Development of a Contact-Loss Measuring System Using Ultraviolet Ray Detection

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Detection of contact-loss arcs is one of the most important methods of judging the current collection performance of the contact-wire/pantograph system, for which optical means are normally used. Until now, measuring contact loss characteristics used optical methods with detectors in the range of visible rays because of their simplicity and for various other reasons. These detectors, which intrinsically cannot be used in the daytime, often erroneously detect signal beams and lights other than contact-loss arcs, even during nighttime inspections. In other countries, however, detectors for wavelengths in the range of ultraviolet rays (contact-loss measuring systems using ultraviolet ray detection) have been developed, which are thought to be free from problems such as the inability to use them during the day and erroneous detection of miscellaneous lights at night. In the circumstances, therefore, there was an urgent need to develop a Japanese version of a contact-loss measuring system using ultraviolet ray detection.

The contact-loss measuring system using ultraviolet ray detection is fitted with a sensor to detect ultraviolet rays or a photoelectric cell near the pantograph. There are two methods to process the data obtained from the sensor. One is to transmit the data as electrical signals into the car. The other is to use quartz optical fibers for data transmission and convert the data into electrical signals in the car. The RTRI developed a version of the latter type, using low-priced plastic optical fibers in place of quartz optical fibers to limit the cost. The following description of the newly-developed system summaries the equipment, outlines its basic characteristics and gives the results of field running tests.

Figure 1 depicts the contact-loss measuring system that uses ultraviolet ray detection in the version with plastic optical fibers. As plastics absorb ultraviolet rays, the system has a unit at the light sensor to convert ultraviolet rays into visible rays. The conversion unit consists of an interference filter and a fluorescent glass plate. The unit extracts only ultraviolet rays from contact-loss arcs with the interference filter, converts them into visible rays with the fluorescent glass plate and transmits the resultant rays through the optical fibers.

Figure 2 illustrates the basic characteristics of the system. The interference filter in the conversion unit has a transmission range of 206 to 226 nm (see Fig. 2(a)). Figure 2(b) shows the voltage output characteristics of the system against the receiving contact-loss arc incident angle. When the arc incident angle is inclined by ±7° from the center, the output voltage decreases by 10% from that at the incident angle of 0°.

Figure 2(c) shows the characteristics of voltage output versus incident ray intensity. It reveals that there is virtually no reaction against the incident of direct sunshine.

Figure 3 compares the measurement results obtained by the conventional contact-loss measuring system using visible ray detection with those obtained by the new system, which were recorded in field running tests implemented on a narrow-gauge line at night. The two peaks at 0 to 10 sec indicate the occurrence of contact-loss, which were detected by both systems. The contact loss measuring system with visible ray detection recorded a waveform of a DC component superimposed with four pulses at 10 to 30 sec. The DC component is the pantograph monitoring light reflected on the tunnel wall, and the four pulses are the lights reflected on hinged cantilevers. In contrast, the contact-loss measuring system with ultraviolet ray detection presented satisfactory measurement results, without having such complicated peak-studded waveforms.

The RTRI expects that the contact-loss measuring system with ultraviolet ray detection described here will be fitted to inspection cars and test vehicles, so leading to stable transport and a reduction in the amount of maintenance work for railways.

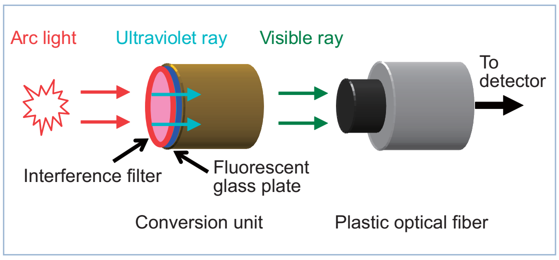

Fig. 1 An outline of the contact-loss measuring system with ultraviolet ray detection using plastic optical fibers

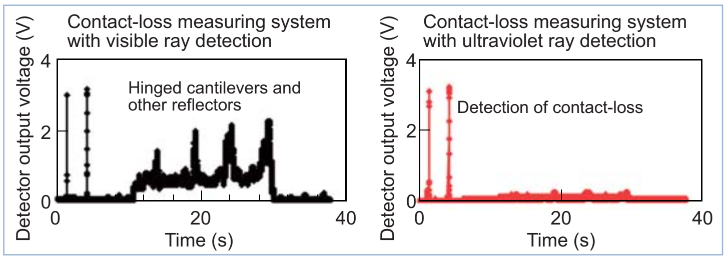

Fig. 3 Results of field running tests

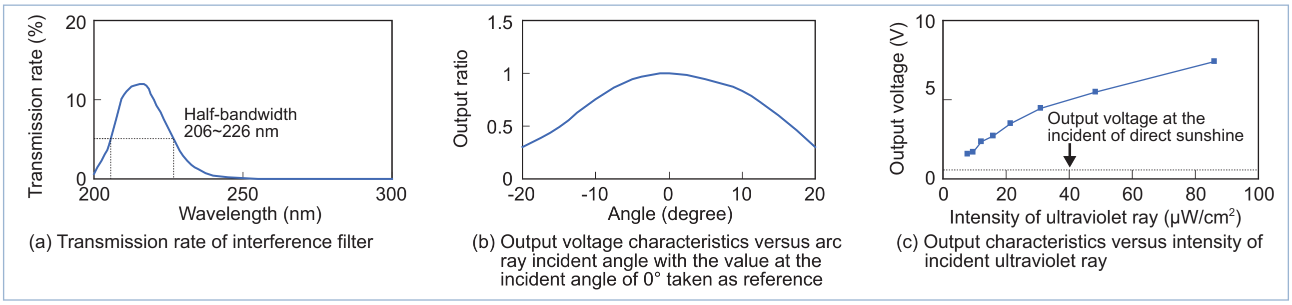

Fig. 2 Basic characteristics of the contact-loss measuring system with ultraviolet ray detection