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TEST OF TBA-1a TRANSMITTER INCLUDING
COMPARATIVE TESTS OF TBA TRANSMITTER

By
O. C. Dresser

Report No. 1002

NAVY DEPARTMENT
OFFICE OF NAVAL RESEARCH
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REPORT ON

Test of TBA-1a Transmitter

including

Comparative Tests of TBA Transmitter

BY
NAVAL RESEARCH LABORATORY
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TEST OF

T.B.A.-1A. TRANSMITTER, INCLUDING COMPARATIVE TESTS OF T. B. A. TRANSMITTER.

Tests conducted May 27 to September 6, 1933.

O. C. Dresser

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Approved:

H. R. Greenlee

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Appendices

1. AUTHORIZATION

The tests herein reported were authorized by the Bureau of Engineering letter S67/52/T.B.A. 1A(6-16-WS) of 21 June 1933 to the Naval Research Laboratory.

2. OBJECT OF TESTS

The object of the tests was to determine the relative merits of the Model T.B.A. equipment functioning as a crystal controlled transmitter and the Model T.B.A.-1A equipment, non-crystal controlled; also to determine the relative performance of the Model T.B.A. equipment functioning without crystal control (provision for self-excited operation having been incorporated as an emergency feature) and the Model T.B.A.-1A which was designed expressly for operation without crystals.

3. REFERENCES

The following references were used as a guide for the conduct of the tests.

Reference; (a) Bureau of Engineering letter S67/52/T.B.A.-1A (6-16-WS) of 21 June 1933 to Naval Research Laboratory.
(b) Basic specifications R.E.13A 420 D.
(c) Bidder's descriptive specifications R.A.1371.
(d) Type Test Report of Model T.B.A.-1A equipment, Serial No. 33
(e) Type Test report of starter and motor generator set from I.N.M. at Schenectady.

4. ABSTRACT OF TESTS

Under this heading it is desired to point out briefly wherein the equipment under test fails to meet completely the requirements laid down in the governing specifications and to indicate such features of design and construction where it is believed improvements are desirable and necessary.

Refer to Specifications R.E. 13A 420 D.

Par. 2-3. The transmitter can not in any sense be considered to be of rugged construction. The entire frame work is of very light construction which permits buckling when the transmitter rests on an uneven surface.
The master-oscillator compartment supporting members are not sufficiently rigid to properly maintain the compartment contacts in alignment.
The means provided for fastening the transmitter to the desk are inadequate.
The indicating arms on the shafts of the P. A. Tank Capacitor and the Antenna Tuning Capacitor are not securely fastened to shafts.

Par. 2-4. The I.P.A. plate blocking condenser is not provided with means for fastening securely.
There is insufficient clearance between the relay compartment door and desk. The means provided for securing the shielding to the transmitter frame are unsatisfactory.
The movement of the M.O. compartment endangers the high voltage wiring.
The contact members carrying the circuits from the 1st Buffer stage to the I.P.A. stage are misaligned and the contact is not positive.
The M.O. dial, (A), lock is misaligned with dial.
The M.O. Inductance switch (B) is of very light construction and subject to varying degrees of contact pressure.
The M.O. Band Change Switch (C), control knob and shaft assembly are also of light construction and are inadequately fastened to switch.
The M.O. thermostat is most inaccessibly located.
The 1st B.A. Tuning Capacitor (D) dial lock is unsatisfactory.
The M.O. Compartment Thermal Fuse Clips lack sufficient spring to completely open the heater circuit when the Thermal Fuse becomes plastic.
The stop in shaft of 3rd doubler Band Change Switch (L) is mislocated.
The Antenna Transmission Line Switch (T) assembly is unsatisfactory.
The location of the heater relay in the M.O. compartment is unsatisfactory.
(See Sec. 5 par. 2-4 of this report for complete details).

Par. 2-5. The equipment does not operate satisfactorily in all ambient temperatures between the limits of minus 1°C to 51.5°C. (See Sec. 5 par. 2-5 and plates 1 to 12 inclusive).

Par. 2-7. The use of iron or steel is not reduced to a minimum.

Par. 2-8. The high voltage generator brushrigging and terminals are insulated with phenolic insulation.

Par. 2-10. The P.A. Plate Choke By-Pass Capacitor Symbol 139 arced over repeatedly and caused the high-voltage fuse to blow.

Par. 2-14, 2-15.
The P.A. Filament and Screen-Grid by-pass capacitor, Symbol 83, overheats badly on a two hour locked key run.

Par. 2-17. At the high frequency end of the range the P.A. tubes are subject to severe overloads when operating at the rated input called for in the instruction book.

Par. 2-18. The requirement that the equipment must be designed so that safe operation and satisfactory performance are assured is not complied with completely. See pars. 2-3, 2-4, 2-5, 2-14, 2-15 and 2-17.

Par. 2-19. Although this test could not be conducted at the Laboratory due to the lack of proper facilities, the ability of the equipment to meet this requirement is open to question due to the reasons given under par. 2-3.

Par. 2-20. It is believed that the equipment will not comply with the requirements of this paragraph. See Sec. 5 par. 2-20 of this report.

Par. 2-21. See par. 2-20.

Par. 2-22. While it is believed that the intent of this paragraph is complied with it may be pointed out that much time would be saved when a break-down occurs if the parts of the transmitter which are subject to more or less frequent replacement, such as resistors, were marked with a number corresponding to the symbol number of the part as indicated on the wiring diagram.

Par. 3-16. The transmitter in certain ambient temperatures fails to meet the requirements of this paragraph. See Tables and Plates 1 to 12 inclusive.

Par. 3-18. The M.O. Tuning Vernier does not comply with the requirements of this paragraph.

Par. 3-22. The friction type locking devices on the M. O. Dial and 1st B. A. dial are not satisfactory.

Par. 3-30. The M. O. Cabinet Heating Circuit Indicating Lamp is not properly connected in the heater circuit.

Par. 3-39 (2). The foundation pedestal can be bolted to the deck but lacks security as pointed out under par. 2-3.

Par. 3-39 (3). It is necessary to cut hole in shielding in order to carry the cable connections to the terminal panel.

Par. 3-40. The knurled head screws used to secure the shielding are unsatisfactory and the shielding would be improved mechanically if heavier material were employed.

5. METHODS AND RESULTS OF TESTS.

Under this heading reference is made to Basic Specifications R.E. 13A 420D and comment is made under the section and paragraph designations as they appear in the above reference.
Where no comment is made, the equipment under test meets the requirements completely.

SPECIFICATIONS R.E. 13A 420D.

Par. 2-3. The frame of the transmitter and the means for securing the unit to the deck fail to meet the requirements of "rugged construction." The vertical corner members are 1/8" x 1-1/4 x 1-1/4" aluminum angle and the horizontal frame members are 1/8" x 1" x 1" aluminum angle. Gusset plates and corner brackets are 1/8" x 4" x 4". In numerous places the angles and gusset plates are cut away still further weakening the structure. The shields are 1/16" aluminum sheet and the front panels are 3/16" aluminum.
The brackets used in securing the transmitter to the deck are pieces of 5/16" x 2" x 2" aluminum angle 3/4" wide. These angles are provided only in the rear of the transmitter. The front edge of the transmitter is provided with 1/8" x 1" x 1" aluminum angle in which holes are drilled for fastening. It is believed that these fastenings would be inadequate should the deck tilt to such a degree that a strain would be imposed on the securing members.
The indicating arms on the shafts of the P. A. Tank Capacitor and the Antenna Tuning Capacitor are not broached or pinned to the shafts. They are held in place merely by the friction of the screw head. If the indicating arm is brought forcibly against the right hand stop the arm loosens and is free to rotate on the shaft which destroys the previous calibration of the circuits.
The M. O. Compartment, weighing 197 lbs. is supported in the transmitter by means of 1/8" x 1" x 1" aluminum angles. These supports are not sufficiently rigid and under slight vibration, variable contact occurs in the connections to this compartment. This variable contact results in rapid frequency shifts and a rough note.

Par. 2-4. The I.P.A. plate blocking condenser (symbol 30) is secured within the transmitter by means of two thin metallic tabs. These tabs are an integral part of the aluminum condenser case and are about 1/32" thick. The weakness of these tabs prevents the condenser from being mounted rigidly and securely since they can easily be bent and broken off. The flexible "pig-tail" connections to this condenser do not constitute an assembly of good workmanship since the rubber insulation on these leads will not withstand aging and they are subjected

to potentials as high as 1500 volts D.C. It is believed that flexible connections of this type should be avoided in high frequency designs.
The relay compartment door is hinged so low that the bottom edge scrapes the deck which prevents the door from being opened readily.
The knurled head screws used to secure the shielding to the transmitter frame are of such design that they become bent in shipment and handling so that great difficulty is experienced in securing the shields properly.
This difficulty, coupled with the fact that the shields are extremely light, 1/16" thick, makes it difficult to avoid variable shielding effects.
The rear end of the M. O. Compartment skids cut into the lead sheath of the high voltage cables which are secured to the frame of the transmitter in the rear of this unit. This difficulty was eliminated by cutting off about 3/4" from the rear end of the skids.
The contact members carrying the excitation and ground connections from the 1st B. A. stage to the 2nd B. A. stage did not make good contact due to misalignment. The micalex member which carries the contact studs in the 1st B.A. compartment had to be turned around end for end in order that better contact could be made. This piece was apparently erroneously assembled. Furthermore, the shield between the two units upon which the spring contacts are mounted is too light and flexible, permitting the contacts to spring away when the M. O. unit is inserged. This same criticism applies to the shielding of the 1st B. A. compartment which carries the contact studs.
When the equipment was delivered it was found that the heater relay in the M. O. compartment was inoperative due to mis-adjustment. It was found necessary to remove the relay with its associated leads in order to adjust. This relay should be mounted so that adjustment can be made without removing the relay. The M. O. dial is provided with a friction type lock. This lock is misaligned with the center of the dial and when it is tightened it turns the dial enough to cause a M. O. frequency shift of as much as 2 kcs.
The M. O. Inductance Switch (B) is a rotary switch of very light construction and uncertain contact. Under slight vibration this variable contact causes wide frequency shifts.
The M. O. Band Change Switch (C) control shaft assembly is very light and is fastened to the switch by means of a #8 screw and jam nut. This shaft repeatedly loosened during the test period.
The M. O. compartment thermostat is installed in such a way that in order to install or inspect the thermostat the M. O. Tuning Capacitor must be removed. This operation is difficult and special tools are required. Furthermore, when the M. O. Tuning Capacitor is removed the calibration of this circuit is destroyed.
During the tests it was noted that the M. O. heater would not maintain the compartment temperature at the proper point when the ambient temperatures approached 50°C even though the "Oven Heater Rheostat" was 100% out.

This condition at first was attributed to lack of heat capacity. It was later believed, however, that part of this trouble was due to a partially blown thermal fuse causing intermittent contact in the heater circuit. Previous experience has shown that if a thermal fuse holder lacks spring enough to widely separate the holding members when the fuse blows, that the fuse, in a plastic state, will continue to partially complete the heater circuit.

After a new fuse was installed no further trouble was experienced in maintaining the proper compartment temperatures in low ambients.

The control shaft of the 3rd Doubler Band Change Switch (L) is provided with a notch which engages with a plate fastened to the front panel of the transmitter. When the shaft is raised sufficiently to disengage the slot the key circuit is opened. If the shaft is pushed in to the limit of motion, the slot is beyond the engaging plate and the key circuit remains open until the shaft is pulled back into exact position. The slot in this particular assembly is mislocated about 1/8".

The Antenna Transmission Line Switch (T) is of very poor construction and assembly. It consists of two switch blades linked by means of a micalex strip and actuated by means of a cam and shaft controlled from the front panel. Number eight screws are used as bearing pivots having spring washers and nuts to hold the parts in place. If enough tension is applied to the nuts to keep them from loosening, the switch blades cannot be moved. When the nuts are loosened they soon back off under slight vibration. Although this switch was only used a few times it became inoperative before the end of the test period.

The 1st B.A. Tuning Capacitor (D) dial lock does not function as such due to the fact that the center of the locking members are fastened at a single point, this point thus becoming a pivot about which the locking members are free to rotate through about 20° of arc.

Par. 2.5. The equipment does not operate satisfactorily in all ambient temperatures between minus 1°C to 51.5° C. As previously mentioned, the M. O. compartment heater failed to maintain the proper temperature in low ambients until a new thermal fuse was installed. After installing a new thermal fuse the frequency drift was within specification limits between the temperatures of 0° and 30° C.

However, the M. O. compartment thermostat begins to lose control at 30° C and in ambients above 30° the temperature within the compartment continues to rise indefinitely with a resultant frequency drift as great as .06% within a period of six hours. See tables and plates 1, 4, 5, 7, 9, 11 and 12.

Par. 2.7. All cap screws and hinges on the front panel of the transmitter are constructed of ferrous metal. These are protected by a thin coat of lacquer. This covering chips off and at the end of the test period rust spots were present on these parts.

Note: The T.B.A. construction is identical with the above.

Par. 2-8. The use of phenolic insulation is avoided in the transmitter proper in such places as would conflict with par. 2-8. However, the high voltage bush rigging in the plate generator and the generator terminal panels are constructed of phenolic materials. In this connection it may be pointed out that the high voltage brush-rigging in the generators supplied with the model T.A.U.-1 and model T.B.F. equipments are insulated by means of isolantite.

Par. 2-10. In general the requirements of this paragraph are complied with, but it might be pointed out that the P. A. Plate Choke By-pass Capacitor (139) arced over repeatedly and blew fuses in the high voltage generator circuit. The safety gap on this condenser was removed and no further difficulty was experienced from this source. It is not believed that the removal of the safety gap endangers this condenser since the trouble was caused by a high frequency arc across this small gap which then permitted the D. C. voltage to ground itself.

Par. 2-11. Complied with. It should be noted, however, that the plate overload relay is of the automatic reset type. Thus when an overload occurs the contacts of the overload relay open the coil circuit of the interlock contactor which in turn opens the starter circuit of the motor generator. However, before the motor generator can stop, the overload relay closes the coil circuit of the interlock contactor and the process repeats itself. Thus if the key is kept closed a continuous opening and closing of the starter circuit results so that the tubes are repeatedly subjected to the overload condition for short periods, or until such a time as the high voltage fuse burns out. However, the tube protective relay opens in five seconds if the key is held down, so the number of repeated overloads is only 3 or 4. It is believed that such a system fails to give maximum protection. A momentary contact starting system or a hand reset overload relay would subject the tubes to the first overload only.

Par. 2-14, 2-15. During the tests the P. A. Filament and Screen-grid By-Pass Capacitor (83) overheated badly and exuded wax which flowed down between the plates of the P. A. Screen-grid Balance Capacitor. (See plates 27 and 28)

Par. 2-17. In the course of the tests during which the transmitter was operated key locked for one hour periods with short intervals between periods the S.E. 38161 tubes constantly lost emission although the filament voltage was kept constant. In the course of a day's run the output power would fall off as much as 75%. These tubes were reactivated several times by burning the filaments at 11.5 volts with plate voltage off and apparently had suffered no permanent injury at the end of the tests.

These tubes also are subject to overloads as previously reported in N.R.L. report of the test of T.B.A. Transmitting equipment.

Par. 2-18. The requirement of this paragraph is not rigidly complied with. See paragraphs 2-3, 2-4, 2-5, 2-15 and 2-17.

Par. 2-19. Although tests to determine compliance with the requirements of this paragraph could not be conducted at the Laboratory due to the lack of suitable facilities, the ability of the equipment to comply with this requirement is open to question due to the reasons given under paragraph 2-3.

Par. 2-20. The tests conducted at the Laboratory indicate that the equipment will not comply with the requirements of this paragraph.
The M. O. compartment is not flexibly mounted and slight vibration of the transmitter (such as by lightly tapping with the hand)causes serious shifts in frequency.
Slight vibration also causes varying degrees of contact in the connections to the M. O. compartment with attendant diminution in output power.

Par. 2-21. The M. O., 1st B. A. and 2nd B. A. tubes are not flexibly mounted.

Par. 3-4. Receiving observations were made locally to determine the quality of the transmitted signal, key clicks, lilt or other objectionable features in all bands.
The Model T.B.A-1a transmitter emits a note of excellent quality. No lilt or undesirable modulation is present when the transmitter is not subjected to vibration. However under slight vibration the note becomes rough and badly modulated and is difficult to copy.
No tests were conducted with remote observing stations.

Par. 3-16. (As changed by Manufacturer's specifications R.A. 1371, par. 13-4 (c)).
A series of tests was conducted to determine compliance with the requirements of this paragraph. The results of these tests are shown in plates 1 to 12 inclusive and tables 1 to 12 inclusive. In the tests conducted before the thermal fuse was renewed (plates and tables Nos. 1 to 11) it will be noted that the compartment heater apparently lacked sufficient capacity to maintain the proper temperatures when the ambients approach zero degrees centigrade. As previously mentioned, it is thought that this trouble was caused by a partially blown thermal fuse or possibly was due to the heater-relay contacts holding open. Although no adjustment was made on the heater relay at the time the thermal fuse was replaced, no further trouble was experienced in maintaining the proper compartment temperature in ambients below 30° C. However, it was indicated that the thermostat lost control at 30° C..so a six hour run was made at 35-38°C. The results of this test are shown on Table and Plate 12. As will be noted, the compartment temperature climbs steadily with a corresponding drop in frequency which amounted to .027% at the end of the sixth hour. A twenty-four hour run was made (Table 11 and Plate 11) varying the

ambient temperature from 30° to 0° to 45° in steps of 5° per hour. It will be noted that the compartment temperature remained fairly constant and the frequency variation was well within the specification requirements until the ambient temperature of 30° was reached. Here the compartment temperature started to rise and the frequency drifted down until at the end of the run it had changed .044%.

It is believed that the lack of control existing in ambients of 30° and above is due to the amount of heat being dissipated by the M. O. tube which is mounted within the heat chamber and also to the heat of the resistor bank which is located beneath the M. O. compartment.

Comparative tests were conducted on the T.B.A. transmitter, using both the Self-excited and Crystal-controlled Master Oscillators, to determine compliance with the requirements of this paragraph.

In the case of the Crystal-controlled Master Oscillator, the tests indicated a frequency drift of less than .002% with one exception. As an inspection of the results of some of the tests indicated a loss of thermostatic control in ambients approaching 43° C a six hour run was made in an ambient temperature of 42-43 degrees. The results of this test are shown on Table and Plate 19. It will be noted that at the end of the third hour the compartment temperature started to rise and at the end of the sixth hour the compartment temperature had risen nearly five degrees and the frequency had drifted .0115%.

During this test the transmitter was keyed at 40 W.P.M.

A similar run was made at 35° C as shown on Table and Plate 20.

At the end of the fourth hour the thermostat lost control but the compartment temperature rose very slowly so that, at the end of the sixth hour, the frequency drift was only .001%.

The results obtained in the tests using the non-temperature controlled self-excited master oscillator are shown on tables and plates 21 to 26. The maximum frequency drift observed was .09% as indicated on Table and Plate 26.

Tests were made for frequency drift at three points in the transmitter's frequency range and the results obtained are shown on Tables and Plates 1 to 12 inclusive.

In some cases, simultaneous measurements were taken of the M. O. and output frequencies.

The measured output frequencies showed no greater percentage deviation than the M. O. frequencies, hence the output frequency curves were not plotted. All curves are in terms of the M. O. frequency.

Such differences in the two measurements which were noted are attributed to observational errors.

Par. 3-17. (As changed by Manufacturer's specifications R.A. 1371).
(1), (2). Due to the fact that there is an excessive amount of back lash in the M. O. Control Assembly and the dial lock is misaligned, it is impossible to accurately reset the transmitter to any desired frequency. Tightening the M. O. dial lock causes a M. O. frequency shift of approximately one kilocycle at 2250 kcs.

(3) See par. 3-16.

(4). Table 31 summarizes the results of the tests to determine compliance with the requirements of this paragraph.
In conducting this test, two runs were made on each of two M. O. frequencies. The first run was made without any preliminary key-locked period and the second run made immediately thereafter. It will be noted by referring to Table 31 that the second run in each case (columns 2 and 4) shows approximately half the frequency drift as that of the first run. This may be due to the fact that the first run in each case had no preliminary key-locked period and the second run was made after the twenty minute key locked period required for the first run.
It will be noted that in columns 1, 3 and 4 the frequency drift was upward with a rise in voltage. In column 2 the drift was downward. This may be due to the fact that the power supply to the transmitter failed twice when this run was partially completed. This necessitated two repeat runs, the last of which is recorded.
An average of the four runs taken indicate a frequency variation of .00023% per volt.

(5). It is possible to replace any tube from the 2nd B. A. stage to the P. A. stage without materially affecting the frequency. However, this test could not be made with the M. O. or first B. A. tubes because of the very wide frequency changes occurring when only slightly disturbing the position of the M. O. compartment.

Par. 3-18. This paragraph states that in the initial stage the ratio of the tuning vernier shall be such as to provide for the variation of the resonant frequency, per division of marking, of not more than 0.03 of one percent nor less than 0.02 of one percent of any frequency to which the circuit is tuned. In calibrating and determining the frequency range of the M. O. circuit it was found that the maximum frequency variation per division of vernier marking was .014% and the minimum .0026% of the frequency to which the circuit was tuned. The width of the vernier scale divisions is 0.04 inches.

Par. 3-19. The transmitter is provided with adjustable connecting links which permit the M. O. circuit to oscillate either intermittently or continuously.

Par. 3-22. As mentioned under paragraph 3-2, the operation of the M. O. Dial Lock adversely affects the calibration of the circuit. The 1st B. A. Dial Lock is poorly designed and has but slight locking action.

Par. 3-30(d). The operation of the M. O. Compartment Heater Indicating lamp is unsatisfactory. It is connected ahead of the heater in such a way as to light when the heater is not connected in the circuit hence the only indication of a blown thermal fuse is that shown by the compartment thermometer. This lamp should be connected directly across the heater

terminals in order to properly indicate current through the heater.
Note: The T.B.A. transmitter is wired in a like manner.

Par. 3-34. The requirements of this paragraph are complied with but it should be noted that no provision was made to permit the power-supply cables to enter the transmitter units so that they could be connected to the terminal board. It was necessary to place the transmitter on skids to provide access since the shields on all sides of the transmitter extend down to the deck.
The shielding supplied with the T.B.A.1a transmitter is extremely light and flimsy.

Par. 3-39(2). See paragraph 3-2.
(3). No access is provided for cables and it is necessary to cut away the shielding to provide such access.
(4). It is necessary to remove the M. O. Compartment and the shield over the M. O. and 1st B. A. stages in order to replace these tubes.
Further, in order to adjust the M. O. Heater Relay it is necessary to remove the M. O. Compartment and the Heater relay. It is believed that this relay could be rotated 90° on its supporting bracket thus making accessible the adjusting screw.

Par. 3-40. See paragraph 2-4.

Par. 3-47. The insulated hand rails are of light construction and are fastened to the transmitter by means of unprotected steel cap-screws.

SECTION VI POWER EQUIPMENT.

In accordance with instructions contained in reference (a) the tests of the power equipment were restricted to actual operation tests.
The equipment gave excellent service throughout the test period, no failures of any kind being noted.

SECTION VII SPARE PARTS.

The spare parts provided with the transmitter are complete and carefully packed to prevent damage.

SECTION IX INSTRUCTION BOOKS.

The preliminary instruction books provided with the transmitter are complete and sufficient to assure intelligent installation and safe operation of thd equipment.

SECTION X TESTS.

Test #1. Such portions of the transmitter as fail to comply with the requirements have been pointed out and discussed in detail in the previous sections of this report.

Test #2. Test of power required from the supply lines for starting and full power key locked.
The T.B.A.-1a transmitter requires 6.292 K.W. (26 amperes at 242 volts) for full power key locked operation.
As the proper facilities were not available, the power required for starting could not be accurately obtained.
However, the T.B.A.-1a equipment is so nearly identical with the T.B.A. that it is believed the figure of 13.2 K.W. obtained in the tests of the T.B.A. equipment can be accepted.

Test #3. Test of Power Output.
Table #30 summarizes the results of the tests conducted to determine compliance with this requirement of the specifications. The antenna load consisted of two 500 watt, 220 volt lamps connected in series and power output determinations were made through the medium of a calibrated phottonic cell.
It will be noted that in the 12000 kcs. band and the 26000 kcs. band the actual output watts obtained did not meet specification requirements. The discrepancies are not of great magnitude and it is possible that with a different antenna arrangement (absorbing circuit) more efficient results might have been obtained. However, no other means than a lamp load and photo cell determinations can be employed at these frequencies.

Test #4. Test of Frequency Range.
The various circuits of the Model T.B.A.-1a transmitter are so proportioned that the output frequency is continuously variable over the range of 3950 kcs. to 26000 kcs. and sufficient overlap is provided in all circuits so that no gap in the frequency range exists.

Test #5. Test of Frequency, Accuracy and Stability.
The transmitter does not meet these requirements as illustrated in the discussion under paragraphs 3-16, 3-17 and Tables and Plates #1 to 12 inclusive.

Test #6. Test of Accuracy of Tuning Controls, and Time Necessary to change Frequency.
None of the controls, with the exception of the M. O., are unduly critical and an experienced operator can change frequency in one minute. As discussed in paragraphs 3-16 and 3-17, it is extremely difficult if not impossible to accurately reset the M. O. frequency to a pre-calibrated point.

Test #7. Test for Character of Emission.
The requirements of this test are complied with except when the transmitter is subjected to vibration, as noted in paragraph 3-4. No tests with distant receiving stations were conducted.

Test #8. Endurance Test.
The endurance tests illustrated in Tables and Plates #1 to 12 inclusive were conducted without injury to the transmitter other than the difficulties discussed under paragraphs 2-15 and 2-17.

6. Recommendations.

In view of the results obtained during the tests of the T.B.A.-1a equipment, it is believed that a complete re-design of the frequency establishing circuit is indicated. The inherent mechanical weakness of the entire Master Oscillator stage together with uncertain contacts at the supply voltage terminals and the lack of proper control in ambients above 30° centigrade constitutes an assembly which is not suitable for use in the Naval service.

It is believed that the M. O. compartment should be flexibly mounted in order to eliminate, as much as possible, the frequency variations due to vibration.

It is suggested that in future transmitter designs the temperature controlled compartment be maintained at a temperature at least 15° C. above that of the highest ambient temperature specified.

An examination of the frequency stability curves appended show that if a greater temperature gap existed between the highest specified ambient and the operating temperature of the frequency establishing circuit that the operation of the transmitter would be considerably improved.

Further, it is suggested that in crystal controlled transmitters such as the T.B.A. the maximum frequency drift specified should not exceed .005%. The present specification figure of .01% is believed to be too liberal.

In but two cases out of eight tests on the T.B.A. transmitter did the frequency drift exceed .0019% and in both these tests the thermostat had lost control in an ambient temperature of 43° C.

Table 1

TBA-1a TRANSMITTER

L.H.-1 tuned to 8000 kcs measuring output frequency x 2.
L.H.-2 tuned to 2000 kcs measuring M.O. frequency.

Output frequency - 4000 kcs.
M.O. " - 2000 kcs.

TIME	ACTUAL FREQUENCY L.H.-1	L.H.-2	AMB. TEMP.	CABINET TEMP.	LINE VOLTS
1040	8004.154	2001.040	39.0	60.5	237
50	.017	.000	38.8	60.9	234
1100	8003.929	2000.982	40.7	61.2	236
10	Off scale	.938	40.0	61.6	232
20	" "	.900	39.9	62.2	234
30	" "	.855	39.5	62.8	233
40	" "	.808	39.9	63.3	230
Key open for 10 min. while temperature was changed.					
1150	8003.048	2000.760	48.2	63.9	231
1200	8002.840	.711	50.3	64.5	234
10	.700	.674	49.9	65.1	238
20	.437	.610	49.0	65.8	238
30	Off scale	.564	51.0	66.5	236
40	" "	.517	49.9	67.3	236
50	" "	.459	49.7	68.0	236
Key open while temperature was changed.					
1340	Off scale	2000.260	31.6	70.2	232
50	" "	.260	31.0	70.2	233
1400	" "	.261	29.9	70.2	235
10	" "	.266	30.6	70.2	238
20	" "	.268	29.4	70.2	237
30	" "	.276	29.6	70.2	238
40	" "	.286	31.6	70.2	238
50	" "	.276	30.0	70.2	242

Difference between readings taken at 1140 and 1250.
Ambient temperature - 9.8° C
Difference in frequency - 354 cycles
Difference per degree centigrade - 35 cycles, .0017%

Difference between readings taken at 1250 and 1450.
Ambient temperature - 19.7° C
Difference in frequency - 183 cycles
Difference per degree centigrade-9 cycles, .00045%

Difference between readings taken at 1140 and 1450.
Ambient temperature - 9.9° C
Difference in frequency - 532 cycles
Difference per degree centigrade - 53 cycles, .0026%

From readings on L-H-2.

TABLE 2

TBA-1a TRANSMITTER

L-H-1 tuned to 8000 kcs.measuring output frequency x 2.

L-H-2 tuned to 2000 kcs.measuring M.O. frequency.

Output frequency = 4000 kcs.
M.O. " = 2000 kcs.

TIME	ACTUAL FREQUENCY L.H.-1	L.H.-2	AMB. TEMP.	CABINET TEMP.	LINE VOLTS
1000	Off scale	2000.154	29.8	50.0	225
10	" "	.032	30.7	50.5	227
20	8000.053	.009	30.3	51.9	224
30	7999.903	1999.984	30.5	52.2	230
40	.856	.971	30.4	52.9	238
50	.825	.958	30.8	52.7	240
1100	.810	.951	31.0	53.3	238
	Key open while temperature was changed.				
1240	7999.993	1999.996	15.0	55.0	242
50	.977	.991	15.6	55.0	239
1300	.931	.981	14.6	54.9	236
10	.903	.974	15.7	54.8	241
20	.880	.968	15.5	54.7	239
30	.865	.966	15.7	54.7	238
40	.853	.964	15.3	54.7	236
50	.852	.963	15.0	54.9	238
	Key open while temperature was changed.				
1600	7999.828	1999.959	28.0	51.6	242
10	.905	.974	29.7	51.2	240
20	.999	.998	30.0	51.0	238
30	8000.069	2000.016	29.5	51.0	238
40	.078	.018	34.3	51.3	240
50	.013	.000	29.6	51.9	240
1700	7999.918	1999.979	31.0	52.2	239

TABLE 2 (cont'd)

(L.H.-2)

M.O. FREQUENCIES

Difference between readings taken at 1100 and 1350
Ambient temperature - 16° C.
Difference in frequency - 12 cycles.
Difference per degree centigrade - .75 cycle
.000037%

Difference between readings taken at 1350 and 1700
Ambient temperature - 16° C
Difference in frequency - 16 cycles
Difference per degree centigrade - 1 cycle
.00005%

Difference between readings taken at 1100 and 1700
Ambient temperature - 0° C
Difference in frequency - 28 cycles
.0014%

Readings on L.H.-2.

(L.H.-1)

OUTPUT FREQUENCIES x 2 = 8000 kcs.

Difference between readings taken at 1100 and 1350
Ambient temperature - 16° C
Difference in frequency - 42 cycles
Difference per degree centigrade - 2.6 cycles
.000032%

Difference between readings taken at 1350 and 1700
Ambient temperature - 16° C
Difference in frequency - 66 cycles
Difference per degree centigrade - 4 cycles
.00005%

Difference between readings taken at 1100 and 1700
Ambient temperature - 0° C
Difference in frequency - 108 cycles
.0013%

TABLE 3

TBA-1a Transmitter

L.H.-1 tuned to 8000 kcs measuring actual output frequency.
L.H.-2 tuned to 2000 kcs measuring M.O. frequency.

Output frequency = 8000 kcs.
M.O. frequency = 2000 kcs.

TIME	Actual Frequency L.H.-1	L.H.-2	AMB. TEMP.	CABINET TEMP.	LINE VOLTS
0710	-	2000.214	27.4	57.8	230
20	8000.822	.211	32.6	57.8	226
30	.803	.213	30.0	57.8	224
40	.800	.208	30.2	57.9	220
50	.802	.203	29.8	58.0	220
0800	.758	.191	28.2	58.2	212
10	.696	.174	30.3	58.4	236
Key open while temperature was changed.					
0950	8000.551	2000.138	2.8	55.6	242
1000	.446	.114	1.8	55.0	242
10	.405	.100	2.3	54.5	240
20	.347	.083	2.9	54.0	242
30	.307	.076	2.8	53.5	240
40	.289	.072	4.2	53.0	238
50	.268	.066	4.2	53.2	240
Key open while temperature was changed.					
L.H.-1 crystal cabinet was opened to adjust crystals just before 0710					
1100	8000.310	2000.076	26.0	52.5	236
10	.308	.076	30.1	52.2	238
20	.350	.086	29.5	52.0	240
30	.357	.088	30.3	52.0	244
40	.355	.087	29.8	52.1	240
50	.315	.078	29.6	52.4	242
1200	.258	.065	30.0	53.0	242

TABLE 3 (cont'd)
M.O. Frequency as measured on L.H.-2, 2000 kcs.

Difference between readings taken at 0810 and 1050
Ambient temperature - 26.1°C
Difference in frequency - 108 cycles
Difference per degree C - 4 cycles, .0002%

Difference between readings taken at 1050 and 1200
Ambient temperature - 25.8°C
Difference in frequency - 1 cycle

Difference between readings taken at 0810 and 1200
Ambient temperature - 0.3°C
Difference in frequency - 109 cycles, .0054%

Output Frequency as measured on L.H.-1, 8000 kcs.

Difference between readings taken at 0810 and 1050
Ambient temperature - 26.1°C
Difference in frequency - 428 cycles
Difference per degree C - 16 cycles, .0002%

Difference between readings taken at 1050 and 1200
Ambient temperature - 25.8°C
Difference in frequency - 10 cycles
Difference per degree C - less than 1 cycle

Difference between readings taken at 0810 and 1200
Ambient temperature - 0.3°C
Difference in frequency - 438 cycles, .0054%

Note: L.H.-1 crystals probably drifting slightly during this test due to opening crystal cabinet just prior to test.

TABLE 4

TBA-1a Transmitter

L.H.-1 tuned to 8000 kcs measuring actual output frequency.
L.H.-2 tuned to 2000 kcs measuring M.O. frequency x 2.

Output frequency = 8000 kcs.
M.O. tuned to 1000 kcs.

TIME	Actual Frequency L.H.-1	L.H.-2	AMB. TEMP.	CABINET TEMP.	LINE VOLTS
0930	8005.860	2001.465	31.0	49.2	238
40	.887	.467	29.0	49.2	240
50	.892	.475	32.0	49.4	240
1000	.946	.484	30.0	49.8	240
10	.940	.481	29.8	50.1	239
20	.942	.479	30.6	50.6	241
30	.898	.473	30.5	51.2	239
Key open 20 minutes to change temperature.					
1050	8005.720	2001.426	38.8	52.6	236
1100	.620	.402	40.0	53.1	238
10	.480	.366	38.8	53.9	235
20	.370	.336	40.7	54.5	238
30	.228	.307	39.8	55.1	238
40	Off scale	.260	40.2	56.0	240
50	" "	.212	40.0	56.9	240
Key open 10 minutes to change temperature.					
1200	Off scale	2001.148	51.0	57.8	238
10	" "	.085	50.0	58.7	238
20	" "	.026	50.0	59.5	238
30	" "	2000.960	50.8	60.5	239
40	" "	.955	50.0	61.4	237
50	" "	.818	50.3	62.4	238
1300	" "	.740	50.6	63.3	238
Key open 1 hour 50 minutes to change temperature.					
1450	Off scale	2000.441	30.3	66.8	238
1500	" "	.450	30.6	66.6	238
10	" "	.460	30.8	66.6	238
20	" "	.472	31.0	66.6	242
30	" "	.470	30.0	66.6	241
40	" "	.463	30.2	66.7	240
50	" "	.461	30.6	66.8	241

TABLE 4 (cont'd)

M.O. x 2 frequency as measured on L.H.-1, 2000 kcs.

Difference between readings taken at 1030 and 1150
Ambient temperature - 9.5°C
Difference in frequency - 253 cycles.
Difference per degree Centigrade - 26 cycles, .0013%

Difference between readings taken at 1150 and 1300
Ambient temperature - 10.6°C
Difference in frequency - .472 cycles
Difference per degree Centigrade - 44 cycles, .0022%

Difference between readings taken at 1300 and 1550
Ambient temperature - 20°C
Difference in frequency - .279 cycles
Difference per degree Centigrade - 14 cycles, .0007%

Difference between readings taken at 1030 and 1550
Ambient temperature - 0.1°C.
Difference in frequency - 1012 cycles
Difference per degree Centigrade - .05%

TABLE 5

TBA-1a Transmitter

L.H.-1 tuned to 9000 kcs measuring actual output frequency.
L.H.-2 tuned to 4500 kcs measuring M.O. frequency x 2.

Output frequency = 9000 kcs
M.O. tuned to 2250 kcs.

TIME	Actual Frequency L.H.-1	L.H.-2	AMB. TEMP.	CABINET TEMP.	LINE VOLTS
1000	9002.185	4501.092	30.0	52.6	237
10	.225	Off scale	30.0	53.1	240
20	.235	" "	29.3	53.8	241
30	.175	" "	29.8	54.4	242
40	.095	" "	29.8	55.0	240
50	9001.971	4500.956	30.0	55.5	240
1100	.823	.900	29.8	56.2	240
10	9001.680	.835	30.0	56.9	241
Key open to change temperature.					
1120	9001.546	4500.773	39.6	57.4	240
30	.413	.707	39.8	58.0	240
40	.277	.638	41.0	59.6	239
50	.098	.550	40.4	59.2	238
1200	9000.863	.445	39.7	59.9	240
10	.602	.301	39.4	60.6	241
20	.225	.122	40.2	61.5	242
30		4499.932	40.5	62.1	240
Key open to change temperature.					
1250	Off scale	4499.678	50.4	63.5	239
1300	" "	.545	50.6	64.3	238
10	" "	.423	50.3	65.0	237
20	" "	.318	50.0	65.6	238
30	" "	.207	49.8	66.4	238
40	" "	.061	49.5	67.1	236
50	" "	4498.944	50.0	67.9	240
Key open to change temperature.					
1450	Off scale	4498.546	29.2	69.3	238
1500	" "	.615	30.6	68.8	239
10	" "	.690	30.0	68.3	241
20	" "	.746	30.4	68.2	241
30	" "	.800	30.2	68.0	242
40	" "	.810	29.8	68.0	242
50	" "	.820	30.2	68.0	243

TABLE 5 (cont'd)

M.O. x 2 frequency as measured on L.H.-2, 4500 kcs.

Difference between readings taken at 1110 and 1230
Ambient temperature - 10.5°C
Difference in frequency - 903 cycles
Difference per degree Centigrade - 86 cycles, .0019%

Difference between readings taken at 1230 and 1350
Ambient temperature - 9.5°C
Difference in frequency - 988 cycles
Difference per degree Centigrade - 100 cycles, .0022%

Difference between readings taken at 1350 and 1550
Ambient temperature - 19.8°C
Difference in frequency - 120 cycles
Difference per degree Centigrade - 6 cycles, .00013%

Difference between readings taken at 1110 and 1550
Ambient temperature - 0.4°C
Difference in frequency - 2015 cycles
Difference per degree Centigrade - .04%

TABLE 6 (cont'd)

M.O. frequency x 2 as measured on L.H.-1

Difference between readings taken at 1050 and 1200
Ambient temperature - 14.8° C
Difference in frequency - 101 cycles
Difference per degree Centigrade - 6 cycles, .0003%

Difference between readings taken at 1200 and 1400
Ambient temperature - 14.5°C
Difference in frequency - 106 cycles
Difference per degree Centigrade - 7 cycles, .0003%

Difference between readings taken at 1400 and 1510
Ambient temperature - 8.8°C
Difference in frequency - .81 cycles
Difference per degree Centigrade - 9 cycles, .0004%

Difference between readings taken at 1510 and 1620
Ambient temperature - 20.2°C
Difference in frequency - 67 cycles
Difference per degree Centigrade - 3 cycles, .00013%

Difference between treadings taken at 1050 and 1620
Ambient temperature - 0.3° C
Difference in frequency - 9 cycles, .0004%

TABLE 6

TBA-1a Transmitter

Output = 9000 kcs
M.O. frequency = 2250 kcs

TIME	Actual Frequency M.O.	AMB. TEMP.	CABINET TEMP.	LINE VOLTS
0940	2250.555	30.4	53.5	240
50	.555	29.6	53.8	238
1000	.574	30.1	54.1	240
10	.576	30.2	54.5	239
20	.588	30.6	55.0	240
30	.593	29.7	55.4	238
40	.575	29.8	55.9	237
50	.556	30.3	56.3	236
	Key open to change temperature.			
1100	2250.525	14.8	56.8	238
10	.496	15.5	57.1	238
20	.477	14.4	57.4	240
30	.460	14.6	57.5	238
40	.455	15.1	57.5	235
50	.457	15.0	57.5	238
1200	.455	15.5	57.6	238
	Key open to change temperature.			
1300	2250.511	1.7	55.5	237
10	.541	2.6	54.8	234
20	.554	2.2	54.2	236
30	.556	2.8	53.5	237
40	.572	1.4	53.0	238
50	.572	0.9	52.5	237
1400	.561	1.0	52.1	238
	Key open to change temperature.			
1410	2250.541	10.0	52.5	236
20	.541	10.0	51.2	238
30	.524	10.0	50.8	236
40	.507	9.6	50.5	236
50	.506	10.4	50.2	238
1500	.488	10.8	50,0	238
10	.480	9.8	50.0	236
	Key open to change temperature.			
1520	2250.470	27.2	49.9	
30	.472	30.8	49.9	
40	.472	30.4	50.0	
50	.481	30.0	50.1	
1600	.500	30.3	50.4	
10	.521	29.6	50.9	
20	.547	30.0	51.2	

TABLE 7

TBA-1a Transmitter
Output frequency = 9000 kcs.
M.O. frequency = 2250 kcs

TIME	Actual Frequency M.O.	AMB. TEMP.	CABINET TEMP.	LINE VOLTS
0920	2250.379	30.7	Off scale	238
30	.397	29.5	below	236
40	.411	30.0	About 46°	238
50	.438	30.8	"	237
1000	.467	29.8	"	235
10	.487	29.7		239
20	.495	30.2	"	238
Key open 20 min. to change temperature.				
1040	2250.496	40.0	49.-	236
50	.523	39.7	49.0	237
1100	.570	39.7	49.8	240
10	.655	40.6	50.6	238
20	.638	40.4	51.4	241
30	.650	40.3	52.2	240
40	.651	39.6	53.1	240
Key open 20 min. to change temperature.				
1200	2250.595	49.7	55.0	241
10	.569	50.0	56.0	240
20	.524	50.0	56.9	242
30	.480	50.5	57.9	242
40	.425	50.0	59.0	241
50	.337	49.9	60.0	240
1300	.223	49.8	61.2	243
Key open 20 min. to change temperature.				
1320	2250.005	29.0	63.2	240
30	2249.930	30.4	63.9	240
40	.867	30.2	64.4	241
50	.818	30.0	64.8	237
1400	.781	29.8	65.2	239
10	.752	30.6	65.4	241
20	.775	29.4	65.6	239

TABLE 7 (cont'd)

M.O. frequency x 2 as measured on L.H.-1

Difference between readings taken at 1020 and 1140
Ambient temperature - 9.4°C
Difference in frequency - 206 cycles
Difference per degree Centigrade - 21 cycles, .0097%

Difference between readings taken at 1140 and 1300
Ambient temperature - 10.2°C
Difference in frequency - 428 cycles
Difference per degree Centigrade - 42 cycles, .018%

Difference between readings taken at 1300 and 1420
Ambient temperature - 20.4°C
Difference in frequency - 458 cycles
Difference per degree Centigrade - 22 cycles, .001%

Difference between readings taken at 1020 and 1420
Ambient temperature - 0.8°C
Difference in frequency - 720 cycles, .032%

TABLE 8

TBA-1a Transmitter

M.O. frequency = 1500 kcs.
Output frequency = 12000 kcs.

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
0905	30.5	60.0	238	1500.282
10	30.5	59.9	238	.292
20	30.3	59.7	238	.309
30	29.8	59.7	241	.315
40	29.8	59.6	240	.327
50	29.8	59.8	240	.326
1000	31.0	59.9	239	.320
10	30.7	60.1	236	.314
Key open 10 minutes to change temperature.				
1020	20.8	60.4	240	1500.298
30	19.5	60.5	238	.287
40	20.3	60.5	239	.275
50	20.0	60.6	238	.272
1100	19.2	60.5	239	.264
10	19.9	60.6	237	.265
20	20.1	60.6	241	.271
Key open 20 minutes to change temperature.				
1140	10.5	60.5	239	1500.257
50	10.0	60.4	239	.254
1200	9.6	60.0	238	.269
10	10.0	59.5	238	.282
20	9.7	59.2	237	.308
30	10.2	58.7	239	.334
40	9.8	58.4	242	.369
Key open 50 minutes to change temperature.				
1330	0.0	56.0	241	1500.495
40	0.0	55.1	240	.538
50	0.0	54.5	241	.555
1400	-0.5	53.9	241	.588
10	-1.0	53.2	240	.623
20	0.0	52.5	240	.648
30	0.0	52.1	239	.667
Key open 30 minutes to change temperature.				
1500	30.4	50.6	238	1500.708
10	30.5	50.5	238	.711
20	29.9	50.5	238	.721
30	30.6	50.5	241	.729
40	30.2	50.7	239	.729
50	29.4	51.0	240	.731
1600	30.0	51.2	240	.719

TABLE 8 (cont'd)

Difference between readings taken at 1010 and 1120
Ambient temperature - 10.6°C
Difference in frequency - 43 cycles
Difference in frequency per degree C - 4 cycles, .00027%

Difference between readings taken at 1120 and 1240
Ambient temperature - 10.3°C
Difference in frequency - 98 cycles
Difference in frequency per degree C - 9 cycles, .00063%

Difference between readings taken at 1240 and 1430
Ambient temperature - 9.8°C
Difference in frequency - 298 cycles
Difference in frequency per degree C - 30 cycles, .002%

Difference between readings taken at 1430 and 1600
Ambient temperature - 30.0° C
Difference in frequency - 52 cycles
Difference in frequency per degree C - 1.5 cycles, .0001%

Difference between readings taken at 1010 and 1600
Ambient temperature - 0.7°C
Difference in frequency - 405 cycles, .027%

TABLE 9

TBA-la Transmitter

Output frequency - 24000 kcs.
M.O. frequency - 15000 kcs.

TIME	AMB. TEMP.	CABINET TEMP	LINE VOLTS	Actual Frequency M.O.
0950	30.5	52.5	238	1500.468
1000	30.1	52.8	240	.470
10	29.2	53.2	239	.470
20	30.0	53.6	238	.462
30	30.3	54.1	238	.452
40	30.3	54.6	240	.433
50	29.7	55.2	240	.412
Key open 20 minutes to change temperature.				
1110	40.1	56.5	240	1500.372
20	39.9	57.1	240	.354
30	40.0	57.7	238	.321
40	40.0	58.4	239	.288
50	40.2	59.0	242	.253
1200	39.8	59.7	244	.213
10	40.4	60.6	243	.180
20	39.2	61.4	243	.180
Key open 30 minutes to change temperature.				
1250	49.6	63.7	239	1499.972
1300	49.6	64.3	238	.982
10	49.9	65.0	238	.896
20	49.6	65.7	238	.853
30	50.0	66.3	237	.814
40	50.0	67.2	236	.780
50	59.9	67.8	234	.741
1400	50.1	68.8	235	.696
Key open 10 minutes to change temperature.				
1410	30.0	69.1	235	1499.659
20	30.2	70.1	234	.617
30	30.1	70.6	232	.562
40	29.8	70.8	237	.547
50	30.8	71+	239	.532
1500	30.0	71+	239	.532
10	31.0	71+	240	.534
20	29.8	71+	238	.537

TABLE 9 (cont'd)

Difference between readings taken at 1050 and 1220
Ambient temperature - 9.5°C
Difference in frequency - 232 cycles
Difference in frequency per degree C - 24 cycles, .0016%

Difference between readings taken at 1220 and 1400
Ambient temperature - 10.9°C
Difference in frequency - 123 cycles
Difference in frequency per degree C - 11 cycles, .00074%

Difference between readings taken at 1400 and 1520
Ambient temperature - 10.3°C
Difference in frequency - 159 cycles
Difference in frequency per degree C - 15 cycles, .001%

Difference between readings taken at 0950 and 1520
Ambient temperature - 0.1°C
Difference in frequency - 50 cycles, .0033%

TABLE 10

TBA-1a Transmitter

Output frequency = 24000 kcs
M.O. frequency = 1500 kcs

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
0900	29.6	59.7	235	1500.195
10	29.8	59.7	236	.182
20	29.8	59.6	239	.195
30	30.1	59.5	238	.194
40	30.0	59.7	235	.204
50	29.9	59.8	239	.201
1000	29.6	60.0	238	.193
Key open 10 minutes to change temperature.				
1010	19.6	60.3	238	1500.179
20	20.0	60.5	237	.169
30	20.0	60.5	238	.157
40	19.8	60.6	239	.149
50	19.7	60.6	238	.144
1100	19.9	60.6	239	.144
10	19.8	60.6	238	.145
Key open 40 minutes to change temperature.				
1150	9.9	60.0	242	1500.096
1200	10.3	59.5	243	.118
10	9.8	59.2	243	.144
20	9.7	58.7	241	.174
30	10.1	58.4	240	.207
40	9.8	58.0	240	.233
50	10.0	57.6	242	.259
Key open for 1 hour 40 minutes to change temperature.				
1430	2.0	52.4	238	1500.495
40	2.0	51.8	239	.530
50	1.5	51.1	237	.563
1500	1.2	50.6	238	.572
10	1.1	50.1	239	.594
20	1.1	49.7	239	.602
30	.8	49.4	240	.616
1550	27.0	49-	237	1500.631
1600	30.4	49-	240	.647
10	30.8	49-	242	.661
20	30.2	49-	246	.677
30	30.8	49.1	242	.695
40	29.8	49.5	242	.707
50	29.8	50.0	246	.703

TABLE 10 (cont'd)

Difference between readings taken at 100 and 1110
Ambient temperature - 9.8°C
Difference in frequency - 48 cycles
Difference in frequency per degree C - 5 cycles, .0003%

Difference between readings taken at 1110 and 1250
Ambient temperature - 9.8°C
Difference in frequency - 114 cycles
Difference in frequency per degree C- 11 cycles, .00078%

Difference between readings taken at 1250 and 1530
Ambient temperature - 9.2°C
Difference in frequency - 355 cycles
Difference in frequency per degree C - 38 cycles, .0025%

Difference between readings taken at 1530 and 1650
Ambient temperature - 29.0°C
Difference in frequency - 87 cycles
Difference in frequency per degree C - 3 cycles, .0002%

Difference between readings taken at 1000 and 1650
Ambient temperature - 0.2°C
Difference in frequency - 509 cycles, .033%

TABLE 11

TBA-1a Transmitter

Output frequency = 12000 kcs.
M.O. frequency = 1500 kcs.

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
0800	30.6	60.7	229	1499.590
12	31.1	58.6	239	.602
24	30.9	58.0	239	.616
36	31.2	58.2	239	.634
48	30.8	58.2	240	.630
0900	31.4	58.2	238	.612
	Key open 24 minutes to change temperature.			
0924	24.9	58.6	237	1499.562
36	25.0	58.6	239	.542
48	24.6	58.6	239	.535
1000	25.2	58.6	240	.530
12	25.4	61.8	241	.537
24	25.0	61.9	241	.544
	Key open 24 minutes to change temperature.			
1048	19.8	61.8	242	1499.582
1100	19.2	61.9	240	.572
12	20.6	61.9	243	.560
24	19.8	61.9	243	.565
36	19.9	61.9	242	.565
48	19.9	61.9	239	.567
1200	14.6	61.9	238	1499.574
12	14.6	61.9	238	.575
24	15.2	61.9	238	.571
36	14.9	61.8	235	.567
48	15.0	61.5	237	.575
1300	15.1	61.5	234	.590
	Key open 12 minutes to change temperature.			
1312	10.0	60.2	237	1499.602
24	11.0	60.2	237	.571
36	10.2	60.2	236	.592
48	9.8	59.6	235	.590
1400	10.3	59.6	236	.585
12	10.0	59.6	238	.581
	Key open 36 minutes to change temperature.			
1448	5.0	59.6	238	1499.578
1500	5.0	59.6	237	.580
12	4.8	59.6	237	.581
24	5.6	59.6	240	.586
36	5.0	59.6	239	.587
48	4.8	59.6	240	.582

TABLE 11 (cont'd)

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
1712	0.0	58.6	226	1499.585
24	0.2	58.6	244	.599
36	0.4	58.8	240	.619
48	0.3	58.8	242	.601
1800	0.2	58.8	244	.596
12	0.4	58.8	242	.593
Key open 12 minutes to change temperature.				
1824	5.1	58.8	242	1499.590
36	5.0	58.9	238	.585
48	5.3	58.8	241	.581
1900	5.2	58.9	242	.571
12	5.2	58.9	244	.557
24	5.2	58.9	245	.532
Key open 24 minutes to change temperature.				
1948	10.0	59.6	241	1499.513
2000	10.0	59.6	241	.502
12	10.2	59.6	243	.497
24	9.7	59.6	240	.489
36	10.4	59.6	244	.480
48	10.2	59.8	242	.473
2100	15.3	59.8	238	1499.456
12	15.2	59.8	245	.451
24	15.2	59.8	240	.449
36	15.5	59.9	236	.448
48	14.8	59.9	238	.438
2200	15.4	59.6	236	.434
Key open 12 minutes to change temperature.				
2212	20.0	60.2	238	1499.454
24	20.0	60.2	242	.444
36	20.0	60.4	238	.441
48	19.4	60.4	238	.438
2300	20.6	60.4	240	.448
12	20.8	60.4	240	.443
Key open 12 minutes to change temperature.				
2324	24.6	60.4	238	1499.444
36	25.4	60.4	240	.437
48	24.8	60.4	242	.422
0000	26.0	60.4	244	.431
12	25.2	60.4	240	.422
24	25.0	60.4	240	.421

TABLE 11 (cont'd)

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
0036	30.4	60.4	238	1499.421
48	29.6	60.4	233	.415
0100	30.6	60.4	240	.428
12	30.8	60.4	240	.426
24	29.9	60.7	240	.435
36	30.0	61.4	238	.432
Key open 12 minutes to change temperature.				
0148	35.0	61.1	240	1499.455
0200	35.0	61.8	240	.425
12	35.2	62.0	240	.409
24	35.8	62.2	240	.392
36	35.0	62.4	242	.358
48	35.0	63.0	240	.327
Key open 24 minutes to change temperature.				
0312	40.2	63.2	240	1499.265
24	40.0	64.0	240	.231
36	39.8	64.2	239	.203
48	39.7	64.6	240	.185
0400	40.4	64.6	238	.181
12	40.0	66.1	240	.145
0436	45.0	66.9	240	1499.087
48	45.0	67.2	240	.088
0500	45.0	67.4	240	.075
12	44.8	67.4	236	.058
24	45.2	68.5	236	.036
36	45.0	68.5	236	.032
Key open 2 minutes to change temperature.				
0548	31.0	69.3	238	1498.994
0600	31.0	69.5	240	.970
12	30.9	70.4	238	.952
24	31.0	70.4	238	.933
36	30.8	70.4	238	.929
48	31.2	70.4	238	.930

TABLE 11 (cont'd)

Difference between readings taken at 0900 and 1024
Ambient temperature - 6.4°C
Difference in frequency - 68 cycles
Difference in frequency per degree C - 10 cycles, .0007%

Difference between readings taken at 1024 and 1148
Ambient temperature - 5.1°C
Difference in frequency - 23 cycles
Difference in frequency per degree C - 4 cycles, .0003%

Difference between readings taken at 1148 and 1300
Ambient temperature - 4.8°C
Difference in frequency - 22 cycles
Difference in frequency per degree C - 4 cycles, .0003%

Difference between readings taken at 1300 and 1412
Ambient temperature - 5.1°C
Difference in frequency - 8 cycles
Difference in frequency per degree C - 1.5 cycles, .0001%

Difference between readings taken at 1412 and 1548
Ambient temperature - 5.2°C
Difference in frequency - 1 cycle, .000066%

Difference between readings taken at 1548 and 1812
Ambient temperature - 4.4°C
Difference in frequency - 11 cycles
Difference in frequency per degree C - 2 cycles, .00016%

Difference between readings taken at 1812 and 1924
Ambient temperature - 4.8°C
Difference in frequency - 61 cycles
Difference in frequency per degree C - 12 cycles, .00083%

Difference between readings taken at 1924 and 2048
Ambient temperature - 5.0°C
Difference in frequency - 59 cycles
Difference in frequency per degree C - 12 cycles, .0008%

Difference between readings taken at 2048 and 2200
Ambient temperature - 5.2°C
Difference in frequency - 39 cycles
Difference in frequency per degree C - 7 cycles, .0005%

Difference between readings taken at 2200 and 2312
Ambient temperature - 5.4°C
Difference in frequency - 9 cycles
Difference in frequency per degree C - 1.5 cycles, .0001%

TABLE 11 (cont'd)

Difference between readings taken at 2312 and 0024
Ambient temperature - 4.2°C
Difference in frequency - 22 cycles
Difference in frequency per degree C - 5 cycles, .00033%

Difference between readings taken at 0024 and 0136
Ambient temperature - 5.0°C
Difference in frequency - 11 cycles
Difference in frequency per degree C - 2 cycles, .00013%

Difference between readings taken at 0136 and 0248
Ambient temperature - 5.0°C
Difference in frequency - 105 cycles
Difference in frequency per degree C - 21 cycles, .0014%

Difference between readings taken at 0248 and 0412
Ambient temperature - 5.0°C
Difference in frequency - 182 cycles
Difference in frequency per degree C - 36 cycles, .0024%

Difference between readings taken at 0412 and 0536
Ambient temperature - 5.0°C
Difference in frequency - 112 cycles
Difference in frequency per degree C - 22 cycles, .0015%

Difference between readings taken at 0536 and 0648
Ambient temperature - 13.8°C
Difference in frequency - 102 cycles
Difference in frequency per degree C - 7 cycles, .00046%

Difference between readings taken at 0900 and 0648
Ambient temperature - 0.2°C
Difference in frequency - 660 cycles, .044%

TABLE 12

TBA-1a Transmitter

Run made to determine lack of temperature control
in ambients above 30°C
Output frequency = 9000 kcs
M.O. frequency = 2250 kcs

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
0910	32.0	59.2	238	2250.851
20	34.8	59.2	238	.851
30	35.4	59.2	249	.853
40	34.8	59.3	240	.843
50	34.6	59.5	240	.838
1000	34.8	59.7	239	.821
	Key open 10 minutes - generator down.			
1010	34.8	60.0	238	2250.816
20	34.6	60.2	236	.796
30	35.0	60.5	235	.776
40	35.4	60.6	236	.761
50	35.6	60.8	240	.738
1100	35.8	61.2	240	.716
10	36.0	61.5	239	.682
	Key open 10 minutes - generator down.			
1120	34.6	61.8	240	2250.657
30	35.6	62.1	238	.626
40	36.2	62.4	240	.597
50	36.0	62.6	240	.579
1200	36.6	62.9	240	.361
10	36.8	63.2	240	.337
20	36.8	63.6	241	.291
	Key open for 10 minutes - generator down.			
1230	35.6	63.8	238	2250.275
40	36.6	64.1	240	.285
50	36.6	64.3	238	.275
1300	37.0	64.6	242	.254
10	37.2	64.8	242	.245
20	37.4	65.1	240	.223
30	37.6	65.5	242	.233
	Key open 10 minutes - generator down.			

TABLE 12 (cont'd)

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
1340	36.8	65.7	242	2250.214
50	36.8	66.0	244	.196
1400	37.2	66.2	242	.177
10	37.6	66.5	242	.166
20	37.8	66.0	242	.150
30	38.0	66.8	243	.135
40	38.0	67.1	242	.117
	Key open for 10 minutes - generator down.			
1450	36.8	67.4	242	2250.098
1500	37.8	67.7	243	.084
10	38.0	67.8	243	.069
20	38.2	68.0	243	.057
30	38.4	68.2	243	.039
40	38.6	68.4	242	.030
50	38.8	68.7	243	.017

Note that a sudden jump in frequency (218 cycles) occurred at 1200. It is believed that this was caused by accidentally jarring the front panel of the transmitter. This 218 cycles has been subtracted from the total frequency drift in the following table.

Difference between readings taken at 1000 and 1550
Ambient temperature - 4.0° C
Difference in frequency - 804-218 = 586 cycles, .026%
Difference in frequency per degree C - 146 cycles, .0065%

Difference between readings taken 1000 and 1110
Ambient temperature - 1.2°C
Difference in frequency - 139 cycles
Difference in frequency per degree C - 116 cycles, .0051%

Difference between readings taken at 1110 and 1220
Ambient temperature - 0.8°C
Difference in frequency - 173 cycles
Difference in frequency per degree C - 216 cycles, .0095%

Difference between readings taken at 1220 and 1330
Ambient temperature - 0.8°C
Difference in frequency - 58 cycles
Difference in frequency per degree C - 72 cycles, .0032%

Difference between readings taken at 1330 and 1440
Ambient temperature - .4°C
Difference in frequency - 116 cycles
Difference in frequency per degree C - 290 cycles, .013%

TABLE 12 (cont'd)

Difference between readings taken at 1440 and 1550
Ambient temperature - .8°C
Difference in frequency - 100 cycles, .0044%

TABLE 13

TBA Transmitter

Crystal controlled M.O.
Output frequency = 24630 kcs
M.O. frequency = 3078.75 kcs

TIME	AMB. TEMP.	CABINET TEMP.	Actual Frequency M.O.	LINE VOLTS
1000	30.2	50.4	3078.750	240
10	30.8	50.3	.753	238
20	30.0	50.2	.756	239
30	30.4	50.2	.752	240
40	30.0	50.2	.754	238
50	29.6	50.2	.748	238
1100	29.9	50.3	.750	238
Key open 10 minutes to change temperature.				
1110	20.0	50.25	3078.736	238
20	19.6	50.2	.743	238
30	20.2	50.25	.740	239
40	20.2	50.2	.742	238
50	20.2	50.2	.744	240
1200	19.6	50.2	.742	240
10	20.0	50.06	.744	240
Key open 20 minutes to change temperature.				
1230	10.8	50.3	3078.742	242
40	9.9	50.3	.743	242
50	9.6	50.2	.746	241
1300	10.8	50.2	.746	240
10	10.1	50.15	.748	241
20	10.0	50.2	.750	238
30	10.0	50.2	.750	236
Key open 40 minutes to change temperature.				
1410	1.0	50.4	3078.750	241
20	2.3	50.4	.754	242
30	2.3	50.3	.758	238
40	2.9	50.3	.756	236
50	3.3	50.4	.760	240
1500	3.4	50.3	.758	239
10	3.6	50.3	.762	239
Key open 20 minutes to change temperature.				
1530	28.2	50.4	3078.754	238
40	30.6	50.4	.764	238
50	30.2	50.5	.762	238
1600	30.5	50.4	.764	242
10	30.2	50.3	.758	241
20	30.2	50.4	.758	243
30	30.0	50.4	.751	242

TABLE 13 (cont'd)

Difference between readings taken at 1100 and 1210
Ambient temperature - 9.9°C
Difference in frequency - 6 cycles
Difference in frequency per degree C - less than 1 cycle

Difference between readings taken at 1210 and 1330
Ambient temperature - 10°C
Difference in frequency - 6 cycles
Difference in frequency per degree C - less than 1 cycle

Difference between readings taken at 1330 and 1510
Ambient temperature - 6.4°C
Difference in frequency - 12 cycless
Difference in frequency per degree C - 1.8 cycles, .000061%

Difference between readings taken at 1510 and 1630
Ambient temperature - 26.4°C
Difference in frequency - 11 cycles
Difference in frequency per degree C - less than 1 cycle

Difference between readings taken at 1100 and 1630
Ambient temperature - 0.1°C
Difference in frequency - 1 cycle - .000033%

TABLE 14

TBA Transmitter
Crystal controlled M.O.

Output frequency = 24630
C.O. frequency = 3078.750

TIME	AMB. TEMP.	CABINET TEMP.	Actual Frequency M.O.	LINE VOLTS
1100	29.4	50.2	3078.744	238
10	30.6	50.2	.749	236
20	30.0	50.3	.748	238
30	30.0	50.3	.750	237
40	29.6	50.1	.746	238
50	30.4	50.2	.748	238
1200	30.0	50.15	.744	239
Key open 10 minutes to change temperature.				
1210	35.4	50.2	3078.746	236
20	35.8	50.0	.740	240
30	36.2	50.2	.744	240
40	36.0	50.05	.740	236
50	36.2	50.0	.742	240
1300	36.2	50.0	.738	241
10	36.4	50.23	.740	237
Key open 10 minutes to change temperature.				
1320	42.6	50.2	3078.725	237
30	42.8	50.1	.730	237
40	43.0	50.0	.730	240
50	43.0	50.0	.732	238
1400	43.0	49.97	.733	239
10	43.1	50.0	.740	240
20	42.9	50.1	.725	236
Key open 40 minutes to change temperature.				
1500	29.6	50.5	3078.685	234
10	29.8	50.55	.685	238
20	29.8	50.55	.685	238
30	30.8	50.5	.690	239
40	30.0	50.45	.690	241
50	30.2	50.35	.695	242
1600	30.1	50.3	.710	242

TABLE 14 (cont'd)

Difference between readings taken at 1200 and 1310
Ambient temperature - 6.4°C
Difference in frequency - 4 cycles.
Difference in frequency per degree C - less than 1 cycle

Difference between readings taken at 1310 and 1420
Ambient temperature - 6.5°C
Difference in frequency - 15 cycles
Difference in frequency per degree C - 2 cycles, .000066%

Difference between readings taken at 1420 and 1600
Ambient temperature - 12.8°C
Difference in frequency - 15 cycles
Difference in frequency per degree C - 1 cycle, .000033%

Difference between readings taken at 1200 and 1600
Ambient temperature - 0.1°C
Difference in frequency - 34 cycles
Difference in frequency per degree C - .0011%

TABLE 15

TBA Transmitter
Crystal controlled M.O.

M.O. Frequency = 2052.5 kcs
Output frequency = 4105 kcs

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
0910	30.2	50.2	238	2052.500
20	30.6	50.2	239	.497
30	30.0	50.2	240	.500
40	30.2	50.15	239	.498
50	30.2	50.22	238	.500
1000	30.0	50.2	240	.499
10	30.1	50.2	240	.502
Key open 20 minutes to change temperature.				
1030	19.6	50.2	238	2052.498
40	20.0	50.2	239	.499
50	19.7	50.15	240	.502
1100	20.0	50.1	239	.500
10	20.0	50.1	240	.505
20	19.0	50.2	239	.500
30	20.4	50.2	240	.502
Key open 10 minutes to change temperature.				
1140	9.8	50.05	240	2052.503
50	10.0	50.2	240	.503
1200	10.0	50.2	240	.500
10	10.0	50.05	240	.497
20	10.2	50.25	242	.505
30	10.0	50.2	240	.502
40	10.0	50.2	240	.507
Key open 70 minutes to change temperature.				
1350	0.0	50.3	240	2052.495
1400	0.8	50.3	239	.498
10	1.8	50.4	241	.501
20	1.8	50.4	241	.500
30	1.2	50.4	239	.500
40	1.0	50.3	240	.502
50	0.8	50.3	243	.498
1520	29.0	50.3	237	.465
30	29.2	50.4	241	.470
40	29.8	50.3	242	.475
50	30.0	50.4	243	.475
1600	30.4	50.3	243	.474
10	29.9	50.3	244	.479
20	30.0	50.3	245	.475

TABLE 15 (cont'd)

Following taken in terms of M.O. which is measured frequency variation divided by 2.

Difference between readings taken at 1010 and 1130
Ambient temperature - 9.7°C
Difference in frequency - 0

Difference between readings taken at 1130 and 1240
Ambient temperature - 10.4°C
Difference in frequency - 5 cycles
Difference in frequency per degree C - less than 1 cycle.

Difference between readings taken at 1240 and 1450
Ambient temperature - 9.2°C
Difference in frequency - 10 cycles
Difference in frequency per degree C - 1 cycle, .000048%

Difference between readings taken at 1450 and 1620
Ambient temperature - 29.2°C
Difference in frequency - 22 cycles
Difference in frequency per degree C - less than 1 cycle

Difference between readings taken at 1010 and 1620
Ambient temperature - 0.1°C
Difference in frequency - 27 cycles, .0013%

TABLE 16

TBA Transmitter
Crystal Controlled M.O.
Output frequency = 4105
M.O. frequency = 2052.5

TIME	AMB. TEMP.	CABINET TEMP.	LINE VOLTS	Actual Frequency M.O.
0930	30.0	50.2	242	2052.486
40	29.2	50.1	240	.507
50	30.0	50.3	239	.502
1000	30.2	50.2	238	.507
10	30.0	50.3	240	.502
20	29.8	50.2	238	.507
30	30.2	50.2	241	.505
Key open 10 minutes to change temperature.				
1040	36.6	50.2	239	2052.508
50	36.2	50.1	239	.505
1100	36.0	50.2	239	.510
10	36.2	50.2	240	.507
20	36.0	50.2	240	.508
30	36.2	50.2	242	.508
40	36.0	50.15	243	.510
1200	42.8	50.0	242	2052.502
10	43.0	49.95	243	.512
20	43.0	50.0	244	.508
30	43.0	50.15	244	.511
40	43.0	50.15	244	.507
50	43.0	50.0	243	.515
1300	42.9	50.1	242	.512
Key open 40 minutes to change temperature.				
1340	29.6	50.2	236	2052.498
50	29.9	50.2	238	.500
1400	30.8	50.1	238	.510
10	30.2	49.95	238	.512
20	30.2	50.0	237	.515
30	30.2	50.2	238	.516
40	30.0	50.05	238	.515

TABLE 16 (cont'd)

Following in terms of C.O. frequency variation.

Difference between readings taken at 1030 and 1140
Ambient temperature - 5.8°C
Difference in frequency - 5 cycles
Difference in frequency per degree C - less than 1 cycle

Difference between readings taken at 1140 and 1300
Ambient temperature - 6.9°C
Difference in frequency - 2 cycles
Difference in frequency per degree C - negligible

Difference between readings taken at 1300 and 1440
Ambient temperature - 12.9°C
Difference in frequency - 2 cycles
Difference in frequency per degree C - negligible

Difference between readings taken at 1030 and 1440
Ambient temperature - 0.2°C
Difference in frequency - 10 cycles, .0005%

TABLE 17

TBA Transmitter

Crystal Controlled M.O.
Output frequency = 13305 kcs
M.O. frequency = 3326.250 kcs

TIME	AMB. TEMP.	CABINET TEMP.	Actual Frequency M.O.	LINE VOLTS
1030	28.8	50.2	3326.250	240
40	30.0	50.2	.250	240
50	30.6	50.2	.250	241
1100	30.2	50.2	.250	241
10	30.6	50.1	.250	242
20	30.8	50.1	.240	243
30	30.0	50.2	.240	241
Key open 10 minutes to change temperature.				
1140	35.8	50.05	.215	241
50	35.6	50.05	.230	241
1200	36.0	50.1	.225	241
10	36.0	50.2	.228	244
20	35.6	50.05	.225	244
30	36.4	50.0	.220	246
40	36.0	50.0	.215	244
Key open 10 minutes to change temperature.				
1250	42.8	50.1	3326.195	243
1300	43.2	50.1	.207	242
10	43.0	50.0	.210	241
20	42.9	49.95	.205	241
30	43.2	50.0	.205	243
40	43.0	50.05	.203	242
50	43.0	50.1	.197	241
Key open 20 minutes to change temperature.				
1410	29.6	50.4	.215	241
20	30.0	50.55	.170	243
30	30.0	50.6	.165	243
40	30.2	50.65	.150	244
50	30.0	50.65	.150	243
1500	30.0	50.65	.147	243
10	30.0	50.6	.155	242

TABLE 17 (cont'd)

Difference between readings taken at 1130 and 1240
    Ambient temperature - 6.0°C
    Difference in frequency - 25 cycles
    Difference in frequency per degree C - 4 cycles, .00012%

Difference between readings taken at 1240 and 1350
    Ambient temperature - 7.0°C
    Difference in frequency - 18 cycles
    Difference in frequency per degree C - 2 cycles, .00006%

Difference between readings taken at 1350 and 1510
    Ambient temperature - 13.0°C
    Difference in frequency - 42 cycles
    Difference in frequency per degree C - 3 cycles, .00009%

Difference between readings taken at 1130 and 1510
    Ambient temperature - 0.0°C
    Difference in frequency - 85 cycles, .0026%

TABLE 18

TBA Transmitter

Crystal Controlled M.O.
Output frequency - 13305 kcs
C.O. frequency - 3326.250 kcs

TIME	AMB. TEMP.	CABINET TEMP.	Actual Frequency M.O.	LINE VOLTS
0900	30.0	50.2	3326.280	238
10	30.0	50.1	.275	236
20	30.0	50.1	.265	240
30	30.0	50.2	.265	241
40	30.0	50.2	.260	241
50	30.0	50.2	.255	240
1000	30.0	50.2	.250	239
Key open 10 minutes to change temperature.				
1020	20.2	50.05	.225	240
30	20.0	50.15	.230	240
40	20.0	50.2	.235	240
50	20.1	50.2	.230	241
1100	20.0	50.1	.235	241
10	20.0	50.0	.230	239
20	20.0	50.1	.230	238
Key open 50 minutes to change temperature.				
1210	10.5	50.15	3326.225	246
20	10.6	50.0	.230	245
30	10.4	50.2	.240	246
40	10.0	50.2	.240	245
50	9.7	50.2	.245	245
1300	10.1	50.05	.245	245
10	10.0	50.3	.247	243
Key open 50 minutes to change temperature.				
1400	5.4	50.1	3326.240	241
10	6.6	50.3	.255	242
20	7.2	50.25	.260	242
30	7.4	50.3	.260	242
40	7.8	50.2	.260	241
50	8.0	50.3	.260	242
1500	8.0	50.3	.260	242
1520	30.1	50.3	3326.250	240
30	30.0	50.3	.265	242
40	30.0	50.3	.260	242
50	30.0	50.2	.260	242
1600	30.0	50.3	.255	243
10	29.9	50.3	.250	243
20	30.0	50.2	.250	243

TABLE 18 (cont'd)

Difference between readings taken at 1000 and 1120
Ambient temperature - 10.0°C
Difference in frequency - 20 cycles
Difference in frequency per degree C - 2 cycles, .00006%

Difference between readings taken at 1120 and 1310
Ambient temperature - 10.0°C
Difference in frequency - 17 cycles
Difference in frequency per degree C - 1.5 cycles, .000045%

Difference between readings taken at 1310 and 1500
Ambient temperature - 2.0°C
Difference in frequency - 13 cycles
Difference in frequency per degree C - 6 cycles, .00018%

Difference between readings taken at 1500 and 1620
Ambient temperature - 22.0°C
Difference in frequency - 10 cycles
Difference in frequency per degree C - less than 1 cycle

Difference between readings taken at 1000 and 1620
Ambient temperature - 0.0°C
Difference in frequency - 0 cycles

TABLE 21

TBA Transmitter

Self Excited M.O.
Output frequency = 2000 kcs
M.O. frequency = 3000 kcs

TIME	AMB. TEMP.	Actual Frequency M.O.	LINE VOLTS
1020	29.4	3001.818	231
30	29.6	.568	234
40	30.2	.468	235
50	30.0	.338	239
1100	29.6	.218	245
10	30.2	.068	242
20	30.0	..040	240
Key open 10 minutes to change temperature.			
1130	35.4	3001.408	239
40	36.4	.098	238
50	36.2	3000.898	240
1200	36.4	.938	241
10	36.0	.978	242
20	36.6	3001.073	239
30	35.9	.148	240
Key open 10 minutes to change temperature.			
1240	42.6	3001.241	243
50	42.8	.191	240
1300	43.0	.141	240
10	43.0	.063	239
20	42.8	.023	240
30	42.8	3000.958	240
40	43.0	.903	241
Key open 10 minutes to change temperature.			
1350	30.0	3001.133	241
1400	30.8	.128	240
10	30.0	.246	241
20	30.6	.356	243
30	29.9	.432	243
40	30.0	.476	241
50	29.9	.516	242

TABLE 21 (cont'd)

Difference between readings taken at 1120 and 1230
Ambient temperature - 5.9°C
Difference in frequency - 108 cycles
Difference in frequency per degree C - 18 cycles, .0006%

Difference between readings taken at 1230 and 1340
Ambient temperature - 8.1°C
Difference in frequency - 245 cycles
Difference in frequency per degree C - 30 cycles, .001%

Difference between readings taken at 1340 and 1450
Ambient temperature - 13.1°C
Difference in frequency - 613 cycles
Difference in frequency per degree C - 46 cycles, .0015%

Difference between readings taken at 1120 and 1450
Ambient temperature - 0.1°C
Difference in frequency - 476 cycles, .015%

TABLE 22

TBA Transmitter

Self Excited M.O.
Output frequency = 12000 kcs
M.O. frequency = 3000 kcs

TIME	AMB. TEMP.	Actual Frequency M.O.	LINE VOLTS
0920	29.2	2999.728	238
30	30.2	.410	239
40	29.6	.245	239
50	29.4	.060	238
1000	30.2	2998.940	241
10	30.1	Off scale	238
20	30.0	" "	238
Key open 20 minutes to change temperature.			
1040	19.8	2998.910	242
50	20.0	.860	241
1100	20.5	.882	241
10	19.6	.908	240
20	20.2	.930	241
30	20.0	.950	242
40	20.0	.962	243
Key open 20 minutes to change temperature.			
1200	9.2	2999.428	241
10	10.0	.343	242
20	10.0	.403	241
30	11.6	.478	244
40	9.8	.528	240
50	9.6	.558	240
1300	10.3	.608	241
Key open 1 hour 20 minutes to change temperature.			
1420	0.2	3000.678	244
30	1.8	.530	244
40	3.0	.551	241
50	3.0	.550	241
1500	2.8	.560	242
10	2.6	.565	243
20	2.5	.575	241
Key open 10 minutes to change temperature.			
1530	28.6	3000.460	239
40	30.2	.060	242
50	29.8	2999.970	243
1600	30.0	3000.250	244
10	30.0	.482	242
20	30.2	2999.950	242
30	30.0	3000.086	244

TABLE 22 (cont'd)

Difference between readings taken at 1000 and 1140
Ambient temperature - 10.0°C
Difference in frequency - 22 cycles
Difference in frequency per degree C - 2 cycles, .000066%

Difference between readings taken at 1140 and 1300
Ambient temperature - 9.7°C
Difference in frequency - 646 cycles
Difference in frequency per degree C - .0215%

Difference between readings taken at 1300 and 1520
Ambient temperature - 7.8°C
Difference in frequency - 967 cycles
Difference in frequency per degree C - .032%

Difference between readings taken at 1520 and 1630
Ambient temperature - 27.5°C
Difference in frequency - 489 cycles
Difference in frequency per degree C - .016%

Difference between readings taken at 1000 and 1630
Ambient temperature - 0.0°C
Difference in frequency - 1146 cycles, .038%

TABLE 23

TBA Transmitter
Self Excited M.O.
Output frequency = 4500 kcs
M.O. frequency = 4500 kcs

TIME	AMB. TEMP.	Actual Frequency M.O.	LINE VOLTS
1030	30.0	4501.208	240
40	30.0	4500.218	240
50	30.0	4499.918	239
1100	30.0	.643	238
10	30.2	.330	239
20	30.3	.025	241
30	30.4	4498.830	243
Key open 10 minutes to change temperature.			
1140	35.8	4498.140	241
50	36.0	.440	241
1200	36.2	.200	244
10	36.2	.060	240
20	36.0	.000	240
30	35.8	.138	238
40	36.0	.228	236
Key open 10 minutes to change temperature.			
1250	42.6	4498.848	238
1300	42.4	.548	239
10	42.6	.588	239
20	43.0	.558	240
30	42.6	.478	239
40	43.0	.413	237
50	42.8	.348	238
Key open 10 minutes to change temperature.			
1400	30.0	4498.828	238
10	30.1	.708	237
20	29.2	.838	238
30	30.0	.930	240
40	30.8	4499.010	240
50	29.8	.010	239
1500	30.1	.005	241

TABLE 23 (cont'd)

Difference between readings taken at 1130 and 1240
Ambient temperature - 5.6°C
Difference in frequency - 602 cycles
Difference in frequency per degree C - 107 cycles, .0026%

Difference between readings taken at 1240 and 1350
Ambient temperature - 6.8°C
Difference in frequency - 120 cycles
Difference in frequency per degree C - 17 cycles, .00038%

Difference between readings taken at 1350 and 1500
Ambient temperature - 12.7°C
Difference in frequency - 657 cycles
Difference in frequency per degree C - 52 cycles, .0015%

Difference between readings taken at 1130 and 1500
Ambient temperature - 0.3°C
Difference in frequency - 175 cycles, .0039%

TABLE 24

TBA Transmitter
Self Excited M. O.
Output frequency - 4500 kcs
M.O. frequency - 4500 kcs

TIME	AMB. TEMP.	Actual Frequency M. O.	LINE VOLTS
0910	30.0	4500.600	234
20	30.4	4499.778	229
30	29.6	.520	230
40	30.1	.210	230
50	32.0	4498.960	224
1000	30.0	.715	228
10	30.4	.530	226
Key open 10 minutes to change temperature.			
1020	20.0	4498.857	228
30	19.6	.430	232
40	20.0	.430	232
50	20.0	.450	232
1100	20.0	.400	232
10	20.2	.400	232
20	20.1	.400	231
Key open 50 minutes to change temperature.			
1210	10.4	4500.080	234
20	10.0	4499.920	234
30	9.7	4500.060	228
40	10.1	.188	230
50	9.8	.358	230
1300	10.0	.458	228
10	10.0	.598	226
Key open 1 hour 10 minutes to change temperature.			
1420	1.4	4501.828+	230
30	2.2	Off scale	231
40	2.8	" "	231
50	2.6	" "	230
1500	2.6	" "	230
10	3.0	" "	228
20	2.8	" "	220
Key open 10 minutes to change temperature.			
1530	27.0	4501.528	226
40	29.8	4500.600	230
50	30.0	4499.988	232
1600	30.4	.400	232
10	30.3	.020	232
20	29.4	4498.645	233
30	30.0	.445	235

TABLE 24 (cont'd)

Difference between readings taken at 1010 and 1120
Ambient temperature - 10.3°C
Difference in frequency - 130 cycles
Difference in frequency per degree C - 12 cycles, .00027%

Difference between readings taken at 1120 and 1310
Ambient temperature - 10.1°C
Difference in frequency - 2198 cycles
Difference in frequency per degree C - 219 cycles, .0049%

Difference between readings taken at 1310 and 1520
Ambient temperature - 7.2°C
Difference in frequency - more than 1230 cycles
Difference in frequency per degree C - 171 cycles, .0038%

Difference between readings taken at 1520 and 1630
Ambient temperature - 7.2°C
Difference in frequency - 3383 cycles +
Difference in frequency per degree C - .013%

Difference between readings taken at 1010 and 1630
Ambient temperature - 0.4°C
Difference in frequency - 85 cycles, .0019%

TABLE 25

TBA Transmitter
Self Excited M.O.
Output frequency = 8000 kcs.
M.O. frequency - 2000 kcs

TIME	AMB. TEMP.	Actual Frequency M.O.	LINE VOLTS
0920	29.2	2000.276	228
30	29.8	1999.746	229
40	30.0	.510	228
50	29.8	.300	228
1000	30.0	.150	228
10	30.4	.065	230
20	30.0	1998.955	230
Key open 30 minutes to change temperature.			
1050	19.2	1999.580	228
1100	20.2	.125	228
10	20.1	.210	230
20	20.0	.185	228
30	19.8	.225	229
40	20.1	.195	230
50	20.0	.250	229
Key open 20 minutes to change temperature.			
1210	9.9	2000.145	234
20	9.6	.011	231
30	10.0	.181	230
40	10.0	.196	230
50	10.0	.266	229
1300	9.8	.306	230
10	10.0	.400	230
Key open 30 minutes to change temperature.			
1340	0.6	2001.136	230
50	0.8	.036	229
1400	1.0	.266	230
10	0.6	.336	230
20	0.2	.426	232
30	0.0	.506	232
40	-0.4	.616	230
Key open 20 minutes to change temperature.			
1510	29.8	2000.700	230
20	30.0	.066	230
30	30.0	1999.721	232
40	30.4	.410	231
50	30.2	.250	230
1600	30.0	.080	233
10	30.2	1998.930	231

TABLE 25 (cont'd)

Difference between readings taken at 1020 and 1150
Ambient temperature - 10.0°C
Difference in frequency - 29.5 cycles
Difference in frequency per degree C - 29 cycles, .00145%

Difference between readings taken at 1150 and 1310
Ambient temperature - 10.0°C
Difference in frequency - 1150 cycles
Difference in frequency per degree C - 115 cycles, .0057%

Difference between readings taken at 1310 and 1440
Ambient temperature - 10.4°C
Difference in frequency - 1216 cycles
Difference in frequency per degree C - 117 cycles, .0058%

Difference between readings taken at 1440 and 1610
Ambient temperature - 30.6°C
Difference in frequency - 2686 cycles
Difference in frequency per degree C - 88 cycles, .0044%

Difference between readings taken at 1020 and 1610
Ambient temperature 0.2°C
Difference in frequency - 85 cycles, .0042%

TABLE 26

TBA Transmitter
Self Excited M.O.
Output frequency = 8000 kcs
M.O. frequency = 2000 kcs

TIME	Amb. TEMP.	Actual Frequency M.O.	LINE VOLTS
1030	29.8	2001.450	230
40	30.0	.070	229
50	30.6	2000.900	231
1100	29.8	.787	230
10	30.0	.650	230
20	30.0	.548	231
30	30.2	.490	230
Key open 10 minutes to change temperature.			
1140	35.6	2000.540	228
50	36.0	.156	228
1200	36.2	.016	229
10	36.0	1999.936	230
20	35.6	.881	228
30	36.0	.876	230
40	36.0	.891	227
Key open 10 minutes to change temperature.			
1250	42.2	2000.056	230
1300	43.0	1999.666	229
10	42.8	.716	228
20	42.6	.816	229
30	42.9	.908	228
40	42.8	2000.006	230
50	43.0	.034	227
Key open 10 minutes to change temperature.			
1400	30.4	2000.550	228
10	29.6	.450	228
20	30.1	.480	229
30	29.6	.470	228
40	30.0	.400	229
50	29.8	.316	229
1500	30.0	.236	230

TABLE 26 (cont'd)

Difference between readings taken at 1130 and 1240
Ambient temperature - 5.8°C
Difference in frequency - 599 cycles
Difference in frequency per degree C - 103 cycles, .0051%

Difference between readings taken at 1240 and 1350
Ambient temperature - 7.0°C
Difference in frequency - 143 cycles
Difference in frequency per degree C - 21 cycles, .001%

Difference between readings taken at 1350 and 1500
Ambient temperature - 13.0°C
Difference in frequency - 202 cycles
Difference in frequency per degree C - 15 cycles, .00075%

Difference between readings taken at 1130 and 1500
Ambient temperature - 0.2°C
Difference in frequency - 254 cycles, .012%

TABLE 27

Summary of Tables 1 to 12 inclusive

TBA-1a Transmitter

Frequency M.O.	Frequency Output	Temperature Range °C	% Change in frequency per °C
2250	9000	34.8-36.0	.0051
2250	9000	36.0-36.8	.0077
2250	9000	36.8-37.6	.0032
2250	9000	37.6-38.0	.013
2250	9000	38.0-38.8	.0055
1500	24000	29.6-19.8	.0003
1500	24000	19.8-10.0	.00078
1500	24000	10.0- 0.8	.0025
1500	24000	0.8-29.8	.0002
1500	12000	31.4-25.0	.0007
1500	12000	25.0-19.9	.0003
1500	12000	19.9-15.1	.0003
1500	12000	15.1-10.0	.0001
1500	12000	10.0- 4.8	.000066
1500	12000	4.8- 0.4	.00016
1500	12000	0.4- 5.2	.00083
1500	12000	5.2-10.2	.0008
1500	12000	10.2-15.4	.0005
1500	12000	15.4-20.8	.0001
1500	12000	20.8-25.0	.00033
1500	12000	25.0-30.0	.00013
1500	12000	30.0-35.0	.0014
1500	12000	35.0-40.0	.0024
1500	12000	40.0-45.0	.0015
1500	12000	45.0-31.2	.00046
2000	4000	39.9-49.7	.0017
2000	4000	49.7-30.0	.00045
2000	4000	31.0-15.0	.000037
2000	4000	15.0-31.0	.00005
2000	8000	30.3- 4.2	.0002
2000	8000	4.2-30.0	negligible
1000	8000	30.5-40.0	.0013
1000	8000	40.0-50.6	.0022
1000	8000	50.6-30.6	.0007
2250	9000	30.0-40.5	.0019
2250	9000	40.5-50.0	.0022
2250	9000	50.0-30.2	.00013

TABLE 27 (cont'd)

Frequency M.O.	Frequency Output	Temperature Range °C	% Change in frequency per °C
2250	9000	30.3-15.5	.0003
2250	9000	15.5- 1.0	.0003
2250	9000	1.0- 9.8	.0004
2250	9000	9.8-30.0	.00013
2250	9000	30.2-39.6	.0097
2250	9000	39.6-49.8	.018
2250	9000	49.8-29.4	.001
1500	12000	30.7-20.1	.00027
1500	12000	20.1- 9.8	.00063
1500	12000	9.8- 0.0	.002
1500	12000	0.0-30.0	.0001
1500	24000	29.7-39.2	.0016
1500	24000	39.2-50.1	.00074
1500	24000	50.1-29.8	.001

TABLE 28

TBA Transmitter (Crystal Oscillator)

Summary of Tables 13 to 18 inclusive.

Frequency C.O.	Output	Temperature Range °C	Change in frequency per °C
3078.75	24630	29.9-20.0	less than 1 cycle
3078.75	24630	20.0-10.0	" " " "
3078.75	24630	10.0- 3.6	.000061%
3078.75	24630	3.6-30.0	less than 1 cycle
3078.75	24630	30.0-36.4	less than 1 cycle
3078.75	24630	36.4-42.9	.000066%
3078.75	24630	42.9-30.1	.000033%
2052.5	4105	30.1-20.4	no change
2052.5	4105	20.4-10.0	less than 1 cycle
2052.5	4105	10.0- 0.8	.000048%
2052.5	4105	0.8-30.0	less than 1 cycle
2052.5	4105	30.0-36.0	less than 1 cycle
2052.5	4105	36.0-43.0	" " " "
2052.5	4105	43.0-30.0	" " " "
3326.25	13305	30.0-36.0	.00012%
3326.25	13305	36.0-43.0	.00006%
3326.25	13305	43.0-30.0	.00009%
3326.25	13305	30.0-20.0	.00006%
3326.25	13305	20.0-10.0	.000045%
3326.25	13305	10.0- 8.0	.00018%
3326.25	13305	8.0-30.0	less than 1 cycle

TABLE 29

TBA Transmitter
Self Excited M.O.

Summary of Tables 21 to 26 inclusive.

Frequency M.O.	Output	Temperature Range °C	% Change in Frequency per °C
3000	12000	30.0-35.9	.0006
"	"	35.9-43.0	.001
"	"	43.0-29.9	.0015
3000	12000	30.0-20.0	.000066 *
"	"	20.0-10.3	.0215
"	"	10.3-2.5	.032
"	"	2.5-30.0	.016
4500	4500	30.0-36.0	.0026
"	"	36.0-42.8	.00038
"	"	42.8-30.1	.0015
4500	4500	30.0-20.1	.00027
"	"	20.1-10.0	.0049
"	"	10.0- 2.8	.0038
"	"	2.8-30.0	.013
2000	8000	30.0-20.0	.00145
"	"	20.0-10.0	.0057
"	"	10.0- 0.4	.0058
"	"	0.4-30.2	.0044
2000	8000	30.2-36.0	.0051
"	"	36.0-43.0	.001
"	"	43.0-30.0	.00075

* The value of .000066 is in error as at 1010 the frequency had drifted beyond the lower limit of the measuring equipment and at the time the next measurement was taken (1040), the frequency had drifted up to within 22 cycles of the previous measurement. This upward drift was due to the 20 minute key-open period between measurements.

TABLE 30
Test #3
TBA-1a Transmitter

Determination of Power Output
Load consisted of two 500 watt 220 volt lamps in series.

Frequency kcs	Actual Watts in Antenna System	Watts Required by Specifications	Type of Antenna Feed
4000	1147	1000	Ant.
4000	1187	1000	T.L.
8000	1152	1000	Ant.
8000	1130	1000	T.L.
12000	973	1000	Ant.
12000	937	1000	T.L.
16000	825	700	Ant.
16000	812	700	T.L.
20000	670	600	Ant.
20000	690	600	T.L.
26000	515	600	Ant.
26000	513	600	T.L.

TABLE 31

TBA-1a Transmitter
Test #5

Test as per Specifications RE 13A 420D. Frequency shift caused by line voltage variations in steps of one percent per minute from -10 to +10% of normal voltage. Normal line voltage 230 volts.

Line Volts	1 Output 4500 kcs M.O. 2250 kcs	2 Output 9000 kcs M.O. 2250 kcs	3 Output 12000 kcs M.O. 1500 kcs	4 Output 24000 kcs M.O. 1500 kcs
207.0	201 cycles	330 cycles	153 cycles	280
209.3	230	330	157	280
211.6	259	332	159	282
213.9	269	325	160	283
216.2	275	329	162	286
218.5	289	319	166	288
220.8	297	313	170	289
223.1	300	318	174	290
225.4	305	312	175	292
227.7	308	306	177	295
230.0	315	307	180	298
232.3	317	305	185	302
234.6	322	302	191	302
236.9	326	302	194	301
239.2	330	305	198	302
241.5	331	303	207	306
243.8	329	295	214	310
246.1	333	293	220	314
248.4	330	292	226	319
250.7	330	290	234	324
253.0	330	270	249	334
Maximum Shift	132 cycles .0058%	62 cycles .0027%	96 cycles .0064%	54 cycles .0036%

NOTE: The results shown under Columns 1 and 2 were obtained by increasing the voltage in 1% steps from the value of 207 volts. The results under Columns 3 and 4 were obtained by decreasing the voltage in 1% steps from 253 volts.

Transmitter operated at full power, key locked.

Tests made after M.O. compartment temperature had reached equilibrium but without any preliminary key locked period.

Filament voltage was maintained at normal value.

TABLE 32

TBA-1a Transmitter

Change in frequency between full power condition (key locked for 10 minutes) and the intermittently keyed condition (a single 10 second dash beginning not less than 20 minutes after discontinuing the key locked condition). Motor generator stopped for 18 minutes during the interval between the end of the key locked condition and the beginning of the 10 second dash.

Continuously oscillating M.O.

1000 kcs L.H. tuned to 3000 kcs		1500 kcs L.H. tuned to 3000 kcs		2250 kcs L.H. tuned to 4500 kcs	
End of 10 min. key locked period	End of 10 sec.dash 20 min. later	End of 10 min. key locked period	End of 10 sec.dash 20 min. later	End of 10 min. key locked period	End of 10 sec.dash 20 min. later.
Test #1					
536 cyc.	536 cyc.	580 cyc	398 cyc.	554 cyc.	538 cyc.
Change =	0	Change =	-182 cyc.	Change =	-16 cyc.
		.006%		.00035%	
Test #2					
534 cyc	522 cyc.	517 cyc.	492 cyc.	526 cyc.	530 cyc.
Change =	-12 cyc.	Change =	-25 cyc.	Change =	+4 cyc.
.0004%		.00083%		.00008%	

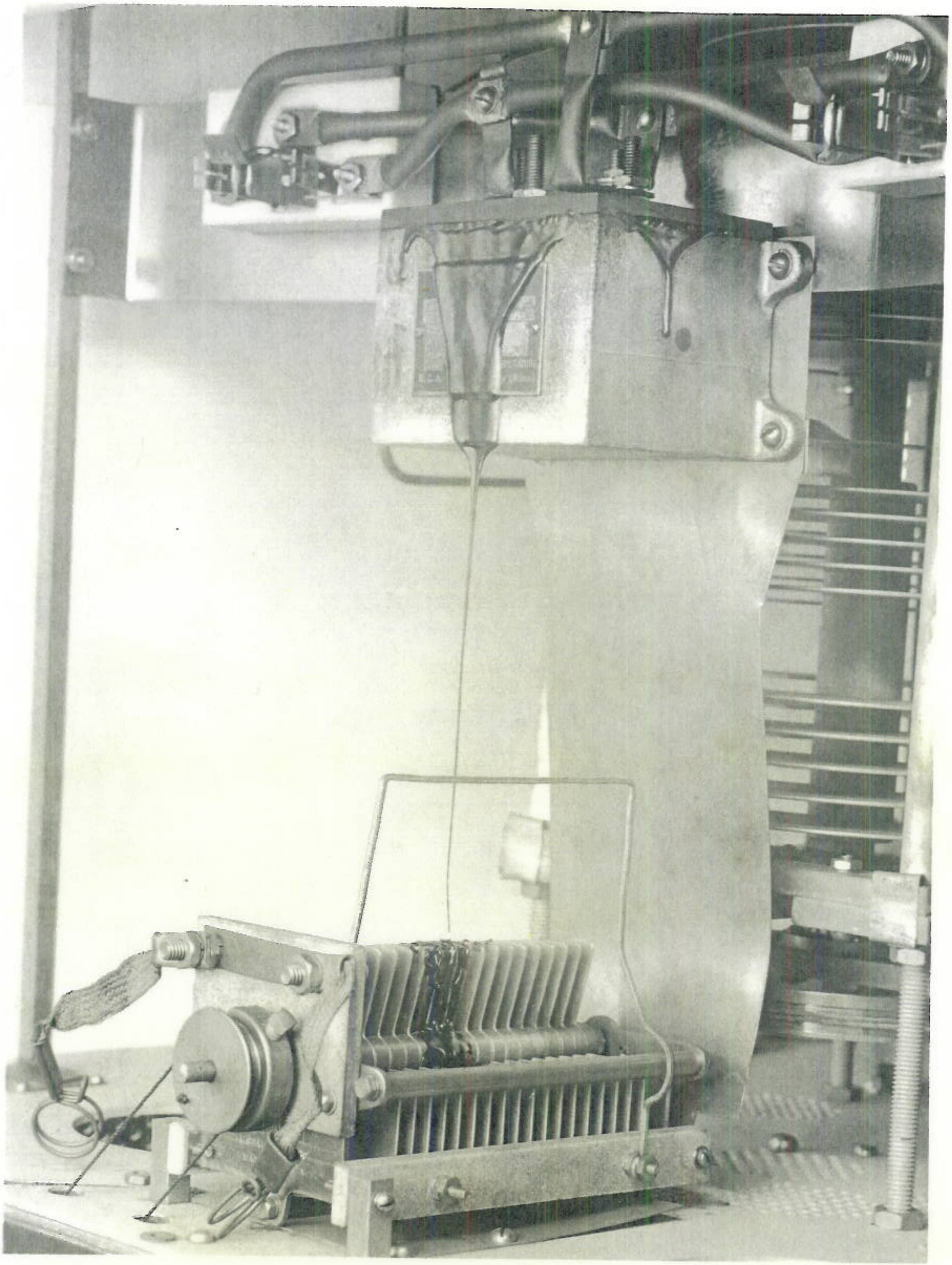


PLATE 27

REPORT NO. 1003
POLARIZATION OF LIGHT AT SEA

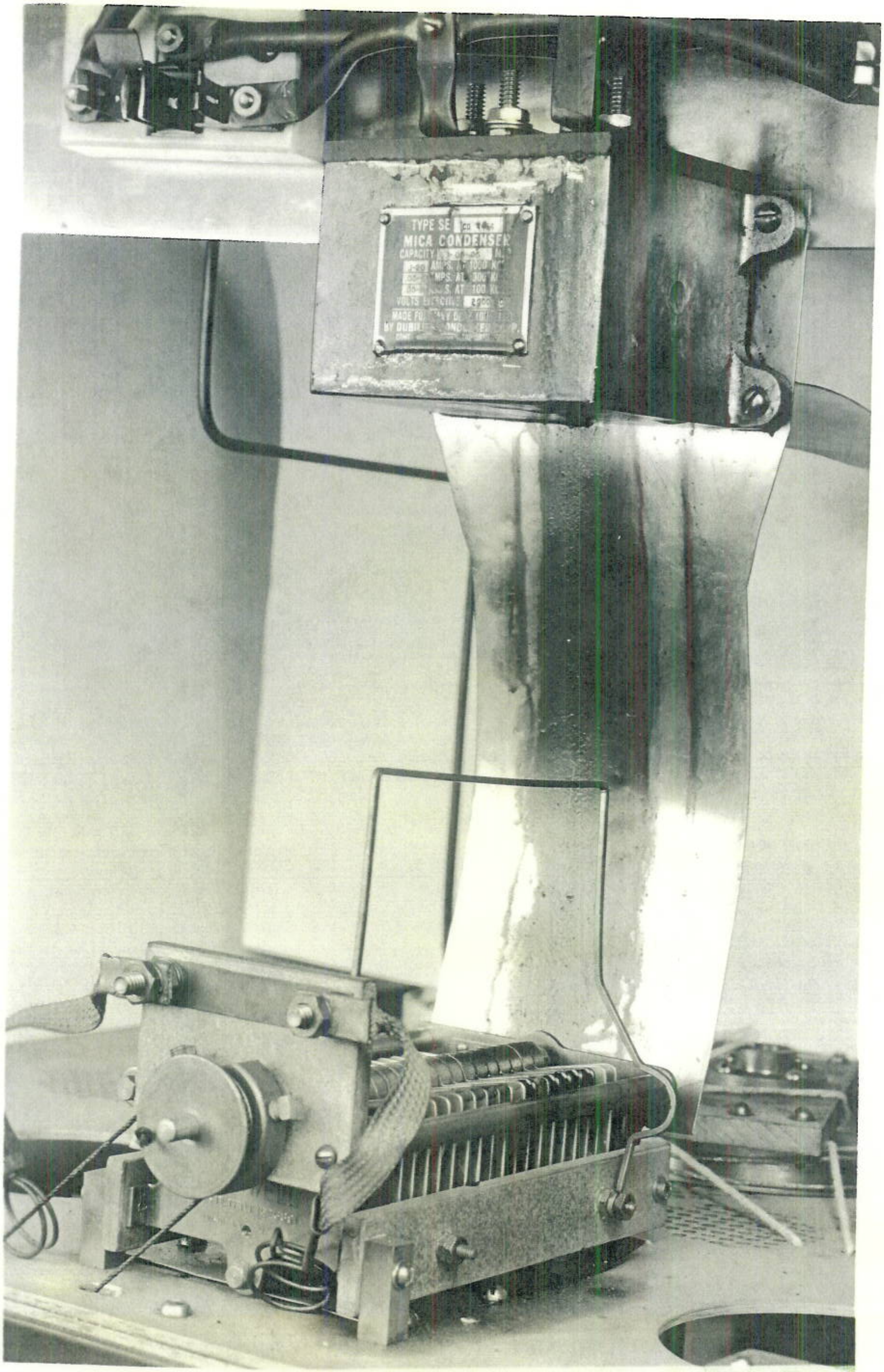
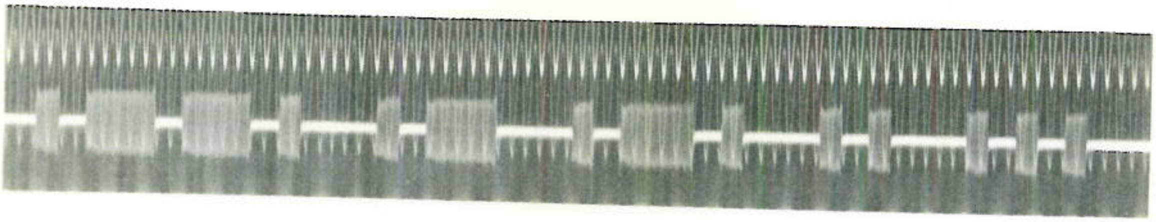
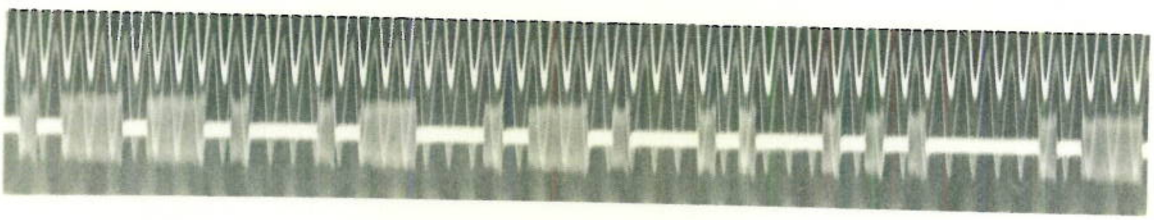


PLATE 28

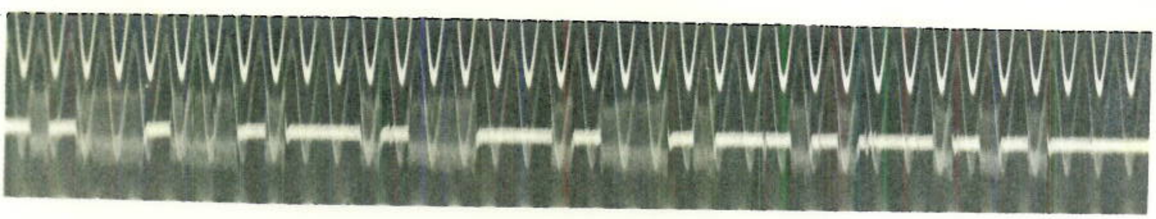
30 WORDS PER MINUTE



40 WORDS PER MINUTE



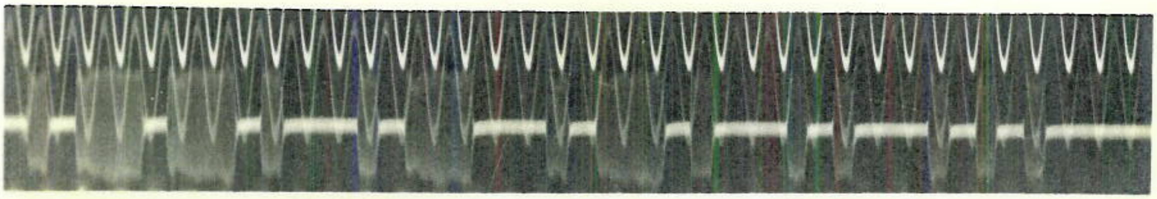
70 WORDS PER MINUTE



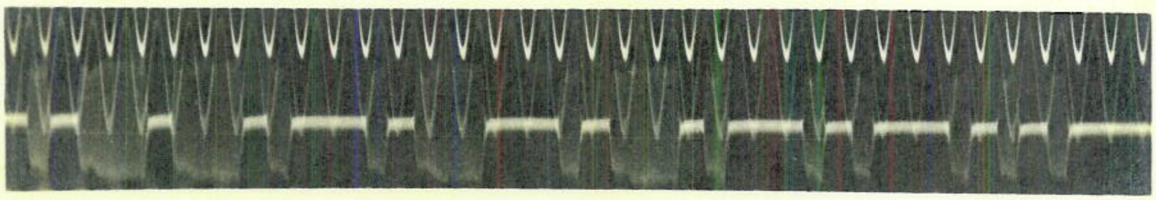
KEYING RECORD

PLATE 29

100 WORDS PER MINUTE (BEGINNING OF 1 HOUR TEST)



100 WORDS PER MINUTE (END OF 1 HOUR TEST)



KEYING RECORD

PLATE 30