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NAVY DEPARTMENT

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Report of Test

of

750 Volt D.C. Voltmeter with Wax-Filled

Multiplier Compartment

FR-1562

Submitted by

Weston Electrical Instrument Corporation

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ANACOSTIA STATION
WASHINGTON, D.C.

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APPENDICES

AUTHORIZATION

1. This work was authorized by Bureau of Engineering letter, reference (a). Other relevant correspondence is listed as references (b) and (c).

Reference: (a) BuEng. ltr. S67/22-L5 (5-2-R6) of 23 June 1939.
(b) Specifications 17-I-12a.
(c) NRL Report R-1486, "Report of Test of Multiplier Resistor for 250 Volt Voltmeter, Submitted by Weston Electrical Instrument Corporation", dated 28 October 1938.

OBJECT OF TEST

2. The object of the test was to determine whether the subject meter complies with specifications, reference (b), and is suitable for Naval use, particularly with respect to the effect of excessive atmospheric humidity on both the meter and its multiplier resistor.

ABSTRACT OF TEST

3. The instrument was inspected for compliance with the dimensional requirements of specifications, reference (b), for 3-1/2" flush mounting d-c instruments. The meter was subjected to high relative humidity at both 50°C and room temperature for a period of 27 days, and the effect noted on the d-c resistance between the terminals as well as on the accuracy of the instrument as a voltmeter. It was heated to a temperature of 65°C and chilled to a temperature of -10°C to determine if the humidity seal was affected at these temperatures. The instrument was subjected to a severe vibration test. The temperature rise at the outside of the case was noted after the instrument had been operated at full scale voltage for several hours.

Conclusions

(a) The instrument under test complies with the applicable requirements of specifications, reference (b).

(b) It is well protected against humidity effects and is considered suitable for Naval use.

Recommendations

(a) It is recommended that this instrument be considered suitable for Naval use.

DESCRIPTION OF MATERIAL UNDER TEST

4. The instrument submitted for test was a Weston Model 301, 750 volt d.c. voltmeter (3-1/2 inches, flush mounting, with case of insulating material) bearing the serial number 1,326,630. This instrument was submitted as embodying a wire wound multiplier resistor with improved protection against the effects of humidity. The self-contained multiplier is housed in a compartment 5/8 inch deep which forms an extension of the case of the meter.

METHOD OF TEST

5. The humidity test consisted in subjecting the instrument to a relative humidity of approximately 90 per cent at a temperature of 50°C for 27 days, during which time the temperature was allowed to drop to approximately 25°C on ten occasions. The resistance of the instrument was measured with a special type Wheatstone bridge, and the voltage readings of the meter were noted in comparison with a standard instrument before the beginning of the tests as well as after the humidity test and again following the vibration test. The instrument was heated to a temperature of 65°C for 7 hours and rapidly chilled to -10°C to determine if its moisture-proof seal was affected by such operation. The meter was mounted on a vibration table and subjected to intense vibration for 24 hours at frequencies between 6 and 30 cycles per second, and at amplitudes of vibration up to approximately 1/8 inch. During the vibration test, the instrument was mounted vertically for 12 hours and horizontally for 12 hours. The temperature rise at the surface of the case was determined by means of a calibrated thermocouple after the meter had been operated at full scale voltage for approximately 7 hours. The case of the meter was opened after the completion of the tests for the purpose of examining the type of seal provided at the junctions of the sections of the case, and the manner of protection afforded the fine wire of the 750,000 ohm multiplier resistor coil.

DATA RECORDED DURING TEST

6. The data recorded during the test are given under Results of Test.

DISCUSSION OF PROBABLE ERRORS

7. The errors involved in the measurements are not greater than the following:

Relative error in voltage determinations	± 1 volt
Relative humidity	± 10%
Temperature	± 2°C

RESULTS OF TEST

8. The results of the tests are given below:

Dimensions. The dimensions of the instrument lie within the limits of Table 3 of specifications, reference (b), for 3-1/2 inch flush mounting meters and are as follows:

Diameter of flange	3-1/2 inches
Diameter of body	2-11/16 inches
Depth of case	1-5/8 inches
Radius of mounting screw circle	1.58 inches
Stud length beyond meter case	11/16 inch

Humidity Test. The instrument was subjected to a relative humidity of approximately 90 per cent at a temperature of 50°C for 12 days, during which time the temperature was allowed to drop to approximately 25° on six occasions, thus raising the relative humidity to the dew-point. The accuracy of the instrument as a voltmeter was now practically the same as before this test (see Table 1). After the meter was heated to 65°C and chilled to -10°C, the humidity test was continued for 15 more days, with four cooling periods to room temperature. The voltage readings of the voltmeter after the 27-day test did not differ from those taken before the beginning of the tests by as much as 1/2 per cent of the full scale value of the meter, as shown in Table 1 (the rated accuracy of this type of instrument is 2 per cent of the full scale value). There was no visible accumulation of moisture inside the glass, or other evidence of the penetration of water into the case of the meter. No measurable change was noted in the resistance of the 3/4 megohm multiplier resistor. Therefore, the protection against humidity applied to this meter appears to be quite effective.

Heat Effect at 65°C. After the meter had been heated to a temperature of 65°C for 1-1/2 hours while mounted in a horizontal position, it was found that one of the insulating plugs, used to close the holes in the back of the multiplier compartment after the wax had been poured into it, had fallen out and approximately one teaspoonful of wax had flowed out of the multiplier compartment. This plug was pressed into place and the meter immediately subjected to a temperature of -10°C for 4 hours. No other effect was noted due to these extreme changes in temperature. The last check of the accuracy of the meter was made after these temperature tests, and following 15 more days of humidity tests as previously stated.

Temperature Rise at Full Scale Voltage. After the rated maximum voltage of 750 volts had been applied to the meter terminals for a period of 7 hours, no detectable rise in surface temperature had occurred. The power dissipated in the meter was only 3/4 watt. (1 ma through 3/4 meg.)

Vibration Test. After the 24-hour vibration test, the meter functioned with no loss of accuracy, and there was no evidence of any damage.

Means Provided for Protection Against Humidity Effects. The multiplier resistor is impregnated with a water-proofing wax and mounted in a sealed compartment on the back of the meter. The cover of this compartment is provided with two holes in addition to those for the terminal studs, and after the cover is clamped in place, liquefied wax is poured into one of the holes while the other is used as an air vent. The multiplier is thus wholly embedded in wax, as shown in Plate 1, where a portion of the annular multiplier coil may be seen in the upper portion of the rear view of the meter. After the multiplier compartment is filled with the wax, tight fitting plugs are pressed into these holes as shown in the right view of Plate 1. The manufacturer's representative states that the sealing compound used at the junction of the meter case and the multiplier compartment and that used around the terminal studs is Glyptal; also that a non-hardening wax-like substance is employed to seal the glass to the meter case, and around the zero adjuster screw.

CONCLUSIONS

9. The instrument under test complies with the applicable requirements of specifications, reference (b).

10. It is well protected against humidity effects and is considered suitable for Naval use.

TABLE 1

Comparison of Test Meter with Standard Voltmeter
Before and After Humidity Test

VOLTAGE READINGS

Standard Meter	Meter Under Test		
	Before Test	After 12 Days	After 27 Days
113.0	111	113	111
225.0	223	225	223
550.0	548	552	550

Readings in column 4 were taken after completion of both the humidity and vibration tests.

Due to scale of meter under test a tolerance of one volt should be applied to values in columns 2, 3 and 4.

Plat 1