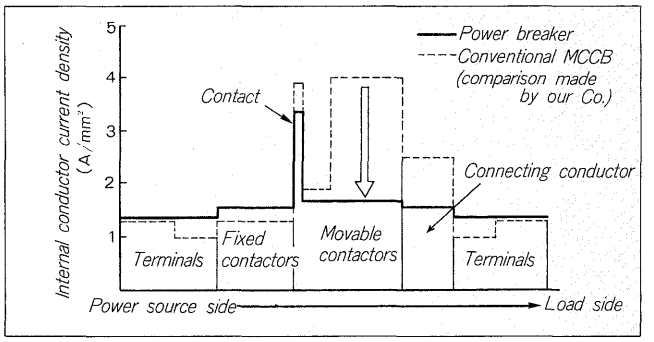


Fig. 18 Comparison of current dentsity in circuit breakers



extinguishing chamber than those of the same-frame MCCB and ACB, and by the link mechanism which is compact in size and opens its pole with high speed, interrupts securely the short circuit current in about one cycle.

The cycle in which the rated interruption current is closed and interrupted is called duty operation, and for this, JIS C8370 "Molded case Circuit Breaker" establishes the value of "0"–1 min.–"CO" for rated voltage and frequency (whereas 0: interruption, and CO: closing interruption) for the duty operation. In consideration of the fact that the power breakers will be used in the main circuit, the interruption performance higher than that established in the standards of "0"–t–"CO" t–"CO" for the duty operation is confirmed in the power breakers. *Fig. 17* shows an example of oscillogram for interruption test of AC480V and 85kA.

(2) Reverse connection interruption performance

The circuit breaker for mains need to be guaranteed for interruption performance even when they are reversely connected to power source side/load side, in case they are used for leading-in of low-voltage bus bar, simplification of drawing out, application for spot network protector, and for low-voltage bus bar connection. Power breakers are provided with interruption performance with which reverse connection interruption can also be carried out securely thanks to non charging unit of the operating mechanism through mold's of movable contactor support and particularly to the above-mentioned separator construction.

(3) Short-time current performance

The rated short-time current refers to the limit of current that does not cause any anomaly when current is applied to power breaker under closed circuit condition for the specified duration of time. Power breakers having the short-time tripping element do not, usually, cause any anomalies both thermally and mechanically when a current of 35 kA (symmetrical RMS) as standard during one second.

(4) Making current and latching current performance

The rated making current refers to the limit up to which the power breaker can close according to the duty operation indicated in Paragraph (1) above with rated voltage and frequency, and their standard values will be those shown in *Table 1*. The rated closing current is expressed by conventional short circuit current peak value, and though there are some difference depending on the rated interruption current of the power breaker, they are some 2.1 to 2.3 times of the rated interruption current. Like-wise, the rated latching current denotes the current limit that can be closed under the rated working voltage and rated frequency by the power breaker not provided with instantaneous tripping elements, and the value of AC660V, 35 kA (symmetrical RMS) is guaranteed.

(5) Endurance performance

Power breakers can, without maintenance, open and close electrically for 4,000 times and 4,000 times mechanically in total of 8,000 times, which are the useful life of the apparatus. This endurance is the same for both electrical and manual operations.

(6) Temperature rise characteristics

Fig. 18 shows the comparative list of current density along the current passage inside the power breaker as compared with that of Fuji Electric's MCCB's. The structure of 10 rows of parallel movable contactors in punched copper sheet can lower in large scale the current density as compared with that of conventional thin copper band laminate movable contactor. Consequently, though the power breakers may be compact in size, they can inhibit the temperature rise of the contacts, and conform with the ACB's standards that establish the limit for temperature rise in contacts.

7 APPLICATION OF POWER BREAKERS

As we have seen, the performance of the power breakers surpasses that of present-day MCCB's and they can now replace a part of the demands for ACB's as the new system breakers. *Fig. 19* shows the scope of application for power breakers. For users now thinking of using MCCB's, it is possible to grade up the quality of the low-voltage protection system without having their cost raised, and those parts of customers who have been obliged to use ACB's for their function's sake, they can expect to lower their cost all by using the power breakers.

(1) Selective interruption compatibility in combination with MCCB

The selective interruption compatibility is indispensable for improving the reliability of power distribution that

Fig. 19 Applicable range of power breakers

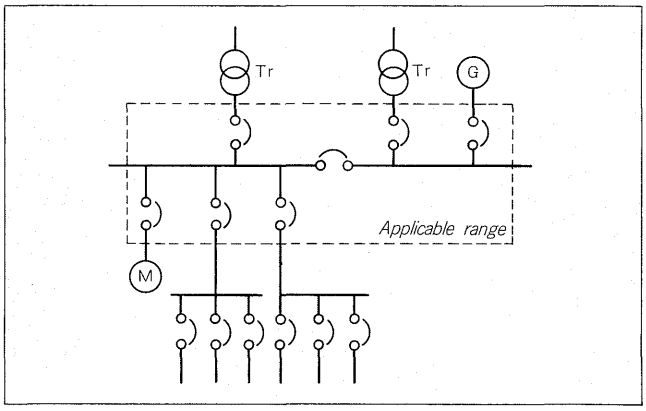


Fig. 20 Outer view of draw-out type power breaker

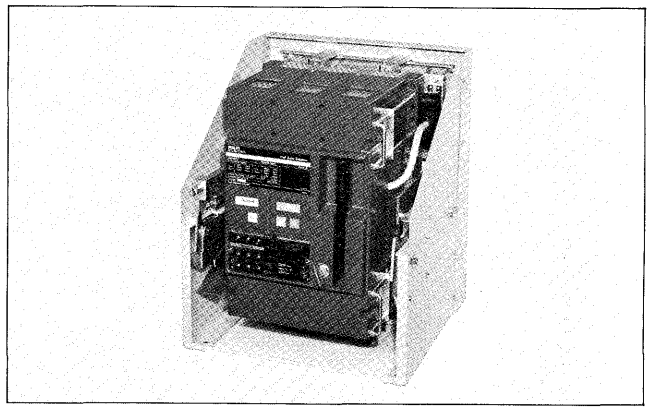


Table 3 List of selective interruption compatibility for power breakers

Voltage			220/460V			
Series	Lower hierarchied MCCB	Rated interruption capacity (kA) 220V/460V	Type / Rated current (A)	SE1603PD	SE2003PD	SE2503PD	SE3203PD
				1,600 1,400	2,000, 1,600 1,800, 1,400	2,500, 2,000 2,000, 1,800	3,200, 2,800 3,000, 2,500
				125/85	125/85	125/85	125/85
S	SA103H	85/ 42		85/42	85/42	85/42	85/42
	SA203H	85/ 42					
	SA403H	85/ 42					
	SA603H	85/ 42		65/42	65/42	65/42	65/42
	SA803H	85/ 42		65/35	65/35	65/35	65/35
	S1203	85/ 50		–	–	35/35	35/35
	S1603A	130/ 85					
H	H103	100/100		100/85	100/85	100/85	100/85
	H203	100/100		100/60	100/60	100/60	100/60
	H403	100/100		100/50	100/50	100/50	100/50
	H603	100/100		70/35	70/35	70/35	70/35
	H803	100/100		35/35	35/35	35/35	35/35

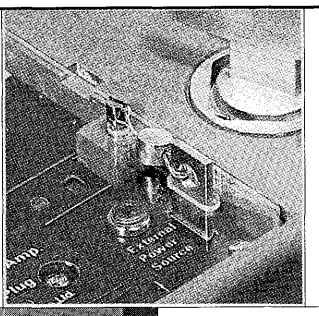
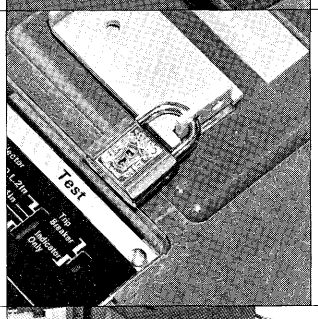
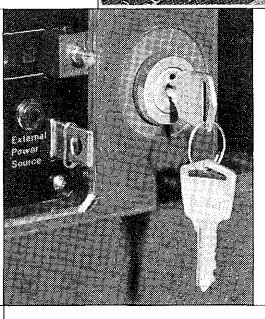
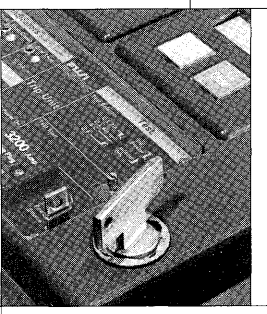
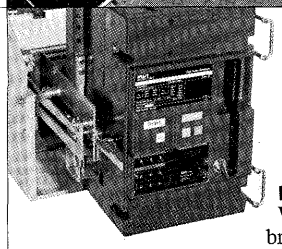
keeps distributing energy to the healthy circuits, and for localizing the range of black-outs due to the accident. And all this can be attained by simply combining the power breakers with Fuji Electric's general type current limiting wire circuit breakers, and by carrying out overcurrent protection with MCCB alone for the low-voltage distribution system, by constructing a system, and thus, improving the economicity. *Table 3* shows the list of selective interruption compatibility between Fuji Electric's MCCB's.

(2) Protector circuit breaker

The network protector of the spot network receiving system is composed of protector fuse, protector circuit-breaker and network relay. The network protector is provided with three main features, namely, reverse power interruption, closing of differential voltage, and closing of non voltage. For example, during the network operation, when there emerges any accident, the failed circuit alone will be cut out automatically and the power distribution will continue with other healthy circuits.

For the spot network receiving installation, its feature can be said to be that all opening and closing operations of protector breakers which are equivalent of receiving breakers in other power receiving system are all automaticized. Power breakers are provided with all the necessary performance as protector breaker. In case the power breakers are to be used as protector breakers, use those without

Table 4 Each locking device for power breakers

OCR Unit		Closing cannot be effectuated with rating plug and units removed		OCR cover can be sealed.	**Test lock** When accident current is detected during OCR testing, lock the test and interrupt the accident current.
OFF operation		Manual push button pad lock		**Cylinder lock**	 **Castle lock** (lock made by Castle Co. of U.K.)
Draw-out device	 **Draw-out lock** When the circuit-breaker is taken in or out, this lock will be locked automatically.	**Draw-out position lock** Circuit breaker will be locked at its position by pad lock.		**Extension rail lock** When the extension rail is not perfectly set, breaker will not operate.	

motor control type/electronic OCR.

(3) Mounting and connection

As mounting system, there are two types, namely, fisxed and draw-out type. The fixed type can be classified further to front panel connection type and rear panel connection type, however, changing of front panel connector and that of rear panel is easily done. The rear panel connecting terminal is turnable by 90° (the rear panel terminal for 3,200AF shall be chosen depending on the direction of the inserted conductor), wiring well adapted to the bay construction can be easily made and it has the same flexibility of that of conventional MCCB's. Also, the draw-out type has become easier to handle if compared with the conventional draw-out type MCCB's and by adopting various parts as interlocks, shutters, position display switch, automatic coupling terminals, current transformer for instruments, etc. its function has greatly improved.

(4) Various lock devices

In due consideration of the fact that the power breakers will be used as circuit breakers for the mains, the various safety locks provided are complete. The outline of these locks are shown in *Table 4* above.

8 SUMMARY

We have introduced the outline of the charateristics, structure and application of power breaker. By a rapid progress of electronics, the stationary type of the tripping device for low-voltage large-capacity circuit breakers have become the mainstream, and we are accumulating steadily our good record in the field also. Mounting of microcomputers to power breakers envolves various possibilities for the future, such as, for example, demand supervision of the circuits, display recording of accident informations, interlock control on operational compatibility among circuit breakers. We are under investigation as for the functions that give practical total merits. We will have the greatest pleasure if our report has given our customers a guideline for the future regarding the low-voltage circuit breakers.