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NAVY DEPARTMENT
BUREAU OF ENGINEERING

Report of

Test of Head Telephone Receivers, Type CAU-49003

(Automatic Electric Company)

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AUTHORIZATION

1. This work was authorized by Bureau of Engineering letter, reference (a). The governing specifications are listed as reference (b). Reference (c) is also pertinent.

Reference: (a) BuEng let.NOs-49415(7-8-W8) of 12 July 1938.
(b) BuEng Specifications RE 13A 511B.
(c) NRL Report No. R-1066.

OBJECT OF TEST

2. The object of the test was to determine whether the high impedance head telephone receivers submitted by the American Automatic Electric Sales Company in connection with Contracts NOs-49415 and NOs-56717 comply with the governing qualification specifications, reference (b), and are suitable for Naval use.

ABSTRACT OF TEST

3. The receivers were tested to determine the following characteristics:

- (a) Compliance with specifications as to dimensions and materials.
- (b) Operation at high energy input (50 milliwatts).
- (c) Effect of mechanical shock.
- (d) D.C. resistance.
- (e) Impedance at the frequency of primary resonance.
- (f) Efficiency factor at the frequency of primary resonance.
- (g) Primary resonance frequency.
- (h) Magnitude of secondary resonance peak.
- (i) Band width of primary resonance peak.
- (j) Band width of secondary resonance peak.
- (k) Effect of humidity on sensitivity.
- (l) Effect of humidity on insulation resistance.
- (m) Effect of humidity on materials.

Conclusions

(a) The receivers submitted for test under Contracts NOs-49415 and NOs-56717 comply with the governing specifications in all respects except that the thickness of the caps is slightly less than the minimum specified.

(b) The receivers are considered suitable for Naval use with the exception that the thickness of the caps should conform to the specifications.

(c) The telephone receiver head bands submitted with the receivers comply with the governing specifications in all respects except that the thickness of the material of the yokes is considerably less than that required by the specifications.

(d) The head bands are considered suitable for Naval use with the exception that the dimensions of the yoke should conform to the specifications.

Recommendations

(a) It is recommended that these receivers and head bands be considered suitable for Naval use provided that the receiver caps and head band yokes are increased in thickness to conform to the specifications.

MATERIAL UNDER TEST

4. The material under test consisted of 5 pairs of high impedance head telephone receivers manufactured by the Automatic Electric Company and submitted by the American Automatic Electric Sales Company, bearing the type number CAU-49003 with 5 head bands bearing type number CAU-49009.

METHOD OF TEST

5. The receivers were tested in all respects as outlined in the specifications, reference (b), except that the mechanical shock test could not be made first because the final hard rubber caps were not submitted until after the audio output tests were completed. The shock test was made just before the humidity test.

(a) A description of the method of determining acoustical output, involving use of the artificial ear, is given in reference (c), paragraph 5.

(b) The impedances of the receivers at their peak response frequencies were calculated from measurements of the inductance and resistance on a General Radio Type 650A impedance bridge. The electrical power input was computed from the known input voltage and the impedance. The efficiency factors in bars squared per microwatt were computed from the measured acoustical air pressure outputs and electrical inputs of the receivers.

(c) The insulation test between coil winding and case was made with a General Radio megohmmeter Type 487A (50 - 100 volts) and checked with a Biddle 500 volt "meg" insulation tester type 675.

(d) To test whether there was sufficient clearance between the pole pieces and the diaphragms, the input currents required for energy inputs of 6 milliwatts and 50 milliwatts were computed for the primary resonance frequency, and currents of these values were applied to four of the test telephones.

DATA RECORDED DURING TEST

6. The data recorded during the test, or values computed therefrom are given in Table 1.

PROBABLE ERROR OF RESULTS

7. The errors in the determination of the various values are estimated to be within the values given below.

Dimensions (except length of band and radius of yoke of head band)	± .002 inch
Length of band of head band	± 1/16 inch
Radius of yoke of head band	± 1/64 inch
D.C. resistance	± .5 ohm
Impedance	± 10%
Frequency	± 5 cycles
Efficiency factor	± 15%
Secondary resonant peak	± .2 db
Humidity	± 10%

RESULTS OF TEST

8. Certain observed or computed test data are given in Table 1 for each of the 10 receivers. In Table 2 the "weights" obtained by each receiver in the tests listed in paragraph 7-4 of reference (b) are tabulated, together with the total "weight" of each receiver and the average total "weight" of the ten receivers. In compiling Table 2, the probable error of measurement was taken into consideration, so that any receiver is considered to have passed the test if the observed value after being adjusted by the amount of the probable error lies within the limits. The average mark achieved by the receivers was 99.6.

9. The following comments on the results of the test refer to the similarly numbered paragraphs in the specifications reference (b).

4-1 and 4-2. The receivers comply with these requirements.

4-3. Six of the ten caps were too small in dimension H, sheet 12 B of reference (b), the measured dimension varying from 0.457 to 0.4761 inch, where it should be 0.5 ± 0.03 inch. The concavity of the outer face of the cap is about 0.161 inch which is approximately four-fifths that of receivers manufactured by the Western Electric Company, and previously submitted by American Automatic Electric Sales Company. However, in a 15 minute test by wearing the phones, the receivers under test seemed as comfortable as the Western Electric receivers. One of the receiver caps (which were exposed to normal room conditions off the receivers during the humidity test) warped enough that it could not be started properly on the receiver case threads until the cap threads had been scraped. Another of the caps fitted tight after the humidity test of the rest of the receiver.

4-4. The magnet bobbins are wound with enameled wire treated with varnish. There was no evidence of entrance of moisture in the humidity test.

4-5 and 4-6. The receiver cases comply with these requirements.

4-7. The magnets, diaphragm and wound bobbins have protective varnish or enamel coatings.

4-8. The spacing between diaphragm and pole faces meets the requirements of this paragraph.

4-9. The diaphragms have the dimensions and marking required by sheet 12B of reference (b), and have clean punched edges.

4-10. The cords have not yet been received for test.

4-11. The head bands fail to comply with the specifications sheet labeled "Head Band Type _____ 49009" of reference (b), in the thickness of the material of the head phone yoke. This thickness was 0.047 to 0.051 inch, whereas the specification calls

for $1/16 \pm .01$ inch ($0.0625 \pm .01$ inch). In a test in which one of the head phone sets under test, and one of the Western Electric phones previously submitted by the American Automatic Electric Sales Company (which complies in this dimension) were dropped from a height of 3 feet, the receivers fell out of the yoke more often in the case of the head band under test. The riveted joint fastening the yoke to the slide rod was loose, permitting some rocking motion in several cases. In other respects the head bands comply with the specifications.

- 4-12. The receivers and head bands are marked as required by their governing drawings, reference (b).
- 6-2. All the receivers passed the mechanical shock test without visible loosening or damage of parts.
- 6-3. The d-c resistances of all the receivers were within the limits specified by Table 1 of the specifications, reference (b).
- 6-4. The impedances of all the receivers were within the limits specified by Table 1 of reference (b).
- 6-5. The efficiency factors of all the receivers were above the minimum of 900 bars squared per microwatt. The average efficiency factor was 1108.
- 6-6. All of the primary resonance peaks of the receivers fell within the limits 1000 - 1200 cycles.
- 6-7. The secondary resonance peak was less than 4 decibels below the primary resonance peak in 20% of the receivers after adjustment of the values by the amount of the probable error (0.2 decibel) in the direction to favor the receivers. In these two cases, the secondary peaks (without adjustment of the values) were 3.45 decibels below the primary peak.
- 6-8 and 6-9. The band widths of the primary and secondary resonance peaks of all the receivers complied with the requirements.
- 6-10. The sensitivity after humidity exposure of 3000 hours at a relative humidity of 90% and temperature of 50° C of all of the receivers was in no case more than 1 decibel below the corresponding values before exposure, and hence complies with this requirement. The average sensitivity after exposure was substantially the same as before the exposure.
- 6-11. The insulation resistances of all the receivers were beyond the range of the Biddle 500 volt, 0-100 megohm tester, and varied from 690 to 1000 megohms on the General Radio 50 - 100 volt megohm meter. Hence they meet the requirement of the minimum of 50 megohms.
- 6-12. After the humidity test, the faces of one or both of the magnet pole pieces in 8 of the receivers were rusty, but this rust had no noticeable effect on the operation of the receivers. The insulation material showed no evidence of warping.

CONCLUSIONS

10. The receivers submitted for test under Contracts NOs-49415 and NOs-56717 comply with the governing specifications in all respects except that the thickness of the caps is slightly less than the minimum specified.

11. These receivers are considered suitable for Naval use with the exception that the thickness of the caps should conform to the specifications.

12. The telephone receiver head bands submitted with the receivers comply with the governing specifications in all respects except that the thickness of the material of the yokes is considerably less than that required by the governing specifications.

13. These head bands are considered suitable for Naval use, with the exception that the dimensions of the yoke should conform to the specifications.

Table 1

Data on Head Telephone Receivers Type CAU-49003
(Contracts NOS-49415 and NOS-56717)

(Letters in column headings correspond to the letter headings of Par.7-5 of Specifications RE 13A 511B)

Sample Test No.	D.C.		Efficiency Factor (d)	Peak Cycles (e)	Sec. Peak db below Pri. (f)	Pri. band width % 4 db 8 db (g)	Sec. band width % 3 db (h)	Insul. Resis. megohms (i)
	Resistance Ohms (b)	Impedance Ohms (c)						
196	1042	12070	1049	1045	3.45	15.34 33.27	36.64	1000
197	1042	11600	1212	1036	4.0	16.03 34.37	40.05	750
198	1027	12140	1132	1056	4.0	14.68 30.40	37.88	750
199	1041	11810	1011	1034	3.45	14.41 32.63	36.10	900
200	1061	11450	1340	1072	4.6	14.75 28.74	39.07	980
201	1048.5	11920	1082	1063	3.7	15.52 31.62	37.57	840
202	1047	11360	1072	1078	4.8	14.56 27.18	39.78	700
203	1032	12220	1121	1063	3.8	14.96 30.11	38.78	800
204	1030	12030	1132	1068	3.7	14.52 30.25	38.74	800
205	1052	12360	939	1059	4.0	14.93 31.36	39.17	690

Table 2

Table of "Weights" for Head Telephones, Type CAU-49003
(Contracts NOS-49415 and NOS-56717)

(Letters in column headings correspond to the letter headings of Par. 7-5 of Specifications RE 13A 511B)

Sample Test No.	D.C. R. (a)	Shock (b)	Impedance (c)	Efficiency Factor (d)	Peak Freq. (e)	Sec Peak (f)	Pri. Band Width (g)	Sec. Band Width (h)	Effect of Humidity	sens. ins.res. mat'ls	Total	
196	5	2	20	20	20	0	2	2	20	2	5	98
197	5	2	20	20	20	2	2	2	20	2	5	100
198	5	2	20	20	20	2	2	2	20	2	5	100
199	5	2	20	20	20	0	2	2	20	2	5	98
200	5	2	20	20	20	2	2	2	20	2	5	100
201	5	2	20	20	20	2	2	2	20	2	5	100
202	5	2	20	20	20	2	2	2	20	2	5	100
203	5	2	20	20	20	2	2	2	20	2	5	100
204	5	2	20	20	20	2	2	2	20	2	5	100
205	5	2	20	20	20	2	2	2	20	2	5	100
Average total % Failures	0	0	0	0	0	20	0	0	0	0	0	99.6