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Report of

Weston Transmitting Tube Tester Model 786-2
Submitted by

Weston Electrical Instrument Corp.

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WASHINGTON, D. C.

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AUTHORIZATION

1. This problem was authorized by reference (a). References (b) and (c) are also pertinent.

References:

- (a) NAF ltr. F42-1(2)(5268) to Director, NRL, of 17 March 1942.
- (b) Weston note of exceptions to Contract N156s-21746 and NAF requisition 583-Aero Series 1942 - 9 September 1941
- (c) NAF ltr. N156s-21746 (24688)R-2 to Weston Electrical Instrument Corp. of 15 May 1942.

OBJECT OF TEST

2. The object of this test was to determine whether the Weston Transmitting Tube Tester, Model 786, Type 2, complies with the requirements of reference (b); to check the manufacturer's tabulated test data on a number of tubes available to him; and to compile sufficient information on the remaining tubes for the completion of the test data.

ABSTRACT OF TEST

3. The sample transmitting tube tester was tested to determine the following:

- (a) ease, simplicity, accuracy of operation
- (b) flexibility of application
- (c) compliance with the mechanical requirements of reference (b)
- (d) compliance with the electrical requirements of reference (b), such as available electrode voltages, facilities for measuring circuit conditions of a tube under test
- (e) necessary information for more complete testing data

CONCLUSIONS

It is concluded:

- (a) That the transmitting tube tester complies with reference (b).
- (b) That radiation from the 6 Mc oscillator in this equipment may constitute a military hazard.
- (c) That the recommended changes should be carried out to make this equipment suitable for Naval use.

RECOMMENDATIONS

It is recommended:

- (a) That the power line cable be filtered at its entrance to the case and shielded.
- (b) That a conspicuous nameplate bearing the substance of the following warning be attached: "WARNING - Do not operate during radio silence", and that this warning be incorporated in the instruction book and regarded as more important than the high voltage warning.
- (c) That the manufacturer revise the instruction book to provide servicing instructions and wiring diagram as well as complete testing data.
- (d) That some provision be made for more accurately reading the voltage drop across rectifiers under test.
- (e) That smoother grid voltage control for static tests be attained.
- (f) That the transmitting tube tester with the changes recommended above, be considered satisfactory for Naval use at times and places where radiation does not constitute a military hazard.

EQUIPMENT UNDER TEST

4. This equipment was designed to provide means for taking measurements on a selected group of medium and low power transmitting tubes. It includes suitable power supplies for the various electrode potentials and instruments for measuring these potentials. Sockets for each of the tube types listed in the instruction book are available and internal connections are supplied so that these tubes can be tested for power output at a frequency of approximately 6 megacycles, or static tests can be made at electrode potentials within the capabilities of the set.

5. The equipment is housed in a relay rack type of construction with non-ferrous material used throughout; its size is 19" wide by 26-1/4" high by 8-3/4" overall depth; weight, 112 lbs. The set is provided with side angle brackets for bench mounting, and with panel mounting holes suitably spaced for standard 19 inch relay rack mounting. The equipment is completely self-contained with the exception of the connector leads required for top terminal tube connection and operates directly from any 105-125 volt 60 cycle line. The power input at 110 volts is 110 watts plus the power absorbed by the tube under test, which includes filament, plate and dummy load losses.

METHOD OF TEST

6. Since this equipment is self-contained no external instruments were employed for tube testing. Various tube specimens were tested for power output as a 6 Mc oscillator in accordance with the operating instructions and typical test data. The types which were tested were all included in the tube list stipulated in the contract; all types were not available. In some cases, both "good" and "bad" specimens were tested. Emission was checked by reducing the filament voltage and observing the power output.

7. Static tests were made to determine plate resistance, mutual conductance and amplification factor on one tube.

8. Various rectifier tubes were tested for voltage drop.

9. The leakage into the power line and the radiation were observed with field intensity measuring equipment.

10. The equipment was mechanically inspected for workmanship.

DATA RECORDED DURING TEST

11. The data recorded during test are given in the appended Tables, I to V.

DISCUSSION OF PROBABLE ERRORS

12. The manufacturer guarantees the panel meters to be accurate within 2% of full-scale deflection. The error involved in employing these instruments in tests, where small deflections and increments were observed, was within 10%; where power output was observed, 5%.

13. The approximate accuracy of the leakage and radiation observations was not better than 50%.

RESULTS OF TESTS

14. The tests conducted on this equipment indicate that it complies with the note in reference (b) in providing the necessary facilities for testing medium and low power transmitting tubes. The power output and emission tests for amplifier tubes are satisfactory in every respect. Results of the tests are given in Table I.

15. This equipment is quite usable, although not highly accurate, for determining static characteristics. The increments of voltage and current, because of their small proportions, can not be observed to the full scale deflection degree of accuracy. Considerable error may be introduced by fluctuations of line voltage. The results of the static characteristic tests are given in Table III. The grid voltage meter was found to have a discrepancy between corresponding voltage readings on the two scales. Calibration of the meter, given in Table IV, revealed an error in the meter itself although the full scale deflection was correct for both ranges. Adjustment of the grid voltage control was found to be quite rough with consequent inconvenience on some static tests. Static measurement of plate resistance and amplification factor of tetrodes and pentodes is subject to much greater error because of the small increments of plate current and grid voltage, respectively required to limit the various potentials to the linear portion of the operating characteristic. Some samples of tube types 807 and 1625 were found to oscillate when set up for a static test. In principle, this equipment simulates the most essential tests of the Navy Tube Specification RE 13A 600 as required by reference (b). Strict adherence to this specification was, therefore, discounted in approving for Naval Service. The primary application of this equipment is to determine whether a tube is "good" or "bad".

16. Voltage drop was measured across rectifier tubes operated at maximum average plate current, not exceeding 200 ma. The high voltage supply with its associated voltmeter and milliammeter was employed in this test. For the high vacuum types of rectifiers, the drop was too small to be read accurately on the plate voltmeter; furthermore, it was even more difficult to read the drop of mercury vapor tubes. It was, therefore, impractical to set up close limits for this particular test. It can be stated that a 5% reduction of filament voltage manifests any slight defect in a rectifier tube. The plate current, under this condition of bad vacuum rectifiers, gradually decreases with a constant applied plate voltage. In the case of bad mercury vapor plate rectifiers, voltage greatly in excess of the rated drop exists for maximum current. A low range multiplier on the plate voltmeter with a reduction of primary voltage on the plate transformer would provide adequate means for a more satisfactory test of rectifiers. Results of these tests are given in Table II.

17. The data on the radiation and leakage of the 6 Mc oscillator are given in Table V. This information was obtained in a room with sheet steel walls. Consequently, large errors due to reflection were involved except on field intensities within six feet of the equipment. The measurement outside the building was low because of the attenuation due to the metal construction in the building. Even with the errors involved in the observations, the conclusions were sufficiently positive to brand this equipment as a military hazard when it is operated in combat zones without regard for its 6 Mc. radiation.

18. The original specifications, reference (b), stipulated the incorporation of a time delay relay to automatically allow the filaments of the high voltage rectifiers and the tube under test to stabilize before the application of plate voltage. The note excepted this item with the substitution of separate electrode and filament voltage switch controls for the two energy sources and associated green and red bullseye pilot lights. The justification for this substitution as given in the note is sound; in this respect, the safety and ease of operation as affected by this change is quite satisfactory.

19. In the note, reference (b), the manufacturer stated that it would be impractical to include certain tubes in the specified list because of limitations involved in the number of tube sockets and associated wiring. However, the manufacturer did agree to incorporate one of these tubes, the RCA type 813, at the request of the Bureau of Aeronautics. This change increased the number of adapters required for testing the same number of tubes; in consideration of the wide application of the type 813 in aircraft transmitters,

the compromise was satisfactory.

20. Completion of the testing data was not possible since certain tube types were not available. The additional instruction book testing data for the available tube types are given in Tables I and II. These data can not be taken as average values because a sufficient number of good tubes were not available for test. Until this information can be augmented with reliable average data, it may be employed as a guide in use of this equipment.

CONCLUSIONS

21. It is concluded:

- (a) That the transmitting tube tester complies with reference (b).
- (b) That radiation from the 6 Mc oscillator in this equipment may constitute a military hazard.
- (c) That the recommended changes should be carried out to make this equipment suitable for Naval use.

TABLE I

ADDITIONAL DATA FOR INSTRUCTION BOOK

POWER OUTPUT & OSCILLATION TESTS														
Fil. Volts	Socket	Tank Switch Position	Plate Volts	Plate Ma	I Screen Volts	Grid I μ A	Output		Reduced Filament Voltage Test					
							Observed	Instr. Book	Observed	Instr. Book	10% Red.	Output		
							Amps	Amps	Volts	Amps	Volts	Amps	Volts	Amps
10.0	Jumbo 4	2	1250	150	---	7.4	1.97	1.96	8.4	1.96	8.4	1.96	9	1.97
6.3	7	4	500	55	250	2.0	0.7	0.7	5.4	0.66	5.4	0.70	5.7	0.68
6.3	5	3	600*	100	200	3.0	1.18	1.24	5.4	1.16	5.4	1.22	5.7	1.18
10.0	Giant 7	4	1250	150	400	8.0	1.86	---	---	---	---	---	9.0	1.84
10.0	5	4	1250	150	300	6.0	1.9	2.02	8.4	1.87	8.4	2.02	9.0	1.88
10.0	5	4	1250	120	400	5.0	1.6	---	---	---	---	---	9.0	1.60
10.0	5E	4	1250	100	200	7.5	1.57	---	---	---	---	---	9.0	1.50
11A	4	4	1250	150	---	8.2	1.82	---	---	---	---	---	9.0	1.82
10.0	5C	4	1500	70	300	---	1.02	1.15	8.4	1.00	8.4	1.14	9.0	1.00
B	10.0 5D	3	1250	125	250	---	1.60	---	---	---	---	---	9.0	1.58

* NOTE: Ep listed as 750 in instruction book data. 600 volts max. is manufacturer's spec.

TABLE II

RECTIFIER TEST

Tube Type	Fil. Volts	Socket	Plate Current	Drop Volts	Fil. Volts 5% Red.	Plate Current Ma	Drop Volts
1616	2.5	4	130	66	2.37	130	70
836	2.5	4	200	40	2.37	200	40
RK21	2.5	4	200	40	2.37	200	40
RK22	2.5	4	100 p/plate	20	2.37	100	20
866A	2.5	4	200	15	2.37	200	15

TABLE III

STATIC CHARACTERISTIC TESTS

Mutual Conductance

Tube	E_p	$(I_p)_2$	$(I_p)_2$	$(E_G)_1$	$(E_G)_2$	G_M	Nominal G_M
211	1000	53.0	72.0	-71.0	-65.0	3170	3150
		52.0	82.0	-72.5	-63.5	3300	
		64.0	93.0	-69.0	-60.5	3410	
	750	53.0	67.5	-44.0	-40.0	2755	2750
		45.5	58.0	-46.0	-42.2	3300	
		42.0	53.0	-47.0	-43.7	3330	

Amplification Factor

Tube	I_p	$(E_G)_1$	$(E_G)_2$	$(E_p)_1$	$(E_p)_2$	μ	Nominal μ
211	114	1000	900	-50	-42	12.5	12
	50	900	800	-45	-37	12.5	
	50	800	700	-37.2	-28.5	11.5	

Plate Resistance

Tube	E_G	$(E_p)_1$	$(E_p)_2$	$(I_p)_1$	$(I_p)_2$	R_p	Nominal R_p
211	-46	750	710	47	37.6	4260	4400
	-50	750	780	35	42	4290	
	-50	750	720	32.7	26.2	4610	
	-70	1000	960	63	50.4	3170	3800
	-69	1000	960	66	52.7	3000	
	-75	1000	950	46	31.8	3080	

TABLE IV

CALIBRATION OF D.C. GRID VOLTAGE METER

Weston Model 301, No. 1496935

50 Volt Scale		250 Volt Scale	
Standard	No. 1496935	Standard	No. 1496935
50	50	250	250
40	40.8	200	205
30	31.5	150	158
20	21.8	100	109
10	11.1	50	56

TABLE Va

RADIATION AND LEAKAGE OBSERVATIONS

Line Leakage Measurement

R.F. Voltage on a.c. line receptacle at equipment 8000 μ v.

TABLE Vb

Field Intensity Measurement

<u>Station</u>	<u>Intensity</u>	<u>Comments</u>
6 ft. from equipment	0.2 v/m	
150 ft. from equipment in corridor	1500-2000 μ v/m	error introduced by steel walls
125 ft. from equipment outside building	1400 μ v/m	error introduced by steel construction of building

Conditions of Oscillator for above tests

Freq. - 6.3 mc.

Power in dummy antenna - 56 watts

Tube - 211