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BuShips Prob. T5-320

NAVY DEPARTMENT [redacted]

Test of Collins Type 18M-5 Radio Equipment (Receiver Portion)

(See NRL Report No. R-1664 for Transmitter Portion)

Navy Model TCH Equipment

Collins Radio Company, Cedar Rapids, Iowa
contractor.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Number of Pages: Text - 28 Tables - 18 Plates - 38

Authorization: BuShips let. S67/43 of 20 July 1940.

Date of Test: 17 October ~~19~~ to 22 November 1940.

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Distribution: BuShips (10)

Collins Portion

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Top view of chassis

AUTHORIZATION OF TEST

1. The tests herein reported were authorized by Bureau of Ships letter, reference (a), and additional pertinent information is given in reference (b).

References: (a) BuShips let. S67/43 of 20 July 1940.

(b) BuEng Specifications RE 13A 571B.

OBJECT OF TEST

2. The object of the tests herein reported was to determine the following:

(a) The extent to which the receiver portion of the Collins radio equipment meets the governing specifications, reference (b).

(b) The obtaining of information to serve as a basis for making recommendations as to changes in the present model which are found necessary or desirable to make the equipment more completely fulfill the needs of the Naval Service.

ABSTRACT OF TEST

3. The Collins 18M-5 equipment was set up in the Laboratory and the receiver portion given a general inspection of the mechanical construction and wiring. The electrical tests conducted to determine compliance with reference (b) were as follows:

(a) Accuracy of main tuning dial calibration and band overlap.

(b) CW and MCW sensitivity and mcw signal/noise ratio.

(c) Overall selectivity.

(d) Preselection selectivity.

(e) Image selectivity.

(f) Intermediate frequency rejection.

(g) Radiation of first oscillator to antenna post.

(h) Maximum undistorted output.

(i) Resonant overload for CW reception.

(j) Overall fidelity.

(k) Frequency and gain stability under the following conditions:

(1) Supply voltage variation

(2) Changes in ambient temperature

(3) Changes in relative humidity

(4) Variation of gain control

(5) Variation of input signal

~~(6) Two receivers on same antenna~~

6(7) Reset of band switch

7(8) Reset of oscillator control switch

(l) Output hum level.

(m) Regeneration and instability

(n) Oscillator operation

(o) Effect of sharp pulses on output

(p) Damage and deterioration of equipment at 50° C ambient temperature.

(q) Spurious oscillations

(r) Effect on receiver of very strong fields

(s) Cross modulation and spurious responses in very strong fields.

(t) Range and linearity of volume control

(u) Operation of receiver with replacement tubes.

Conclusions

(a) The Collins equipment (receiver portion) does not meet the majority of the electrical requirements of shipboard specifications. The use of only five tubes and the small space required for portability precludes many refinements required for specification compliance.

(b) The construction is fair though not as rugged as desired. Individual parts are well mounted except for the main tuning condenser and the i-f transformers. These parts are very poorly made. The main tuning condenser should be more rugged and have greater plate spacing. The i-f transformers should not be mounted on their controls and should have the coils wound on a more rugged and nonhygroscopic ~~polystyrene or similar~~ low loss form.

(c) Many of the parts are inaccessible for replacement without the removal of other parts. Alignment of the r-f stages is difficult due to the small space between receiver and transmitter sections.

(d) The main tuning dial does not have a long enough scale for easy reading of fractions of megacycles. A calibration chart should be provided for the equipment.

(e) The vacuum tubes are not of approved Navy type, requiring special spares to be furnished with the equipment.

(f) The dynamotor should be of a continuous duty type. See NRL Report No. R-1664. No failure of parts occurred during the test and no readjustment was necessary after the original realignment of the r-f and i-f stages. Better shielding of the r-f stages would eliminate a change of alignment when the chassis is ~~was~~ placed in its cabinet.

(g) Since no indication has been given as to the type of service intended for the TCH equipment, it is impossible to state definitely whether the equipment is suitable in all respects for Naval Service.

Recommendations

The tests, as herein reported, indicate that the subject equipment does not meet Navy specifications. Certain deficiencies should be corrected; other deficiencies should be allowed if the equipment is to be used for emergencies or as portable equipment. Recommendations are given below in reference to paragraph 216:

(a) That consideration be given to the non-Navy standard type of vacuum tubes employed. (30d)

(b) That consideration be given to the approval of the low voltage electrolytic capacitor used as a cathode by-pass. (30i)

(c) That a zinc chromate primer be used on the chassis and shield cans. (34)

(d) That ~~xhm~~ consideration be given to approval of the finish used on the various units, even though it does not comply with the usual Navy requirements. (36)

(e) That the main tuning condenser be redesigned for ruggedness and plate spacing and non-corrosive contacts between rotor assembly and condenser frame be included. (51)

(f) That the output transformer ~~used by~~ be placed in a hermatically sealed case and that the transformer be designed for a 600 ohm load. That consideration be given to the relatively poor construction employed in the i-f transformers and if accepted, sufficient spares be included with each equipment. (60, 164)

(g) That the cable plugs be furnished with gaskets ~~xxx~~ to make them submergence-proof and that the shielding be connected to the plug as well as the ground lead. (67, 68)

(h) That non-glare glass be used for the tuning dial. (72)

(i) That "staking" not be depended upon in redesigning the main tuning condenser. Soldered assemblies are desired. (75)

(j) That suitable shockproof mountings be included for mounting transmitter-receiver unit. (82)

(k) That knurled screws be used for fastening the chassis to the cabinet and further that they should, when loosened, remain with the cabinet. (91)

(l) That consideration be given to approval of the nomenclature used on dials and controls. (94, 132, 150)

(m) That the silver contacts on the band change switch and oscillator control switch be made with much thicker silver contact surfaces. (Specifications call for .0015 thickness.)

(n) That in redesigning the main tuning condenser the direction of rotation be reversed in order that the tuning control and its vernier operate according to the governing specifications. (101)

(o) That consideration be given to approval of the main tuning dial and its vernier provided its direction of rotation as in (n) is taken care of, and also if the highest frequency markings be made on the longest scale and that the dial and viewing window have less clearance to reduce parallax. (104, 107, 110, 111, 113)

(p) That the Bureau give consideration to waiving the specification requirement calling for a dial masking device. (117)

(q) That, because of the close spacing between receiver and transmitter sections, the necessary tools be furnished for alignment of the r-f stages. (118)

(r) That a suitable calibration chart be mounted on the inside of the transmitter-receiver cover. (123)

(s) That ~~the~~ consideration be given to approval of the omission of/an antenna compensator because of space limitations. (128)

(t) That ~~the~~ consideration be given to approval of the antenna circuit for connection to only one type of antenna. (138)

(u) That consideration be given to the approval of omission of an antenna circuit protective device. (146)

(v) That, because of the compactness of the set, consideration be given to the omission of the following:

(1) Radio selectivity (broad-sharp)

(2) Audio selectivity (broad-sharp)

(3) Output level control

(4) Frequency vernier control (on front panel)

(5) D-C voltmeter

(6) Tuning meter

(7) Output meter

(8) Pilot light

That in future sets, AVC should be incorporated in the circuit, including an AVC "on-off" switch. (142-2)

(w) That ~~the~~ consideration be given to the approval of omission of terminals for the insertion of a d-c microammeter in the second ~~selector~~ detector circuit. (167)

(x) That consideration be given to the approval of the output transformer even though not electrostatically balanced. (169)

(y) That consideration be given to the approval of the receiver circuit even though peak noise is not limited. (171)

(z) That ~~the~~ consideration be given to the approval of the omission of an audio band pass filter.

(aa) That consideration be given to the approval of the power unit provided it be made of a continuous duty type.

(bb) That consideration be given to the results of the electrical tests as listed under DEFECTS (Par. 216, (28-31, 33-35).) in appraisal for service application. (183, 184, 185, 188, 189, 195, 197, 198)

(cc) That the r-f transformers and the antenna relay switch be shielded in order to reduce radiation of the first oscillator to the antenna. (189)

(dd) That rigidity be given to the main tuning condenser mounting to eliminate frequency modulation of the received signal. (~~25~~ 205)

(ee) That the trimmers on the r-f stages be so made as to permit alignment of the transformers. (207)

(ff) That changes be made in the cabinet and panel construction to insure good electrical bonding where these two meet. (210)

(gg) That consideration be given to the results of the cross modulation and overload selectivity tests in appraisal for service application.

(~~hh~~ ii) That the subject equipment not be considered as meeting shipboard specifications; and that it be employed only where the sacrifice in performance and ruggedness, as set forth in this report, can be tolerated.

(hh) That steps be taken to eliminate serious key clicks in receiver phones when hand key is used.

(ii) That means be provided to assure that the antenna binding post will not become loosend with service use.

MATERIAL UNDER TEST

4. The material under test consisted of one Collins Type 18M-5 transmitter and receiver and associated equipment, which was composed of the following items.

(a) One - Type 18M-5 transmitter and receiver, complete with cover and canvas carrying case.

(b) One - Type 415E-3 dynamotor.

(c) One - Type 38C-1 carrying case complete with the following:

(1) One - Type 67A-1 telegraph key with cord and plug.

(2) One - Type 273N3 headphones

(3) One - Type 20N404 microphone

(4) One - Type 65F-4 power cable.

(5) One - Type 65F-5 battery cable.

(d) One instruction book.

5. The subject equipment was manufactured by the Collins Radio Company of Cedar Rapids, Iowa.

METHOD OF TEST

6. The following instruments or apparatus were employed in conducting the tests described herein:

(a) Standard Signal Generator, General Radio Company, Model LCA, Serial No. 8

(b) Standard dummy antenna, General Radio Company Type 418G

(c) Beat frequency oscillator, General Radio Company, Model 713A, Ser.No. 141.

(d) Wave analyzer, General Radio Company, Model 736A, Ser.No. 118.

(e) Standard signal generator, Ferris Instrument Company, Model 16C - Serial No. 44.

(f) Output meter, Ballintine Laboratories, Inc. Model 300, Serial No. 14.

(g) Vacuum tube voltmeter, Hickok Electrical Instrument Co. Model 110.

(h) Power pack, General Radio Company Model 672-A, Ser.No. 139.

(i) Crystal frequency indicator, Bendix Radio Corp. Model LM-4, Serial No.244.

(j) Output power meter, General Radio Model 583A Ser.No. 16.

7. The equipment was received from the Transmitter Section after they had made complete tests on the transmitter except for vibration. It was set up in a screened booth, where all tests were made except for temperature, humidity, and vibration. Because the dynamotor unit, as reported by the Transmitter Section, would not carry the load continuously, a power pack was used to supply the B voltage. The value of this voltage was determined by a preliminary test using the dynamotor. The voltage of this power pack as well as that of the twelve volt storage battery was checked and kept constant during the tests.

8. The standard signal generator was connected through short shielded leads to a standard dummy antenna, which was connected to the receiver input terminals. The output of the receiver was connected to a 500-ohm load, as this was the specified output as given in the instruction book. The output meter provided no additional loading.

9. The following tests were made and performed by standard methods unless otherwise indicated:

(a) CW and MCW Sensitivity. Since standard noise level could not be reached in the mcw condition; values of sensitivity were taken at 20 decibels

above noise level, at standard output of 6 milliwatts, and at 50 milliwatts output.

(b) MCW signal/noise ratio.

(c) Overall selectivity.

(d) Preselection selectivity.

(e) Image selectivity.

(f) Intermediate frequency selectivity (direct reception).

(g) Radiation. A standard dummy antenna was used in this test.

(h) Maximum undistorted output.

(i) Resonant overload.

(j) Overall fidelity.

(k) Frequency and gain stability with:

(1) Line Voltage Variation. Storage battery and dynamotor were used in this test.

(2) Ambient Temperature. As the frequency shift was too great to be measured by the output audio beat note, the input frequency was varied to give a 1,000 cycle audio output note.

(3) Relative humidity. See (2) above.

(4) Gain Control Setting.

(5) Input Signal.

(6) Reset of Switches.

(l) Hum Level.

(m) Regeneration.

(n) Oscillator Action.

(o) Static Surges. A strobotac was used to apply five volts of static pulses to the input terminals of the receiver.

(p) Receiver characteristics during and after vibration.

(q) Cross modulation.

(r) Spurious responses.

(s) Overload selectivity.

(t) Gain control action.

DATA RECORDED

10. Complete data were recorded for all tests conducted and this information is contained in Tables 1 to 18, inclusive, and Plates 1 to 38, inclusive.

PROBABLE ERRORS

11. Estimates of the probable errors in the results of the tests are given in the following table. These are estimated from the advertised errors for the instruments employed combined with the errors due to voltage fluctuation, radio frequency leakage, and resetting of instruments and receiver controls. The latter errors were minimized as far as possible.

Name of Test	Estimated Overall Accuracy
Frequency calibration	± 0.005%
Sensitivity, mcw signal/noise ratio	± 10%
Selectivity, cross modulation	
(Sensitivity off resonance)	± 10%
(Frequency setting off resonance)	± 0.02%
Overall fidelity	± 0.5 db
Resonant overload, input voltage	± 10%
Range and linearity of volume control	± 10%
Resettability	± 0.005%
Frequency stability	± 0.005%
Gain stability	± 10%
Hum level	± 0.5 db
Maximum undistorted output	± 0.5 db

RESULTS OF TESTS

12. General Description of Receiving Equipment.

A. Type 18M-5. (Receiver Section) In this unit, the receiving equipment is located in the lower section of the cabinet. By means of the power switch, the receiver may be in an operative condition without the transmitter being warmed up,or with this switch thrown to "voice" or"cw" it is in operation but with the transmitter also warmed up for operation. Depression of the microphone button or key operates a relay, which in turn opens both the antenna circuit to the first r-f stage of the receiver and the cathode to ground circuit. The receiver itself is a conventional superheterodyne preceded by one radio frequency stage. The first detector tube is a combination mixer oscillator and is followed by a single intermediate stage. The second detector tube also includes the functions of a beat frequency oscillator and first audio frequency amplifier stage. Following this is an audio output stage.

B. Type 415E-3 Dynamotor Unit. This power unit operates off of 12 volts (two six volt storage batteries) and is put into operation by means of the power switch on the 18M-5 unit. This switch when thrown to any of the "on" positions operates a relay in the dynamotor unit, putting power on the "low" end of the unit and supplying high voltage to the set. The filaments and relay power of the 18M-5 is supplied directly from the storage battery. The base of the dynamotor unit contains the necessary filters, fuses, and starting relay.

C. A complete set of cables is furnished for connecting the storage batteries to the dynamotor and the dynamotor to the 18M-5 unit.

D. The 38C-1 unit contains besides the cables the telegraph key, microphone, and headphones, each with its associated cord and plug. The key is mounted on the inside of the cover so as to be ready for mobile operation.

13. Frequency Range. The 18M-5 receiver unit covers a frequency range of 2 to 16 megacycles by means of a three position switch, which separates the range into bands of two to four, four to eight, and eight to sixteen megacycles. There is also a switch that changes the operation from master oscillator, for operation over the whole range, to two positions of crystal controlled operation.

14. Vacuum Tube Complement. The vacuum tubes used in the receiver are as follows:

Commercial Type No.	Function
6S7G	Radio frequency amplifier
6K8G	First detector - high frequency oscillator
6S7G	Intermediate frequency amplifier.
6T7G	Second detector - beat frequency oscillator - First a-f amplifier.
6G6G	Second a-f amplifier.
VR-150	Voltage stabilizer for oscillator tubes and all tube screen voltages (in transmitter shelf)

15. Type 18M-5 Circuit Elements (Receiver Section). Inasmuch as this is a typical superheterodyne receiver, detailed description of the circuit elements will be given only for certain unusual arrangements. The numbers used refer to the circuit diagram and not to the manufacturer's parts list as given in the instruction book.

A. First Detector and High Frequency Oscillator. The 6K8G tube used in this circuit is a triode hexode converter. The mixer circuit is conventional. The high frequency oscillator is also conventional except that a three-position switch allows the use of a normal oscillator (MO) or two Pierce operated crystals, CO1 and CO2.

B. Second Detector, Beat Frequency Oscillator, and First Audio Amplifier. The 6T7G tube used in this circuit is a duplex diode triode. In mcw the tube functions normally as a detector and amplifier; however, on throwing the "voice-cw" switch to "cw", a radio frequency capacitor is placed across the grid resistor. This allows the tube, in conjunction with its tuned plate circuit and grid feedback circuit, to operate as an r-f oscillator. This tuned oscillator circuit is tuned to approximately 1,000 cycles off the intermediate frequency.

C. Filament Circuit. The tubes used are of the 6-volt heater type. A series parallel connection is used for connecting these heaters, as a 12-volt supply voltage is used.

16. Circuit Description of the 415E-3 Dynamotor Unit. This is a commercial dynamotor operating off a 12-volt supply. Conventional ripple and radio frequency filters are included in the unit. Specific discussion of the subject equipment in reference to the Specifications RE 13A 571B, reference (b), follows .

17. Par.1-1.(1) Not applicable

(2) See par. 146 and 147.

(3) See par. 205.

(4) See par. 197 and Table 11.

18. Par. 1-2. The equipment is complete and ready for use upon proper connections to the antenna and battery supply.

19. Par. 1-3. Not applicable.

20. Par. 1-4, 5. The working coverage of the subject equipment is from 2 to 16 megacycles.

21. Par. 1-6. The equipment is capable of operating on either cw or voice modulated radio frequency throughout its range.

22. Par. 1-7. Not applicable.

23. Par. 1-8. The equipment is operated from a 12-volt storage battery supply.

24. Par. 1-9. The receiver is of the superheterodyne type. See Par. 14.

25. Par. 1-10. Not applicable.

26. Par. 1-11. A minimum number of types of vacuum tubes of the 6-volt heater type have been used. None of the tubes are Navy approved types.

27. Par. 1-12. Not applicable. Power requirement is 62.5 watts.

28. Par. 1-13. Each complete equipment consists of:

1 Transmitter receiver unit complete with tubes and carrying case;

1 Dynamotor power unit;

1 Case with complete set of cables, headphones; key, and microphone.

29. Par. 1-14. The equipment is guaranteed for a period of one year from date of delivery.

30. Par. 2-1. The equipment was inspected by the Laboratory with due consideration given to the General Specifications for the Inspection of Material issued by the Navy Department.

31. Par. 2-2. (1) Inasmuch as the subject equipment was not specifically designed for the Navy and as individual parts were not furnished, the specifications governing individual parts can be dealt with only by a superficial examination of said parts.

(a) Ceramics. Ceramic insulating material is employed in the vacuum tube sockets, main tuning condenser, trimming condensers, antenna post mounting, break-in relay, multi-tap switches, r-f coil forms and r-f choke. It appears to be of a good commercial grade.

(b) Laminated Paper Base Phenolic Insulation. Laminated paper base phenolic insulation is employed for the mounting of the fixed condensers and resistors and for the dynamotor relay. It appears to be of standard commercial grade.

(c) Molded Phenolic Insulation. Molded phenolic insulation is employed for the fuse receptacles, cable plugs, and companion receptacle bases, mica dielectrid fixed capacitors, and crystal holders. It appears to be of standard commercial grade.

(d) Vacuum Tubes. Two of the five vacuum tubes employed are of the multi-purpose type. None of the tubes are on the list of approved Navy types.

(e) Fixed Composition Resistors. The fixed composition resistors employed are color coded and of a standard commercial type.

(f) Fixed Wire Wound Resistors. The fixed wire wound resistors are coated with a vitreous enamel and are marked as to resistance but not for wattage. They are manufactured by the Ohmite Company.

(g) Fixed Mica Dielectric Capacitors. The fixed mica dielectric capacitors are sealed in molded bakelite cases. Those in the receiver have pigtail leads and are manufactured by Cornell-Dubilier while those in the dynamotor have lugs and are manufactured by Sangamo.

(h) Fixed Foil-Paper Capacitors. The fixed foil-paper capacitors used for r-f or a-f by-passing and filtering except in two instances are single units impregnated with wax in paper containers. One 600-volt 2 microfarad filter condenser in the receiver is sealed in a metal container and one 600-volt 2 microfarad filter condenser in the dynamotor is sealed in a metal container.

(i) Electrolytic Capacitor. One 12 mfd. 150 volt bypass condenser is used in the receiver.

(j) Nameplates. The nameplate on the transmitter-receiver unit is incorporated in the reverse photo etched panel. The nameplate on the dynamotor is reverse photo etched. The nameplates are not of the approved Navy type.

(k) Aluminum Alloys. The framework for supporting the main tuning dial is of aluminum alloy. Aluminum alloy, likewise, has been used for the chassis and panel of the equipment.

(l) Electric Cables. The cable used for connecting the storage-battery to the dynamotor is of a flexible two wire rubber covered type with battery clips on one end and a Cannon plug on the other. The cable connecting the dynamotor to the receiver is a flexible five conductor shielded type with rubber covering. It has Cannon plugs on both ends.

(2) In general the component parts are commercially standard parts. However, each item is numbered on the circuit diagram and where possible on the photographic plates. These numbers refer to the Collins Parts List, which gives specifications for the part as well as the manufacturers parts number.

31. Par 2-3. This equipment is, in general, unusually well constructed, considering its compactness. The main tuning condenser is of very poor construction both electrically and mechanically. The electrical contact to the rotor is not durable. The plates are flimsy. The rotor is mounted on suitable rotor and thrust bearings but the whole condenser is not mounted in a satisfactory manner to preclude vibration from shock. The parts in most cases are mounted rigidly, however, the r.f. chokes are wound on small isolantite rods which might snap off in severe shock.

32. Par. 2-4. The workmanship appears to be of fair quality, in fact, much better than in most commercial receivers.

33. Par. 2-5. Except for the tube shields, the component parts are, as far as practicable, heavily lacquered.

34. Par. 2-6. The aluminum and aluminum alloy used in cases and in the chassis have not been primed with a zinc chromate primer, however, except for the tube shields a very heavy and satisfactory coat of lacquer has been used.

35. Par. 2-7. The chassis is finished in a grey lacquer.

36. Par. 2-8. The case exterior is not of a standard navy type finish.

37. Par. 2-9. The operating panel is completely photo etched.

38. Par. 2-10. The chassis and component parts are finished ~~in a~~ to give a reasonably uniform appearance.

39. Par. 2-11. The use of iron and steel has been minimized.

40. Par. 2-12. The equipment operated ~~satisfactorily in~~ temperatures between 10° C. and 50° C. For frequency and gain stability see Plates 18, 19, 20, and 21.

41. Par. 2-13. Fuses have been provided in the dynamotor unit.

42. Par. 2-14. No ventilating louvers have been provided, however, at 50°C such ventilation does not appear necessary.

43. Par. 2-15. See paragraph 206.

44. Par. 2-16. The equipment does operate satisfactorily when inclined up to 45° in any direction from vertical.

45. Par. 2-17. No vibration test was made, however see paragraph 31. It is expected that such a test will be made when shock mounts have been furnished for the equipment.

46. Par. 2-18. No spare parts were furnished with test equipment. See paragraph 30 (2).

47. Par. 2-19. See paragraph 30 (1) (j).

48. Par. 2-21. Except in certain parts of the chassis constructing lock washers have been used. Screws and nuts are cadmium plate brass, while the lock washers are cadmium plated steel.

49. Par. 2-22. Soldering has been done in a neat secure manner, All wires have been satisfactorily secured before soldering.

50. Par. 2-23. Electrolytic capacitors have not been used except for one case, where a low voltage high capacity capacitor has been used to bypass the cathode resistor of the last audio stage.

51. Par. 2-24. Variable trimming capacitors are commercial rotary plate air dielectric type. They have ceramic insulation and have sufficient spring pressure to keep them locked in adjustment. Plate spacing is approximate-.018 inch. The main tuning condenser plate spacing averages .01 inch but the spacing is not uniform.

52. Par. 2-25. Ceramic insulating material has been used for all high potential radio frequency circuits.

53. Par. 2-26. Rivets have not been used.

54. Par. 2-27. Color coded wire has been used.

55. Par. 2-28. All wire used in r.f. and other circuits is of a satisfactory size and of proper rigidity, or flexibility, as required in each case.

56. Par. 2-29. No sample of the insulated hook-up wire is available for flame test, however, it is of good commercial grade and appears to be satisfactory.

57. Par. 2-30. No asbestos covered wire has been used or is necessary for heat resistant purposes.

58. Par. 2-31. Grommets have been used where wires passthrough metallic partitions.

59. Par. 2-32. All foil paper capacitors are in individual cases, however, these are waxed paper shells.

60. Par. 2-33. Transformers are in metal containers but not hermetically sealed. Flexible leads have been used. Foil paper condensers are in wax sealed cardboard containers. Metal transformer cases are lacquered but not protected otherwise. Composition resistors are a commercial type molded in a bakelite composition. The R.F. transformers are of a satisfactory type. The I.F. transformers are wound on a paper form. The coil and paper is wax impregnated. The iron core plunger units with their lock nuts are the supports for the units.

61. Par. 2-34 to 2-38, inc. Not applicable as no units are available for type tests.

62. Par. 2-39-40. Cables are of multiconductor shielded type, with a soft rubber covering over the shielding and are formed in a smooth round manner.

63. Par. 2-41. The cables appear to be of a type to give maximum flexibility with minimum "set".

64. Par. 2-42. The cable shielding is of close woven braid.

65. Par. 2-43. The cables are properly equipped with female connecting plugs and in the case of the battery cable with battery clips at the battery end.

66. Par. 2-44. The connecting plugs are Cannon type La Cal. The shells do not appear to be capable of withstanding 200 pounds pressure, but no test was made.

67. Par. 2-45. The plugs on the ends of the cables are not connected to the shielding.

68. Par. 2-46. No gaskets are included in the plugs to make them water (submergence) proof. No test made.

69. Par. 2-47. The shells on the connecting plugs are non-ferrous, but not corrosive resistant.

70. Par. 2-48. All cables are six (6) feet in length.

71. Par. 2-49. No electrical indicating instruments are used in the receiver section of the equipment.

72. Par. 2-50. The glass used is not of the non-glare type.

73. Par. 2-51. See paragraph 71.

74. Par. 2-52. No "die cast" parts have been used in the receiver proper, however the connecting plugs on the power cables are so made.

75. Par. 2-53. Stator plates on main tuning capacitor have been secured by "staking" alone. No plating has been used, the parts being of aluminum. ~~chromium.~~

76. Par. 3-1. The equipment consists of the receiver (proper) and a power unit.

77. Par. 3-2. The receiver is of the cabinet type while the power unit (dynamotor) is not.

78. Par. 3-3. The dimensions of the receiver unit are as follows:

Depth - 8 1/2"

Height - 14 1/4"

Width - 9 3/4"

79. Par. 3-4. The dimensions of the dynamotor unit are as follows:

Depth - 6 1/4"

Height - 6 1/2"

Width - 3 1/2"

80. Par. 3-5. The weight of the units are as follows:

Receiver unit - 24 pounds 12 ounces.

Dynamotor - 8 pounds 3 ounces.

81. Par. 3-6. No protuberances are on the side of cabinet and none extend more than three (3) inches beyond the face.

82. Par. 3-7. No method for mounting has been included on the receiver unit. The dynamotor may be mounted on or hung from the operating table.

83. Par. 3-8-9. No shock-proof mountings have been included.

84. Par. 3-10. The panel of the receiver is integral with the chassis for easy removal of the unit from the cabinet.

85. Par. 3-11. The receiver is connected to the power unit with a single multiconductor cable with female attachment plug on each end.

86. Par. 3-12. The receptacle for the cable connection is mounted on the front lower left corner of the panel.

87. Par. 3-13. Not applicable.

88. Par. 3-14. Guides have not been provided but chassis slides easily into cabinet.

89. Par. 3-15. The chassis when removed from its case may be placed on its bottom, sides, or back.

90. Par. 3-16. No pulls have been provided on the front panel, However by means of a flange on the sides it may be removed from case without undue strain on the control knobs.

91. Par. 3-17. Wing nuts or knurled screws are not provided for fastening panel to case. When removed the screws used become completely separated.

92. Par. 3-18. The panel is completely photo etched.

93. Par. 3-19. All controls are located on the front panel and in a symmetrical manner.

94. Par. 3-20. The controls,though suitably marked,have not been marked according to standard Navy nomenclature. See paragraphs 132 and 150.

95. Par. 3-21. ~~The controls though~~ All markings are permanent and easily read at a distance of 24 inches.

96. Par. 3-22. Reversed photo etching has been used on the panel. However, the finish is a glossy black. This finish, though of a pleasing appearance, gives considerable glare.

97. Par. 3-23. Band change switches are of the rotary self-cleaning

wiping type, but not heavily made for long usage. They are of a standard commercial grade and do not comply with specifications for shipboard use. The contact springs are short and the silver plating thin.

98. Par. 3-24. Positive acting positioning devices are provided.

99. Par. 3-25. Silver plating on contacts is not fifteen mils in thickness, (probably less than ~~two~~ one mils).

100. Par. 3-26. All dials, except those calibrated in frequency, are marked on the bases of 0-10 evenly spaced divisions, with half division marks ✓

101. Par. 3-27. The main tuning dial and its vernier control are counter clockwise for an increase in frequency. The volume control is clockwise for an increase in volume. The counter clockwise motion is not standard Navy practice.

102. Par. 3-28. Non-glare glass has not been used. The glass is secured by clips of a satisfactory type.

103. Par. 3-29. Vernier control of the main tuning is used.

104. Par. 3-30. The main tuning Vernier has a ratio of 120 to 1.

105. Par. 3-31. The vernier is of the split gear type--and is easy running. The backlash is much less than half the marked ~~half~~-divisions.

106. Par. 3-32. The frequency calibration of the receiver is in megacycles.

107. Par. 3-33. The length of the shortest calibrated scale is four (4) inches. The highest frequency band is the shortest.✓

108. Par. 3-34. The tuning device is of the moving scale type.

109. Par. 3-35. The calibration of all bands ~~is~~ in megacycles. Band 1 is marked in .1 megacycles with numerals at .2 megacycles. Band 2 is marked in .2 megacycles with numerals at .8 megacycles. Band 3 is marked in .5 megacycles with numerals at 1 megacycle points.

110. Par. 3-36. The tuning device has a linear scale which, in combination with the vernier scale, provides 1200 divisions on its complete rotation. The main dial provides 60 divisions and the vernier 20 divisions. The divisions on the main dial have 3/16 inch spacing.

111. Par. 3-37. The fiducial marks are strongly constructed and of such design to permit easy and rapid reading but care must be taken to eliminate parallax. Internal illumination is not used. The reading point has the same width as main scale divisions.

112. Par. 3-38. All scale divisions are readily discernable at a distance of 24 inches and have a width of approximately .01 inch.

113. Par. 3-39. Scale markings are white on a gloss black background. This dial is reverse photo etched in the same manner as the panel.

114. Par. 3-40. Scale and fiducial marks on the main dial are behind the panel. The opening is small and in keeping with specification, 9-33. See paragraph 210.

115. Par. 3-41. Non-glare glass is not used but the scale is readable in light arriving at a 45-degree angle. No auxiliary lighting is provided.

116. Par. 3-42. The opening for reading the dial is of such a size as to permit two significant and identifying frequency calibration figures to be visible at all times.

117. Par. 3-43. The band change switch does not eliminate the reading of the wrong scale except as to reference to the accompanying markings. As only three bands are used, this method is not particularly objectionable.

118. Par. 3-44. Component parts are not easily removed without the removal of other parts.

119. Par. 3-45. Rivets are not used.

120. Par. 3-46. Component parts of the equipment are of proper rating.

121. Par. 3-47. R. F. and I. F. coils are properly designed as to spacing and insulations except for the i.f. coils, which are wound on paper forms.

122. Par. 4-1 to 4-7, inc. Not applicable.

123. Par. 4-8. No calibration chart is provided.

124. Par. 5-1. The preselector and IF/AF stages are combined in one unit.

125. Par. 5-2. Band switching is employed.

126. Par. 5-3. The frequency range is covered in three (3) bands.

127. Par. 5-4. A uni-controlled tuning dial is employed.

128. Par. 5-5. The preselector or r.f. section of the receiver is controlled by a main tuning dial and band selector switch. No antenna compensator is used.

129. Par. 5-6. See paragraphs 103-117, inclusive.

130. Par. 5-7. See paragraphs 97-99, inclusive.

131. Par. 5-8. No antenna compensator used.

132. Par. 5-9. (1) See paragraphs 109-111, inclusive.
(2) Title "Receiver Band Switch", positions marked 1.2.3.
(3) See paragraph 131.

133. Par. 5-10. See Table 16.

134. Par. 5-11. See Plates 25, 26, 27.

135. Par. 5-12. See Table 15.

136. Par. 5-13, 5-14. See paragraph 131.

137. Par. 5-15. Two preselector resonant circuits are used (for each band) between the antenna post and the first detector grid. See Plates 3,4, and 5 for the selectivity of these circuits. One r.f. amplifying stage is used. See Plates 16 and 17.

(1) Two resonant circuits do not precede the first tube.
(2) See Table 4.
(3) See Plate 6.

138. Par. 5-16. Only one value of antenna impedance is provided. See Table 14.

139. Par. 5-17. See Table 14.

140. Par. 5-18. See paragraph 139.

141. Par. 5-19. A suitable binding post is used for the antenna input connection. However, in the test model this terminal could not be tightened to eliminate its turning.

142. Par. 5-20. The antenna input terminal and ground terminal are mounted on the front panel on the lefthand side.

143. Par. 5-21. The input terminal is mounted on a ceramic insulator.

144. Par. 5-22. Individual trimmers are provided to trim both the capacity and inductance of each r.f. circuit.

145. Par. 5-23. Individual trimmers are provided to trim both the capacity and inductance of each first oscillator circuit.

146. Par. 5-24. No protective device is employed in the antenna circuit to take care of induced high voltages from nearby transmitters. The receiver is, however, protected from its associated transmitter voltage by a relay (See par 12 A.

147. Par. 5-25. No protective device has been included in the antenna circuit. See par 12 A

148. Par. 6-1. The preselector and IF/AF stages are combined in one unit.

149. Par. 6-2. I. Mounted on the front panel, besides the preselector control devices, are the following:

(1) Manual gain control

(2) Oscillator control

(3) Reception transfer switch (CW/MCW)

(4) Power switch (combined with transmitter-off, receive, voice, CW).

(5) Telephone jack.

II. The following are not included:

(1) Radio selectivity switch (Broad-Sharp)

(2) Audio selectivity switch (Broad-Sharp)

(3) Output level control.

(4) A.V.C. .OL switch (on-off).

(5) Frequency vernier.

(6) D.C. Voltmeter.

(7) Tuning meter.

(8) Output meter.

(9) Pilot Light.

150. Par. 6-3. The controls are marked as follows:

(1) The "Gain Control": calibrated 0 to 10 in half divisions. Zero is minimum gain, clockwise rotation.

(2) Title "Osc. control": Marked "MO, CO_1, CO_2" for master oscillator and crystal oscillator 1 and 2.

(3) No title, marked "voice - CW."

(4) Title "Power SW" Marked "Off-Receive - Voice - CW." Voice and CW place the transmitter in operation and receiver in non-operating position upon depressing microphone button or key.

(5) Title "Headphones".

151. Par. 6-4, 5, 6. No borad-sharp selectivity included.

152. Par. 6-7. The manual gain control varies the gain in the R.F. and I.F. tubes. A variation of 74 db is secured. See Plate 14.

153. Par. 6-8. No automatic volume control or output limiter included.

154. Par. 6-9. The relationship between angular rotation of the gain control and receiver gain is within the ± 12 db limit. See Plate 15.

155. Par. 6-10. The gain control operates in such a manner as to permit a uniform increase in gain. See Plate 15.

156. Par. 6-11. A minimum of extraneous noises are introduced into the audio output by the gain control.

157. Par. 6-12 to 6-24 incl. Not applicable.

158. Par. 6-25. No frequency vernier is included on the front panel. The control is in the rear of the chassis where screwdriver adjustment permits a change of frequency from zero beat to over 10,000 cycles on both sides of the zero beat points.

159. Par. 6-26 to 6-37. Not applicable.

160. Par. 6-38. The power switch serves the function of turning on and off the equipment. When turned to positions of "receive", "voice", or "CW, the dynamotor relay is operated as well as connections made to supply filament power to the vacuum tubes. In the "receiver" position high voltage is supplied only to the receiver section of the unit.

161. Par. 6-39. No pilot light included.

162. Par. 6-40. The telephone jack is a commercial standard type. It is mounted near the bottom of the panel to the left of center.

163. Par. 6-41. The telephone jack is permanently connected across the output transformer.

164. Par. 6-42. The intermediate frequency transformers with their trimmers are installed in individual shielded containers, but some of their construction is not satisfactory. See paragraph 60.

165. Par. 6-43, 6-48. Not applicable.

166. Par. 6-49. The "Q" of individual i.f.circuits is less than 500.

167. Par. 6-50, 51, 52. No terminals are provided in the second detector CIRCUIT FOR THE INSERTION OF A D. C. microammeter.

168. Par. 6-53. The measured impedance of the output transformer is 1200 ohms though the instruction book indicates that the impedance should be 500 ohms.

~~xx169xxxxParxxx6-54xx Notxxapplicablexx~~

~~170xxxxPaxxx6-55xxxxNo~~

169. Par. 6-54. The output transformer is not electrostatically balanced. One side is grounded.

170. Par. 6-55. Not applicable.

171. Par. 6-56. No noise limiter is included. The circuit does not inherently reduce peak noise.

172. Par. 6-57 to 6-63. No audio band pass filter is included. See Plates 10, 11, 12, and 13.

173. Par. 7-1. The power unit is operated from a 12-volt storage battery.

174. Par. 7-3,4.5. Not applicable.

175. Par. 7-6. The power consumption when operating the receiver alone is 68 watts.

176. Par. 7-7 to 7-13. Not applicable.

177. Par. 7-14. Radio frequency filters are inserted between the 12-volt supply and the low end of the dynamotor and between high end of the dynamotor and the high voltage terminal.

178. Par. 7-15. Not applicable.

179. Par. 7-16. See Table 11.

180. Par. 7-17. Fuses are inserted in the plus 12 volt line to the low end of dynamotor. They are easily replaceable. The fuses are of the "little fuse" 3 AG type.

181. Par. 9-1. In testing the electrical qualifications of the receiver the following conditions, except where specifically noted, were used:

(1) The equipment was operated on a 12-volt storage battery and an A-C power pack giving the proper "B" supply voltage. See Paragraph 8.

(2) The input was applied to the receiver through a standard G.R. dummy antenna.

(3) The audio output was measured with respect to a 500-ohm non-inductive resistance load as this was the output impedance given

in the instruction book. However, a check made with a 600 ohm load showed a 20% increase in power. All values of sensitivity have been corrected to correspond to this 600 ohm output as required by the governing specifications.

(4) The manual gain control was adjusted for standard noise level in the c.w. position and for maximum gain in MCW (standard noise level could not be reached on MCW).

(5) All vacuum tubes used were of normal transconductance values.

(6) The equipment was operated at room temperature (approximately 22° C.) and less than 50% humidity.

182. Par. 9-2. Not applicable.

183. Par. 9-3. The C.W. sensitivity is not met in band 1 and low end of band 2. See Table 1.

184. Par. 9-4. The MCW sensitivity is given in Table 2. This gives the sensitivity for 20db above noise level and for 6 M.W. and 50 M.W. output. The required sensitivity is not met in Band 1.

185. Par. 9-5. MCW signal/noise ratio is greater than 3/1. See Table 3.

186. Par. 9-6. Overall selectivity is shown on Plates 1 and 2. It does not completely fall within the limits.

187. Par. 9-7. The preselector selectivity is not within maximum limits as shown on Plates 3,4, and 5.

188. Par. 9-8. The image selectivity, as shown on Plate 6, does not meet the requirements.

189. Par. 9-9. The direct reception of the intermediate frequency, as shown on Plate 6, does not meet the requirements.

190. Par. 9-10. The output of the first oscillator reaching the antenna post is shown in Table 4. In all cases it is much greater than that allowed. Measurements were made with a standard dummy connected to the receiver.

191. Par. 9-11. The maximum undistorted output as shown in Plate 8 meets the specifications.

192. Par. 9-12. Resonant overload does not occur under 300 milliwatts. See Plate 9.

193. Par. 9-13. The specified resonant overload is almost obtained for the required variation of ~~92~~ CW input of two orders. See Plate 9.

194. Par. 9-14. The linearity of the overall receiver gain between the limits of three and thirtydb below resonant overload is within one db.

195. Par. 9-15. The overall fidelity as shown on Plates 10, 11, 12, and 13 does not fall within the limits for an input that gives standard output.

196. Par. 9-16. Not applicable.

197. Par. 9-17. Frequency and gain stability tests are summarized in Table 11. Individual test results are shown in Tables 5 to 10, inclusive, and Plates 18 to 21, inclusive.

198. Par. 9-18. The output hum level, as shown in Table 12, is greater in all cases than the maximum requirements.

199. Par. 9-19 to 9-21. Not applicable.

200. Par. 9-22. Interstage and overall regeneration has been minimized so that no evidence of oscillation or instability occur at full gain.

201. Par. 9-23, 24. The oscillator tubes operate satisfactorily. However, on replacement of 2nd oscillator tube of transconductance one-third below book rating ~~one~~ the tube did not oscillate.

202. Par. 9-25. Static pulses do not cause a reduction in sensitivity after .003 seconds. See Plate 24.

203. Par. 9-26. Equipment is not available for this test.

204. Par. 9-27. The receiver operated satisfactorily after undergoing the temperature and humidity tests.

205. Par. 9-28. The subject equipment was not placed on the vibration

table. However, pounding on the test table caused serious frequency modulation.

206. Par. 9-29. The subject equipment operated satisfactorily in an ambient temperature at 50° C. without damage or deterioration of any parts.

207. Par. 9-30. Except for the inductive trimmer in the first r.f. stage of the first band, all trimmers had sufficient electrical leeway for calibration adjustments.

208. Par. 9-31. The beat frequency oscillator is properly adjusted to give a 1,000-cycle beat note.

209. Par. 9-32. No spurious responses appear in the output of the receiver due to the first or second oscillator or a combination of the two.

210. Par. 9-33. The subject equipment when placed in a field of 25,000 to 50,000 MV/Meter and resonated to said field (dummy antenna shielded) had an output much greater than standard output. The cabinet is separated from the front panel by a rubber gasket, which, though fine from the point of view ~~of view~~ of "spray proofing," is not satisfactory from the electrical standpoint. This may be responsible for the poor operation in this test.

211. Par. 9-34. The subject equipment has no appreciable oscillator drag or detector distortion when signals up to 105 microvolts are applied. See Plate 24 for time delay action.

212. Par. 9-35. See Paragraph 205.

213. Par. 9-36. The subject equipment is not satisfactory in regard to cross modulation and overload selectivity. See Plates 16 and 17.

214. Par. 11. No spare parts furnished.

215. Par. 12. One instruction book was furnished with subject equipment. This book includes in its contents a description of the circuit, installation methods, operation methods, and maintenance and service. Included also is a circuit diagram, lists of parts with replacement numbers and photographs of the chassis and equipment.

SUMMARY OF DEFECTS

216. There are summarized below the various defects and instances encountered during the test where the subject equipment does not meet the usual Naval Requirements. Numbers in parenthesis refer to paragraphs discussing defect.

1. The vacuum tubes employed are not Navy standard types. (30d).
2. An electrolytic capacitor is used as a cathode bypass (30i).
3. No zinc chromate primer has been used (34).
4. The case exterior is not a standard Navy type finish. (36).
5. The main tuning condenser is not rugged enough and spacing between plates is too small. (51).
6. The transformer used is not in a hermetically sealed case and further does not have a 500 ~~cycle~~ ohm output ~~impedance~~ as stated in the instruction book. The I.F. transformers are wound on paper forms. (60, 164, 168).
7. The cable plugs are not waterproof (68).
8. The glass used is not of the "nonglare" type. (72)
9. The stator plates of the main tuning capacitor are not secured satisfactorily (75).
10. No method of mounting the receiver unit has been provided. (87).
11. The method of securing the chassis to the cabinet is not satisfactory (91).
12. The nomenclature of the dials and controls is not in accordance with usual Naval practice. (94, 132, 150).
13. The band change switch is not durable. (99).
14. The direction of rotation of the main tuning dial and its vernier are in the opposite sense to the usual specification requirements (101)
15. (a) The vernier ratio for the main tuning dial is outside of the specification limits. (104).

(b) The main dial scale is too short (107).

(c) The auxiliary tuning scale is marked in 60 rather than 100 divisions (110).

(d) Parallax has not been made as small as advisable (111).

(e) Scale markings and background of main dial are not of approved type. (113).

16. The band change switch does not eliminate reading of the wrong band. (117).

17. Component parts are not easily changed. (118).

18. No calibration chart has been provided (123)

19. No antenna compensator is used (128).

20. No provision is made for feeding the receiver by a concentric line (138)

21. No antenna circuit protective device is used (146).

22. The following features are not employed in the set. (149-2).

(a) Radio selectivity (broad-share)

(b) Audio selectivity (broad-share)

(c) Output level control.

(d) A.V.C.

(e) Frequency vernier control (on front pane).

(f) D. C. voltmeter.

(g) Tuning meter.

(h) Output meter.

(i) Pilot light.

is not navy standard and is not replaceable by a navy standard jack due to lack of space.

23. The telephone jack

24. Terminals for insertion of a d.c. microammeter in the second detector circuit are not available. (167).

25 The output transformer impedance is not 600 ohms (168). It is not electrostatically balanced (169).

26 The peak noise is not limited (171).

27. No audio band pass filter is used (172).

28. The attenuation of the power unit to r.f. is below 80 db. (178)

29. The C.W. and M.C.W. sensitivity is not within specification limits (183, 184).

30. The overall selectivity does not lie within the required limits (186).

31. The image selectivity is not within the required limits (188).

32. The direct reception of the intermediate frequency is not within the limits (189).

33. The radiation of the first oscillator to the antenna post is too great (190).

34. The overall fidelity does not fall within the specification limits (195).

35. The frequency stability is not within the limits for line voltage variation, change of ambient temperature, and change in relative humidity, ~~and two receivers on one antenna~~ (197).

36. The output hum level is too high (198).

37. The subject equipment is not rigid enough to eliminate frequency modulation due to vibration (205).

38. All trimmers do not cover the necessary range (207).

39. The subject equipment will not operate properly when subjected to a field of 10 Volts/meter (dummy antenna shielded). (210).

40. The subject equipment does not meet the requirements for cross modulation and overload selectivity (213).

41. The antenna binding post is not rigid.

42 The Key clicks as heard in the phones from operation of the hand key are so strong as to be very objectionable.

CONCLUSIONS

217. The Collins Equipment (receiver section) does not meet the majority of the electrical requirements of a Navy shipboard receiver. The use of only five tubes and the small space required for portability precludes many refinements required in such a receiver.

218. The construction is fair,though not as rugged as desired. Individual parts are well mounted except for the main tuning condenser and the I.F. transformers. These parts are considerably below Navy standard. The main tuning condenser should be rugged and have greater plate spacing. The I.F. transformers should not be mounted on their controls and should have the coils wound on ceramic or other approved insulation.

219. Many of the parts are inaccessible for replacement without the removal of other parts. Alignment of the r.f. stages is difficult,due to the small space between receiver and transmitter sections.

220. The main tuning dial does not have a long enough scale for easy reading of fractions of megacycles. A calibration chart should be provided for the equipment.

221. The vacuum tubes [redacted] are not of approved Navy type, requiring special spares to be furnished with the equipment.

222. The dynamotor should be of a continuous duty type. See transmitter report (N.R.L. Report No. R-1664). No failure of parts occurred during the test and no readjustment was necessary after the original realignment of the r.f. and i.f. stages would eliminate a change of alignment when the chassis was placed in its cabinet.

223. Since no indication has been given as to the type of service intended for the TCH equipment, it is impossible to state definitely whether the sacrifice in ruggedness, accessibility, and performance, to favor light weight and

 (see other side)

TABLE 1

C. W. Sensitivity

Band	Freq. MC	Sensitivity ~~MF~~ microvolts
1	2.0	63
	3.0	27
	4.0	15
Crystal 1	2.62	24
" 2	2.53	31
" 2	3.625	15
2	4.0	125
	6.0	4.5
	8.0	4.5
3	8.0	6.5
	12.0	4.4
	16.0	3.2

Note: Required C.W. sensitivity not less than 8 ~~MF.~~ microvolts

TABLE 2

M.C.W. Sensitivity

Band	Freq. MC	Sensitivity in microvolts	
		20 db above noise	6 m.w.	50 m.w.
1	2.0	45	150	360
	3.0	16	40	110
	4.0	7	20	45
Crystal 1	2.59	16	45	105
" 2	2.5	18	45	120
" 2	3.63	7.5	24	50
2	4.0	7.	25	50
	6.0	4.4	11.5	35
	8.0	4.	6	21
3.	8.0	4.5	14	40
	12.0	4.	9	24
	16.0	2.5	4	11

Note: Required MCW sensitivity not less than 18 ~~M.V.~~ micro volts

TABLE 3

M.C.W. signal/noise ratio

Band	Freq. mcy	Signal/noise 6 m.w. output ratio
1	2.0	3.8
	3.0	3.8
	4.0	3.1
Crystal 1	2.62	3.8
" 2	2.53	3.8
" 2	3.625	3.4
2	4.0	3.8
	6.0	3.8
	8.0	3.4
3	8.0	3.4
	12.0	3.8
	16.0	3.6

Note: Required MCW signal/noise ratio not less than 3/1

TABLE 4

Radiation Test

Band Collins	Freq. mcy	Radiation Freq. mcy	Signal on Ant. microvolts
1	2.0	2.455	69
		4.91	49
		7.38	33
		9.82	22
	4.0	4.455	200
		8.91	460
		13.3	470
		17.8	75
2	4.0	4.455	2300
		8.91	140
		13.3	130
		17.8	100
	8.0	8.455	4800
		16.9	8000
3	8.0	8.455	580
	16.0	16.455	10,000

Note: Required minimum radiation, less than 50 microvolts fundamental and 1 microvolt on any harmonic.

[redacted]

TABLE 4

Radiation Test

Band Collins	Freq. mcy	Radiation Freq. mcy	Signal on Ant. ~~mv~~ microvolts
1	2.0	2.4~~55~~	~~190~~ 69
		~~5.12~~ 4.91	~~24~~ 49
		7.~~38~~	~~16~~ 33
		~~9.82~~ 9,82	~~19.5~~ 22
	4.0	4~~.455~~	~~320~~. 200
		8.9~~8~~	~~375~~ 460
		~~13.3~~ 13.3 17.8	~~195~~ 470 75
2	4.0	~~4.95~~ 4,455	~~2700~~ 2300
		~~8.98~~ 8,91	~~133~~ 140
		~~13.52~~ 13.3 17.8	~~170~~ 130 100
	8.0	~~8.65~~ 8,455	~~4300~~ 4800
		16.9~~8~~	~~4300~~ 8000
3	8.0	8.455	~~200~~ 580
		~~16.9~~	~~11~~
	16.0	~~16.52~~ 16.455	~~7000~~ 10,000

Note: Required minimum radiation, less than 50 ~~mv~~ microvolts fundamental and 1 ~~m.v.~~ microvolt on any harmonic.

TABLE 5

Frequency and Gain Stability.

Line Voltage Variation

Battery Voltage	Gain Variation db	Frequency Variation cycles	%
10.8	1.75	60 above	.0030
12.0 normal	0.	0	0
13.2	.25	30 below	.0015
Total Variation	2 db		.0045%

Note: Maximum permissible frequency variation is .0005%
Maximum permissible variation in gain is 2 db.

TABLE 6

Frequency and Gain Stability

Variation of Gain Control

Band	Freq. mcy	Cycles Change	% Variation
1	3	110	.0037
2	6	200	.0033
3	12	220	.0023

Maximum permissible frequency variation is .0005%

[redacted]

TABLE 5

Frequency and Gain Stability.

Line Voltage Variation

Battery Voltage	Gain Variation ~~Volts~~ db	Frequency Variation cycles	%
10.8	76 1.75	60 above	.0030
12.0 normal	62 0	0	0
13.2	60 .25	30 below	.0015
Total Variation	2 db		.0045%

Note: Maximum permissible frequency variation is .0005%
Maximum permissible variation in gain is 2 db.

TABLE 6

Frequency and Gain Stability
Variation of Gain Control

Band	Freq. mcy	~~Gain~~ ~~Max freq.~~	~~Min cycles~~	cycles Change ~~Bf~~	% Variation
1	3	~~1000~~	~~1110~~	110	.0037
2	6	~~1000~~	~~1200~~	200	.0033
3	12	~~1000~~	~~720~~	220	.0023

Maximum permissible frequency variation is .0005%

TABLE 7

Frequency and Gain Stability

Variation with Input Signal

Input Signal	Average Frequency Output Signal	Max. Dif.	% Variation
microvolts			
5	1500	40	.00024
100,000	1540		

Note: Maximum permissible variation .0005%

TABLE 8

Frequency Stability

Reset of Band Switch

Band	Freq.	Frequency Cycles					Max Variation Cycles	%
1	2 mcy	1000	990	950	960	990	50	.0025
2	4	1000	930	850	1080	950	150	.0038
3	8	1000	1010	1080	1010	1040	80	.001
		Reset of Oscillator Control						
1	2 mcy	990	920	960	900	960	90	.0045
2	4	940	980	1010	940	990	70	.0017
3	8	910	980	1030	840	920	190	.0027

Note: Maximum permissible freq. variation is .05%

TABLE 9

Frequency and Gain Stability

Humidity

Band	Freq. mcs	Humidity	Frequency deviation	Sensitivity change	First osc. deviation
1	2	33 - 95%	.07%	1.2db	.048%
3	16.	30 - 93%	.081%	.9db	.058%

Note: Maximum permissible frequency deviation is .05%
Maximum permissible gain variation is 6 db

[redacted]

TABLE 7
Frequency and Gain Stability
Variation with Input Signal

Input Signal μ volts	Average Frequency Output Signal	Max. Dif.	% Variation
5	1500	40	.00024
100,000	1540		

Note: Maximum permissible variation .0005%

TABLE 8

Frequency Stability
Reset of Band Switch

Band	Freq.	Frequency Cycles					Max Variation Cycles	%
1	2 mcy	1000	990	950	960	990	50	.0025
2	4	1000	930	850	1080	950	150	.0038
3	8	1000	1010	1080	1010	1040	80	.001
		Reset of Oscillator Control						
1	2 mcy	990	920	960	900	960	90	.0045
2	4	940	980	1010	940	990	70	.0017
3	8	910	980	1030	840	920	190	.0027

Note: Maximum permissible freq. variation is .05%

TABLE 10

Frequency Stability

(reset of main dial)

3 MC

Clockwise Freq. change in cycles	Counter clockwise Freq. change in cycles
250	50
200	50
200	0
250	25
200	25
200	50
max. shift 250 cycles	.0083%

15 MC

400	2500
0	2500
200	1500
100	2200
max. shift 2500 cycles	.16%

TABLE 11

Frequency and Gain Stability

Summary

Conditions	Frequency Variation		Gain Variation	
	Subject equipment	Maximum permissible	Subject equipment	Maximum permissible
(1) Line Voltage Variation	.0045%	.0005%	2 dbs	2 dbs
(2) Change in ambient temperature	.005-.01%	.002%	2-3 dbs/50°C	6 dbs/50°C
(3) Change in relative humidity	.07-.08%	.05%		
(4) Variation of manual gain	.002-.004%	.0005%	.9-1.2 dbs	6 dbs
(5) Variation of input signal	.0002%	.0005%		
(6) Reset of band switch	.001-.004%	.05%		
(7) Reset of osc. switch	.002-.005%	.05%		
(8) Reset of main control	.0083-.16%	*		

* No limits set by governing specifications

[redacted]

TABLE 9

Frequency and Gain Stability
Humidity

Band	Freq. mcs	Humidity	Frequency deviation	Sensitivity change	First osc. deviation
1	2	33 - 95%	.07%	1.2db	.048%
3	16.	30 - 93%	.081%	.9db	.058%

Note: Maximum permissible frequency deviation is .05%
Maximum permissible gain variation is 6 db

TABLE 10

Frequency Stability
(reset of main dial)
3 ~~Mcy~~ Mc

Clockwise freq. cycles (change in)	Counter clockwise freq. cycles (change in)
250	50
200	50
200	0
250	25
200	25
200	50
max. shift ~~225~~ 250 cycles	~~.0075%~~ .0083%

15 ~~mcy.~~ Mc

400	2500
0	2500
200 (~~other side~~)	1500
100 (~~other side~~)	2200
max. shift ~~1000~~ 2500 cycles	~~.06%~~ .16%

TABLE 11
Frequency and Gain Stability
Summary

Conditions	Frequency Variation		Gain Variation	
	Subject equipment	Maximum permissible	Subject equipment	Maximum permissible
(1) Line Voltage Variation	.0045%	.0005%	2 dbs	2 dbs /6dbs/50°C/ ?
(2) Change in ambient temperature	.005-.01%	.002%	2-3 dbs/50°C	
(3) Change in relative humidity	.07-.08%	.05%	.9-1.2dbs	6 dbs
(4) Variation of manual gain	.002-.004%	.0005%		
(5) Variation of input signal	.0002%	.0005%		
(6) Reset of band switch	.001-.004%	.05%		
(7) Reset of osc. switch	.002-.005%	.05%		
(8) Reset of main control	.0083-.006%	*		

*No limits set by governing specifications

TABLE 12
Hum Level

Band	Freq. mcy	Hum freq. cycles	M. V. output gain min. 2nd osc. off Input 0	min. on 0	min. off 104 mv	max. off 104 mv
			← Power Pack			
1	3	60	1.4	1.5	1.5	33
		120	10	14	11	130
		240	2.7	3	2.3	130
2	6	60	1.4	1.4	1.4	60
		120	11	13	11	310
		240	2.4	3	1.4	280
3	12	60	1.4	1.5	1.4	88
		120	12	14	11	200
		240	2.4	2.5	2.2	150
			← Dynamotor			
1	3	85	7	7.7	7	120
		190	26	34	28	180
2	6	85	10	13	12	370
		190	28	37	27	550
3	12	85	10	12	12	810
		190	29	36	29	1000

Maximum permissible hum is .1 microwatt or with 600 ohm load, 7.7 microvolts.

*Note: In this condition set was microphonic

TABLE 13
Oscillator Operation

First Oscillator
Voltage at mixer tube

Band		Freq. ~~mcy~~ mcy	Osc. Voltage Volts
1		2	1.35
		3	12.
		4	9
2		4	2
		6	6.5
		8	9
3		8	1.2
		12	5.5
		16	30
	Crystal 1	2.045	45
	" 2	3.045	60

TABLE 14
Antenna Impedance

Band	Freq. mcy	Impedance ohms
1	2	3000
	3	1580
	4	1560
2	4	47
	6	75
	8	157
3	8	282
	12	290
	16	560

TABLE 15
Band Overlap

Band	Freq. mcy	Overlap mcy	% overlap
1	1.95		
1	4.13	.2	4.96
2	3.93		
2	8.2	.37	4.7
3	7.83		
3	16.4		

Note: Minimum required frequency overlap is 5%

TABLE 16
Calibration Accuracy

Band	Freq. Collins mcy	Freq. Signal mcy	Freq. Difference mcy	% Deviation
1	2	2.00	0	0
	3	3.05	.05	1.64
	4	4.05	.05	1.23
2	4	3.99	.01	.25
	6	6.03	.03	.5
	8	8.15	.15	1.84
3	8	8.05	.05	.62
	12	12.05	.05	.41
	16	15.9	.1	.63

Note: Maximum allowable deviation is 1%

TABLE 17
Dimensions and weight

	Receiver	Dynamotor
Depth	8 1/2"	6 1/2"
Height	14 1/4"	6 1/2"
Width	9 3/4"	3 1/2"
Weight		

Power Requirements
(Receiver only)

Current	Volts	Watts
5.2 Amps.	12	62.5

TABLE 18
Shielding of Equipment

Band	Freq. mcy	Field mv/meter	Audio Output Volts
1	2	50,000	15
3	12.4	25,000	12

Note: This test was made in the field of a transmitter to which frequency the receiver was resonated. However, the dummy antenna was inside the equipment in order to shield it from pickup.