Our Unique Tools that Change Our Repair and Maintenance Service Works

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Abstract

We are developing our own inspection and diagnosis tools to improve the efficiency and reliability of our repair and maintenance service works. These tools assist in complex on-site work and are packed in the form of a trunk case that is easy to carry. We provide stable and high-quality inspection and diagnosis services by shortening equipment downtime and improving work safety.

We have developed various such tools and renewed some tools that have been developed for several years. These internally developed tools are effectively used in inspection service work as repair and maintenance service tools.

1 Preface

Our field service engineers have a limited working time at project sites. With such a limitation, our company contributes to safe, secure, and stable facility operation. To carry out our repair and maintenance service works efficiently, we developed repair and maintenance service tools which are unique in terms of portability, convenience, high performance, and high measurement accuracy.

In this paper, we introduce the overview of various repair and maintenance service tools we have developed and the functions of these tools.

2 Various Repair and Maintenance Service Tools

2.1 Switching Device Operation Tester

This tester has been available since the release of the circuit-breaker operation tester. Over the years, to improve safety and functionality, it was recently renewed.

Fig. 1 shows the operation panel of the switching device operation tester. This tester is being used during the periodic inspection of the switching devices: Circuit-Breaker (CB), high-voltage Vacuum Magnetic Contact (VMC) and Disconnecting Switch (DS). It conducts the performance test (open and close operation and characteristic tests). Switching devices play important roles such as protection of various power receiving, transforming, distribution, power generation facilities and ensuring safety. There are much equipment to be inspected at large-scale facility sites. As such, it is necessary to proceed with repair and inspection service work efficiently and safely. For this purpose, we changed the connection from the conventional terminal block connection to a plug connection. This is to prevent incorrect wiring and improve work efficiency.

Fig. 1 **Operation Panel of Switching Device Operation Tester**

An operation panel is shown for the switching device operation tester.

Fig. 2 shows the connection between the switching device operation tester and the switching device. Table 1 shows a list of tool applicable models. Compatible models are significantly expanded compared to those for the conventional tester. The tester supports tests for switching devices by other companies in addition to Meiden's high-voltage and general-purpose CB, DS, and VMC. The number of tool applicable models can be further increased by manufacturing plug adapters. Since the factors (DC/

AC output, operation unit, switching time counter) required for the switching device test are integrated, the measurement data can be recorded in the tester main body. The switching devices can be tested with this single measuring device alone.

Fig. 3 shows an example of CB operation measurement using a switching device operation tester. For motion measurement, stable measurement result is achieved by controlling the input and output with a sequencer. It measures the operating (uneven) time of each of the three phases, the operating time of the a-contact and b-contact of the circuit breaker auxiliary switch, and the electric energy storage time of the closing spring.

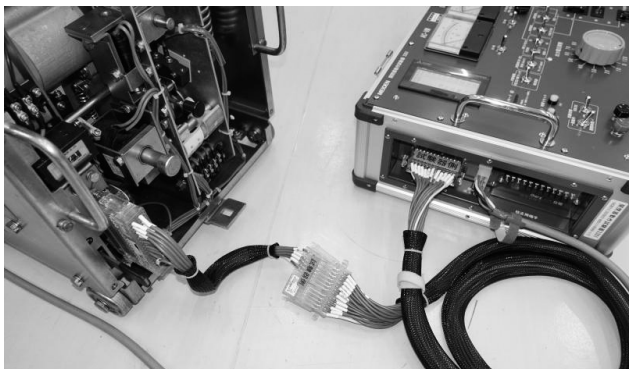

Fig. 2 Connection between Switching Device Operation Tester and Switching Device

An external appearance of cable connection is shown.

2.2 Thyristor Checker

About 40 years have passed since the release

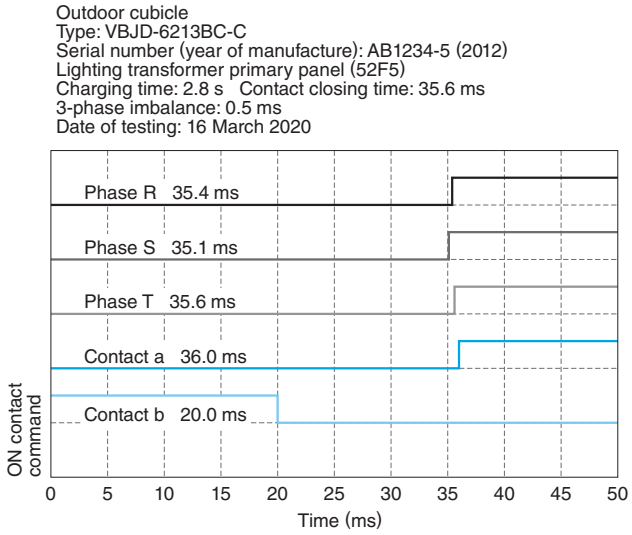

Fig. 3 Example of CB Operation Measurement Using Switching Device Operation Tester

An example of CB operation measurement (closing contact operation time chart) by the switching device operation tester is shown.

Table 1 List of Tool Applicable Models

A list of tool applicable models is shown. When a plug adapter is produced, it then becomes possible to increase the applicable models.

Made by Meiden		Measurement of the lowest operating voltage ( ) For regular excitation type		Time measurement for open-close operations	Aux. switch operating time (Contact a, Contact b)	Measurement of motor-power charging time for closing spring
		Close (make)	Trip (break)			
Oil CB (OCB)	QS-Z~3D (magnetic closure)	52X only	○	○	○	–
Vacuum CB (VCB)	VC-Z~2 (magnetic closure)	52X only	○	○	○	–
	VE Series (magnetic closure)	52X only	○	○	○	–
	VE Series (motor-charged spring closure)	○	○	○	○	○
	VGL (motor-charged spring closure)	○	○	○	○	–
	VN-1 (OFF-charged spring closure)	○	○	○	○	○
	VJ Series (motor-charged spring closure)	○	○	○	○	○
	VR Series (electromagnetic closure)	–	○	○	○	–
	22/33kV cubicle type gas insulated switchgear (C-GIS)	○	○	○	○	○
	VCB for 66/77kV C-GIS	○	○	○	○	○
DS	DS for 22/33kV C-GIS	○	○	–	○	–
	DS for 66/77kV C-GIS	○	○	–	○	–
VMC	VCS-C type (regular excitation, latch)	○	○	○	○	–
	VCS-E type (regular excitation, latch)	○	○	○	○	–
Made by other firms						
VCB	Motor-charged spring closure	○	○	○	○	○
VMC	Regular excitation, latch	○	○	○	○	–

Fig. 4 Operation Panel of Thyristor Checker

An operation panel of the thyristor checker is shown.

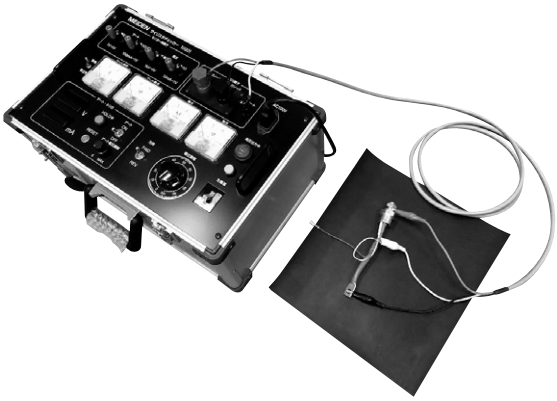

Fig. 5 Example of Test Using Thyristor Checker

An example of test is shown.

of our existing thyristor tester, and this tester has been renewed to ensure and improve repair and maintenance service quality. Even now, there are many products that use thyristors, and maintenance is critical.

Fig. 4 shows the operation panel of the thyristor checker. We use this tester in fault investigation work for power semiconductor devices such as thyristors and diodes to check the device characteristics. Fig. 5 shows an example of a test using a thyristor checker. The output voltage can be measured up to DC3kV$_{peak}$ (30 mA) for half-wave rectification and up to DC3V (270 mA) for gate trigger (arcing characteristic). In addition, it is equipped with an automatic reading and display function for the voltage and current values at turn-on (gate ignition point) when measuring the gate trigger.

2.3 Other Maintenance Tools (Various Lineups)

2.3.1 Automatic Timer Tester

Fig. 6 shows the operation panel of the automatic timer tester. This tester is used for soundness

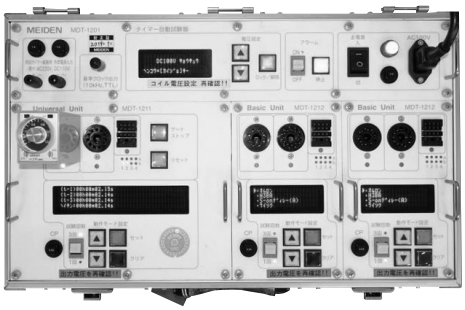

Fig. 6 Operation Panel of Automatic Timer Tester

An operation panel of automatic timer tester is shown.

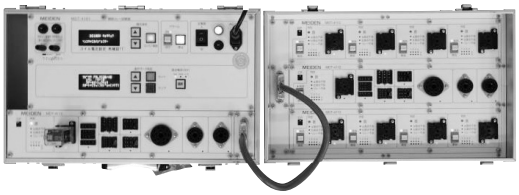

Fig. 7 Operation Panel of Auxiliary Relay Tester

An operation panel of auxiliary relay tester is shown.

inspection of plug-in analog timers (timed relays) and evaluation at the time of new application. It can measure set timers used in various electrical equipment and can judge whether contacts are good or bad. Analog timers are used in many control panels and equipment as devices for setting the time constants of various sequence circuits. This tester grasps the deterioration of the analog timer and helps to improve the reliability of the equipment.

In addition, the time measurement function is required for analog timer testing, contact test function, various test power supplies, and socket pin arrangement. It is equipped with a time measurement function required for analog timer testing, a contact test function, various test power supplies, an automatic socket pin assignment switching function, and has a wide variety of operation modes.

2.3.2 Auxiliary Relay Tester

Fig. 7 shows the operation panel of the auxiliary relay tester. In this tester, the contact quality of the plug-in type of auxiliary relay (auxiliary relay) is judged. Like the timer tester mentioned above, it is used for the soundness inspection of auxiliary relays and the evaluation at the time of new installation.

Auxiliary relays are used in many control panels and equipment, and many auxiliary relays are used in sequence circuits. It is important to understand the deterioration status because a defect in the auxiliary relay that controls the equipment is

Fig. 8 Operation Panel of Auxiliary Relay Contact Resistance Measuring Instrument

An operation panel of the auxiliary relay contact resistance measuring instrument is shown.

directly linked to the equipment stoppage. It is compatible with many types of plug-in type auxiliary relays that have the contact test function, various test power sources, and socket pin placement automatic switching function required for auxiliary relay testing. In addition, the function that automatically detects the insertion and removal action of relays makes it possible to efficiently carry out many identical relay tests, which require numerous repeated insertions and removals, in an extremely short amount of time.

2.3.3 Auxiliary Relay Contact Resistance Measuring Instrument

Fig. 8 shows the operation panel of the auxiliary relay contact resistance measuring instrument. This measuring instrument is used for contact quality judgment and deterioration evaluation of the contacts of the plug-in type auxiliary relay. In addition to the functions of the auxiliary relay tester described above, the contact resistance of all contacts is measured at the same time and compared with the accumulated past data to determine the replacement time and review the replacement cycle. Fig. 9 shows the results and evaluation judgment examples of contact resistance.

2.3.4 Megger Tester

Fig. 10 shows the operation panel of the megger tester. In this tester, the soundness of the megger (insulation resistance tester) up to 1000 V is confirmed and calibrated. Insulation measurement of temporary shutdown facilities and equipment is an important item directly linked to the evaluation of soundness and safety. For this reason, this tester will be used to carry out the pre-use inspection of the megger on the project site. It can also be used as a secondary standard machine during calibration. The functions required for each measurement of “open circuit voltage”,“rated measurement current”,“short circuit current”,and “resistance measurement tolerance”are installed and the tester conforms to JIS C 1302.

Fig. 9 Results and Evaluation Judgment Examples of Contact Resistance

The result of measurement with the use of an auxiliary relay contact resistance measuring instrument and that of evaluation judgment are shown.

Fig. 10 Operation Panel of Megger Tester

An operation panel of the megger tester is shown.

Fig. 11 Operation Panel of Contact Resistance Measuring Instrument

An operation panel of the contact resistance measuring instrument is shown.

2.3.5 Contact Resistance Measuring Instrument

Fig. 11 shows the operation panel of the contact resistance measuring instrument. This measuring instrument measures the contact resistance

Fig. 12 Operation Panel of Generator Dynamic Characteristic Tester

An operation panel of the generator dynamic characteristic tester is shown.

of the main circuit and inspects the aging deterioration of the main circuit of the switch to confirm its soundness. It is used for inspection of switches together with the above-mentioned switch operation tester. In addition, since DC 10 to 100 A current on the main circuit contact can be supplied for a long time, continuous stable testing can be performed and the test time can be shortened.

2.3.6 Generator Dynamic Characteristic Tester

Fig. 12 shows an operation panel of the generator dynamic characteristic tester. This tester detects signs of malfunction of the generator and diagnoses the deterioration status. It also records and evaluates outputs analog signals such as power generation voltage and engine speed (rotation speed), status signals such as engine start, initial excitation, and voltage establishment. By capturing not only the electrical signal of the generator but also the rotation information of the prime mover such as the engine, it is possible to grasp the overall state of the control of the generator. It is equipped with the functions required for each test of the generator, “start and stop test”, “load cutoff test”, “indicial response (sudden load test)”, and “automatic synchronization test”.

2.3.7 Artificial Ground Fault Tester

Fig. 13 shows the operation panel of the artificial ground fault tester. In this tester, a confirmation test after partial renewal of the ground fault direction relay and transformer and a confirmation test of the ground fault directionality are performed. Artificial ground fault tests are conducted to ensure that the ground fault direction relay selects and cuts off only the ground fault line to prevent problems when a ground fault occurs. This tester does not require any application of a high voltage and testing can be done safely and easily.

2.3.8 Pulse Current Generator

Fig. 14 shows the operation panel of the pulse current generator. This generator generates a pulse wave current and checks the soundness of the current detector (Hall CT) used in inverter devices. It can perform not only individual inspection of the current detector, but also function and operation test including the current detector and the equipment unit. It can perform on-site inspection and diagnosis.

Fig. 13 Operation Panel of Artificial Ground Fault Tester

An operation panel of the artificial ground fault tester is shown.

Fig. 14 Operation Panel of Pulse Current Generator

An operation panel of the pulse current generator is shown.

3 Postscript

We introduced our own repair and maintenance service tools used in our repair and maintenance service works.

In the future, we will improve its portability, convenience, and reliability. We will add diagnostic elements (deterioration diagnosis, predictive diagnosis), and will aim to develop more advanced repair and maintenance service tools. By doing so, we intend to provide services that can contribute to the safe, secure, and stable operation of equipment.