4 March 1935

NRL Report No.B-1129

NAVY DEPARTMENT
BUREAU OF ENGINEERING

Report on

Test of Annunciator Equipment and Buzzer.
Chas. Cory Corporation
Exhibitor.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON,D.C.

Number of Pages: Text - 7 Plates - 1

Authorization: Bu.Eng.ltr. CV5/S65-(11-23-Ds) of 24 January 1935.

Date of Test: February 1935.

Prepared by:

W. B. Roberts, Sr.Eng.Aide,
Chief of Section

Reviewed by:

W. M. Haynsworth, Jr., Lieut.,USN

Approved by:

H. R. Greenlee, Captain, USN
Director

Distribution:
Bu.Eng.(5)

mbe

TABLE OF CONTENTS

Appendix

AUTHORIZATION FOR TEST

1. This test was authorized by reference (a) and other additional references pertinent to this problem are listed as references (b) and (c).

Reference: (a) Bu.Eng. ltr. CV5/S65(11-23-Ds) of 24 January 1935.
(b) Navy Department Specifications SGS(65)-41 of 1 May 1934.
(c) Navy Department Specifications 17S11a of 1 April 1931.

OBJECT OF TEST

2. The object of this test was to determine the suitability of the subject material, submitted by the Chas. Cory Corporation, for the Naval service and its compliance with Navy Department Specifications, references (b) and (c).

ABSTRACT OF TEST

3. The subject material was set up at this Laboratory and connected in circuits simulating service conditions and closely observed in order to ascertain its performance and ruggedness while under test for endurance, over and under voltage and frequency, and shock integrity. The usual test for temperature rise of the windings, insulation resistance and dielectric strength, then followed.

CONCLUSIONS

(a) Due to the unsatisfactory operation of the annunciator while under the endurance and shock tests, it is considered unsuitable for the Naval Service.

(b) The buzzer is of good design and workmanship and complies with all of the major requirements of the specifications. With minor modifications as outlined under comments, paragraphs 28, 29 and 30, the buzzer would be suitable for use in connection with annunciators incorporating relays in series with the drop windings.

RECOMMENDATIONS

(a) Due to the satisfactory operation of the buzzer under test, it is recommended that it be approved for use in connection with annunciators incorporating relays in series with the drop windings, subject to comments in this report, paragraphs 28, 29 and 30.

(b) Due to the unsatisfactory results obtained while testing the annunciator, for endurance and shock, it is recommended that it be not approved for the Naval Service.

(c) Inasmuch as the Bureau desires to standardize annunciator drops for the Naval Service, it is suggested that the Bureau make the Portsmouth drops, Bu.Eng.Drwg. 11-T-738, the basis of a standard design. These drops have proved to be very rugged in design and superior in shock integrity to any other drops tested by this Laboratory.

(d) In the event that the Bureau concurs with the suggestion, outlined in the preceding paragraph, it is further recommended that a four drop sample annunciator be submitted to this Laboratory for test by each manufacturer desiring type approval.

DESCRIPTION OF MATERIAL UNDER TEST

4. The material submitted for test consists of four annunciator drops and one relay, shunted with a 1023 ohm resistor, mounted on a rack and one medium pitch, 115 volt, A.C., 60 cycle buzzer. The buzzer is enclosed in a watertight aluminum alloy case.

5. The system operates from a supply of 115 volts, A.C. 60 cycles and is wired as follows:

> L1 is connected to one side of the relay winding and one of the relay contacts. The other side of the relay winding is in common with one side of each of the drop windings. A fixed resistor of 1023 ohms is shunted across the relay for by-passing part of the current. One side of the buzzer winding is connected to the other relay contact. The other side of the buzzer winding and one side of each push button should be connected to L2. When any push button is depressed, a current flows through the drop winding and through the relay winding and shunting resistor to L1. As the current flows through this circuit, the drop armature releases the shutter while the relay contacts close and operate the buzzer.

6. The drops are of the mechanical reset type and each is provided with a shutter designed for holding 1 inch by 1 inch cards. The shutter is released by the armature when it is attracted by the core and falls from the combined force of gravity and a coil spring.

7. The magnetic circuit of each drop is of the "U" type, consisting of a solid core, supporting a single winding and a flat piece of sheet steel bent at an angle of 90° on one end and permanently secured to the inboard end of the solid core. The other end of this bent piece supports the sheet steel armature by means of a slot and a flat steel spring. All steel and brass parts are protected against corrosion by nickel plating.

8. The magnet coil of each drop is wound with enameled wire, insulated from the core by varnished cambric and has a coil head of phenolic insulating material forced on each end of the core. Tinned lugs are provided for connecting the windings in their respective circuits.

9. The relay has a "U" shaped laminated core and a

hinged laminated armature in which is inserted a copper shading coil. The core supports a single winding of enameled wire protected with insulating varnish. Its bobbin is made of phenolic insulating material. The relay has two adjustments, one to limit the stroke of the armature, the other to vary the tension of the armature spring. The relay is single pole and is provided with tungsten contacts.

10. A terminal strip of approved insulating material, equipped with six standard Navy terminal lugs, properly identified by wax-filled engraving in the strip, is secured to the frame with four round-head brass machine screws, nickel plated.

11. The buzzer is designed for operation from a 115 volt, 60 cycle, alternating current supply. The magnetic circuit consists of a "U" shaped laminated core and a laminated armature of rectangular cross section. Two windings, having a total D.C. resistance of 42.1 ohms at ambient of 25.6°C are connected in series and each is placed on its respective pole. Each pole face is covered by a thin strip of nickel plated copper in order to prevent the armature from adhering to the face of the poles.

12. The armature is provided with two locking adjustments, one a stop to limit the stroke away from the pole and the other a spring to return the armature to its normal position against the stop.

13. Two standard Navy terminal lugs secured to an approval insulating block are provided for making line connections.

14. The entire mechanism of the buzzer is mounted on the cover of a watertight cast aluminum alloy case. The case is provided with four mounting lugs and two bosses, one tapped for 3/4" IPS terminal tube.

15. This buzzer is of the contactless type, the armature vibrating at the rate of 120 cycles per second due to its operation on 60 cycle alternating current.

METHOD OF TEST

16. The annunciator and buzzer were first operated for 48 hours at a speed of 10 operating cycles per minute at the required voltage and frequency values. This test was made with the subject material located in a compartment having a constant temperature of 54.4° C.

17. For determining the temperature rise of the

magnet coils, they were connected to the line for 4 consecutive hours at ambient temperature of 54.4°C.

18. The annunciator and buzzer were next tested for satisfactory operation when inclined 30° to the vertical in any direction, on voltages from 20% below to 10% above normal and on frequencies from 5 cycles below to 5 cycles above normal.

19. Each instrument was then tested for shock by subjecting it to 20 hammer blows of 50 foot pounds each, applied on a Bureau of Engineering standard shock stand. During this test, all drops were carefully observed while in the indicating and non-indicating positions.

20. The subject material was next tested for dielectric strength, insulation resistance, current consumption and power factor.

21. In addition, the buzzer was tested for audibility and watertight integrity.

22. In concluding, a general inspection was made to determine the quality of workmanship and conformance of materials with specifications references (b) and (c).

RESULTS OF TEST

23.

Specifications	Requirements	Test Values
Volts	115	115
Current	Alternating	Alternating
Frequency	60 cycles	60 cycles
Amperes	Not more than 0.3 amperes through the push-button	0.143 amperes (Buzzer current 0.122 amperes, at 115 volts, 60 cycles).

Endurance	Time	Voltage	Frequency	*
	36 hours	normal	Normal	Annunciator unsatisfactory
	3 hours	+10%	+5 cycles	
	3 hours	+10%	-5 cycles	Buzzer satisfactory (see comments)
	3 hours	-20%	+5 cycles	

Specifications	Requirements		Test Values
Endurance (cont'd)	Time	Voltage	Frequency
	3 hours	-20%	-5 cycles
Temperature rise	Magnet windings shall not exceed 30° C. above an ambient temperature of 54.4°C. when connected in the circuit for 4 consecutive hours.		Relay - *36.4° C Drop windings - 23.1°C. (Average) Buzzer - 15.6° C. (Operated 4 hours, one minute on every other minute).
Inclination	Buzzer and drops shall operate satisfactorily when inclined 30° to the vertical in any direction on frequencies of 5 cycles below to 5 cycles above normal and on voltages from 20% below to 10% above normal.		Satisfactory.
Shock integrity	Shall operate satisfactorily when subjected to 20-50 foot pound blows on Bu.Eng.standard shock stand.		*Drops unsatisfactory. Buzzer satisfactory
Dielectric test	1240 volts, 60 cycle, A.C. applied between all windings and ground for a period of one minute.		Satisfactory
Insulation resistance	Not less than 5 megohms by 1000 volt megger.		200 megohms by 1000 volt megger.
Power factor	Not less than 30%		Buzzer 30% P.F. Annunciator with one push button depressed 79% P.F.
Audibility	Buzzer shall be audible 30 yards in still air.		150 yards

Specifications	Requirements	Test Values
Watertight integrity	Shall not leak when submerged in 3 feet of sea water for a period of 12 hours.	*Annunciator submitted without case. Buzzer satisfactory.
Weight	- -	Buzzer 4 lbs.2oz.
Dimensions	- -	Overall dia. 7".125 Depth 3".25
Buzzer case material	Aluminum alloy	Aluminum alloy

*Notes failure to comply with the specifications.

COMMENTS

24. Throughout the entire endurance test, the drops occasionally failed to operate correctly. Part of the failures were due to the residual magnetism holding the armature against the face of the pole, preventing the shutter from being reset. The other failures were due to the projecting part of the shutter becoming locked behind the armature instead of resting on its edge when in the non-indicating position.

25. The temperature rise of the relay winding exceeds the allowable rise of 30°C by 6.4°C. This rise will be greater when the annunciator is installed in its watertight case.

26. The annunciator shutters fell from the non-indicating to the indicating position, and occasionally raised from the indicating to the non-indicating position, when subjected to shock. These shocks of 50 foot pounds each were applied in two ways; one with the force of the shock tending to move the annunciator toward the observer, the other, tending to move it away from the observer. The annunciator was mounted in the vertical plane, parallel to the bulkhead and six inches below point of impact.

27. The screw holding the relay armature fell out during the endurance test due to the backing off of the locknuts. To prevent this, a pin of suitable diameter assembled with a washer and cotter key should be substituted.

28. The magnet core of the buzzer is at present unprotected against corrosion. Before assembly, each of the

laminations should be coated with an approved insulating varnish.

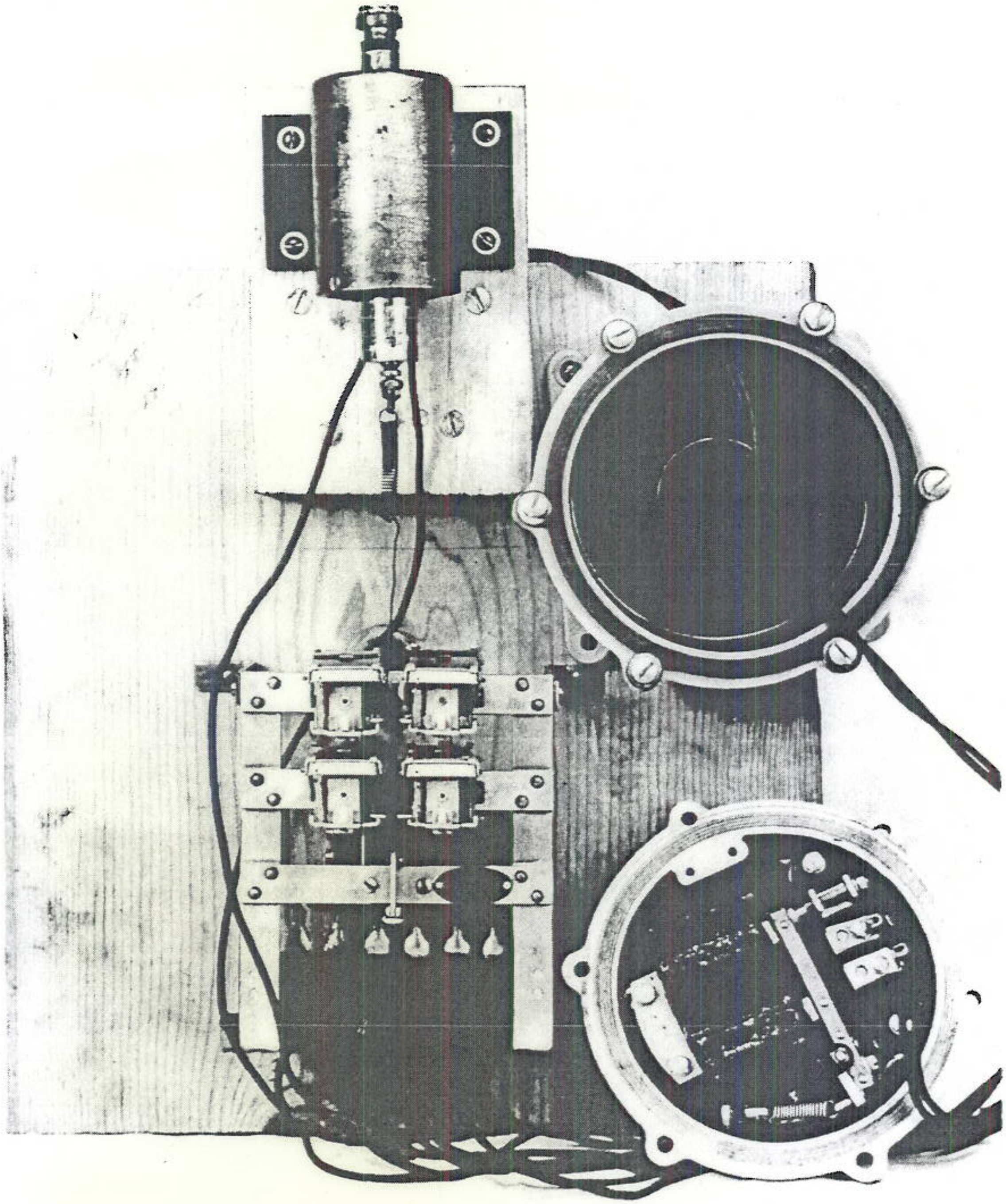
29. The watertight cast aluminum alloy case, with the exception of the cover, is not painted inside and out with two coats of approved aluminum paint as required before the finish coats are applied.

30. The thickness of the present mounting lugs should be increased approximately 0".0625 for a distance of 1" from the end of each lug. This allows the case to come in contact with the bulkhead only at the small areas surrounding the mounting holes and will help in preventing strain or breakage of the lugs when mounted on uneven surfaces.

CONCLUSIONS

31. Due to the unsatisfactory operation of the annunciator while under the endurance and shock tests, it is considered unsuitable for the Naval Service.

32. The buzzer is of good design and workmanship and complies with all of the major requirements of the specifications. With minor modifications, as outlined under comments, paragraphs 28, 29 and 30, the buzzer would be suitable for use in connection with annunciators incorporating relays in series with the drop windings.



1375

PLATE I

1 March 1935

NRL Report No. R-1128
BuEng.Prob. B3-6

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Repair of Model OA Antenna Measuring Equipment
Type 4360, Serial #1
Assigned to Navy Yard, Pearl Harbor.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages:	Text - 5 Tables - 3
Authorization:	BuEng. let. NR90/S67(8-1-W8) of 27 Sept. 1934.
Date of Test:	12 December 1934 to 29 January 1935

Prepared by:

R. S. Baldwin, Asst. Physicist

Reviewed by:

R. B. Owens, Assoc.Radio Engr.
Chief of Section

A. H. Taylor, Physicist
Superintendent, Radio Division

Approved by:

H. R. Greenlee, Captain, USN
Director

Distribution:
BuEng. (5)

TABLE OF CONTENTS

Appendices

AUTHORIZATION

1. This problem was authorized by Bureau letter, reference (a) and additional references pertinent to this problem follow as references (b) to (d) inclusive.

Reference: (a) Bueng.let.NR90/S67(8-1-W8) of 27 Sept. 1934.
(b) Comdt.Navy Yard, Pearl Harbor, let. NR90/S67(43)(15106CW) of 1 Aug. 1934 to Bueng.
(c) Specifications RE 13A 413B.
(d) NRL Report of 10 April 1933 on Problem M6-1.

OBJECT

2. The object of the test was to repair any damage which the antenna measuring equipment may have suffered in the past and to compare the performance of the set from Pearl Harbor, Serial #1, with the set Serial #6 already at the Naval Research Laboratory. The sets, hereinafter, will be referred to as #1PH and #6NRL.

ABSTRACT OF TEST

3. The Set #1PH was repaired mechanically and electrically and tested for accuracy of measurements of capacity and resistance. A number of mechanical defects were found and repaired. Serial #1PH was compared to Set #6NRL and both were tested using certain external loading coils as well as the internal loading coils mounted in the sets.

CONCLUSIONS

(a) Set #1PH has been repaired and is now in proper operating condition.

(b) The Set #1PH was found to operate with approximately the same degree of accuracy as was found to exist for Set #6NRL.

(c) The accuracy is not that required by the specifications but is as good as can be expected from the present equipments.

(d) The accuracy of these sets, however, is not as good as was found for the preliminary models which this Laboratory had an opportunity to test.

RECOMMENDATION

(a) It is recommended that there be manufactured a set of low loss or low resistance inductance coils for each equipment which can be used as External Loading Coils in place of the Internal Loading Coils which are incorporated in the equipments. The accuracy of both capacity and resistance measurements would be improved sufficiently to warrant the use of such coils, particularly in the case of antennae having effective resistances of less than 5 ohms. Even with the use of the external coils, however, the percentage accuracy of the resistance measurements for low antenna resistances will not be great, and the results will be of a qualitative rather than a quantitative nature. For values greater than 5 ohms the accuracy will approach that of the specifications.

DESCRIPTION OF MATERIAL UNDER TEST

4. The material under test was Model OA antenna measuring equipments type CAG-4360, Serial #1 and Serial #6. The frequency range of these sets is from 16 Kcs to 170 Kcs.

METHOD OF TEST

5. The method used in the Model OA type 4360 antenna measuring equipment is a direct substitution method. A radio frequency voltage is fed through an adjustable loading inductance and an antenna tuning condenser to the antenna. The antenna tuning condenser is adjusted until the system is resonated to the impressed frequency. The magnitude of the impressed voltage is read on a vacuum tube voltmeter used in place of a current indicating instrument. As a second step, a transfer switch throws the impressed voltage from the antenna to an adjustable phantom condenser and decade resistance box, both contained within the set and both of which are adjusted until the vacuum tube voltmeter reading is the same as it was in the first case.

6. When external loading coils were used, a decade resistance box was placed in series with the coil so that on transferring from the internal loading coil to the external, additional resistance might be added to keep the voltage drop constant across that portion of the circuit. The necessary additional resistance gave directly the difference in the resistance of the two types of loading coils. For this work, condensers of known capacity and resistance at the frequencies of test were used in place of antennae.

DATA RECORDED DURING TEST

7. The data recorded in the tests are given in Tables 1 to 3.

PROBABLE ERROR OF MEASUREMENT

8. The capacities tested were known to 0.1% and the resistances to 10%.

RESULTS OF TESTS

9. A thorough mechanical and electrical inspection was given the Model OA equipment type 4360 Set #1. This set #1PH was found to have a number of defects, any combination of which might have been the cause of erratic results or of making it appear that the set was inoperable. One of

the fixed condensers making up the Phantom Condenser Bank tested as having an open circuit. There was an intermittent contact in one of the fixed condensers of the Antenna Tuning Capacitor Bank. The transfer switch permitting the change from the real antenna to the phantom circuit did not make good contact, and on one terminal of the switch there was so much solder that occasionally a slight pressure on the handle or knob of the switch resulted in a shorting to ground of the antenna. Likewise, the switch permitting a transfer from an Internal Loading Coil to an External one did not make good contact. The switch blades and studs of the Antenna Tuning Step Capacitor switch, of the Internal Load Selector switch and of the Oscillator Coil Sdector switch had to be disassembled and cleaned. In a part of the Oscillator Coil Selector switch it was found that one set screw was completely out and the other set screw so loose as to be useless. To repair this is a major operation, and either more care must be exercised in the assembly of such an inaccessible switch or else all such switches must be located in an easily accessible spot. Furthermore, the connection from the Internal Loading Coil Tap #9 to the switch stud had broken loose from the lug.

10. Having located and repaired these defects, the measurements set forth in Table 1 were taken on Serial #1PH. The capacity chosen to be measured was of the order of magnitude of one antenna capacity at Pearl Harbor. Additional resistances were added at the low frequency to approximately cover the range of values which were considered reasonably normal ones. The table shows that the error in the measurement of capacity is uniformly small and is approximately constant at those frequencies for which the antenna is used. The resistance values, however, are uniformly high in value, and the error either on a percentage basis or in absolute magnitude is extraordinarily large.

11. The magnitude of the error of measurement with the equipments varies throughout the frequency range with the particular combination of capacity and resistance being measured, and no single value should be expected to apply for all conditions.

12. Table 2 indicates the range of capacity which may be measured at a given frequency using the internal loading coils supplied with the equipment and under the condition that the comparator meter shall read at least 1/3 of the full scale value, which in itself is not sufficient for accurate measurements. The latter part of the table shows that by the use of two external loading coils the

range of values may be increased.

13. This limitation of the capacity range which could be measured at certain frequencies was likewise noticed on set #6NRL.

14. In the preliminary models submitted for test before the production sets were made, this limitation was not observed and its existance in both set #1PH and #6NRL led to the assumption at first that the oscillator output must be low.

15. Investigation showed that this was not the case but that the trouble lay in the unusually high resistance of the internal loading coils. Two coils of the Universal wound type were obtained which had the same inductance as the Internal Load Coils #1 and #7 of set #1PH. These inductances were 20.7 millihenries and 1.13 millihenries respectively. When these Universal wound coils were compared to the corresponding internal loading coils of the two sets, it was found that the large coil had from 55 to 60 ohms and the small coil 38 to 42 ohms less resistance than either corresponding internal coil of the two sets. The ratio of coil resistances, internal to external, was approximately 7 to 1 in the case of the large coil and 4 to 1 in the case of the small coil.

16. Table 3 records the results of measurements taken on each set. A given capacity was measured at the same frequency using, first, a Universal wound coil externally and, secondly, the internal loading coil supplied. Not only is there an improvement in the accuracy of the capacity measurement to a very appreciable degree, but the extraordinarily marked increase in the accuracy of resistance measurements indicates that such coil resistances as exist at present in the sets can not be tolerated. As indicated in the last column, one of the major difficulties in using the internal loading coils in these cases is the greatly reduced comparator reading. The reduction is so great that normally one would say that the measurement could not be made at all.

17. Since, in the examination of the preliminary model no suspicion arose as to high resistance of the loading coils no tests were made to cover this point, and it is not known in what respect the loading coils of the production equipments differ from those in the model.

18. Under the present circumstances, the simplest way to gain an increase in accuracy with these sets is to make up a series of coils of inductance corresponding to the internal loading coils and use the coils externally, or in case of a transmitting antenna use the actual loading

coil of the transmitting set itself. The oscillator is shielded from the loading coil, even though this is used externally, so that no trouble should be experienced from that source, and any other interfering voltage will be picked up by the antenna itself and will give as much trouble as though it were picked up by the loading coil.

19. It is of the utmost importance that all the phantom circuit elements shall be of the lowest possible resistance. This method of measurement essentially determines the difference in resistance between the real antenna and phantom condenser which is substituted. In order that the greatest possible change shall be registered on the comparator meter, which is the means of indicating the difference, the circuit resistance exclusive of the antenna or phantom condenser should be small enough so that at least a ten per cent change in the phantom resistance should be observable for any antenna resistance greater than 1 ohm. Since the smallest phantom resistance steps are of 0.1 ohm values, for any antenna resistances less than 1 ohm the percentage error must be increasingly larger as the value decreases, unless one resorts to interpolation of the comparator meter reading.

CONCLUSIONS

20. Set #1PH has been repaired and is now in proper operating condition.

21. The set #1PH was found to operate with approximately the same degree of accuracy as was found to exist for set #6NRL.

22. The accuracy is not that required by the specifications but is as good as can be expected from the present equipments.

23. The accuracy of these sets, however, is not as good as was found for the preliminary models which this Laboratory had an opportunity to test.

TABLE 1

Data on Accuracy of Capacity and Resistance Measurement
QA 4360, Serial #1
Capacity being measured = 10,224 Mmfd.

Freq.in Kcs.	Load Coil	Phantom Capacity	Capacity error in %	Resistance added in addition to condenser resistance	Total of condenser resistance and added resistance	Apparent resistance as measured by set.	Resistance error in %
20	1	9898	-3.2	0.0	0.24	2.3	+858
20	1	9868	-3.5	0.4	0.64	2.6, 2.2 } 2.4	+275
20	1	9935	-2.8	0.8	1.04	2.2, 3.2, 3.4, 3.0 } 2.95	+184
20	1	9850	-3.7	1.2	1.44	3.8, 3.4 } 3.6	+150
25	2	9856	-3.7	0	0.19	2.4	+1165
30	3	9897	-3.2	0	0.16	2.1	+1210
35	4	9858	-3.7	0	0.14	2.35	+1580
50	5	9948	-2.7	0	0.10	1.63	+1500
75	6	9406	-8.0	0	0.065	3.26	+5010
100	7	9136	-10.6	0	0.05	3.55	+7000

TABLE 2

Data on Capacity Range Measurable at Certain Frequencies.

Freq. in Kcs.	Load	Capacity in Mmfd. Maximum	Minimum
16.65	Internal	24,400	14,200
20.4	"	17,700	5,100
23.5	"	13,900	3,100
27.5	"	20,800	2,000
36.0	"	16,300	< 1,000
48.7	"	17,700	< 1,000
100.0	"	6,600	< 1,000
170.0	"	6,600	< 1,000
16.65	External Univ.Coil (20.7 mh)	30,200	14,600
16.65	Internal Coil #1	24,400	14,200
160.0	External Univ.Coil(1.13 mh)	8,600	< 1,000
160.0	Internal Coil #7	3,300	< 1,000

TABLE 3

Data on Capacity and Resistance Measurements with External Loading Coil as well as Internal Loading Coil.

Set No.	Freq. in Kcs.	Load	Phantom Capacity	Cap. error in %	Apparent resistance by set.	Resistance error in %	Comparator reading, 15 ma full scale
Capacity being measured 29,000 mmfd. R of condenser = 0.42 ohms.							
1 PH	19.8	Universal Coil 20.7 mh	28,320	-3.1	0.86	+105	1.32 ma
		Internal Coil #1	24,320	-16.8	16.06	+3,730	0.18
Capacity being measured 22,500 mmfd. R = 0.2 ohms.							
1 PH	17.8	Universal Coil 20.7 mh	22,400	-0.44	0.59	+195	1.49
		Internal Coil #1	21,050	-6.9	4.09	+1,940	0.26
6NRL	17.8	Universal Coil 20.7 mh	22,200	-1.3	0.66	+230	1.48
		Internal Coil #1	21,150	-6.0	3.66	+1,730	0.19
Capacity being measured 5,000 mmfd. R = 0.62 ohms.							
1 PH	150	Universal Coil 1.13 mh	4,924	-1.5	1.55	+158	1.45
		Internal Coil #7	4,555	-8.9	5.55	+826	0.21
6 NRL	150	Universal Coil 1.13 mh	4,911	-1.8	1.65	+183	1.45
		Internal Coil #7	4,358	12.8	7.35	+1,125	0.10