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SUBJECT

Report of Test
on
Type K Multi-Channel
Transmitting and Receiving Equipments

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by

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BUREAU OF ENGINEERING

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Report of Test

on

Type K Multi-Channel

Transmitting and Receiving Equipments

manufactured
by
Aircraft Radio Corporation

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Naval Air Station, Anacostia, letter F42-1/46-52(7)/NA6 (203) Serial #39089 of 15 June 1939, to Director, Naval Research Laboratory.

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AUTHORIZATION

1. The tests herein reported were authorized by Bureau of Engineering letter, reference (a). Additional references pertinent to these tests are listed as references (b) to (f).

Reference: (a) BuEng let.C-NOs-64476(1-4-R6) of 10 January 1939.
(b) Schedule 500-677 Aeronautics.
(c) BuEng Specifications RE 13A 403D.
(d) BuEng Specifications RE 13A 558B.
(e) NAS Anacostia let.F42-1/46-52(7)/NA6(203) Serial 39089 of 15 June 1939.
(f) NAS Anacostia let.F42-1/13/52/46-52(7)/NA6(206) Serial 39090 of 15 June 1939.

OBJECT OF TEST

2. The object of these tests is to determine the compliance of the equipment with the requirements of the specifications, references (b) to (f); also to determine the adaptability in coordinating the Type K equipment with other types to be used in the same aircraft.

ABSTRACT OF TEST

3. The equipment was tested for mechanical construction and electrical performance, the adaptability for installation and operation in Navy planes and suitability for use in the Naval Service. It was bench and flight tested as a single unit and in multiple.

4. The receiver was tested for the following: frequency range and overlap, sensitivity, AVC sensitivity, overload characteristics, image response, selectivity, overload selectivity, fidelity, AVC action, audio distortion, audio distortion in multiple, frequency drift at constant ambient temperature, frequency drift at variable temperature, frequency drift at variable humidity, frequency drift due to manipulation of volume control, frequency drift due to primary voltage change, output change due to primary voltage change, current drain on primary source, calibration accuracy, reset by local and remote control, output change in multiple, interaction between receivers in multiple.

5. The transmitter was tested for the following: adjustment accuracy, lost motion, back and torque lash, detuning of circuits, change of tubes, variation of supply line voltage, variation in ambient temperature, frequency drift at variable humidity, frequency drift due to locked key operation, frequency change due to locked key to intermittently keyed condition, frequency change from continuously keyed to intermittently keyed condition, frequency change due to roll and pitch, frequency change due to vibration, radio frequency power output measurements, modulation capabilities, percentages of modulation, modulation fidelity, modulation sensitivity, carrier frequency stability, current drain on primary source.

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Conclusions

The following conclusions were reached as a result of these tests:

(a) This equipment is satisfactory for use in Naval Aircraft provided certain mechanical and electrical defects discussed herein and in the Naval Air Station's report, Appendix B of this report, are corrected in future equipments.

(b) The Type K equipment permits great flexibility in installation and use of radio communication equipment.

(c) The receivers do not meet the requirements of reference (c). These specifications, however, refer to shipboard equipment and are in general more rigid than required for aircraft equipment. The performance of the Type K receivers is considered very good. Audio fidelity and distortion should be improved as should the cw overload characteristics.

(d) The impregnating compound in certain components leaked out of the case during high temperature tests.

(e) The performance of the transmitters in general is good. While they do not in all cases meet the requirements of reference (d), their departure from these requirements is not great. Some improvement could possibly be obtained in frequency stability but for an equipment of such small size and weight, the performance is good.

(f) In order to obtain the maximum accuracy of calibration, the crystal frequencies should correspond to that of a definite mark on the transmitter dials. The crystals themselves should be ground to this frequency with a high degree of accuracy.

(g) Modifications of existing specifications will be necessary for other equipments to permit use of the Type K receivers and interphone unit as given in reference (f).

(h) The tubes used are not on the Navy approved list. Approval should not be given before further study of the tube situation preferably obtaining the views of other manufacturers prior to adopting new types.

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Recommendations

It is recommended that:

(a) This equipment be given a service test to obtain added information on the operation of the systems provided by the equipment.

(b) In case equipment of this type is procured that the results of the tests as reported herein be used as the basis for performance specifications for such new equipment.

(c) The specifications for other associated radio equipment be revised to permit operation with the required units of the Type K equipment as recommended in reference (f).

(d) Consideration be given to utilizing the interphone unit of this equipment as the speech amplifier and/or modulation for other voice transmitters.

(e) The manufacturer be advised of the mechanical and electrical deficiencies of this equipment as discussed in this report so that he may furnish information as to the possibility of corrective measures.

(f) The vacuum tubes used in this equipment shall not be added to the Navy approved list prior to a conference between other manufacturers and the Navy leading to standardization of new tube types. Consideration should be given at this time to the use of 12 volt heaters in new types of receiving and small transmitting tubes.

(g) This equipment be considered of a type suitable for use in Naval aircraft provided the deficiencies discussed in this report be corrected in production equipments.

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EQUIPMENT UNDER TEST

Receivers

6. The equipment under test is known as Type K Multi-Channel Radio Equipment and is manufactured by the Aircraft Radio Corporation of Boonton, N.J. The receivers are of the superheterodyne type and are designed for the reception of cw and mcw and telephone signals and with both manual and automatic gain control. The equipment consists of six receiver units, two low frequency units covering the frequency range of 200 to 1500 kilocycles and designed for either loop or antenna reception, and four units designed for antenna reception only, covering the frequency range of 3 to 20 megacycles. The equipment is designed for either local or remote control and by means of a rack mounting accommodating four units permits the operation of these units individually or in any combination simultaneously with local control and individually or all four simultaneously with remote control. All tuning dials are calibrated for frequency. Each unit employs six tubes: one 6K7 as an r-f amplifier, one 6K8 as a mixer, two 6K7's as i-f amplifiers, one 6R7 as a detector and cw oscillator and one 1278 as an audio amplifier. Each unit has its own dynamotor for power supply. These dynamotors are interchangeable with all units. The entire equipment receives its power from the airplane's 12 volt battery.

Transmitters

7. The transmitting equipment consists of the following parts:

(1) Four transmitter units
(2) Four unit mounting rack
(3) Modulator unit
(4) Four unit control box
(5) Antenna relay
(6) Connecting cables

The transmitters are of the master oscillator type and are continuously adjustable over a given frequency band. Each band contains a built-in crystal frequency indicator, consisting of a control resonator and a cathode ray tube for indicating resonance between the frequency of the master oscillator and the crystal. Oscillator tuning control, antenna meter, antenna tuning control, and tapped coil, antenna and ground posts are located on the front panel. The compensating condenser for adjusting the master oscillator circuit to the crystal frequency to correspond to the dial calibration is located in the top cover. The transmitters are for voice, cw, and mcw emissions. Mounting racks are provided to accommodate either two or four transmitter units. The transmitters are slid into the rack and held with screw clamps. The power connections are made at the rear of the transmitters as the units are slid into the racks. Jacks are provided for checking voltages and currents of the units.

8. The modulator unit consists of the voice and mcw modulator tubes and circuits and the dynamotor for supplying the power for the transmitter operation. It also provides an interphone unit when operatively connected to other units of the equipment.

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9. The four unit control box contains all the controls for tuning and operating one or all the receivers on cw or mcw for manual or automatic control except the antenna trimming condenser which is located on the front panel of the receiver unit and transmitter controls for selecting any one of the transmitters for cw, mcw, or tone emission and a standby or transmit selector, and a master switch for turning on the transmitters. Jacks are provided for two headphones, two microphones and one remote telegraph key. A built-in key and recall button are provided. The extension control box provides a jack for phones, key and microphone and also has built-in key and recall button.

10. The antenna relay provides a means for connecting the antenna to either the receiver or transmitter and is connected to the modulator unit through a cable to the transmitter rack.

11. A separate interphone unit has also been submitted for test, although not originally required as a part of the equipment. This unit is designed primarily to provide an interhpone and auxiliary equipment (frequency indicator, direction finder, etc.) power source when the receiver units are used with other than the Type K transmitting equipments.

12. Shielded connecting cables with water-tight screw connector plugs connect the various units.

METHOD OF TEST

13. A description of the methods used in conducting the test follows. The equipment was checked for mechanical construction and workmanship and then assembled and tested for electrical performance. In all tests, unless otherwise stated, the primary source was 14 volts. For greater accuracy the frequency measurements were made at zero beat with the receivers in the cw position.

Receivers

14. The receivers were tested as follows:

(a) The frequency range and overlap were determined with the use of a Model LM-1 crystal frequency indicator. The receiver tuning control was adjusted to minimum and maximum setting, the crystal frequency indicator tuned to resonance at these settings as indicated by zero beat, and the frequency recorded. The overlap was determined from these frequencies with respect to the frequency range required by the specifications.

(b) The sensitivity measurements were made with the use of a standard signal generator and an output power meter. The output of the standard signal generator was coupled to the input of the receiver and the output of the receiver to a 600 ohm non-inductive resistive load of the output power meter. The microvolts input to the receiver, in the manual position and in both cw and mcw conditions, necessary to obtain standard output, was recorded.

(c) The AVC sensitivity was determined in the same manner as above except with the receiver in the AVC position.

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(d) The overload characteristics were determined with the use of a standard signal generator and an output power meter. The apparatus was connected as for the sensitivity measurements and the microvolts input increased from the value necessary for standard output until complete blocking of the receiver occurs. The output was recorded at various values of input.

(e) The image response was determined with the use of a standard signal generator and an output power meter. The standard signal generator was coupled to the receiver and adjusted to produce standard output with the receiver at full gain. The standard signal generator was then tuned to the image frequency and the input to the receiver increased until not more than standard output was again obtained. The input to the receiver and the output were recorded.

(f) The selectivity measurements were made with the use of a standard signal generator and an output power meter. The standard signal generator, coupled to the receiver, was adjusted for standard output. The frequency both above and below resonance was recorded where standard output was again obtained after increasing the input 2, 10, and 100 times the value necessary for standard output.

(g) The overload selectivity was determined with the use of two standard signal generators and an output power meter. Both standard signal generators hereafter referred to as No. 1 and No. 2 were coupled through 300 ohm non-inductive resistors to the receiver. No. 1 was adjusted to produce standard output and all controls left fixed. No. 2 was adjusted to zero beat to establish the dial setting for the base frequency and then detuned from resonance. The input from No. 2 was then increased to 0.1 volt and retuned toward resonance from both above and below until an output change of 3 decibels was obtained. These measurements were also made with a 1.0 volt input and on both cw and mcw conditions of the receivers. The number of kilocycles above and below resonance where the output change of 3 decibels occurred was recorded.

(h) The fidelity measurements were made with the use of a standard signal generator, a beat frequency oscillator, and an output power meter. The beat frequency oscillator was coupled to the standard signal generator as a source of external modulation. The input to the receiver, modulated 30 per cent at 400 cycles, was adjusted for standard output and with all other controls remaining fixed, the modulation frequency was adjusted in steps from 100 cycles to 3,000 cycles and the output recorded at each step. The fidelity was determined as the percentage departure of the output at the various modulation frequencies from that at 400 cycles.

(i) The AVC action was determined with the use of a standard signal generator and an output power meter. With the receiver in the AVC position and adjusted for full gain the input was adjusted for standard output. With all other controls remaining fixed, the input was increased 10, 100, and 1,000 times and the output recorded.

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(j) The audio distortion was determined with the use of a beat frequency oscillator, a standard signal generator, an output power meter and a wave analyzer. The beat frequency oscillator was coupled to the standard signal generator as an external source of modulation. The standard signal generator was adjusted to produce 250 milliwatts output from the receiver at full gain. The output of the receiver was coupled to a wave analyzer. The modulation frequency was adjusted in steps from 200 to 3000 cycles. The millivolts output as indicated by the wave analyzer was recorded at successive harmonics of the modulation frequency from which the percentage of the combined RMS harmonics was determined.

(k) The frequency drift at a constant ambient temperature was determined with the use of an LM-1 crystal frequency indicator and an output power meter. The receiver was adjusted for standard output at full gain and from a cold start, measurements were made at 5 minute intervals for a period of one hour. The measurements were made at crystal check points on the LM-1 indicator to obtain increased accuracy.

(l) For the frequency drift measurements at variable temperature, the receiver was installed in a temperature control chamber. The receiver adjusted for standard output at full gain was allowed a 10 minute warm-up period, after which the temperature was varied over the range of -20° C to +50° C and the frequency measured at regular intervals with an LM-1 frequency indicator.

(m) The frequency drift at variable humidity was determined with the use of the same apparatus as for variable temperature, the percentage of humidity being controlled in the temperature control chamber. The receiver was allowed a 10 minute warm-up, after which the percentage of humidity was varied from a low value to approximately 100% and frequency measurements made at regular intervals.

(n) The frequency change due to primary voltage change was determined as follows. The receiver was adjusted for standard output at 11 volts and allowed a 30 minute period to stabilize. The frequency was measured and the voltage increased to 15 volts. Frequency measurements were made instantaneously and after a 10 minute period. The voltage was reduced to 11 volts and again measurements made instantaneously and after a 10 minute period.

(o) The output change due to voltage change was determined by adjusting the receiver for standard output at 14 volts. The voltage was then adjusted to 11, 12, 13, 14, 15, and 16 volts respectively and the output recorded at each.

(p) To determine the current drain, an ammeter was connected in the primary circuit and the current recorded at various voltages from 11 to 16 volts.

(q) The calibration accuracy was determined with the use of an LM-1 frequency indicator. The receiver was set to frequency as indicated by the tuning dial and the actual frequency measured with the frequency indicator.

(r) The reset measurements were made by setting the receiver on a predetermined frequency, recording the setting, detuning the receiver, retuning

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to the recorded setting, then measuring the frequency. This procedure was followed for three settings each from a clockwise and counter-clockwise direction. The reset frequency was determined as an average of the frequency of the three resets.

(s) The output change with two receivers in multiple was determined by adjusting both to operating condition but with input to one only and that one adjusted for standard output. The output switch of the second receiver was adjusted from the out to the in position and the change in output recorded.

(t) The interaction between receivers was determined with two receivers in operation in the multiple rack. Each receiver was tuned through its entire frequency range with and without an input signal and the character of output, if any, recorded.

Transmitters

15. The transmitters were tested as follows:

(a) Adjustment Accuracy. The equipment was set up and with the tuning dial set on the crystal check point, the frequency of the master oscillator circuit was adjusted to coincide with that of the crystal by means of the compensation control. The transmitter was then tuned to another frequency point as indicated on the dial and measured on the Model LK frequency indicator. The measured frequency was compared with the dial calibration.

(b) Lost Motion, Back and Torque Lash. The transmitter was set at a predetermined frequency point. The transmitter was detuned, then retuned to the predetermined frequency setting by approaching the point from clockwise and counter-clockwise directions and the frequency measured after each reset. The frequency difference was determined as an average of several clockwise and counter-clockwise resets.

(c) Detuning of Circuits. The equipment was adjusted for full power cw output and the plate current and frequency noted. The antenna circuit was then detuned to one side of resonance until the plate current read a maximum value and the frequency at this point noted. This procedure was followed for the other side of resonance.

(d) Variation of Supply Line Voltage. With the transmitter operating under full power key locked conditions, the normal supply voltage was increased from 10% above normal to 10% below normal within one minute. Again this procedure was followed with the exception that a five minute period was allowed in varying the voltage from one extreme to the other. The frequency change in both tests was measured from the frequency at the lowest voltage.

(e) Change of Tubes. The equipment was adjusted for maximum cw output and allowed to operate for a warm up period of 20 minutes after which time the frequency was measured. The master oscillator tube was then replaced and after a warm up period of five minutes the frequency was read. Similar replacements were made in the power amplifier stage. This procedure was followed with each of the available tubes on hand. The average deviation from the mean frequency was used for the calculations made under this test.

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(f) Frequency Change due to Variation in Ambient Temperature. With the transmitter placed in the refrigerator, the temperature within the refrigerator was reduced to -30° C, at which time the transmitter was turned on at full power key locked cw condition. The emitted frequency was measured by the Model LK frequency indicator. Readings of the emitted frequency were taken at definite intervals during a period of one hour, the temperature remaining constant. At the end of the hour the temperature within the refrigerator was increased to -20° C and again readings of the emitted frequency were taken. This procedure was followed in temperature steps of ten degrees, each step being maintained for one hour. The highest temperature was 50° C.

(g) Frequency Drift (Variable Humidity). With a constant ambient temperature of between 45° C and 50° C the transmitter was operated under full power key locked cw conditions for a period of 30 minutes at 30% humidity, then for a period of one hour at 95% humidity, and finally for a period of one hour at 30% humidity. The greatest variation of the emitted frequency as measured by the Model LK frequency indicator at any time during the second and third periods to the observed frequency at the end of the first period was taken.

(h) Frequency Drift (Locked Key Operation). With the ambient temperature maintained constant between 45° C and 50° C, the transmitter was operated under full power key locked conditions for a period of two hours. The maximum frequency variation between the frequency observed immediately after the first 20 minutes and the frequency at any time during the remainder of the test was measured on the Model LK frequency indicator measured.

(i) Frequency Drift (Locked Key to Intermittently Keyed Condition). The transmitter was operated under full power key locked cw condition for a period of 10 minutes, immediately after which the key was released for a 20 minute period, the filaments remaining energized. At the end of the 20 minute idle period the key was locked for 10 seconds and the frequency measured. This procedure was again followed with the exception that during the idle 20 minute period the filaments were not energized. The change in frequency between the observed frequency at the end of the 10 minute key locked period and the observed frequency at the end of the 10 second dash was measured.

(j) Frequency Drift (Continuously Keyed to Intermittently Keyed). Using a Creed relay the transmitter was continuously keyed under full power cw conditions at 30 words per minute for a period of 30 minutes, then the key was released for a period of 20 minutes, the filaments remaining energized. Immediately after the 20 minute idle period, the key was locked for a 10 second dash. The change in frequency between the continuously keyed and the 10 second dash emitted frequencies was calculated.

(k) Frequency Change (Roll and Pitch). The transmitter was mounted on a table which could be tilted 45° either side of the vertical at the rate of five cycles per minute. After the transmitter had been in operation for approximately twenty minutes for stabilization, the frequency was noted at the start of the roll and pitch tests. Readings of the frequency by means of the Model LK frequency indicator were taken at five minute intervals for



30 minutes. The frequency variation due to roll or pitch for a complete cycle was noted and used to calculate the frequency variation. Normal frequency drift was also noted over the same period.

(l) Frequency Change (Vibration). The transmitter was mounted on a vibration stand which was adjusted for vibration at the rate of 1800 cycles per minute and of 1/32 inch amplitude. After a warm up period of approximately twenty minutes, the frequency was noted at the start of the vibration period. The frequency was noted at five minute intervals for a period of 30 minutes. The signal was also tuned in on a radio receiver and the character of the signal noted.

(m) Power Output. The power output of the transmitter was measured for antennas of different constants. Measurements were made for one frequency in each band. Values of resistance and antenna current were used in the power calculations.

(n) Modulation Capabilities. Using a Navy Type RS-38 microphone, the voice modulation was observed on a cathode ray oscillograph.

(o) Modulation Percentages. Measurements of modulation were made using a cathode ray oscillograph. An audio oscillator was used to supply modulating voltage through a microphone mixer, the output of which was fed into the microphone jack of the transmitter. A portion of the output of the transmitter was fed to one pair of plates of the cathode ray tube, the other pair of plates being connected to the internal sweep circuit. At 1000 cycles modulation, the pattern shown on the cathode ray was made to conform to 100% modulation by means of adjusting the microphone mixer at which time the modulation voltage was recorded, and using this modulation voltage as a constant, other recordings of percentages of modulation were made throughout the modulation frequency range of 200 to 3,000 cycles. The above procedure again was followed with the exception that the microphone modulation voltage was held constant at 1.5 volts and the percentage of modulation measured for 1000 cycles input. The percentage of modulation is determined by the dimensions of the pattern on the cathode ray tube. Hence

$$\text{Percentage of modulation} = \frac{\text{max} - \text{min}}{\text{max} + \text{min}} \times 100$$

(p) Modulation Fidelity. The same procedure was followed as that under test for modulation percentages.

(q) Modulation Sensitivity. The same procedure was followed as that under test for modulation percentages.

(r) Carrier Frequency Stability. The transmitter was placed in the refrigerator and the temperature of the chamber was reduced. At some temperature below zero the transmitter was placed in full power cw locked key condition, the emitted frequency being measured by the Model LK frequency indicator. The temperature was allowed to drift slowly upward until a change of 50° C was made. At intervals of time the emitted frequency was measured during the temperature change.

(s) Current Drain. The current drain from the primary power source was measured by appropriate voltmeter and ammeter instruments. The current drain measurements were made for voice and cw positions.

(t) Harmonic Distortion. Harmonic distortion was measured by coupling the output of the transmitter through a detector circuit to a previously calibrated wave analyzer and thus percentages of distortion were read directly for each of the harmonics. The total value of harmonic distortion was then computed by taking the square root of the sum of the squares of the individual harmonic percentages.

(u) Temperature Rise of Dynamotor. The thermocouple was calibrated at room temperature and the hot junction fastened to the dynamotor frame. Temperature readings were taken at the start and end of a one hour period, during which time the dynamotor was operating under full transmitter load.

(v) Altitude Flight. The equipment was installed in a Type XSF airplane at the Naval Air Station for flight test. During the flight test the equipment was operated on the ascent of the plane up to 24,000 feet. The transmitter was then detuned and reset to the original frequency. After a shutdown period of from five to ten minutes, during which time the altitude was maintained, the equipment was operated as the airplane descended. Readings of frequency change for the ascent and descent, and the reset frequency were made at the Naval Research Laboratory on a Type RA heterodyne frequency meter.

(w) Input and Output Power at Various Input Voltages. At a frequency point of the transmitter the input voltage was varied from 11 volts to 15 volts inclusive in steps of one volt. For each of these steps the input power and output power were measured for cw, tone, and mcw emission.

(x) Key Locked Test for Frequency Drift at Various Voltages. The transmitter was set at a definite frequency point and placed in operation. Readings of the frequency were made by means of the Model IM frequency indicator. These readings were taken from instantaneous operation and at two minute intervals for the first ten minutes, and at five minute intervals for the next fifty minutes thereafter, at an input voltage of 14 volts. Immediately after each of the five minute interval readings, the voltage input was lowered from 14 volts to 11 volts and upon taking the emitted frequency measurement at 11 volts, the input voltage was immediately returned to 14 volts.

(y) Check Points of Crystals. After the transmitter had been in operation for a short warm up period, it was tuned to a dial setting to correspond to the crystal check frequency. The compensating condenser was then adjusted for maximum shadow on the cathode ray indicator. The frequency was then measured on a Type RA heterodyne frequency meter.

(z) CW Start and Steady Output Powers at Various Antenna Capacities and Resistances. The equipment was operated at full power for cw signals feeding into a dummy antenna of 13.3 and 24.3 ohms for capacities varying between 28 and 228 micromicrofarads. The power output was read when the transmitter was turned on and again after a warm up period of approximately twenty minutes.

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DATA RECORDED DURING TESTS

16. Complete data were recorded on all tests and are discussed in RESULTS OF TESTS. These data are shown on Tables 1 to 75 and Plates 1 to 49 appended to this report.

DISCUSSION OF PROBABLE ERRORS

17. Following is a list of apparatus used with the magin of error according to the manufacturer's guarantee.

	± %
Crystal Frequency Indicator, Radio Research Company Model IM-1, Serial No. 5	0.01
General Radio Standard Signal Generator, Model LC-A, Serial No. 2	10.00
General Radio Standard Signal Generator, Type 605-B, Serial No. 814	10.00
General Radio Output Power Meter, Type 583-A, Serial No. 67	5.00
General Radio Beat Frequency Oscillator, Type 713-B, Serial No. 713-B	
General Radio Wave Analyzer, Type 636-A, Serial No.102	2.5
Frigidaire Temperature Control Chamber	1.0
Weston D.C. Voltmeter, Model 45, Serial No. 41660	0.5
Weston D.C. Voltmeter, Model 45, Serial No. 41097	0.5
Weston D.C. Ammeter, Model 45, Serial No. 30006	0.33
Weston D.C. Ammeter, Model 45, Serial No. 41433	0.5
Weston Milliammeter, D.C., Model 45, Serial No. 41433	0.5
Westinghouse R.F. Ammeter, Serial No. 913356	2.0
Heterodyne Frequency Meter, Navy Type RA	0.002
G-M Thermocouple	1.0
Precision Hygrometer	15.0
Model LK-1 Frequency Drift Indicator Serial No. 2	20 cycles
RCA Cathode Ray Oscillograph Serial No. 4222	

RESULTS OF TESTS

18. The results of these tests are discussed with respect to the requirements of references (c) and (d) as well as generally. Neither of the above specifications applies to the Type K equipment since it is an entirely different type of equipment and has characteristics found only in itself.

19. The following comments are with respect to the shipboard receiver specifications, reference (c), with corresponding paragraph notations.

2-2. The materials used in the equipment are generally satisfactory. The vacuum tubes, except the Type 38568K, are not on the Navy approved list. It seems, however, that there are valid reasons for the use of the particular types chosen.

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2-3. The equipment in general is ruggedly constructed and of the best material for each specific employment. The small snap slides are considered too frail.

2-4. The workmanship on the equipment is excellent.

2-5. All items entered in the construction of the equipment are corrosive resistant or suitably protected therefrom. Cadmium plating on the antenna trimmer condenser is unsatisfactory. This condenser shorted due to small particles of cadmium flaking from the plates during tests. Radio frequency inductances are plugged into sockets and are held in place with machine screws. The connections are therefore made by pressure contacts. Pressure contacts should be eliminated in radio frequency circuits.

2-6. Iron or steel is not used except where specifically required.

2-7. The equipment operates between the temperature limits of -30° to $+52^{\circ}$ C. Wax leaked from the cases of certain components during test.

2-8. The equipment is suitably protected against heavy overload.

2-9 and 2-10. No provision is made for ventilation; however, under long periods of continuous operation during tests no damage occurred to the equipment.

2-16. Lock washers have not been used with all machine screws.

Electrical Characteristics

6-1. The sensitivity does not meet this requirement at any point in the frequency range. The cw sensitivity is substantially the same as required for mcw up to 9 megacycles. Sensitivities for both 10 milliwatts and 5 milliwatts are recorded in Table 3.

6-2. While the equipment does not fully meet the requirements of this paragraph, it is quite good for this compact unit. With the exception of a few scattered points, the requirements are met above 1200 kilocycles. Below this frequency, the selectivity is some 2 or 3 times poorer than required by reference (c). Table 16 gives the measured values for 10, 100, and 1,000 times resonant input.

6-3. Requirements for image rejection are not met. Measured image ratios are shown in Table 15. These ratios, with the exception of the lowest values, are considered good for aircraft work.

6-4. The hum level from the dynamotors is audible but so low an accurate measurement is impossible.

6-5. Microphonic tendencies were not objectionable at the Laboratory. Some noise from vibration was encountered in flight and is believed to be due to poor contact in the tube socket.

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6-6. This equipment will not meet this requirement being in some cases more responsive to the intermediate frequency than to the image frequency.

6-7. This equipment does not meet the requirements of this paragraph as shown by the overload selectivity tables. With an interfering signal of 100,000 microvolts, an output change of ± 3 decibels is obtained at the specified 5% off resonance at some frequencies. At other frequencies these requirements are closely approached. Tables 17, 18, and 19 give overload selectivity data.

6-8. With more than one receiver connected to the same antenna, there was no change in selectivity but with two receivers tuned to the same frequency when receiving a cw signal there was a reduction of signal from standard output of approximately 40%.

6-9. With two or more receivers connected in multiple and whether or not they are connected to a common antenna, an interfering signal occurs when the heterodyne oscillator frequency of one receiver falls within the frequency range of another receiver and when a harmonic of its own beat frequency oscillator falls at the frequency to which the receiver is tuned. The strength of the interfering signal causes an output which varies from 0.3 milliwatt to 50.0 milliwatt depending on the harmonic.

6-11. The frequency change after a 10 minute warm-up period does not in all cases meet the requirements of this paragraph. The results of this test are shown on Table 27 and Plates 21 to 24 inclusive.

6-13. The equipment performs well within the reset requirements of this paragraph as shown on Table 44.

6-14. The equipment operated without damage to any integral parts throughout the tests some of which required continuous operation over long periods of time.

6-19. The equipment is so designed that all d-c potential and substantially all radio frequency have been removed from the telephone cords when receiving. However, the recall system places an excessive direct current through the phones.

6-20, 6-21, 6-22. The volume control action meets the requirements of these paragraphs.

6-23. The average operator may change from one frequency to another within the range of any receiver in the specified time of one minute.

6-24. In all cases the tuning arrangement is such that there is practically even spacing of frequency per division of the dials which are calibrated in frequency.

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6-32. The equipment is provided with automatic volume control with a
and panel adjustment for setting the level. The characteristics
6-33. are shown in Tables 4 and 23.

20. Additional tests were conducted on the receivers. These tests include frequency calibration, overlap, stability, audio frequency characteristics, and power drain.

(a) Frequency range and overlap are shown in Table 1. In general, the overlap is adequate. However, the 13 to 20 megacycle unit has only 10 kilocycles or 0.05% overlap at the high end. This is unsatisfactory since under certain conditions of temperature and humidity the frequency change is in excess of this amount which would prevent tuning the receiver to 20 megacycles.

(b) Overload characteristics are shown on Tables 5 to 14 and Plates 1 to 14 inclusive. The mcw characteristics are satisfactory, but the cw are not. The maximum output is not sufficient and the falling off of output is too rapid. This is probably due to a weak cw oscillator.

(c) Frequency stability with variations in temperature is shown in Tables 28 to 33 inclusive, with variations in humidity in Tables 34 to 39 inclusive and with change in applied voltage in Table 40. The frequency stability should be improved with respect to temperature and humidity.

(d) Calibration accuracy is shown in Tables 42 and 43. It will be noted that the accuracy is not generally as good as it should be and that the actual frequency differs from the dial calibration in the same direction so that a slight change in the position of the dial on the shaft would provide very good accuracy of calibration.

(e) Audio fidelity as shown in Tables 20 to 22 inclusive shows some evidence of side band cutting at the lower radio frequencies. In general the fidelity is satisfactory. The harmonic distortion shown in Tables 24 and 25 is excessive at the low audio frequencies. The effect of paralleling receiver outputs is shown in Table 26. The distortion is increased somewhat.

(f) Power supply drain is shown in Table 41 together with output change due to power supply voltage change.

21. The following comments on the transmitter are with respect to the requirements of reference (d) which applies to patrol plane transmitters of the Model GO type. Paragraph notations follow that of the specification.

2-2. The component parts of the equipment are of good quality. Certain resistors as mentioned in Appendix B, paragraph 14, are operated so near their rating that long time service life is questionable. All the vacuum tubes used in the transmitting equipment are not on the Navy approved list. All except the oscillator are 12 volt heater equivalents of standard 6 volt heater tubes. Consideration should be given these tubes due to a possible change in the d-c voltage of aircraft from 12 volts to 24 volts.

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2-3. The equipment is ruggedly constructed. It, however, is small in size and many of the parts must be classed as midget.

2-7. The equipment operated without failure in high ambient temperatures and continuously for periods of 10 hours in variable ambient temperatures. The dynamotor has a temperature ris e of 60° C which is considered excessive. It has, however, operated satisfactorily.

2-8. Fuses are provided for protection against overload.

2-15. Lacquer has been used to secure screw heads in certain locations in lieu of lock washers. This is unsatisfactory.

2-16. The tube access cover plate has no interlock; thus, its removal exposes the plate caps of the tubes which have the potential of the dynamotor output applied. A warning plate is attached to this cover. The antenna ammeter is above ground potential and it is possible to obtain a radio frequency burn from the screws holding the meter to the insulated panel to which it is mounted.

2-54. The screws used in the equipment are of odd sizes. They should conform in all cases to the Navy requirements.

2-62. No failures occurred at high altitudes.

3-8. The equipment will tune into various fixed antennas shown in Tables 59, 74, and 75.

3-13(1). The equipment is satisfactory for all bands except the 3.7 - 4.8 megacycle band. Two points on this band are outside the tolerance. The frequency of the crystal for this band was checked and found to be approximately 1 kilocycle below the stated value. Table 45 is descriptive of the results.

3-13(2). The equipment is well within the tolerance for all frequencies measured except for one point. The point in error was for a setting of the dial which fell between dial division marks. This point is also in the band 3.7 - 4.8 megacycles, whose checking crystal frequency is approximately 1 kilocycle below the stated value. The results are given in Table 46.

3-13(4). During these tests a 25% increase in plate current was not attainable. The circuit was therefore detuned until maximum plate current was reached. The 3.0 - 3.7 megacycle, 3.9 - 4.8 megacycle, and 6.2 - 8.0 megacycle bands were within the specified tolerance, and the 4.8 - 6.2 megacycle band is outside the tolerance as shown by the Table 47.

3-13(6). For the change of power amplifier tubes for the 8 megacycle test point, the results are outside the specification. The results are given in Table 48.

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3-13(7). The equipment does not meet this requirement for any band for the one minute time change, and is satisfactory only for the 3.0 - 3.7 megacycle band for the five minute time change test. The results are shown in Table 49.

3-13(8). The equipment is well within the specifications for this requirement as shown in Tables 50 and 51.

3-13(9). The frequency variation for all bands is within the tolerance of this requirement. The decrease in power for the bands 3.0 - 3.7 megacycles and 6.2 - 8.0 megacycles is within the tolerance but outside the tolerance for the bands 3.7 - 4.8 megacycles and 4.8 - 6.2 megacycles. The results are given in Table 52.

3-13(10). The frequency variation for the bands 3.0 - 3.7 megacycles and 3.7 - 4.8 megacycles is outside the tolerance. For the bands 4.8 - 6.2, and 6.2 - 8.0 megacycles, it is within the tolerance. Complete data are given in Tables 53 and 54.

3-13(11). The equipment does not meet the tolerance of this requirement for the bands 3.7 - 4.8 megacycles, 4.8 - 6.2 megacycles, and 6.2 - 8.0 megacycles. It is satisfactory for the band 3.0 - 3.7 megacycles when the master oscillator and power amplifier tube filaments are energized for the shut down period. The equipment meets the tolerances of this requirement for all bands when the tube filaments are not energized during the shut down period. Results are shown in Tables 55 and 56.

3-13(12). The frequency variation for all bands is outside the tolerance of this requirement as shown in Table 57.

3-13(13). The frequency variation is within the tolerance for both roll and pitch on all bands. Data are given in Table 58. In this table the drift is indicated which is a normal steady change. The column headed "Observed Periodic Variation" gives the frequency change which occurs while the equipment moves from one extreme position of roll or pitch to the extreme opposite position. The frequency change is not abrupt but follows quite smoothly the motions of the equipment.

3-13(14). Vibration produced a rough note on cw which was not considered unsatisfactory. No permanent changes were noted.

3-17. A crystal resonator circuit uses an electron ray (magic eye) indicator. One crystal is provided for each transmitter with an adjustment for setting the dial calibration at the crystal frequency.

3-21. The frequency control has no lock. It has, in lieu thereof, a sleeve which can be pulled out to cover the knob, thereby preventing accidental movement of the knob. Sufficient friction exists in the control to prevent shifting from vibration, etc.

3-25. It is impossible to vary the power output in this equipment. Satisfactory voice operation depends on full power output to obtain the proper loading on the power amplifier.

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3-31. Improved break-in operation should be provided. This is further discussed in Appendix B.

22. Additional tests were conducted on the transmitters as follows:

(a) The equipment modulates satisfactorily with Navy Type RS-38 microphone. The mcw modulation is over 100%. This should be reduced to avoid side band splatter.

(b) The modulation fidelity is shown on Table 60. It is considered satisfactory.

(c) Somewhat more audio input voltage into the primary of the microphone transformer is required for 100% modulation than is required by reference (b). However, 100% modulation can be obtained using the standard Navy type microphone and therefore is considered satisfactory. Table 61 gives the modulation percentages with the specified 1.5 volts input.

(d) Audio distortion on tone modulation is shown in Table 65. The distortion is less than 10% except in the 6.2 - 8.0 megacycle band.

(e) Table 66 shows the results of a temperature run on the dynamotor. The temperature rise of 60° C is excessive. Measurements of the total current from the dynamotor show it to be overloaded by about 10% under certain conditions.

(f) Frequency drift measurements taken during flight are given in Table 67 to 70 inclusive. The maximum frequency change is just under 0.05% with a temperature change of 28° C and up to 24,500 feet altitude.

(g) Checks of the crystal frequencies gave the results shown in Table 73. The crystal in the 3.7 - 4.8 megacycle transmitter shows a frequency 0.026% low. Since the accuracy of the entire band depends on the accuracy of the crystal, these crystals should have high accuracy, preferably better than 0.01%.

23. The results of tests of the interphone unit are discussed in the Naval Air Station's report, Appendix B of this report. Since the Type K equipment does not provide power for auxiliary radio equipment, the interphone unit will be a necessary addition to each installation using transmitting equipment other than the Type K and where direction finding equipment is used. Consideration should be given to utilizing this unit as the speech amplifier for transmitters of the GN and GP series.

24. Numerous mechanical features of this equipment which are considered unsatisfactory for Naval service are discussed in Appendix B. Since this equipment is of an experimental nature, these items should be corrected in the event of any quantity procurement.

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CONCLUSIONS

25. The following conclusions were reached as a result of these tests:

(a) This equipment is satisfactory for use in Naval Aircraft provided certain mechanical and electrical defects discussed herein and in the Naval Air Station's report, Appendix B of this report, are corrected in future equipments.

(b) The Type K equipment permits great flexibility in installation and use of radio communication equipment.

(c) The receivers do not meet the requirements of reference (c). These specifications, however, refer to shipboard equipment and are, in general, more rigid than required for aircraft equipment. The performance of the Type K receivers is considered very good. Audio fidelity and distortion should be improved as should the cw overload characteristics.

(d) The impregnating compound in certain components leaked out of the case during high temperature tests.

(e) The performance of the transmitters in general is good. While they do not in all cases meet the requirements of reference (d), their departure from these requirements is not great. Some improvement could possibly be obtained in frequency stability but for an equipment of such small size and weight, the performance is good.

(f) In order to obtain the maximum accuracy of calibration, the crystal frequencies should correspond to that of a definite mark on the transmitter dials. The crystals themselves should be ground to this frequency with a high degree of accuracy.

(g) Modifications of existing specifications will be necessary for other equipments to permit use of the Type K receivers and interphone unit as given in reference (f).

(h) The tubes used are not on the Navy approved list. Approval should not be given before further study of the tube situation, preferably obtaining the views of other manufacturers prior to adopting new types.

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Table 1

Type K Multi-Channel Radio Equipment

Frequency Range and Overlap

Required Range		Actual Range - kc	Overlap Kc	Overlap %
200–580 kc	Low end	196.385	3.615	1.81
	High end	593.800	13.8	2.40
520–1500 kc	Low end	511.10	8.9	1.7
	High end	1528.766	28.766	1.9
3 - 6 mc	Low end	2932.150	67.85	2.26
	High end	6104.300	104.30	1.74
6 - 9 mc	Low end	5854.945	145.055	2.4
	High end	9183.20	183.200	2.03
9 - 13.5 mc	Low end	8842.40	157.6	1.75
	High end	13779.20	279.2	2.07
13.5–20 mc	Low end	13080.00	420.0	3.1
	High end	20010.00	10.0	0.05

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Table 2

Type K Multi-Channel Radio Equipment

Receiver Sensitivity

Signal Generator Coupled Direct to Receiver Full Gain

Frequency	Microvolts Input for 10 milliwatt Output MCW	CW
200 kc	2.3	0.35
300	4.2	0.9
400	5.6	1.3
500	7.5	1.7
550	8.2	1.8
600 kc	3.0	0.7
800	3.9	1.1
1000	5.6	1.6
1200	8.3	2.3
1400	10.0	2.8
3 mc	4.0	1.1
4	3.9	1.1
5	4.7	1.4
6	5.2	1.6
6 mc	2.8	0.9
7	3.9	1.2
8	5.2	2.1
9	5.0	1.6
9	22.0	6.0
10	27.0	6.5
11	32.0	7.5
12	35.0	8.3
13	39.0	9.5
14 mc	43.0	9.2
16	49.0	9.5
18	54.0	10.0
20	70.0	17.0



Table 3

Type K Multi-Channel Radio Equipment

Receiver Sensitivity

	Microvolts Input for 10 mw output				Microvolts Input for 5 mw output			
	Ant.Cplg. 300 ohms		Ant.Cplg. 100 uuf.		Ant.Cplg. 300 ohms		Ant.Cplg. 100 uuf.	
Freq	MCW	CW	MCW	CW	MCW	CW	MCW	CW
200 kc	8.7	4.5	10.0	5.2	5.7	3.1	7.1	3.8
300	3.8	1.8	4.1	2.1	2.5	1.4	2.8	1.5
400	5.0	1.5	5.3	1.6	3.5	0.8	3.6	1.1
500	6.2	1.6	6.0	1.5	4.5	1.1	4.2	1.0
550	8.0	2.0	6.7	1.6	5.8	1.4	4.7	1.1
600 kc	5.3	3.5	4.3	2.7	3.7	2.4	2.9	1.8
800	4.1	2.2	4.2	1.8	2.8	1.5	2.9	1.2
1000	6.1	2.0	5.4	1.8	4.3	1.3	3.9	1.2
1200	10.0	3.4	8.3	2.5	7.3	2.4	5.8	1.7
1400	15.0	4.8	10.0	3.0	10.0	3.4	7.6	2.1
3 mc	4.5	2.7	4.1	2.3	3.0	1.8	2.7	1.5
4	5.6	1.7	3.2	1.6	3.7	1.2	2.2	1.1
5	7.8	2.6	3.7	1.5	5.7	1.8	2.6	1.0
6	13.0	4.1	4.8	1.6	8.0	2.8	3.3	1.1
6 mc	6.9	1.6	4.6	1.1	4.8	1.1	3.1	0.8
7	11.0	2.6	5.2	1.5	8.4	1.8	3.6	1.0
8	16.0	4.7	6.0	2.0	11.0	3.2	4.2	1.4
9	22.0	5.2	6.2	1.0	16.0	3.6	4.5	0.7
9 mc	22.0	7.0	10.0	3.0	16.0	4.8	8.0	1.8
10	35.0	8.5	13.0	4.0	25.0	5.8	10.0	2.9
11	47.0	11.0	16.0	4.8	35.0	8.3	11.0	3.5
12	62.0	15.0	17.0	5.3	44.0	10.0	12.0	4.0
13	82.0	20.0	20.0	6.3	58.0	14.0	15.0	4.7
14 mc	99.0	19.0	30.0	5.9	71.0	13.9	21.9	4.25
16	120.0	24.0	30.0	6.2	90.0	18.0	21.9	4.59
18	160.0	28.0	36.0	3.0	111.0	18.8	24.5	2.16
20	230.0	47.0	42.0	8.5	163.0	35.3	29.4	6.04

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Table 4

Type K Multi-Channel Radio Equipment

AVC Sensitivity

Frequency	Microvolts input for 10 mw input	
	CW	MCW
200 kilocycles	5.7	170
300	3.0	12
400	3.8	12
500	5.2	18
550	5.8	19
600 kilocycles	4.0	35
800	2.0	8.3
1000	2.8	10
1200	4.2	15
1400	5.7	25
3 megacycles	1.3	7.2
4	1.0	5.9
5	1.1	6.6
6	1.6	7.5
6 megacycles	1.4	6
7	1.6	6
8	1.4	8.8
9	2.2	8.8
9 megacycles	9.0	19
10	10.0	30
11	11.0	34
12	12.0	37
13	13.0	44
14 megacycles	15.0	52
16	17.0	52
18	13.0	57
20	21.0	67



Table 5

Type K Multi-Channel Radio Equipment

Receiver Overload

250 kilocycles				500 kilocycles			
CW		MCW		CW		MCW	
Input MCV	Output MW	Input MCV	Output MW	Input MCV	Output MW	Input MCV	Output MW
2.5	10	4.7	10	1.5	10	5	10
4.0	20	5.0	11	2	17	8	23
6.0	35	6.0	15	4	42	10	34
8.0	50	8.0	25	6	70	20	120
10.0	70	10.0	35	8	85	40	360
20.0	110	20.0	120	10	100	60	500
40.0	130	40.0	350	20	120	80	575
60.0	135	60.0	500	40	130	100	575
80.0	140	80.0	600	60	135	200	500
100.0	145	100.0	600	80	135	400	340
200.0	160	200.0	500	100	135	500	100
300.0	160	400.0	300	200	130	600	200
400.0	150	500.0	200	300	100	800	230
500.0	120	1000.0	275	400	32	1000	240
600.0	75	2000.0	130	600	9	2000	210
800.0	10	3000.0	60	800	6.5	4000	200
1000.0	6	4000.0	33	1000	5.5	8000	200
2000.0	4	5000.0	26	2000	2.5	10000	200
4000.0	2.5	10000.0	26	4000	1.5		
6000.0	2	100000.0	15				

Table 6

Type K Multi-Channel Radio Equipment

Receiver Overload

600 kilocycles				1400 kilocycles			
CW		MCW		CW		MCW	
Input MCV	Output MW	Input MCV	Output MW	Input MCV	Output MW	Input MCV	Output MW
2.4	10	4	10	3	10	10	10
4	23	6	20	4	17	20	40
6	34	8	34	6	29	40	130
8	41	10	50	8	38	60	250
10	45	20	170	10	45	80	400
20	50	40	470	20	50	100	500
40	55	60	550	40	58	200	550
60	60	80	550	60	61	400	450
80	63	100	550	80	61	600	400
100	65	200	450	100	64	800	375
200	70	400	375	200	75	1000	300
400	65	600	450	400	80	2000	425
600	35	800	450	600	45	to	
800	8.5	10000	450	800	14	10000	
1000	5			900	5		

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Table 7

Type K Multi-Channel Radio Equipment

Receiver Overload

3 megacycles				6 megacycles			
CW		MCW		CW		MCW	
Input MCV	Output MW	Input MCV	Output MW	Input MCV	Output MW	Input MCV	Output MW
2.4	10	4.4	10	1.7	10	5.4	10
4	21	6	16	4	28	8	21
6	34	8	28	8	34	10	35
8	38	10	43	10	36	20	110
10	40	20	140	20	36	40	280
20	44	40	330	30	36	60	440
30	42	60	500	40	33	80	500
40	40	80	550	60	30	100	550
60	37	100	550	80	27	200	550
80	34	200	500	100	24	400	500
100	30	400	500	200	15	600	500
200	18	600	475	300	2.5	800	500
300	2.5	800	400	400	1	1000	400
400	1	1000	275			2000	65
		2000	18			4000	12
		4000	2			6000	9
						8000	8
						10000	8

Table 8

Type K Multi-Channel Radio Equipment

Receiver Overload

6 megacycles

Output MW - CW			Output MW - MCW		
Input MCV	Full Gain	Reduced Gain	Input MCV	Full Gain	Reduced Gain
0.8	10	1.0	4.2	10	1
1	15	1.5	6	23	2
1.5	26	2.5	8	40	3
2	35	4.0	10	60	5
4	60	13.0	20	180	20
6	75	24.0	40	430	52
8	80	32.0	60	510	140
10	80	37.0	80	470	200
20	80	80.0	100	338	260
40	80	100.0	200	320	500
60	50	100.0	300	290	425
80	15	100.0	400	500	400
100	10	100.0	800	450	500
200	5	80.0	1000	330	500
300	4	23.0	2000	50	
700	0	0.0	4000	6.5	
			6000	3.0	
			10000	1.5	

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Table 9

Type K Multi-Channel Radio Equipment
Receiver Overload
8.5 megacycles

CW			MCW		
	Output Milliwatts			Output Milliwatts	
Input MCV	Full Gain	Reduced Gain	Input MCV	Full Gain	Reduced Gain
0.5	15	1.5	6	10	1
1	22	2.5	8	15	1.8
2	30	4	10	24	2.7
4	45	8	20	80	10
6	50	13	40	230	38
8	51	19	60	360	80
10	55	25	80	450	120
20	60	50	100	475	170
40	60	70	200	500	400
60	60	75	400	500	500
80	55	75	600	500	500
100	50	75	800	500	500
200	10	75	1000	480	500
400	5	40	2000	135	
600	2.5	0	4000	33	
				3.5	
			1000	2.5	

Table 10

Type K Multi-Channel Radio Equipment
Receiver Overload
9 megacycles

CW			MCW		
	Output Milliwatts			Output Milliwatts	
Input MCV	Full Gain	Reduced Gain	Input MCV	Full Gain	Reduced Gain
2.8	10	1	10	10	1
5	24	3	40	120	12
8	50	6	60	240	30
10	60	10	80	360	50
20	100	30	100	500	70
40	130	65	200	600	200
60	140	100	400	600	500
80	145	120	600	610	600
100	140	140	800	610	600
200	60	160	1000	610	600
400	28	150	2000	525	
600	20	120	4000	290	
800	15	70	8000	10	
1000	12	50	10000	6	
2000	4	20			
4000	1.5	10			
5000	1.5	6			

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Table 11

Type K Multi-Channel Radio Equipment
Receiver Overload
13 megacycles

CW			MCW		
	Output Milliwatts			Output Milliwatts	
Input MCV	Full Gain	Reduced Gain	Input MCV	Full Gain	Reduced Gain
6	10	1	20	10	1
8	20	1.5	40	38	3
10	30	2.5	60	60	7
20	80	11	80	95	12.5
40	135	37	100	150	20
60	148	65	200	400	65
80	150	90	400	450	200
100	150	110	600	450	320
200	145	160	800	500	500
400	45	170	1000	530	500
600	30	170	2000	550	
800	24	160	4000	500	
1000	20	145	6000	400	
2000	9	135	8000	180	
4000	2.5	21	10000	220	
5500	1.5	16	15000	30	
10000	4	6	20000	15	
to			30000	5	
100000	4	2.5			

Table 12

Type K Multi-Channel Radio Equipment
Receiver Overload

14 megacycles				20 megacycles			
CW		MCW		CW		MCW	
Input MCV	Output MW	Input MCV	Output MW	Input MCV	Output MW	Input MCV	Output MW
4.5	10	18	5	4.9	5	30	10
6	16	25	10	7.1	10	60	38
8	27	40	24	10	20	80	60
10	40	60	50	20	50	100	90
20	100	100	130	40	110	200	290
40	170	200	350	60	140	400	460
60	190	300	440	80	150	600	480
80	190	400	420	100	150	800	500
100	190	600	420	200	150	1000	500
200	170	800	450	400	110	2000	500
400	50	1000	500	600	40	4000	500
600	28	2000	480	800	34	6000	350
800	21	4000	360	1000	28	8000	220
1000	17	6000	220	2000	15	10000	80
2000	7	8000	70	4000	3	20000	30
3000	3	10000	20	5000	1	30000	4
		14000	10			40000	2

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Table 13

Type K Multi-Channel Radio Equipment
Comparison of 13.5-20 mc Receivers Nos.1 and 2
Sensitivity

Freq	MCV Input for 10 mw Output				MCV Input for 5 mw Output			
	Rec.No.1		Rec.No.2		Rec.No.1		Rec.No. 2	
mc	CW	MCW	CW	MCW	CW	MCW	CW	MCW
14	6	25	6.8	24	4.3	18	4.8	17
16	6.5	23	7.3	23	4.8	17	5.4	17
18	3	27	3	27	3.0	19	3.0	19
20	8	30	8.3	29	5.5	21	5.9	21

Overload
20 megacycles CW

Input MCV	Output MW	
	Rec.No.1	Rec.No.2
5.4	10	9
8	21	20
10	30	30
20	80	85
40	140	150
60	160	170
80	165	175
100	165	180
200	155	170
400	75	50
600	30	35
800	25	30
1000	20	21
2000	8.5	10
4000	1	2.5
5000	1	1.5

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Table 14

Type K Multi-Channel Radio Equipment
Receiver Overload
Input Coupled Through a 300 Ohm Resistor
14 megacycles

CW		MCW	
Input	Output	Input	Output
4.3	5	17	5
5.9	10	24	10
8.6	20	35	20
10	26	60	55
20	65	100	135
40	130	200	340
60	150	350	500
80	150	400	500
100	155	600	450
200	150	800	450
400	125	1000	400
600	45	2000	400
800	32	4000	300
1000	27	6000	220
2000	13	8000	80
4000	2	10000	20
5000	1.5		

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Table 15

Type K Multi-Channel Radio Equipment
Image Response

Fundamental Frequency	Ratio
200 kilocycles	50,000
300	14,500
400	9,000
500	5,500
600	83,300
800	20,857
1000	16,000
1200	9,000
1400	10,000
3 megacycles	90,900
4	71,400
5	83,300
6	66,600
6	333,000
7	200,000
8	222,000
9	250,000
9	Greater than 250,000
10	" " "
11	" " "
12	" " "
13	" " "
14	
16	100,000
18	66,600
20	40,000

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Table 16

Type K Multi-Channel Radio Equipment
Receiver Selectivity

Frequency	Percentage Frequency Spread at Resonance Input					
	x 10		x 100		x 1000	
	-	+	-	+	-	+
200 kc	1.0	1.6	1.7	2.4	3.0	3.2
300	1.25	.6	1.9	1.0	2.6	2.4
400	1.0	.6	1.4	1.0	2.2	1.5
500	.5	.9	.8	1.2	1.9	1.4
600	.9	.5	1.3	.9	1.8	1.6
800	.6	.5	1.0	.8	1.4	1.35
1000	.4	.6	.7	.9	1.3	1.2
1200	.3	.55	.6	.8	1.1	1.2
1400	.3	.475	.55	.65	.9	1.1
3 mc	.5	.3	.7	.5	1.0	.8
4	.3	.2	.5	.35	.65	.6
5	.2	.3	.3	.4	.5	.55
6	.15	.2	.2	.3	.4	.45
6	.3	.25	.65	.55	1.25	1.1
7	.3	.25	.55	.55	1.2	1.1
8	.25	.25	.55	.5	1.05	1.0
9	.25	.2	.55	.45	1.0	.95
9	.325	.25	.65	.55	1.2	1.1
10	.35	.25	.6	.55	1.1	1.0
11	.3	.225	.55	.45	1.0	1.0
12	.25	.2	.55	.45	.95	.95
13	.25	.2	.5	.4	.9	.85
14	.225	.2	.45	.4	.95	.1
16	.175	.2	.4	.375	.85	.9
18	.125	.175	.4	.35	.8	.85
20	.125	.15	.35	.3	.7	.8

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Table 17

Type K Multi-Channel Radio Equipment
Receiver Overload Selectivity

Frequency kc	Input Volts of Interfering Signal	CW Kc Off Resonance Above	CW Kc Off Resonance Below	MCW Kc Off Resonance Above	MCW Kc Off Resonance Below
200	0.1	6.8	9.6	7.8	9.6
	1.0	9.2	12.0	10.6	10.8
300	0.1	6.0	7.2	8.4	6.6
	1.0	14.4	11.1	11.7	9.9
400	0.1	8.8	10.0	8.0	9.2
	1.0	14.0	14.4	10.0	11.6
500	0.1	5.5	6.5	8.0	10.0
	1.0	12.5	16.0	11.5	17.0
600	0.1	12.6	13.2	10.8	13.8
	1.0	19.2	19.8	15.0	18.0
800	0.1	16.0	16.0	12.8	13.6
	1.0	23.2	21.6	20.8	20.0
1000	0.1	17.0	17.0	14.0	15.0
	1.0	25.0	23.0	23.0	24.0
1200	0.1	15.6	19.2	13.2	16.8
	1.0	21.6	27.6	20.4	25.2
1400	0.1	15.4	16.8	14.0	15.4
	1.0	25.2	26.6	22.4	25.2



Table 18

Type K Multi-Channel Radio Equipment
Receiver Overload Selectivity

Frequency mc	Input Volts of Interfering Signal	CW Kc Off Resonance Above	CW Kc Off Resonance Below	MCW Kc Off Resonance Above	MCW Kc Off Resonance Below
3-6 band					
3	0.1	42	45	30	30
	1.0	54	54	45	42
4	0.1	32	32	28	32
	1.0	64	60	60	64
5	0.1	35	30	30	30
	1.0	65	65	50	64
6	0.1	30	30	30	30
	1.0	42	48	72	90
6-9 band					
6	0.1	96	96	102	96
	1.0	144	192	138	198
7	0.1	98	98	98	98
	1.0	147	161	126	147
8	0.1	96	104	104	96
	1.0	168	160	168	160
9	0.1	108	99	108	108
	1.0	153	189	163	189

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Table 19

Type K Multi-Channel Radio Equipment

Receiver Overload Selectivity

Frequency mc	Input Volts of Interfering Signal	CW Kc Off Resonance Above	CW Kc Off Resonance Below	MCW Kc Off Resonance Above	MCW Kc Off Resonance Below
9-13.5 band					
9	0.1	108	108	117	90
	1.0	162	162	153	162
10	0.1	110	100	90	90
	1.0	160	150	150	140
11	0.1	99	99	99	88
	1.0	154	154	154	143
12	0.1	96	96	96	72
	1.0	156	144	144	132
13	0.1	91	104	91	84
	1.0	143	149	136	143
13.5-20 band					
14	0.1	112	126	105	112
	1.0	182	175	161	154
16	0.1	96	112	104	120
	1.0	208	176	160	152
18	0.1	108	108	117	117
	1.0	189	171	144	161

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Table 20

Type K Multi-Channel Radio Equipment

Receiver Fidelity

Initial adjustment 2.45 volts (10 mw) output modulated 30% at 400 cycles.
The percentage output is with reference to the output at 400 cycles.

Modulation Freq	OUTPUT 200 kc		300 kc		400 kc		500 kc	
Cycles	Volts	%	Volts	%	Volts	%	Volts	%
100	1.16	47.4	1.34	54.8	1.16	47.4	1.09	44.7
200	1.89	77.4	1.97	80.6	1.89	77.4	1.73	70.7
300	2.32	94.8	2.32	94.8	2.32	94.8	2.26	92.3
400	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0
500	2.38	97.2	2.45	100.0	2.45	100.0	2.57	104.9
600	2.32	94.8	2.32	94.8	2.32	94.8	2.57	104.9
700	2.19	89.4	2.26	92.3	2.26	92.3	2.45	100.0
800	1.97	80.6	2.04	83.8	2.12	86.6	2.38	97.2
900	1.81	74.2	1.97	80.6	1.97	80.6	2.26	92.3
1000	1.73	70.7	1.81	74.2	1.89	77.4	2.19	89.4
1500	1.09	44.7	1.34	54.8	1.55	63.3	1.64	67.0
2000	0.86	35.3	1.16	47.4	1.34	54.8	1.39	57.0
3000	0.77	31.6	1.02	41.8	1.02	41.8	1.09	44.7

Modulation	OUTPUT 600 kc		800 kc		1000 kc		1200 kc		1400 kc	
Freq:Cycles	Volts	%	Volts	%	Volts	%	Volts	%	Volts	%
100	1.34	54.8	1.28	52.4	1.22	50.0	1.22	50.0	1.22	50.0
200	2.04	83.8	1.97	80.6	1.89	77.4	1.97	80.6	1.89	77.4
300	2.32	94.8	2.32	94.8	2.32	94.8	2.32	94.8	2.32	94.8
400	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0
500	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0	2.51	102.4
600	2.45	100.0	2.45	100.0	2.51	102.4	2.45	100.0	2.51	102.4
700	2.45	100.0	2.32	94.8	2.45	100.0	2.45	100.0	2.51	102.4
800	2.32	94.8	2.26	92.3	2.45	100.0	2.38	97.2	2.45	100.0
900	2.26	92.3	2.19	89.4	2.45	100.0	2.32	94.8	2.38	97.2
1000	2.12	86.6	2.12	88.6	2.45	100.0	2.26	92.3	2.32	94.8
1500	1.73	70.7	1.73	70.7	2.19	89.4	1.89	77.4	1.97	80.6
2000	1.84	54.8	1.34	54.8	1.81	74.2	1.55	63.3	1.64	67.0
3000	1.09	44.7	1.09	44.7	1.22	50.0	1.22	50.0	1.28	52.4

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Table 21

Type K Multi-Channel Radio Equipment

Receiver Fidelity

Initial adjustment 2.45 volts (10 mw) output modulated 30% at 400 cycles. The percentage output is with reference to the output at 400 cycles.

OUTPUT

Modulation Freq. Cycles	3 megacycles		4 megacycles		5 megacycles		6 megacycles	
	Volts	%	Volts	%	Volts	%	Volts	%
100	1.22	50.0	1.16	47.4	1.09	44.7	1.02	41.8
200	1.89	77.4	1.81	74.2	1.81	74.2	1.81	74.2
300	2.32	94.8	2.32	94.8	2.26	92.3	2.26	92.3
400	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0
500	2.57	104.9	2.57	104.9	2.51	102.4	2.57	104.9
600	2.63	107.3	2.63	107.3	2.57	104.9	2.68	109.4
700	2.68	109.4	2.68	109.4	2.63	107.4	2.68	109.4
800	2.68	109.4	2.74	111.8	2.68	109.4	2.74	111.8
900	2.63	107.4	2.74	111.8	2.74	111.8	2.74	111.8
1000	2.63	107.4	2.74	111.8	2.74	111.8	2.68	109.4
1500	2.45	100.0	2.68	109.4	2.68	109.4	2.63	107.4
2000	2.32	94.8	2.51	102.4	2.45	100.0	2.45	100.0
3000	1.81	74.2	1.97	80.6	1.89	77.4	1.89	77.4

OUTPUT

Modulation Freq Cycles	6 mc		7 mc		8 mc		9 mc	
	Volts	%	Volts	%	Volts	%	Volts	%
100	1.09	44.7	0.94	38.7	0.94	38.7	0.94	38.7
200	1.73	70.7	1.64	67.0	1.73	70.7	1.64	67.0
300	2.19	89.4	2.19	89.4	2.19	89.4	2.19	89.4
400	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0
500	2.63	107.3	2.57	104.9	2.57	104.9	2.57	104.9
600	2.68	109.4	2.57	104.9	2.68	109.4	2.68	109.4
700	2.79	114.0	2.63	107.3	2.74	111.8	2.68	109.4
800	2.79	114.0	2.79	114.0	2.79	114.0	2.68	109.4
900	2.85	116.3	2.79	114.0	2.79	114.0	2.74	111.8
1000	2.79	114.0	2.79	114.0	2.79	114.0	2.74	111.8
1500	2.68	109.4	2.68	109.4	2.79	114.0	2.63	107.3
2000	2.45	100.0	2.45	100.0	2.74	111.8	2.45	100.0
3000	1.97	80.6	1.81	74.2	2.04	83.8	1.89	77.4

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Table 22

Type K Multi-Channel Radio Equipment

Receiver Fidelity

Initial adjustment 2.45 volts (10 mw) output modulated 30% at 400 cycles. The percentage output is with reference to the output at 400 cycles.

OUTPUT

Modulation Freq. Cycles	9 mc		10 mc		11 mc		12 mc		13 mc	
	Volts	%	Volts	%	Volts	%	Volts	%	Volts	%
100	1.02	41.8	1.09	44.7	1.09	44.7	1.02	41.8	1.09	44.7
200	1.81	74.2	1.81	74.2	1.81	74.2	1.73	70.7	1.89	77.4
300	2.19	89.4	2.26	92.3	2.26	92.3	2.26	92.3	2.32	94.8
400	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0
500	2.51	102.4	2.57	104.9	2.51	102.4	2.51	102.4	2.57	104.9
600	2.57	104.9	2.63	107.3	2.57	104.9	2.57	104.9	2.63	107.3
700	2.63	107.3	2.68	109.4	2.68	109.4	2.63	107.3	2.68	109.4
800	2.68	109.4	2.68	109.4	2.68	109.4	2.63	107.3	2.74	111.8
900	2.68	109.4	2.68	109.4	2.68	109.4	2.63	107.3	2.74	111.8
1000	2.68	109.4	2.68	109.4	2.65	108.4	2.63	107.3	2.74	111.8
1500	2.63	107.3	2.63	107.3	2.57	104.9	2.57	104.9	2.63	107.3
2000	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0
3000	2.04	83.8	2.04	83.8	2.04	83.8	2.04	83.8	2.04	83.8

OUTPUT

Modulation Freq Cycles	14 mc		16 mc		18 mc		20 mc	
	Volts	%	Volts	%	Volts	%	Volts	%
100	0.73	30.0	0.73	30.0	0.75	30.8	0.77	31.6
200	1.5	61.2	1.5	61.2	1.55	63.3	1.55	63.3
300	2.12	86.6	2.12	86.6	2.12	86.6	2.15	87.8
400	2.45	100.0	2.45	100.0	2.45	100.0	2.45	100.0
500	2.57	104.9	2.63	107.3	2.65	108.4	2.71	110.6
600	2.68	109.4	2.74	111.8	2.76	112.6	2.90	118.4
700	2.76	112.6	2.83	115.0	2.90	118.4	2.95	120.4
800	2.85	116.3	2.87	117.2	2.95	120.4	3.00	122.4
900	2.85	116.3	2.9	118.4	2.97	121.2	3.07	125.3
1000	2.87	117.2	2.92	119.2	3.00	122.4	3.07	125.3
1500	2.87	117.2	2.87	117.2	2.97	120.4	3.04	124.0
2000	2.71	110.6	2.76	112.6	2.85	116.3	2.95	120.4
3000	2.26	92.3	2.29	93.5	2.38	97.2	2.45	100.0

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Table 23

Type K Multi-Channel Radio Equipment

AVC Action

Input adjusted for standard output (2.45 volts) with full gain.

	400 kilocycles				1000 kilocycles			
	CW		MCW		CW		MCW	
Input	Output Volts	Ratio	Output Volts	Ratio	Output Volts	Ratio	Output Volts	Ratio
Fund.	2.45		2.45		2.45		2.45	
x 10	7.34	3.0	4.90	2.0	5.20	2.12	5.20	2.12
x 100	8.48	3.46	7.74	3.16	5.58	2.28	7.55	3.80
x 1000	9.00	3.67	12.24	5.0	5.90	2.41	10.95	4.47
	4.5 megacycles				7.4 megacycles			
Fund.	2.45		2.45		2.45		2.45	
x 10	4.77	1.95	5.20	2.12	5.47	2.23	5.20	2.12
x 100	5.08	2.08	7.14	2.93	6.70	2.73	7.34	3.0
x 1000	5.20	2.12	9.48	3.87	6.92	2.82	9.90	4.04
	11 megacycles				18 megacycles			
Fund.	2.45		2.45		2.45			
x 10	7.34	3.0	4.90	2.0	5.02	2.05		
x 100	9.16	3.74	6.70	2.73	6.84	2.79		
x 1000	9.80	4.0	9.16	3.74	9.00	3.67		

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Table 24

Type K Multi-Channel Radio Equipment

Receiver Audio Distortion
Output 250 milliwatts

Modulation Freq Cycles	Percentage of Fundamental Output Harmonics 2	3	4	5	Pct. RMS
	400 kilocycles				
200	19.0	6.5	2.2	1.1	20.22
400	10.0	5.0	1.6	1.3	11.36
600	7.5	4.5	1.6	1.2	8.97
800	7.0	4.0	1.6	1.0	8.27
1000	7.0	3.5	1.5	0.8	8.0
2000	8.5	2.0	1.1	0.55	8.8
3000	5.5	1.3			5.65
	1000 kilocycles				
200	11.0	5.0	1.5	1.0	12.21
400	6.4	4.5	1.5	1.2	8.06
600	5.0	4.0	1.4	1.1	6.63
800	5.0	3.8	1.2	1.1	6.48
1000	5.0	3.6	1.5	1.1	6.43
2000	7.3	1.9	1.1	0.7	7.65
3000	7.1	1.2	1.3	1.0	7.38
	4.5 megacycles				
200	22.5	9.5	3.0	1.0	24.61
400	12.0	6.2	2.2	1.0	13.71
600	10.2	5.2	2.0	0.9	11.65
800	10.0	5.0	2.0	0.6	11.36
1000	9.0	4.5	2.1	0.3	10.27
2000	7.5	2.7	1.3	0.6	8.09
3000	6.5	1.9	1.2	0.9	6.92

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Table 25

Type K Multi-Channel Radio Equipment
Receiver Audio Distortion
Output 250 milliwatts

Modulation Freq Cycles	Percentage of Fundamental Output Harmonics								Pct. RMS
	2	3	4	5	6	7	8	9	
7.5 megacycles									
200	25.0	10.5	2.3	0.8	0.0	0.55	0.25	0.00	27.22
400	14.0	6.5	2.5	1.0	0.6	0.3			15.68
600	12.5	5.0	2.3	0.7	0.5				13.68
800	12.0	4.5	2.2	0.6	0.4				13.02
1000	11.0	3.5	1.9	0.5					11.7
2000	10.0	2.5	1.2	0.6					10.39
3000	7.0	1.8	1.05	0.85					7.34
11.0 megacycles									
200	18.0	7.8	2.5	1.2	0.45	0.6			19.82
400	12.0	5.2	2.3	1.1	0.6	0.45			13.34
600	11.0	4.5	2.5	1.0	0.55	0.4			12.2
800	10.5	4.3	2.4	0.9	0.5	0.35			11.63
1000	10.5	3.8	2.2	0.8	0.45	0.3			11.4
2000	9.0	2.2	1.5	0.7	0.25	0.2			9.41
3000	6.5	1.2	1.6	1.2					6.88
14 megacycles									
200	33.0	7.8	4.2	2.7	1.0	0.5	0.8	0.8	34.3
400	12.8	3.8	3.4	2.2	0.7	0.3	0.2	0.2	13.98
600	9.0	3.0	2.8	1.9	0.45	0.25	0.2	0.2	10.09
800	7.0	2.1	2.5	1.5	0.25	0.2	0.1	0.1	7.88
1000	5.5	1.7	2.3	1.3	0.22	0.2			6.34
2000	2.5	0.45	1.3	0.65	0.0	0.2			2.93
3000	3.5	1.5	0.8	0.40	0.0				3.9
20 megacycles									
200	32.0	8.5	4.8	2.3	0.35	0.85	1.1	0.9	33.6
400	14.0	3.8	3.4	2.4	0.6	0.35	0.0	0.0	15.11
600	9.2	2.7	3.0	2.0	0.5	0.3	0.22	0.1	10.25
800	7.0	2.2	2.2	1.5	0.3	0.22	0.2	0.1	7.82
1000	5.8	1.8	2.5	1.4	0.25	0.2	0.15		6.72
2000	2.3	0.52	1.35	0.65		.2	0.15		2.8
3000	3.5	1.6	0.82	0.3					3.94

[redacted]

Table 26

Type K Multi-Channel Radio Equipment

Receiver Audio Distortion
Two receivers in operation in rack
Receiver to be measured adjusted for 250 mw output and output allowed to drop when second receiver was turned on.

1000 kilocycles
Percentage of Fundamental Output

Modulation Freq Cycles	Harmonics 2	3	4	5	6	Pct. RMS
200	21.0	7.0	1.2	0.9		22.18
400	11.5	5.5	1.0	0.0		12.78
600	7.5	4.5	0.7	0,7		8.8
800	5.0	3.7	0.5	0.5		6.24
1000	3.6	3.0	3.5	0.5		4.71
2000	2.0	2.8	0.0	0.0		3.45
3000	6.5	0.6	1.6	0.55		6.74

1000 kilocycles
Output 250 mw with both receivers in operation

200	46.0	17.0	11.5	4.0		50.5
400	18.0	7.0	3.0	1.6		19.61
600	10.0	5.0	1.9	1.0		11.38
800	5.5	4.0	0.8	1.1		6.92
1000	4.0	3.1	0.2	0.95		5.14
2000	8.5	8.0	1.8	0.0		11.8
3000	25.0	7.0	3.2	2.9		26.31

7.5 megacycles
Output 250 mw with both receivers in operation

200	37.5	15.5	3.2	0.7	0.6	40.7
400	16.0	8.0	2.0	1.0	0.4	18.2
600	11.0	5.0	1.7	0.4	0.25	12.2
800	8.5	4.0	1.2	0.6		9.48
1000	4.5	5.5	1.2	0.6		7.23
2000	5.0	3.5	0.6	0.45		6.14
3000	9.5	4.0	3.5	1.2		10.95

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Table 27

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Temperature 25° C)

Time Min.	400 kc Freq-kc	1000 kc Freq-kc	4.5 mc Freq-kc	7.5 mc Freq-kc	11.0 mc Freq-kc	16.0 mc Freq-kc
0	400.000	1000.00	4500.0	7500.0	11000.0	16000.0
5	0.116	999.40	4499.5	7498.0	10997.8	15995.3
10	399.975	9.34	98.6	95.0	95.8	94.2
15	9.900	9.26	97.6	93.5	94.0	91.6
20	9.941	9.24	96.6	91.7	92.0	90.0
25	9.965	9.22	95.9	90.5	91.0	88.0
30	9.983	9.20	95.4	89.7	90.2	87.4
35	9.900	9.21	94.9	88.9	89.6	85.2
40	9.858	9.30	94.5	88.4	89.4	84.7
45	9.900	9.34	94.2	88.1	9.4	84.4
50	9.941	9.36	93.8	88.0	9.4	84.1
55	9.925	9.38	93.5	87.8	9.4	84.0
60	9.917	9.40	93.2	87.8	9.4	84.0
Drift 1st 10 minutes						
Cycles	141	660	1400	5000	4200	5800
Per cent	0.035	0.066	0.031	0.066	0.038	0.036
Drift next 50 minutes						
Cycles	117	140	5400	7200	6400	10200
Per cent	0.029	0.014	0.12	0.094	0.058	0.064

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Table 28

Type K Multi-Channel Radio Equipment
Receiver Frequency Drift (Variable Temperature)

400 kilocycles

Time Min.	Temp °C	Freq kc	Time Min	Temp °C	Freq kc
0	+24	400.360	195	-20	400.656
5	21	.280	200	18	.624
10	18	.408	205	14	.608
15	13	.432	210	10	.592
20	10	.440	215	7	.570
25	7	.464	220	4	.552
30	4	.480	225	0	.536
35	2	.504	230	+3	.520
40	0	.520	235	7	.504
45	-2	.528	240	11	.488
50	4	.536	245	14	.472
55	5	.544	250	17	.440
60	7	.552	255	20	.408
75	10	.580	270	27	.328
90	13	.608	285	34	.280
105	15	.624	300	40	.304
120	17	.640	315	47	.344
135	18	.656	330	52	.360
150	19	.664	345	34	.520
165	20	.656	360	24	.560

Maximum frequency change over any 20° temperature change
+ 21° to +1° = 232 cycles = 0.058%

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Table 29

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Temperature)

1000 kilocycles

Time Min	Temp °C	Freq kc	Time Min	Temp °C	Freq kc
0	+25	1000.00	230	-16	999.6
5	23	.02	235	12	.6
10	21	.14	240	8	.64
15	18	.24	245	4	.7
20	14	.3	250	0	.76
25	10	.28	255	+3	.8
30	7	.14	270	9	.92
45	0	.04	285	18	1000.12
60	-4	999.86	300	27	.2
75	8	.78	315	35	.32
90	10	.68	330	43	.56
105	12	.64	345	50	.96
120	14	.62	355	53	1001.2
135	15	.62	360	47	.34
150	16	.6	365	41	.4
165	17	.6	370	37	.36
180	18	.6	375	33	.3
195	18.5	.6	380	29	.24
210	19	.6	385	25	.14
225	20	.6			

Maximum frequency change over any 20° temperature change

+33° to +53° = 900 cycles = 0.09%

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Table 30

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Temperature)

4.5 megacycles

Time Min.	Temp °C	Freq kc	Time Min.	Temp °C	Freq kc
0	+21	4498.6	190	-5	4510.3
5	18	8.3	195	0	10.0
10	14	9.3	200	+5	9.3
15	11	9.8	205	8	8.7
20	8	4500.6	210	11	7.1
25	4	1.6	215	14	6.5
30	1	2.5	220	19	5.4
45	-5	4.7	225	21	4.7
60	9	6.2	230	24	3.8
75	12	7.3	235	27	2.9
90	14	8.3	240	30	4502.0
105	16	9.3	255	38	4499.2
120	17	10.3	270	45	6.9
135	19	10.6	285	50	4.9
150	20	10.9	300	53	2.5
165	22	11.4	315	43	3.6
170	19	11.2	330	35	6.3
175	17	11.0	345	28	4498.8
180	13	10.8	360	24	4500.2
185	10	10.6	375	21	4501.2

Maximum frequency change over any 20° temperature change

+1° to -19° = 8.7 kilocycles = 0.19%

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Table 31

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Temperature)

7.5 megacycles

Time Min.	Temp °C	Freq kc	Time Min.	Temp °C	Freq kc
0	+25	7498.765	215	-17	7515.525
5	23	98.000	220	14	14.855
10	18	98.475	225	11	14.475
15	13	99.715	230	8	14.000
20	10	7501.140	235	5	12.810
25	6	02.855	240	1	12.180
30	4	04.570	255	+6	08.475
45	0	07.145	270	12	05.810
60	-5	09.240	285	19	02.475
75	9	10.855	300	28	00.570
90	12	11.705	315	37	7497.525
105	15	13.145	330	45	95.810
120	17	14.090	345	50	94.475
135	18	14.855	360	53	92.860
150	19	15.145	365	42	92.395
165	20	15.050	370	34	93.810
180	21	14.955	375	26	95.620
195	22	15.525	380	25	97.810
210	22	15.620			

Maximum frequency change over any 20° temperature change

+13° to -7° = 10.285 kilocycles = 0.137%



Table 32

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Temperature)

11 megacycles

Time Min.	Temp °C	Freq kc	Time Min	Temp °C	Freq kc
0	+26	10997.8	240	-21	11014.6
5	21	98.2	245	18	14.8
10	18	98.8	250	12	14.2
15	14	99.8	255	8	13.6
20	11	11000.8	260	4	13.0
25	9	01.8	265	1	12.2
30	6	02.8	270	+3	11.2
45	0	06.0	285	7	09.8
60	-4	07.8	300	14	08.4
75	7	09.2	315	22	06.8
90	10	10.2	330	32	05.6
105	12	11.0	345	39	03.6
120	14	11.8	360	47	01.4
135	15	12.4	375	53	10999.4
150	16	12.8	380	46	98.4
165	17	13.2	385	40	98.8
180	18	13.4	390	34	11000.2
195	19	13.8	395	27	01.6
210	20	14.2	400	25	02.8
225	21	14.4			

Maximum frequency change over any 20° temperature change

+21° to +1° = 9.3 kilocycles = 0.084%

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Table 33

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Temperature)

16 megacycles

Time Min.	Temp °C	Freq kc	Time Min	Temp °C	Freq kc
0	+22	16000.00	275	-10	16015.50
5	19	98.50	280	8	15.00
10	15	98.75	285	6	14.50
15	13	99.00	290	4	13.00
20	10	15999.75	295	0	11.50
25	7	16001.25	300	+5	08.50
30	4	03.00	305	8	06.50
45	-1.5	08.25	310	11	04.50
60	6	12.00	315	13.5	02.75
75	9	14.25	320	16	01.00
90	11	16.5	325	20	15999.00
105	12	17.75	330	23	96.25
120	14.5	18.75	335	29	94.25
135	15	20.00	340	36.5	89.00
150	17	20.75	345	40	86.25
165	18	21.50	350	43	83.75
180	19	21.75	355	45	81.75
195	20	22.00	360	48	81.75
210	20.5	22.25	365	52	81.75
225	21	22.75	370	42	82.50
240	21.5	22.87	375	32	86.25
255	22	23.00	380	22	91.00
260	20	22.50			
265	16	20.25			
270	14	17.00			

Maximum frequency change over any 20° temperature change

+4° to -16° = 17.35 kilocycles = 0.108%

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Table 34

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Humidity)

400 kilocycles

Time Min	Temp °C	Humidity %	Freq kc
0	+27	40	400.000
5	29	45	399.984
10	32	53	.960
15	35	71	.912
20	37	84	.864
25	39	86	.808
30	41	88	.728
35	43	90	.640
40	47	95	.560
45	50	96	.456
50	52	96	.352
55	50	90	.304
60	53	95	.256
65	50	93	.280
70	53	94	.264
75	50	90	.280
80	51	95	.296
85	50	85	.296
90	50	95	.336

Maximum frequency change during test	744 cycles
Change over same temperature range from Table 27	80 cycles
Change due to humidity variation	664 cycles



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Table 35

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Humidity)

1000 kilocycles

Time Min.	Temp °C	Humidity %	Freq kc
0	+24	55	1000.000
5	28	58	.060
10	30	65	.100
15	33	80	.080
20	35	85	.040
25	38	87	1000.000
30	40	88	999.940
35	43	96	.860
40	47	97	.680
45	49	96	.580
50	51	96	.300
55	54	95	999.000
60	53	85	998.840
65	54	94	999.100
70	51	90	999.360
75	52	91	1000.200
80	51	80	.320
85	50	94	.380
90	51	93	.300

Maximum frequency change during test	1.160 kc
Change over same temperature range from Table 28	1.018 kc
Change due to humidity variation	0.142 kc

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Table 36

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Humidity)

4.5 megacycles

Time Min.	Temp °C	Humidity %	Freq kc
0	+25	55	4500.0
5	27	57	4499.6
10	29	65	99.1
15	31	76	98.7
20	34	86	98.1
25	36	86	97.3
30	38	87	96.3
35	40	89	95.3
40	42	90	94.4
45	45	95	93.1
50	48	96	91.9
55	50	95	90.7
60	52	95	89.2
65	54	95	87.6
70	52	85	86.9
75	53	95	86.9
80	52	85	86.9
85	51	92	87.3
90	53	100	87.4

Maximum frequency change during test	13.1 kc
Change over same temperature range from Table 29	11.0 kc
Change due to humidity variation	2.1 kc

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Table 37

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Humidity)

7.5 megacycles

Time Min	Temp °C	Humidity %	Freq kc
0	+28	45	7500.000
5	32	49	7499.620
10	35	58	98.900
15	37	72	98.000
20	40	85	96.860
25	42	87	95.910
30	44	88	94.960
35	47	90	93.550
40	49	91	92.570
45	52	95	91.280
50	53	96	89.620
55	52	93	88.950
60	54	96	88.475
65	51	87	88.285
70	53	95	88.285
75	51	85	88.000
80	52	94	88.570
85	51	85	88.190
90	53	96	88.570

Maximum frequency change during test	12.000 kc
Change over same temperature range from Table 30	7.710 kc
Change due to humidity variation	4.290 kc

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Table 38

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Humidity)

11 megacycles

Time Min.	Temp °C	Humidity %	Freq kc
0	+24	50	11000.0
5	28	55	10999.8
10	32	63	99.4
15	35	75	98.6
20	37	84	98.2
25	40	86	97.4
30	42	87	96.6
35	45	90	95.6
40	48	92	94.4
45	51	95	92.8
50	53	95	91.0
55	52	85	89.6
60	53	95	89.2
65	51	85	88.6
70	51	91	89.0
75	53	95	89.2
80	51	85	88.8
85	53	96	89.2
90	52	85	88.6

Maximum frequency change during test	11.4 kc
Change over same temperature range from Table 31	7.2 kc
Change due to humidity variation	4.2 kc

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Table 39

Type K Multi-Channel Radio Equipment

Receiver Frequency Drift (Variable Humidity)

16 megacycles

Time Min.	Temp °C	Humidity %	Freq kc
0	+23	37	16000.00
5	25	40	15999.00
10	26	50	98.00
15	27	61	97.00
20	29	80	96.25
25	31	88	94.75
30	34	92	92.00
35	39	100	90.75
40	41	100	88.50
50	45	98	81.75
60	50	96	78.50
70	53	90	73.00
80	50	92	73.00
90	53	96	15972.00

Maximum frequency change during test	28.00 kc
Change over same temperature range from Table 32	14.50 kc
Change due to humidity variation	13.50 kc

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Table 40

Type K Multi-Channel Radio Equipment

Frequency Change due to Voltage Change

Original setting at 11 volts 30 minute warm-up period

	400 kilocycles		Freq Change	Pct.
	11 volts kc	15 volts kc	kc	Change
Instantaneous	400.400	400.408	0.008	0.002
10 minutes		400.304	0.104	0.026
Instantaneous	400.280		0.024	0.006
10 minutes	400.400		0.120	0.03
	1000 kilocycles			
Instantaneous	1009.0	1009.040	0.040	0.004
10 minutes		1008.940	0.100	0.01
Instantaneous	1008.94		0.000	0.00
10 minutes	1009.0		0.060	0.006
	4.5 megacycles			
Instantaneous	4505.9	4505.8	0.100	0.002
10 minutes		4503.8	2.000	0.044
Instantaneous	4503.3		0.500	0.011
10 minutes	4505.5		2.200	0.049
	7.5 megacycles			
Instantaneous	7497.810	7497.620	0.190	0.0025
10 minutes		7495.150	2.470	0.033
Instantaneous	7494.770		0.380	0.0051
10 minutes	7496.860		2.090	0.028
	11.5 megacycles			
Instantaneous	11451.000	11449.800	1.200	0.010
10 minutes		11446.000	3.800	0.033
Instantaneous	11445.200		0.800	0.007
10 minutes	11449.600		4.400	0.004
	16.0 megacycles			
Instantaneous	15999.650	15995.475	4.175	0.026
10 minutes		15989.560	5.915	0.037
Instantaneous	15986.080		3.480	0.022
10 minutes	15995.650		9.570	0.06

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Table 41

Type K Multi-Channel Radio Equipment

Output Change Due to Voltage Change

MW Output

Frequency	11 volts	12 volts	13 volts	14 volts	15 volts	16 volts
400 kc	7.0	8.0	9.0	10.0	10.5	11.0
1000 kc	6.0	8.0	9.0	10.0	11.0	12.0
4.5 mc	4.5	6.0	8.0	10.0	13.0	15.0
7.5 mc	4.5	6.0	8.0	10.0	13.0	15.0
11.5 mc	5.0	6.0	7.5	10.0	12.0	14.0
16.0 mc	5.0	7.0	8.0	10.0	11.0	12.5

Current Drain

Receiver	11 volts	12 volts	13 volts	14 volts	15 volts	16 volts
200-580 kc	2.25 amp	2.35 amp	2.50 amp	2.65 amp	2.75 amp	2.90 amp
520-1000 kc	2.25	2.40	2.50	2.65	2.75	2.90
3-6 mc	2.25	2.40	2.50	2.65	2.75	2.90
6-9 mc	2.40	2.50	2.65	2.80	2.95	3.05
9-13.5 mc	2.40	2.55	2.70	2.85	3.00	3.10
13.5-20 mc	2.30	2.45	2.55	2.70	2.80	3.00

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Table 42

Type K Multi-Channel Radio Equipment

Calibration Accuracy

200 to 580 kc band

Receiver Setting	Measured Freq.kc	Kilocycles Off	Per cent Off
200 kc	199.500	-0.500	0.250
300	300.955	+0.995	0.330
400	400.375	+0.375	0.094
500	499.562	-0.438	0.088
580	581.600	+1.600	0.276

520 to 1500 kc band

520 kc	521.900	+1.900	0.365
600	604.830	+4.830	0.800
800	809.322	+9.322	1.160
1000	1006.685	+6.685	0.668
1200	1202.580	+2.580	0.215
1400	1401.182	+1.182	0.084
1500	1501.370	+1.370	0.090

3 to 6 mc band

3 mc	3003.95	+03.95	0.130
4	4010.27	+10.27	0.256
5	5001.10	+01.10	0.022
6	6000.00	0.0	0.000

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Table 43

Type K Multi-Channel Radio Equipment

Calibration Accuracy

6 to 9 megacycles

Receiver Setting	Measured Freq-kc	Kc Off	% Off
6 mc	6001.155	+1.155	0.019
7	7002.200	+2.200	0.314
8	7999.077	-0.923	0.011
9	9003.800	+3.800	0.042

9 to 13.5 megacycles

9	8999.20	-0.80	0.009
10	9982.80	-17.80	0.178
11	10966.95	-33.05	0.300
12	11957.47	-42.53	0.360
13	12986.80	-13.20	0.100

13.5 to 20 megacycles

13.5	13480.600	-19.400	0.14
14	13974.476	-25.524	0.18
15	14983.429	-16.571	0.11
16	15974.422	-25.578	0.16
17	16971.000	-29.000	0.17
18	17971.440	-28.560	0.16
19	18994.779	- 5.220	0.03
20	19984.376	-15.624	0.08

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Table 44

Type K Multi-Channel Radio Equipment

Reset

Freq Band	CLOCKWISE: Max Change from Original Sett'g % Local Control	CLOCKWISE: Max Change from Original Sett'g %Remote Control	CLOCKWISE: Average Change Over Band % Local Control	CLOCKWISE: Average Change Over Band %Remote Control	COUNTER-CLOCKWISE: Max Change from Original Sett'g % Local Control	COUNTER-CLOCKWISE: Max Change from Original Sett'g %Remote Control	COUNTER-CLOCKWISE: Average Change Over Band % Local Control	COUNTER-CLOCKWISE: Average Change Over Band %Remote Control
kc								
200-580	0.008	0.012	0.006	0.0113	0.044	0.054	0.0215	0.0250
520-1500	0.016	0.0145	0.0078	0.0094	0.027	0.087	0.0131	0.0650
mc								
3 - 6	0.0098	0.035	0.005	0.0153	0.017	0.065	0.0130	0.0430
6 - 9	0.0073	0.021	0.0033	0.0100	0.012	0.048	0.0052	0.0233
9 - 13	0.004	0.0088	0.0024	0.0052	0.028	0.040	0.0120	0.0270
14 - 20	0.0065	0.0084	0.0041	0.0057	0.026	0.041	0.0165	0.0278

Table 45

Type K Multi-Channel Radio Equipment

Adjustment Accuracy
Tolerance 0.02% allowed in accordance
with BuEng Spec. RE-13A-558B

Crystal check point - kc	Dial Setting Freq-kc	Aver.Meas. Freq.-kc	Error Cycles	Error %
3105.0	3000.0	3000.10	100	0.0033
	3250.0	3249.68	320	0.0095
	3500.0	3499.64	360	0.013
4135.0	3750.0	3748.36	1640	0.043
	4000.0	3997.62	2380	0.059
	4500.0	4499.22	780	0.017
5000.0	5000.0	5000.10	100	0.002
	5500.0	5499.92	80	0.0016
	6000.0	5999.26	740	0.012
6600.0	6500.0	6499.75	250	0.0038
	7000.0	7001.17	1170	0.016
	7500.0	7501.17	1170	0.015
	8000.0	8000.15	150	0.0018

Table 46

Type K Multi-Channel Radio Equipment

Lost Motion, Back and Torque Lash

Allowed tolerance 0.02% in accordance with BuEng Spec. RE 13A 558B

Band mc	Freq kc	Clockwise Av.Meas'd Freq kc	Counter-Clockwise Av.Meas'd Freq.kc	% of Variation	Crystal Check Pt. Freq kc	Measured Check Point Freq.kc
3.0-3.7	3000.0	3000.1	3000.1	0.0	3105.0	3105.6
	3250.0	3249.675	3249.7	0.0007		
	3500.0	3499.625	3499.65	0.0007		
3.7-4.8	3750.0	3748.935	3747.775	0.031	4135.0	4134.3
	4000.0	3997.76	3997.48	0.007		
	4500.0	4499.6	4498.85	0.0166		
4.8-6.2	5000.0	5000.0	5000.2	0.004	5000.0	5000.0
	5500.0	5499.975	5500.1	0.0023		
	6000.0	5999.26	5999.26	0.0		
6.2-8.0	6500.0	6499.6	6499.9	0.005	6600.0	6600.3
	7000.0	7001.05	7001.29	0.0034		
	7500.0	7500.92	7501.095	0.0023		
	8000.0	8000.085	8000.215	0.0016		

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Table 47

Type K Multi-Channel Radio Equipment

Detuning of Circuits

Percentage of error allowed 0.003, in accordance with BuEng Spec. RE 13A 558B.

Band mc	Frequency kc	Clockwise Detuning Plate Curr.- ma	Counter-clkwse Det. Plate Curr. - ma	Max % Det.
		Freq. 3502.5 kc Plate Current 178 ma		
3.0-3.7	3502.540	190		6.7
	3502.510		188	5.6
Maximum variation 40 cycles, error 0.0011%				
		Freq. 4502.5 kc Plate Current 183 ma		
3.7-4.8	4502.6	188		2.7
	4502.4		190	3.8
Maximum variation 100 cycles, error 0.0022%				
		Freq. 5502.5 kc Plate Current 180 ma		
4.8-6.2	5502.25	187		3.9
	5502.56		187	3.9
Maximum variation 250 cycles, error 0.0045%				
		Freq. 6502.5 kc Plate Current 174 ma		
6.2-8.0	6502.60	190		9.2
	6502.65		191	9.8

Maximum variation 150 cycles, error 0.0023%

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Table 48

Type K Multi-Channel Radio Equipment

Change of Tubes

Allowable variation for master oscillator tubes 0.1%
Allowable variation for power amplifiers 0.001%
in accordance with BuEng Spec. RE 13A 558B

Freq kc	M.O. Tube No.	Freq. kc	P.A. Tube No.
8002.0	7	8002.0	16 and 17
8001.0	15	8002.5	20 and 33
8000.5	18	8002.5	22 and 35
8000.65	20	8002.85	32 and 36
8003.6	24	8003.0	25 and 26
8005.0	21	8002.85	18 and 31
8005.0	25	8003.0	27 and 40
		8003.0	29 and 30
		8002.5	16 and 39

Variation in frequency for master oscillator tube 0.021%

Variation in frequency for power amplifiers 0.0035%

NOTE: Master oscillator tube No. 23 was not used because of its erratic behavior.

Freq kc	M.O. Tube No.	Freq kc	P.A. Tube No.
6501.25	7	6501.0	16 and 17
6501.075	15	6501.0	20 and 33
6501.0	18	6500.975	22 and 35
6501.15	20	6500.95	32 and 36
6500.4	21	6501.0	25 and 26
6501.35	24	6500.975	27 and 40
6500.85	25	6500.95	29 and 30
		6501.05	16 and 39
		6500.975	18 and 31

Variation in frequency for master oscillator tube 0.0035%

Variation in frequency for power amplifiers 0.0003%



Table 49

Type K Multi-Channel Radio Equipment

Variation of Supply Line Voltage
Allowed variation in frequency 0.005% in accordance with BuEng Spec. RE 13A 558B

Band mc	Input Volts: 10% Below 12.6 V.	Normal 14 Volts	10% Above 15.4 V.	Cycles Variation from Lowest Voltage	% Variation	Time of Variation Min.
	Frequency kc					
3.0-3.7	3502.30	3502.5	3502.575	275	0.0078	1
3.7-4.8	4503.40	4502.5	4502.15	1250	0.0277	1
4.8-6.2	5502.95	5502.5	5502.10	850	0.0154	1
6.2-8.0	6502.00	6502.5	6503.75	1750	0.0269	1
3.0-3.7	3502.40	3502.5	3502.475	75	0.0021	5
3.7-4.8	4503.25	4502.5	4503.00	250	0.0055	5
4.8-6.2	5503.00	5502.5	5502.10	900	0.0163	5
6.2-8.0	6503.50	6502.5	6501.95	1550	0.0223	5

Table 50

Type K Multi-Channel Radio Equipment

Variation in Ambient Temperature
Allowed average variation in frequency 0.003% in accordance with BuEng Spec. RE 13A 558B

Frequency 6000 kc. Band 4.8-6.2 mc

Temp. °C	Measured Freq. kc	Freq. Variation /°C in %
-30.2	6000.575	0.0000
-20.0	6000.30	0.00045
-10.0	6000.275	0.000041
0.0	6000.525	0.00041
10.0	6000.825	0.00049
20.0	6001.55	0.0012
30.0	6002.09	0.00089
40.0	6002.775	0.0011
50.0	6003.45	0.0011
	Frequency 8000 kc. Band 6.2-8.0 mc	
-27.0	7996.20	0.0000
-19.4	7996.50	0.00038
-10.0	7996.70	0.00025
0.0	7996.100	0.00075
10.0	7995.65	0.00056
20.0	7995.45	0.00025
30.0	7994.95	0.00062
40.0	7994.20	0.00093
50.0	7993.35	0.00106

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Table 51

Type K Multi-Channel Radio Equipment

Variation in Ambient Temperature

Allowed average variation in frequency 0.003% in accordance with BuEng Spec. RE 13A 558 B

Frequency 3500 kc Band 3.7 - 4.8 mc

Temp °C	Measured Freq kc	Freq Variation /°C in %
-30.9	3502.5	0.000
-20.0	3502.375	0.000356
-10.0	3502.21	0.00043
0.0	3501.96	0.00071
10.0	3501.75	0.0006
20.0	3501.44	0.00088
30.0	3501.05	0.0011
40.0	3500.36	0.00197
50.0	3499.91	0.00128

Frequency 4500 kc Band 3.7 - 4.8 mc

-30.03	4497.26	0.000
-20.0	4497.10	0.00035
-10.0	4497.20	0.00022
0.0	4497.10	0.00022
10.0	4496.575	0.0011
20.0	4496.175	0.0009
30.0	4496.05	0.00028
40.0	4495.575	0.0015
50.0	4495.00	0.0012

[redacted]

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Table 52

Type K Multi-Channel Radio Equipment

Variation in Humidity (Ambient Temperature Constant)

Allowed frequency change 0.04% in accordance with BuEng Spec. RE 13A 558B

Allowed output decrease 15%

Frequency 4500 kc Band 3.7 - 4.8 mc

Total Hours	Time/change of Humidity Minutes	Temp °C Mean	Humidity in % Mean	Measured Freq kc	Output Decrease in %	Freq Change in %
0.5	30	46.9	30.0	4502.15	18.2	-
1.5	60	49.5	95.1	4500.575	-	0.0349
2.5	60	48.6	30.0	4501.525	-	0.0138

Frequency 6000 kc Band 4.8 - 6.2 mc

0.5	30	46.5	29.5	6002.5	20.8	-
1.5	60	47.0	95.0	6000.905	-	0.0265
2.5	60	46.3	30.0	6001.85	-	0.0108

Frequency 8000 kc Band 6.2 - 8.0 mc

0.5	30	47.0	30.0	8000.95	14.7	-
1.5	60	48.0	95.0	7998.84	-	0.0138
2.5	60	46.46	30.0	8000.325	-	0.0078

Frequency 3500 kc Band 3.0 - 3.7 mc

0.5	30	47.4	30.7	3502.3	10.8	-
1.5	60	49.0	94.5	3501.075	-	0.0349
2.5	60	49.5	30.0	3501.8	-	0.014

[redacted]

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Table 53

Type K Multi-Channel Radio Equipment

Locked Key Operation for Two Hours
Allowed frequency variation 0.01%
in accordance with BuEng Spec. RE 13A 558B

Frequency 4500 kc Band 3.7 - 4.8 mc			Frequency 3500 kc Band 3.0 - 3.7 mc	
Time Min	Temp °C	Measured Freq kc	Temp °C	Measured Freq kc
0	47.5	4503.00	48.0	3502.30
5	46.5	2.55	46.8	1.625
10	47.0	2.25	46.8	1.35
15	45.2	2.10	47.0	1.15
20	48.2	1.95	46.8	1.05
30	45.5	1.75	47.5	3500.85
40	47.0	1.60	48.0	0.70
50	46.5	1.50	48.8	0.625
60	46.5	1.55	49.0	0.612
70	46.2	1.55	49.5	0.575
80	46.5	1.575	50.0	0.55
90	46.2	1.575	49.0	0.575
100	47.0	1.40	48.0	0.55
110	47.0	1.40	45.8	0.50
120	47.3	1.40	46.0	0.55

Max. variation 550 cycles or 0.0122% from 20 to 120 minutes.

Max. variation 1050 cycles or 0.023% from 0 to 20 minutes.

Max. variation 550 cycles or 0.0157% from 20 to 120 minutes.

Max. variation 1250 cycles or 0.0356% from 0 to 20 minutes.

[redacted]

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Table 54

Type K Multi-Channel Radio Equipment

Locked Key Operation for Two Hours

Allowed frequency variation 0.01% in accordance with BuEng Spec. RE 13A 558B.

Freq. 8000 kc Band 6.2 - 8.0 mc			Freq. 6000 kc Band 4.8 - 6.2 mc	
Time Min.	Temp °C	Measured Freq. kc	Temp °C	Measured Freq. kc
0	48.0	8004.5	46.2	6002 .75
5	47.5	2.15	45.0	6001.95
10	45.4	1.55	45.0	6001.60
15	48.5	1.70	45.5	1.25
20	46.8	1.25	45.4	1.15
25	46.5	1.225	45.7	1.00
30	46.2	1.15	45.8	6000.90
40	46.1	1.10	48.5	6001.00
50	46.1	1.10	47.8	6000.80
60	48.5	1.40	47.8	0.75
70	47.5	1.25	47.8	0.575
80	47.3	1.25	48.0	0.55
90	46.7	1.35	48.1	0.575
100	47.2	1.30	48.5	0.525
110	47.5	1.275	48.8	0.50
120	47.8	1.30	48.8	0.50

Max. 150 cycles variation or 0.0018% from 20 to 120 minutes.

Max. variation 650 cycles or 0.0108% from 20 to 120 minutes.

Max. variation 3250 cycles or 0.0406% from 0 to 20 minutes.

Max. variation 1600 cycles or 0.026% from 0 to 20 minutes.

[redacted]

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Table 55

Type K Multi-Channel Radio Equipment

Locked Key to Intermittently Keyed Condition

Allowed frequency variation with M.O, filament not energized
0.05% in accordance with BuEng Spec. RE 13A 558B

Freq 3500 kc Band 3.0-3.7 mc

Time Minutes	Measured Freq kc
0	3502.5
10	3503.5
Shutdown period	
30: 10 "	3502.75

Variation 750 cycles or
0.021%

Freq 4500 kc Band 3.7-4.8 mc

Time Minutes	Measured Freq kc
0	4502.5
10	4503.15
Shutdown period	
30:10 "	4502.5

Variation 650 cycles or
0.014%

Freq 5500 kc Band 4.8-6.2 mc

Time Minutes	Measured Freq. kc
0	5502.5
10	5502.4
Shutdown period	
30 : 10 "	5503.0

Variation 600 cycles or
0.019%

Freq 6500 kc Band 6.2-8.0 mc

Time Minutes	Measured Freq. kc
0	6502.0
10	6501.9
Shutdown period	
30 : 10 "	6504.4

Variation 2500 cycles or
0.0384%

[redacted]

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Table 56

Type K Multi-Channel Radio Equipment

Locked Key to Intermittently Keyed Condition

Allowed frequency variation with M.O. filament energized 0.01%
in accordance with BuEng Spec. RE 13A 558B

Freq 3500 kc Band 3.0-3.7 mc

Time Minutes	Measured Freq. Kc
0	3502.5
10	3502.975
Shutdown period	
30 : 10"	3502.65

Variation 325 cycles or
0.0092%

Freq 4500 kc Band 3.7-4.8 mc

Time Minutes	Measured Freq.Kc
0	4502.5
10	4502.75
Shutdown period	
30 : 10"	4500.5

Variation 2250 cycles or
0.049%

Freq. 5500 kc Band 4.8-6.2 mc

Time Minutes	Measured Freq. Kc
0	5502.5
10	5502.325
Shutdown period	
30 : 10"	5503.1

Variation 775 cycles or
0.014%

Freq. 6500 kc Band 6.2-8.0 mc

Time Minutes	Measured Freq. kc
0	6502.5
10	6502.275
Shutdown period	
30 : 10 "	6504.85

Variation 2575 cycles or
0.039%



Table 57

Type K Multi-Channel Radio Equipment

Change from Continuously Keyed to Intermittently Keyed Condition

Allowed frequency variation with filaments energized during idle 20 minute period 0.005% in accordance with BuEng Spec. RE 13A 558B

Freq. 3500 kc Band 3.0-3.7 mc

Time Minutes	Measured Freq kc
0	3502.50
30	3503.05
Shutdown period	
50 : 10 "	3402.55

Variation 500 cycles or 0.014%

Freq. 4500 kc Band 3.7-4.8 mc

Time Minutes	Measured Freq kc
0	4502.50
30	4502.45
Shutdown period	
50 : 10 "	4503.80

Variation 1350 cycles or 0.029%

Freq. 5500 kc Band 4.8-6.2 mc

Time Minutes	Measured Freq. kc
0	5502.5
30	5502.75
Shutdown period	
50 : 10"	5503.75

Variation 1000 cycles or 0.018%

Freq. 6500 kc Band 6.2-8.0 mc

Time Minutes	Measured Freq. kc
0	6502.00
30	6502.55
Shutdown period	
50 : 10"	6503.65

Variation 1100 cycles or 0.0168%

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Table 58

Type K Multi-Channel Radio Equipment

Inclination due to Roll and Pitch

Allowed variation 0.002% in accordance with BuEng Spec. RE 13A 558B

ROLL

Band mc	Base Freq kc	Start Freq kc	Normal Freq kc end of 30 min.	Normal Drift cy.	Normal % of Drift	Observed Periodic Variation cycles	Variation %
3.0-3.7	3000.0	3002.50	3002.49	10	0.0003	0.0	0.00
	3500.0	3502.50	3502.05	450	0.012	0.0	0.00
3.7-4.8	4000.0	4002.50	4002.325	175	0.0043	50.0	0.0011
	4500.0	4502.50	4502.48	20	0.0004	25.0	0.00055
4.8-6.2	5000.0	5002.475	5002.21	265	0.0052	25.0	0.0005
6.2-8.0	6500.0	6502.5	6502.05	450	0.0069	25.0	0.00038
	8000.0	8002.5	8002.25	250	0.0031	75.0	0.00093

PITCH

3.0-3.7	3000.0	3002.5	3002.01	490	0.016	50	0.0016
	3500.0	3502.0	3501.22	780	0.022	75	0.0021
3.7-4.8	4000.0	4002.5	4001.975	525	0.013	50	0.0012
	4500.0	4502.5	4502.425	75	0.0016	50	0.0011
4.8-6.2	6000.0	6002.5	6002.26	240	0.0039	50	0.00083
	6500.0	6502.5	6502.075	425	0.0065	30	0.00046
6.2-8.0	8000.0	8002.5	8002.5	0	0.0	150	0.0018

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Table 59

Type K Multi-Channel Radio Equipment

D.C. Input and Radio Frequency Power Output Measurements at 14 Volts Input

Band mc	Freq kc	DC Amps Input cw	mcw	voice	DC Watts Input cw	mcw	voice	RF Output cw	mcw	voice	Antenna ohms res.	uuf cap
3.0-3.7	3000.0	14.6	12.2	12.0	204.0	171.0	168.0	3.62	2.24	1.34	1.145	60
	3105.0	14.6	12.2	11.8	204.0	171.0	165.0	4.09	2.54	1.34		
	3350.0	14.6	12.2	11.8	204.0	171.0	165.0	5.05	2.86	1.79		
	3700.0	14.7	12.5	12.3	206.0	175.0	172.0	6.33	3.62	2.24		
3.7-4.8	3700.0	14.2	12.0	11.6	198.5	168.0	162.5	6.72	3.58	1.85	2.195	60
	4135.0	14.2	12.0	11.7	198.5	168.0	164.0	8.76	5.47	3.26		
	4250.0	14.3	12.0	11.7	200.0	168.0	164.0	9.66	5.47	3.33		
	4800.0	14.0	12.0	11.8	196.0	168.0	165.0	13.15	7.50	4.80		
4.8-6.2	4800.0	15.0	12.4	11.7	210.0	173.5	164.0	18.4	11.60	6.34	2.195	100
	5000.0	14.6	12.2	11.8	200.0	171.0	165.0	18.4	11.10	6.70		
	5500.0	14.5	12.3	12.1	203.0	172.5	169.5	21.7	13.20	8.10		
	6200.0	13.2	11.8	11.7	185.0	165.0	164.0	21.9	13.50	9.70		
6.2-8.0	6200.0	14.5	12.0	11.7	203.0	168.0	163.5	34.6	18.6	10.80	5.145	100
	6600.0	14.7	12.2	11.8	206.0	171.0	165.0	27.2	15.7	10.80		
	7100.0	14.2	12.2	12.0	198.0	171.0	168.0	36.1	22.6	16.70		
	8000.0	14.5	12.3	12.2	203.0	172.5	171.0	38.8	26.0	18.5		

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Table 60

Type K Multi-Channel Radio Equipment

Percentage of Modulation

Band 3.0 - 3.7 mc

Freq kc	Modulation volts	Modulation Frequency Cycles 200	250	300	350	400	500	1000	2000	3000	370
3000	1.92	64.8				81.0	87.5	100	100	87.5	
3105	1.94	68.6			79.0		84.2	100	100	89.2	
3350	1.90	66.6					83.3	100	100	88.3	80.0
3700	1.93	62.5				81.0	87.3	100	100	91.0	
		Band 3.7 - 4.8 megacycles									
3700	1.86	68.8			81.0		87.5	100	100	93.6	
4135	1.90	66.6		80.5			85.8	100	100	90.2	
4250	1.92	64.0			80.6		87.0	100	100	93.4	
4800	1.92	67.4		79.5			72.7	100	100	91.0	
		Band 4.8 - 6.2 megacycles									
4800	1.90	72.0		80.4			85.6	100	100	92.2	
5000	1.92	71.9		81.0			90.4	100	100	94.0	
5500	1.84	65.0		81.5			85.6	100	100	96.4	
6200	1.80	71.5		80.5			89.9	100	100	94.9	
		Band 6.2 - 8.0 megacycles									
6200	1.84	71.5	79.2				89.2	100	96.2	86.0	
6600	1.86	71.5	79.0				89.5	100	92.8	85.7	
7100	1.86	69.2		80.5			88.0	100	91.8	84.3	
8000	1.84	66.7		81.0			90.0	100	90.5	85.5	

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Table 61

Type K Multi-Channel Radio Equipment

Percentage of Modulation

Band 3.0 - 3.7 megacycles

Freq kc	Modulation Volts	Percentage Modulation at 1000 cycles Voice	Tone
3000	1.5	75.8	100+
3105	1.5	68.5	100+
3350	1.5	76.4	100+
3700	1.5	72.8	100+
Band 3.7 - 4.8 megacycles			
3700	1.5	75.6	100+
4135	1.5	75.0	100+
4250	1.5	75.0	100+
4800	1.5	72.5	100+
Band 4.8 - 6.2 megacycles			
4800	1.5	76.6	100+
5000	1.5	77.7	100+
5500	1.5	78.7	100+
6200	1.5	80.0	100+
Band 6.2 - 8.0 megacycles			
6200	1.5	78.5	100+
6600	1.5	81.0	100+
7100	1.5	78.0	100+
8000	1.5	79.0	100+

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Table 62

Type K Multi-Channel Radio Equipment

Transmitter Frequency Drift

(Variable Temperature)

Band 3.0 - 3.7 megacycles Frequency 3500 kc			Band 3.7 - 4.8 megacycles Frequency 4500 kc		
Time Min	Temp °C	Freq. Drift Cycles	Time Min	Temp °C	Freq Drift Cycles
0	+21.0	0	0	+ 6.0	0
10	16.5	475	10	2.5	600
20	11.0	640	20	-0.2	800
30	7.0	695	30	2.3	900
40	3.5	695	40	4.4	950
50	0.8	675	50	5.3	985
60	-1.5	650	60	6.3	995
70	3.2	620	70	7.5	995
80	5.0	590	80	8.4	1000
90	6.3	560	90	9.2	1000
100	7.8	545			
110	8.6	515	0	-21.8*	0
120	9.8	510	10	18.2	1225
130	10.2	495	20	16.0	1460
140	11.2	495	30	13.2	1600
150	12.0	455	40	11.0	1725
160	12.9	440	50	5.8	1925
			60	2.5	2025
0	-22.9	0	70	+ 2.8	2250
10	19.2*	505	80	7.8	2355
20	17.6	940	90	15.0	2590
30	11.2	1200	100	23.2	2695
40	7.0	1500	110	30.0*	2925
50	3.0	1665	120	34.8	3100
60	+1.3	1855	130	38.0	3450
70	4.2	2020	140	41.6	3625
80	8.2	2140	150	45.2	3865
90	14.5	2255	154	47.5	3895
100	22.8	2400			
110	25.5	2590			
120	32.3*	2795	MaximumDrift 0.065%		
130	38.8	3000			
140	42.5	3175			
150	47.8	3400			
160	51.0	3665			

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Maximum Drift 0.071%

* Temperature range used to calculate per cent drift.

[redacted]

Table 63

Type K Multi-Channel Radio Equipment

Transmitter Frequency Drift (Variable Temperature)

Band 4.8 - 6.2 megacycles

Frequency 5000 kilocycles			Frequency 6000 kilocycles		
Time Min	Temp °C	Freq Drift Cycles	Time Min	Temp °C	Freq Drift Cycles
0	-22.8*	0	0	+21.8	0
10	7.0	890	7	18.0	455
20	+3.5	1300	10	16.0	605
30	4.5	1575	20	10.2	840
40	5.0	1900	30	7.2	900
50	8.6	2150	40	3.8	900
60	13.0	2175	50	1.2	860
70	22.5	2510	60	-0.7	850
80	28.6*	2900	70	2.0	870
90	29.5	3210	80	3.4	850
100	34.0	3490	90	5.2	850
110	38.9	3675	100	6.2	840
120	43.3	3875			
130	45.8	4055	0	-20.2*	0
137	49.0	4150	10	11.5	400
			20	9.2	670
			30	2.2	860
			40	+9.5	1050
			50	12.0	1300
			60	18.3	1660
Maximum Drift .0.058%			67	25.0	2000
			70	25.5	2000
			80	29.0*	2340
			91	35.6	2700
			100	39.0	3025
			110	43.5	3350
			120	48.0	3565

Maximum Drift 0.039%

* Temperature range used to calculate per cent drift.

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Table 64

Type K Multi-Channel Radio Equipment

Transmitter Frequency Drift (Variable Temperature)

Band 6.2 - 8.0 megacycles

Frequency 7000 kilocycles			Frequency 7000 kilocycles		
Time Min	Temp °C	Freq. Drift Cycles	Time Min	Temp °C	Freq. Drift Cycles
0	+ 23.0	0	0	-17.0*	0
10	19.0	1500	10	16.0	1205
20	12.2	1750	20	13.0	1650
30	8.5	1775	30	10.5	1800
40	5.8	1775	40	8.2	1900
50	2.8	1790	50	6.5	1950
60	0.5	1810	60	5.5	2050
70	-1.0	1825	70	+5.5	2150
80	2.9	1835	80	7.8	2295
90	4.0	1845	90	12.0	2450
100	5.0	1845	100	20.0	2550
110	6.0	1825	110	27.4	2745
120	6.8	1815	115	30.0	2900
130	7.2	1800	120	34.9*	3050
140	8.0	1800	130	39.0	3340
150	8.5	1800	140	44.4	3690
160	9.0	1800	150	48.0	4000
170	9.6	1800			
180	10.2	1775			
190	10.2	1750	Maximum Drift 0.043%		

*Temperature range used to calculate per cent drift.

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Table 65

Type K Multi-Channel Radio Equipment

Harmonic Distortion at 1000 Cycles

Transmitter Tone Modulated

Harmonic	3350 kc % Distortion	4250 kc % Distortion	5500 kc % Distortion	7100 kc % Distortion
2	5.0	5.5	5.6	6.5
3	6.5	6.5	6.8	8.15
4	2.0	2.1	2.25	2.65
5	0.65	0.71	0.75	0.76
6	0.07	0.065	0.175	0.085
7	0.26	0.34	0.41	0.375
8	0.28	0.32	0.34	0.385
9	0.165	0.15	0.124	0.185
10	0.02	0.01	0.03	0.11
11	0.1	0.09	0.091	0.11
12	0.1	0.095	0.1	0.065
RMS values Total	8.477	8.813	9.145	10.799

Table 66

Temperature Rise of Dynamotor

Time Min	Room Temp °C	Dynamotor Temp. °C	Temp Rise °C
0	27	27	0
60	27	87	60

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Table 67

Type K Multi-Channel Radio Equipment

Altitude Flight for Frequency Drift

Transmitter Frequency 3005 kc

Time Min	Measured Freq kc	Altitude ft. x 10^3	Temp °C	Time Min.	Measured Freq kc	Altitude ft. x 10^3	Temp °C
0	3003.10	2	+ 6	45	3003.56	24	-18
2	3.01	3	4				
4	3.13	5	3	57	3004.27	24	20
6	3.25	7	3	58	4.27	25	21
7	3.25	8	3	59.6	4.27	25	21
9	3.25	9	3	62	4.24	25	21
10	3.25	10	3	63	4.18	24	21
11	3.19	11	3	64.5	4.18	23	21
12	3.19	12	3	66	4.08	22	20
14	3.25	13	2	68	4.08	22	20
16	3.25	14	1	69	4.02	21	20
19	3.38	15	-1	71	3003.93	20	20
21	3.41	16	3	72	3.93	19	19
23	3.44	17	5	74	3.93	18	18
24	3.44	18	6	75.5	3.93	17	17
25	3.47	19	7	76.5	3.87	16	16
28.5	3.53	20	8				
29	3.47	21	9	78	3.68	14	14
32	3.44	22	11	80	3.65	12	12
35	3.68	23	12	81	3.65	11	11
36	3.77	23	13	82	3.59	10	10
37	3.53	23	14	83	3.59	9	9
38	3.53	24	15	84	3.59	8	7
40	3.65	24	15	87	3.56	7	4
44	3.59	24	16	89	3.50	6	3
				90	3.44	5	1
				92	3.41	4	+ 1
				93.5	3.41	3	2
				96	3.41	2	3

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Table 68

Type K Multi-Channel Radio Equipment

Altitude Flight for Frequency Drift

Transmitter Frequency 4105 kilocycles

Time Min.	Measured Freq kc	Altitude ft. x 10^3	Temp °C	Time Min.	Measured Freq kc	Altitude ft. x 10^3	Temp °C
0	4102.8	3	+ 10	97	4101.84	23	- 16
2	2.70	4	10	98	1.84	21	17
4	2.65	5	8	100	1.84	19	16
5	2.70	6	7	101	1.79	18	15
8	2.75	7	7	103	1.79	16	14
10	2.65	8	7	105	1.79	15	14
12	2.65	9	6	106	1.79	15	14
14	2.60	10	6	107	1.84	14	12
16	2.65	11	6	108	1.79	13	10
17	2.75	12	4	110	1.31	12	9
20	2.60	13	3	111	1.31	11	8
23	2.85	15	2	112	1.41	10	7
25	2.89	15	2	113.5	1.46	9	5
27	2.89	16	-3	115	1.46	8	4
29	2.89	16	3	116	1.46	7	2
31	2.85	16	3	117	1.46	6	+1
33	2.85	17	5	118	1.46	6	1
34.5	2.85	17	5	119	1.46	5	3
37	2.85	18	7	120	1.17	4	3
38	2.85	18	7	122	1.03	3	4
40	2.85	18	7	123	1.03	2	4
43	2.85	19	8	125	1.03	1	4
45	2.85	19	8				
47	2.80	20	10				
49	2.85	20	10				
51	2.90	21	12				
53	3.00	21	12				
55	2.85	22	13				
57	2.90	23	14				
60	2.90	23	14				
63	2.85	24.5	16				
65	3.00	24.5	19				
83	2.13	23.7	18				
92	2.13	24	16				
95	4101.89	23	16				

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Table 69

Type K Multi-Channel Radio Equipment

Altitude Flight for Frequency Drift

Transmitter Frequency 6240 kilocycles

Time Min.	Measured Freq. kc	Altitude ft. x 10^3	Temp °C	Time Min.	Measured Freq. kc	Altitude ft. x 10^3	Temp °C
0	6238.6	3	+ 6	42	6238.72	24.3	-22
2	8.66	5	4	48.5	8.60	24.3	26
4	8.72	7	2	49.6	8.72	24	26
5	8.79	8	1	51	8.91	24	26
6	8.85	9	0	52	8.91	23	26
7	8.91	10	-1	53	6239.04	23	26
8	8.98	11	2	54	9.04	22	26
9	6239.11	12	3	55	6238.91	21	25
11	9.87	13	4	57	8.91	20	25
12.5	9.62	14	6	58.5	9.79	19	25
14	9.36	15	7	59.5	8.79	18	23
16	9.23	16	9	61	8.72	17	22
17	9.17	16	10	62	8.60	16	20
19	9.23	17	12	64	8.60	15	19
20	9.23	17	12	65	8.53	14	18
23	9.30	18	14	66	8.85	13	16
24	9.30	18	14	67	8.40	12	15
25	9.55	19	16	69	8.21	10	14
26	9.68	20	17	70	8.21	9	13
28.5	6240.32	20	17	72	8.02	8	12
30	0.38	21	18	73	6237.90	7	10
31	0.38	22	18	74	7.82	6	10
32	0.35	22	18	75	7.82	6	10
33.5	0.19	23	19	76	7.64	5	10
35.5	0.00	23	19	77	7.58	4	9
37	0.00	23	20	78	7.58	2	7
39	0.00	24	21				
41	6239.13	24	21				

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Table 70

Type K Multi-Channel Radio Equipment

Altitude Flight for Frequency Drift

Transmitter Frequency 5295 kilocycles

Time Min.	Measured Freq.kc	Altitude ft.x 10^3	Temp °C	Time Min	Measured Freq.kc	Altitude ft.x 10^3	Temp °C
0	5294.63	1	+ 4	44	5294.57	24	29
3	4.45	3	4	50	4.63	24.3	32.5
4	4.45	4	3				
5	4.38	5	3	61	5295.37	24.2	32.5
6	4.45	6	2	62	5.25	23	32.5
7	4.51	7	2	63	5.18	22	32
8	4.45	8	1	64	5.06	21	32
9	4.57	9	0	64	5.06	20	31
10	4.45	10	-2	65	5294.94	19	30
11	4.63	11	3	65	4.94	18	29
12.5	4.69	12	5	66	4.88	17	29
14	4.75	13	7	67	4.88	16	28
16	4.69	14	8	69	4.88	14	27
17	4.69	15	11	70	4.75	12	26
19	4.75	15	12	70.5	4.63	11	25
21	4.69	16	14	71	4.70	10	23
23	4.63	17	17	72.5	4.45	9	22
24	4.63	17	17	74	4.45	8	20
27	4.63	18	18	75	4.38	7	18
29	4.69	18	20	76	4.32	6	15
31	4.63	19	22	77	4.26	5	12
33	4.63	19	22	78	4.32	4	10
35	4.51	20	23	79	4.32	3	7
37	4.38	21	24	80	4.32	2	4
39	4.51	22	25				
40.5	4.45	23	26				
42	4.45	23	27				
43	4.45	23	27				

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Table 71

Type K Multi-Channel Radio Equipment

Input and Output Power in Watts

Input Volts	Power Input Watts			Power Output Watts			Freq.kc	Band mc
	Voice	Tone	CW	Voice	Tone	CW		
15	195.0	180.0	235.5	2.69	2.94	8.73	3350.0	3.0-3.7
15	190.5	190.5	232.5	4.16	7.68	16.1	4250.0	3.7-4.8
15	192.0	192.0	237.0	7.9	12.2	26.05	5500.0	4.8-6.2
15	189.0	198.0	225.0	10.78	19.12	39.8	7100.0	6.2-8.0
14	169.4	170.8	210.0	2.35	3.6	8.3	3350.0	3.0-3.7
14	162.4	172.2	201.9	3.59	7.48	13.82	4250.0	3.7-4.8
14	165.2	173.6	210.0	5.97	11.5	23.9	5500.0	4.8-6.2
14	177.8	175.0	207.6	13.3	17.0	32.0	7100.0	6.2-8.0
13	149.5	170.8	180.7	2.02	3.6	6.33	3350.0	3.0-3.7
13	149.5	149.5	179.4	3.59	6.52	12.25	4250.0	3.7-4.8
13	145.5	151.0	179.5	5.44	9.84	18.2	5500.0	4.8-6.2
13	123.5	156.0	182.0	12.0	16.65	28.0	7100.0	6.2-8.0
12	141.6	138.0	165.6	2.69	3.46	6.52	3350.0	3.0-3.7
12	132.0	134.4	156.0	3.6	5.97	10.3	4250.0	3.7-4.8
12	134.4	134.4	158.4	6.52	9.27	16.1	5500.0	4.8-6.2
12	138.0	135.5	155.0	10.78	13.3	22.42	7100.0	6.2-8.0
11	123.2	118.6	137.5	2.35	2.82	4.78	3350.0	3.0-3.7
11	118.8	118.8	135.3	3.88	5.28	8.93	4250.0	3.7-4.8
11	118.8	117.7	134.2	5.45	8.51	12.5	5500.0	4.8-6.2
11	118.9	117.6	129.8	9.38	11.25	16.85	7100.0	6.2-8.0

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Table 72

Type K Multi-Channel Radio Equipment

Frequency vs Time (Ambient Temperature)

14 Volts Input

Time Min	Measured Freq kc	Measured Freq kc	Measured Freq kc	Measured Freq kc	Measured Freq kc	Measured Freq kc
0	3250.90	3749.86	4500.4	5001.30	6000.53	7002.00
2	0.75	9.64	4499.8	5001.00	0.42	7001.24
4	0.60	9.51	9.5	5000.80	6000.00	7000.95
6	0.50	9.38	9.3	0.50	5999.79	0.66
8	0.40	9.25	9.3	0.30	9.42	0.43
10	0.25	9.19	9.3	0.10	9.37	0.29
15	0.10	9.13	9.5	5000.00	9.37	0.19
20	3249.95	9.13	9.5	5000.00	9.16	7000.00
25	9.80	3748.95	9.4	4999.90	9.16	6999.90
30	9.75	8.91	9.4	9.90	9.16	9.80
35	9.60	8.81	9.4	9.70	9.16	9.60
40	9.50	8.76	9.2	9.70	9.16	9.50
45	9.45	8.76	9.2	9.70	9.16	9.30
50	9.40	8.67	9.2	9.70	9.16	9.30
55	9.35	8.62	9.1	9.50	9.16	9.20
60	9.30	8.62	9.0	9.50	9.16	9.10
Cy.drift	650	670	1100	1200	160	1710
% Drift 1st 10 min.	0.0199	0.01785	0.0245	0.024	0.0024	0.024
Cy.drift	950	570	300	600	210	1190
% Drift next 50 min.	0.0292	0.0152	0.0067	0.012	0.0035	0.017

11 Volts Input

10	3250.75	3749.82	4500.8	5001.8	6002.20	7003.0
15	0.60	9.82	0.8	1.6	6001.90	7002.8
20	0.40	9.82	0.6	1.5	1.80	2.7
25	0.30	9.68	0.6	5000.4	1.70	2.6
30	0.25	9.64	4499.9	0.4	1.47	2.5
35	0.10	9.59	9.9	5001.1	1.47	2.4
40	3250.00	9.55	9.9	1.1	1.47	2.2
45	0.00	9.49	9.7	1.1	1.47	2.1
50	3249.95	9.49	9.6	1.1	1.47	2.1
55	9.90	9.44	9.6	5000.9	1.47	2.0
60	3249.85	9.44	9.6	0.9	1.47	7001.9
Cy.drift	900	380	1200	900	730	1100
% drift	0.0277	0.0102	0.026	0.018	0.012	0.016

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Table 73

Type K Multi-Channel Radio Equipment

Frequency of Crystals at Crystal Check Points

Band mc	Crystal Freq kc	Measured Freq kc	Difference Cycles
3.0-3.7	3105.0	3105.16	+ 160
3.7-4.8	4135.0	4133.95	-1050
4.8-6.2	5000.0	4999.95	- 50
6.2-8.0	6600.0	6600.00	0

Table 74

Type K Multi-Channel Radio Equipment

CW Start and Steady Output Power
Antenna Resistance 13.3 ohms

Band mc	Freq kc	Ant. cap. mmf	Start Ant. Amps	Steady Ant. Amps	Watts Start Power	Watts Steady Power
3.0-3.7	3350	48	0.93	0.91	11.5	11.0
	3350	50	1.04	0.94	14.4	11.75
	3350	75	1.12	1.06	16.65	14.95
	3350	117	1.07	1.03	15.38	14.10
	3350	228	1.20	1.08	19.15	15.50
3.7-4.8	4250	40	0.9	0.9	10.78	10.78
	4250	50	1.04	1.0	14.38	13.30
	4250	75	1.06	1.0	14.95	13.30
	4250	117	1.02	0.98	13.80	12.84
	4250	228	1.00	0.98	13.30	12.84
4.8-6.2	5500	44	1.22	1.18	19.60	18.50
	5500	50	1.31	1.28	22.80	21.80
	5500	75	1.35	1.28	24.20	21.80
	5500	117	1.36	1.30	24.60	22.50
	5500	228	1.30	1.22	22.45	19.80
6.2-8.0	7100	28	0.98	0.96	12.78	12.25
	7100	50	1.44	1.36	27.60	24.60
	7100	75	1.56	1.46	32.30	28.40
	7100	117	1.67	1.44	36.30	27.60
	7100	228	1.50	1.44	29.90	27.60

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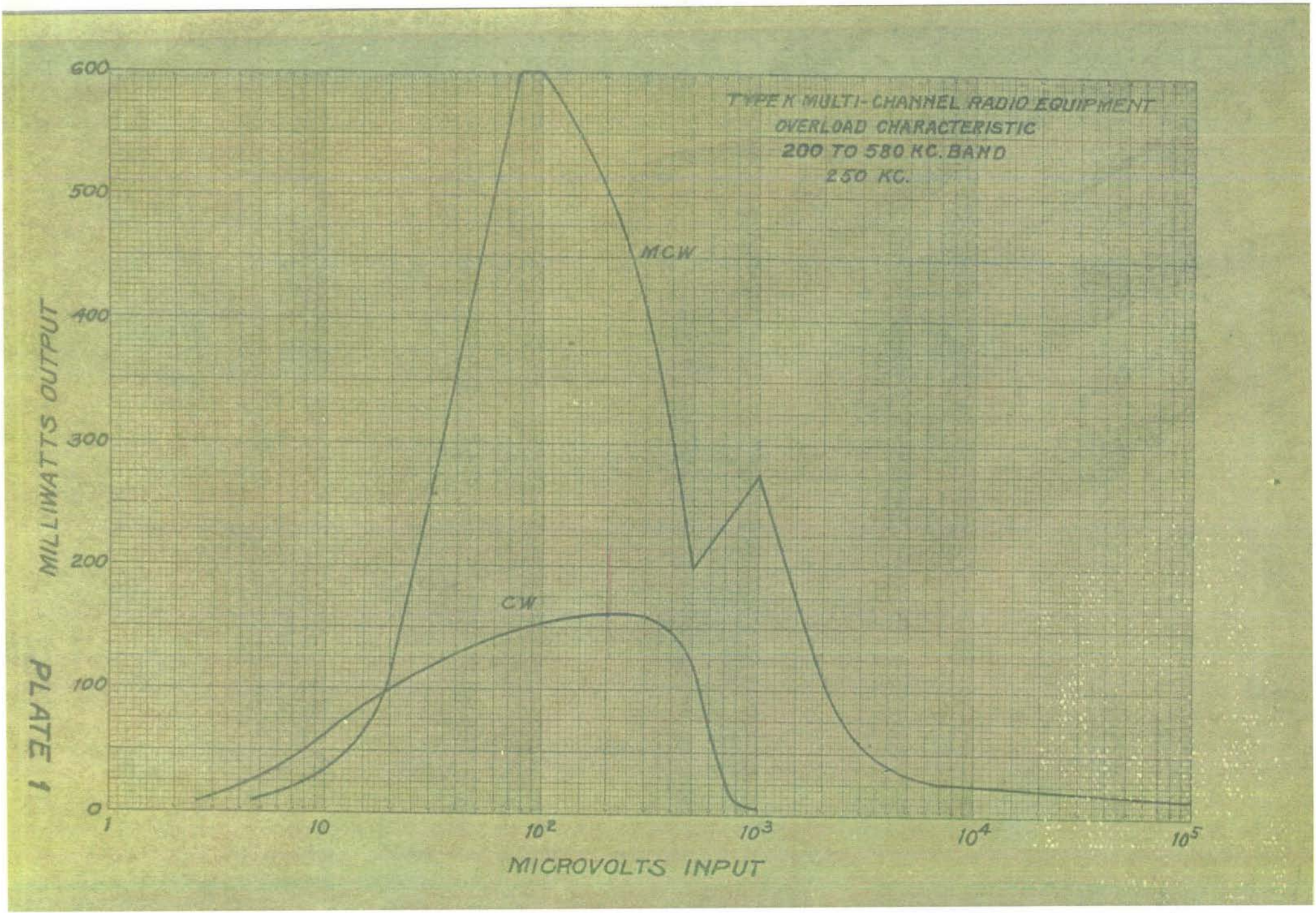

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
200 TO 580 KC. BAND
250 KC.
MCW
CW
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT

PLATE 1

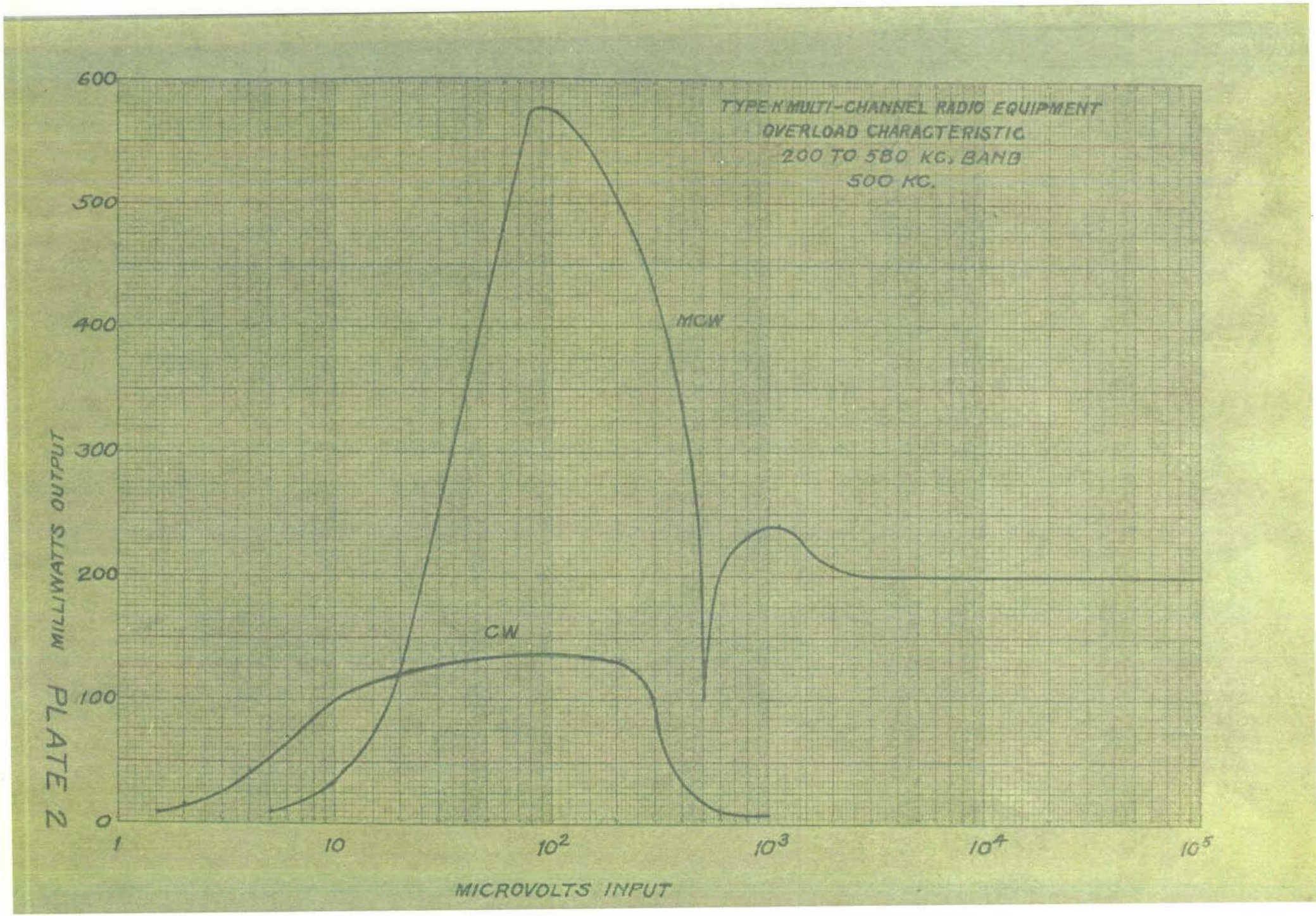
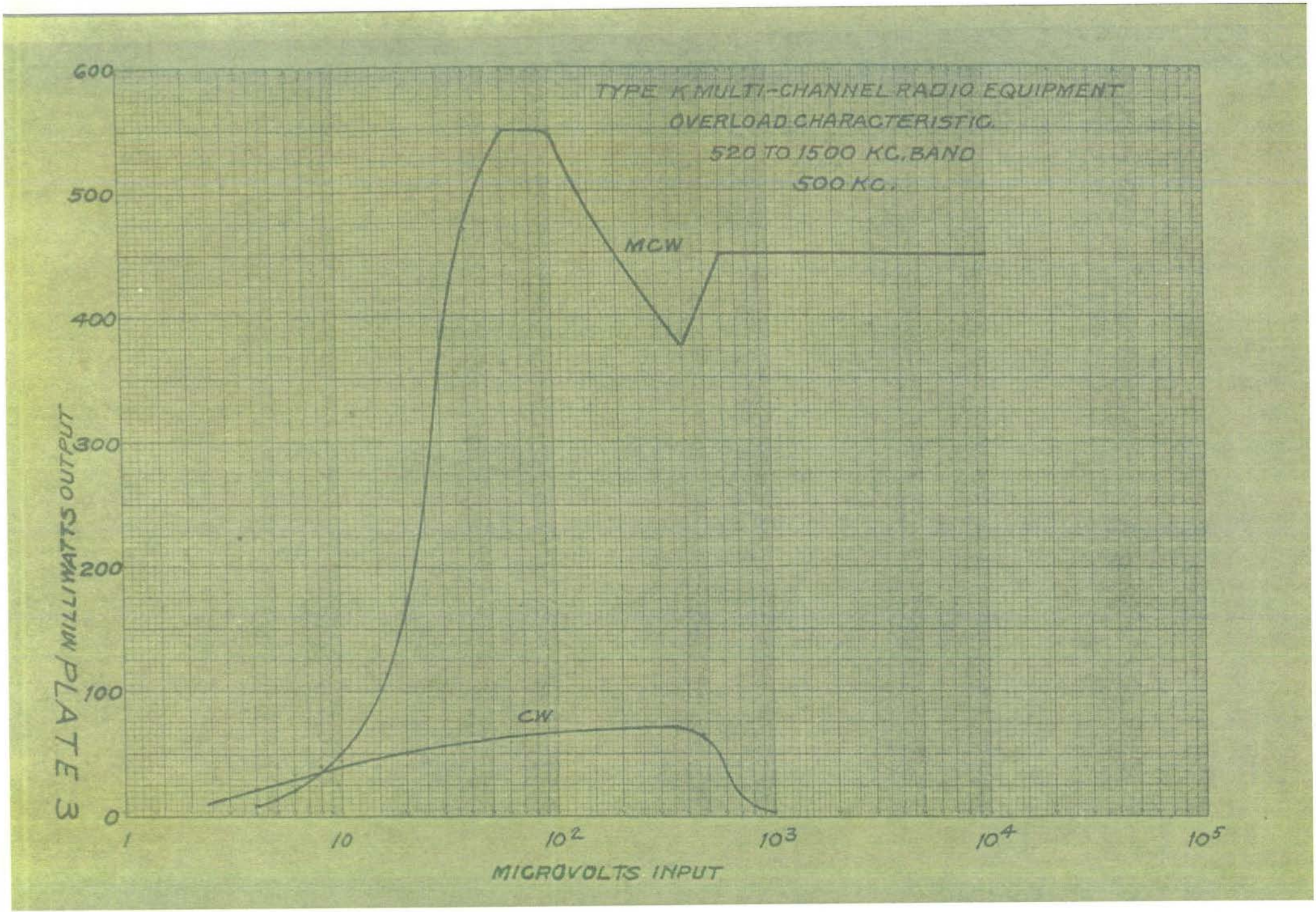

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
200 TO 580 KC. BAND
500 KC.
MCW
CW
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT

PLATE 2


TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
520 TO 1500 KC. BAND
500 KC.
MCW
CW
600
500
400
300
200
100
0
PLATE 3 MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT

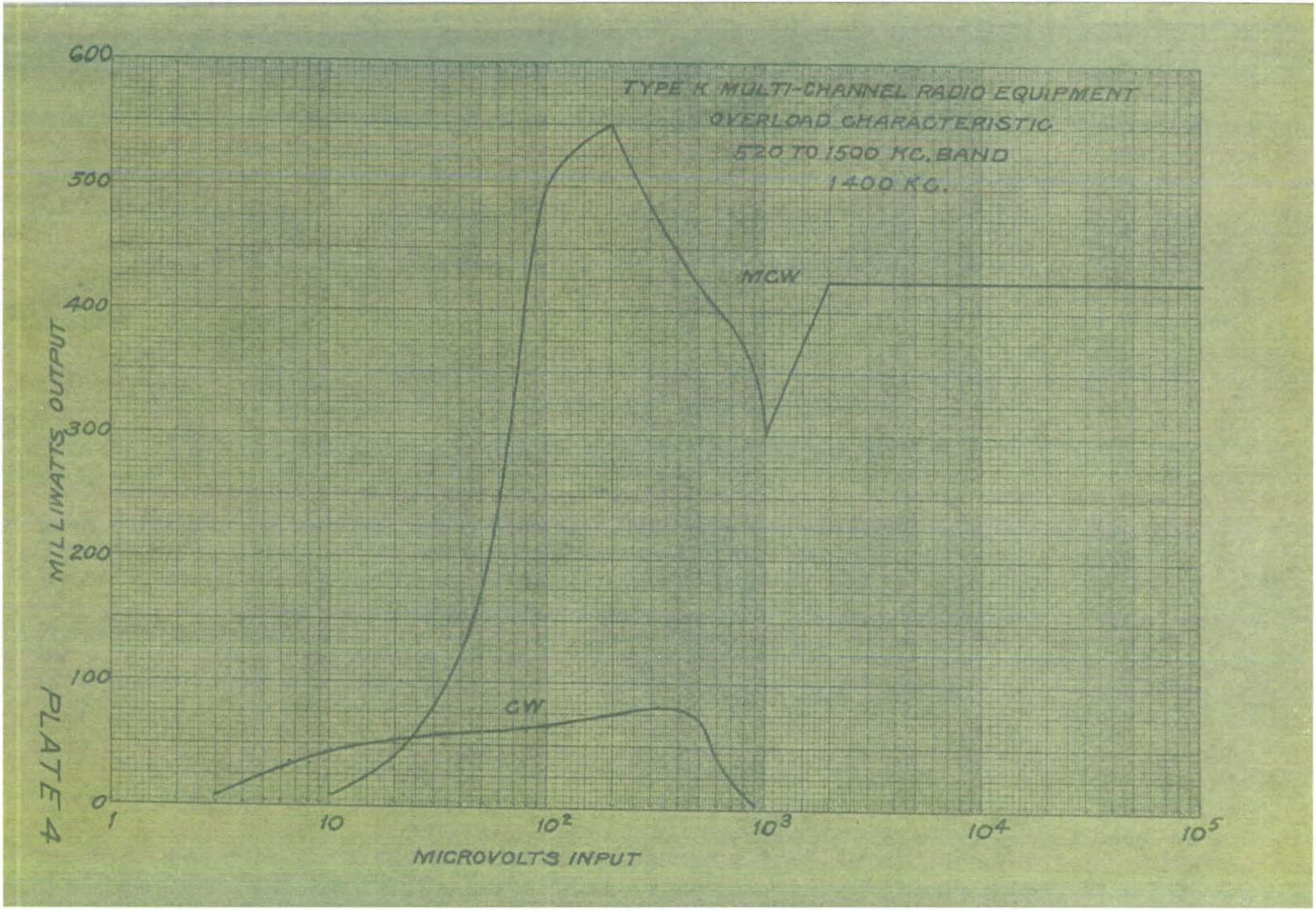

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
520 TO 1500 KC. BAND
1400 KC.
MCW
CW
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT

PLATE 4

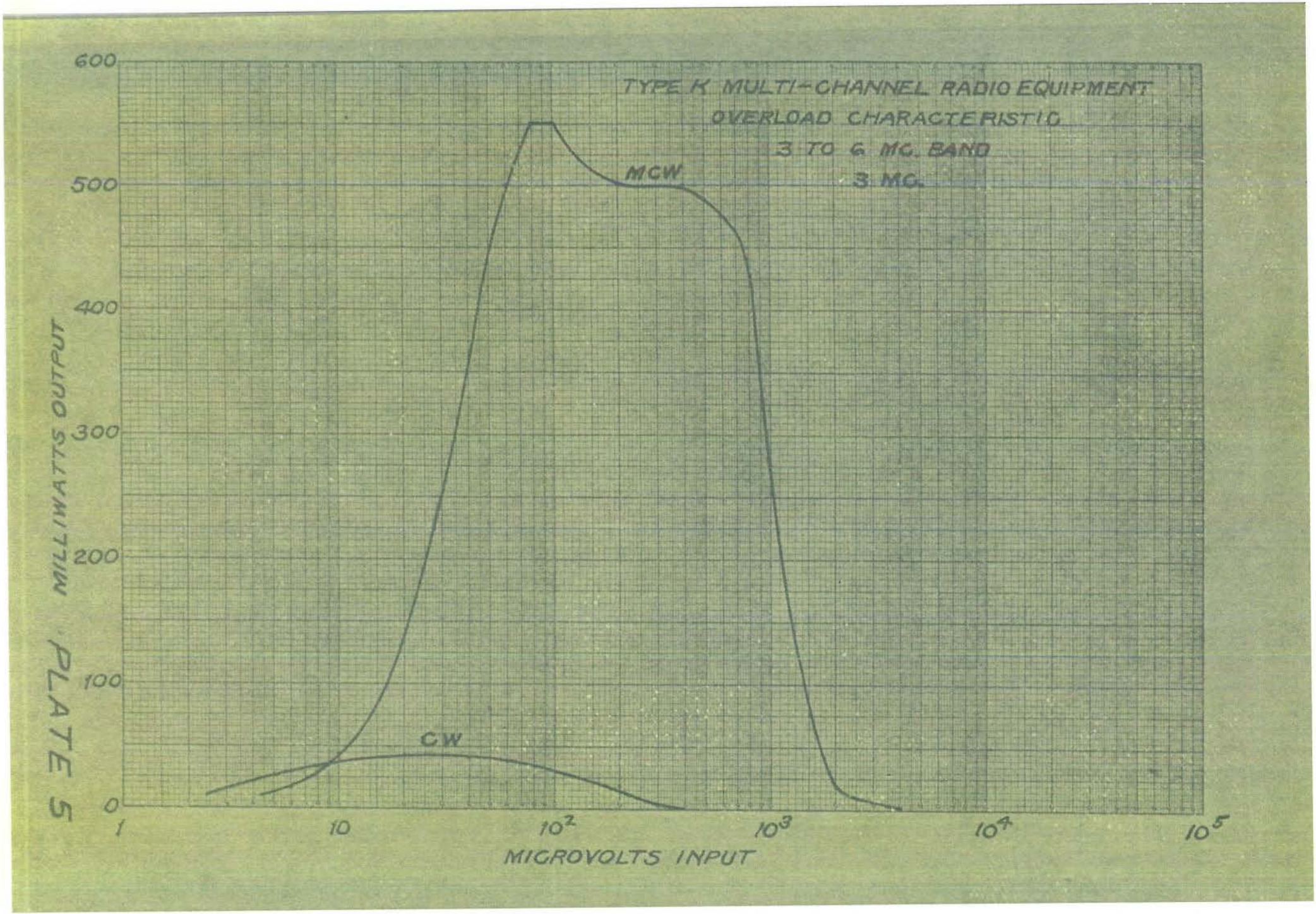

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
3 TO 6 MC. BAND
3 MC.
MCW
CW
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT

PLATE 5

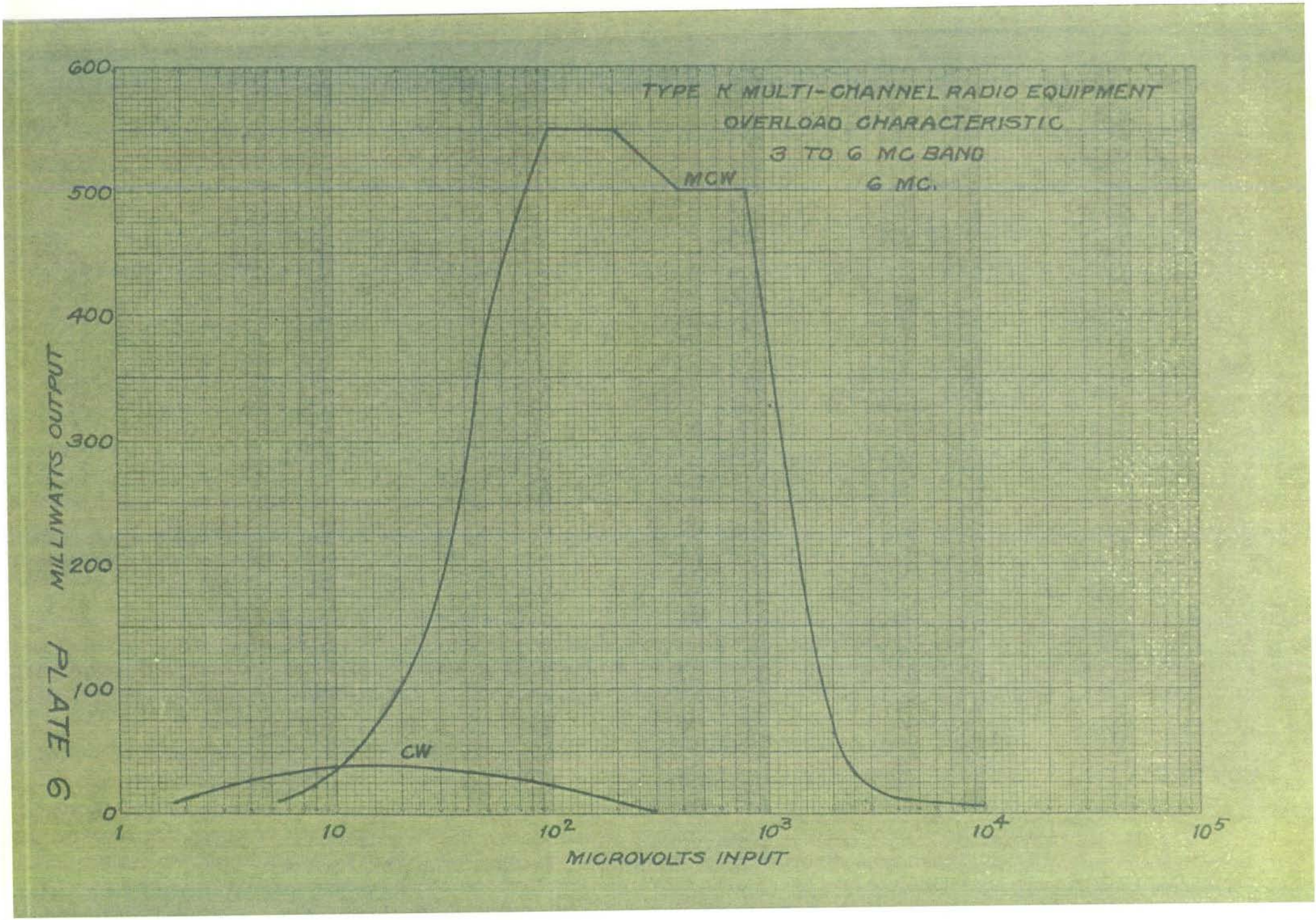

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
3 TO 6 MC BAND
6 MC.
MCW
CW
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT

PLATE 6

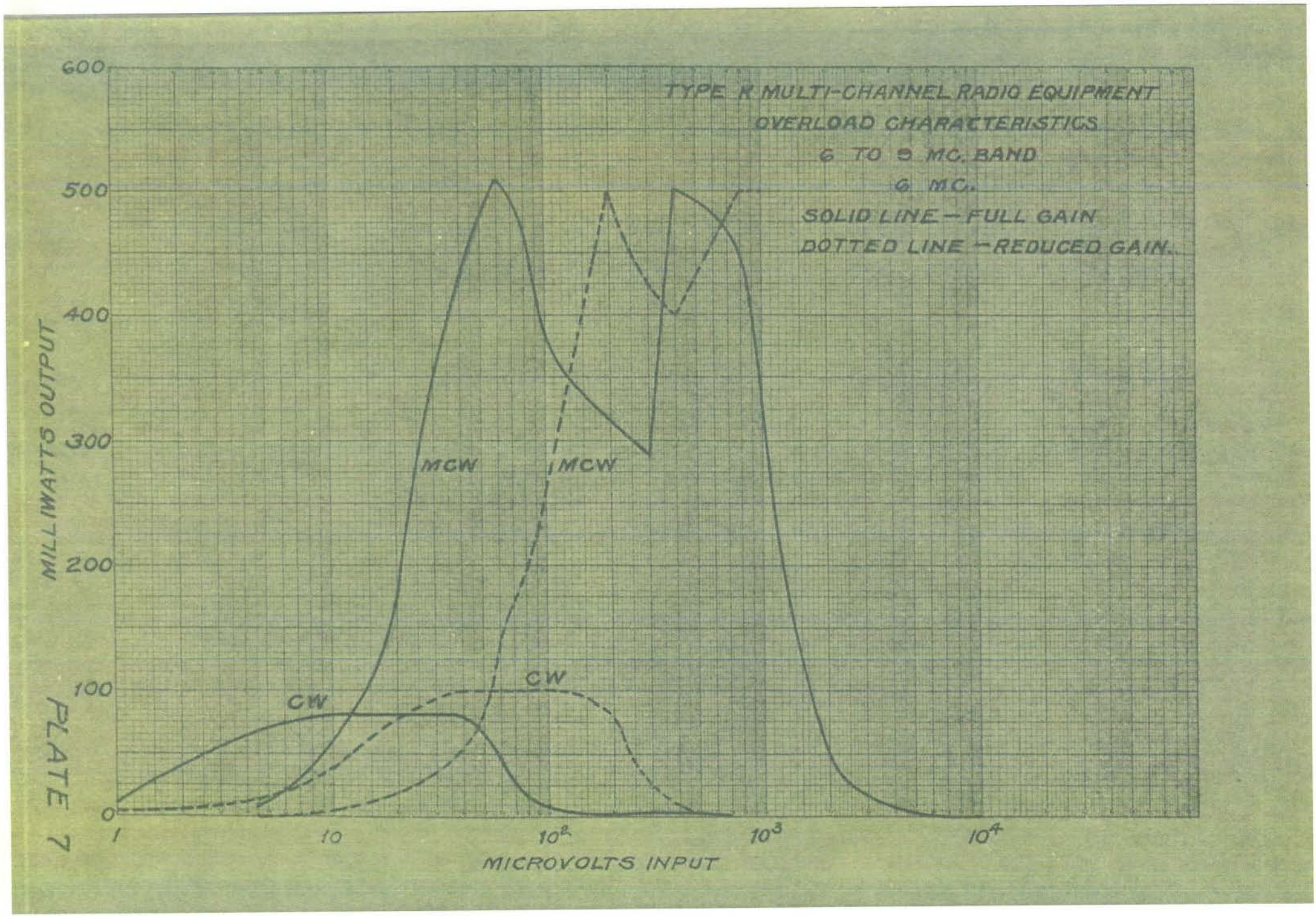
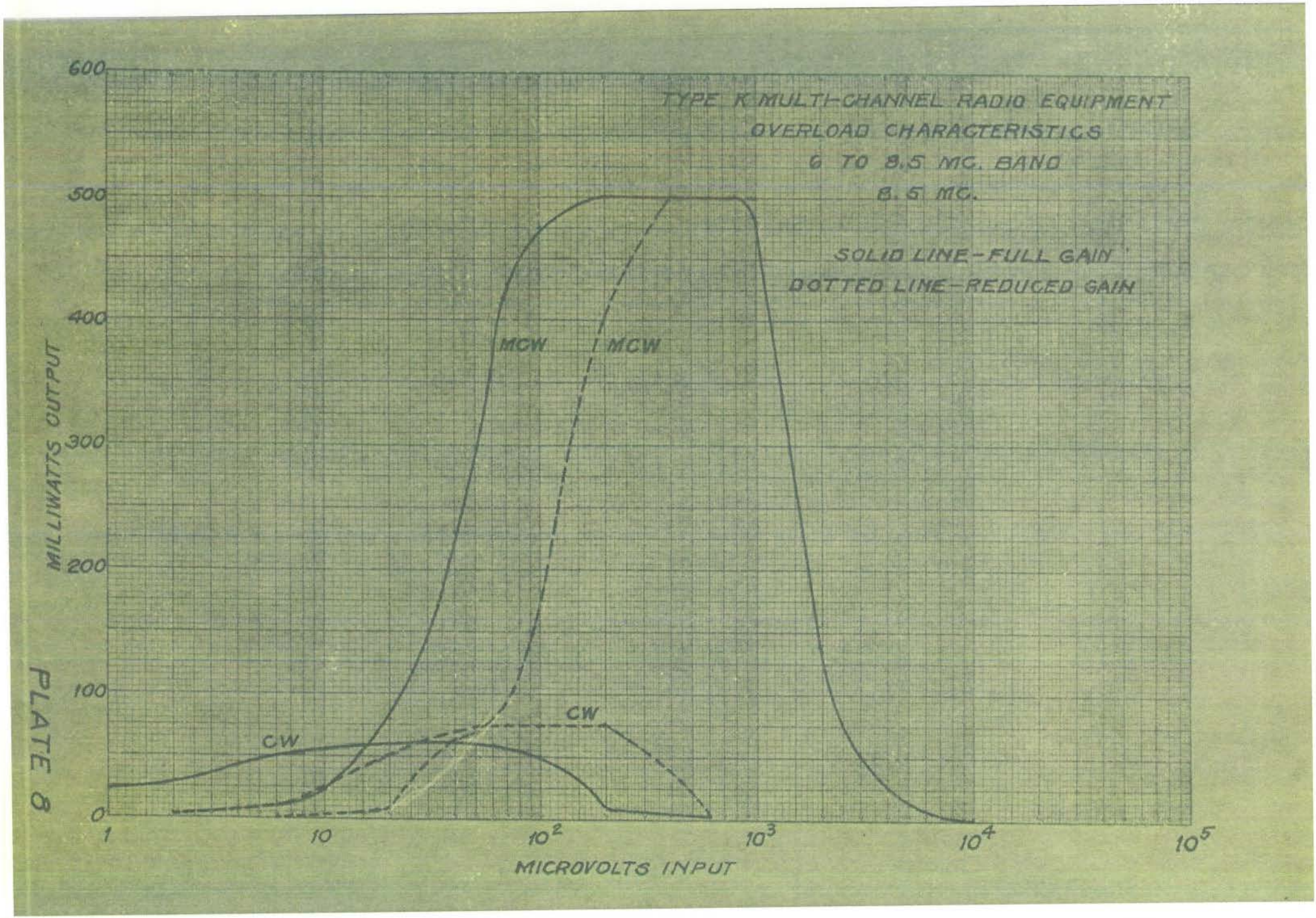

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTICS
6 TO 9 MC. BAND
6 MC.
SOLID LINE – FULL GAIN
DOTTED LINE – REDUCED GAIN.
MILLIWATTS OUTPUT
600
500
400
300
200
100
0
MCW
MCW
CW
CW
1
10
10^2
10^3
10^4
MICROVOLTS INPUT

PLATE 7


TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTICS
6 TO 8.5 MC. BAND
8.5 MC.
SOLID LINE - FULL GAIN
DOTTED LINE - REDUCED GAIN
MCW
MCW
CW
CW
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT
PLATE 8

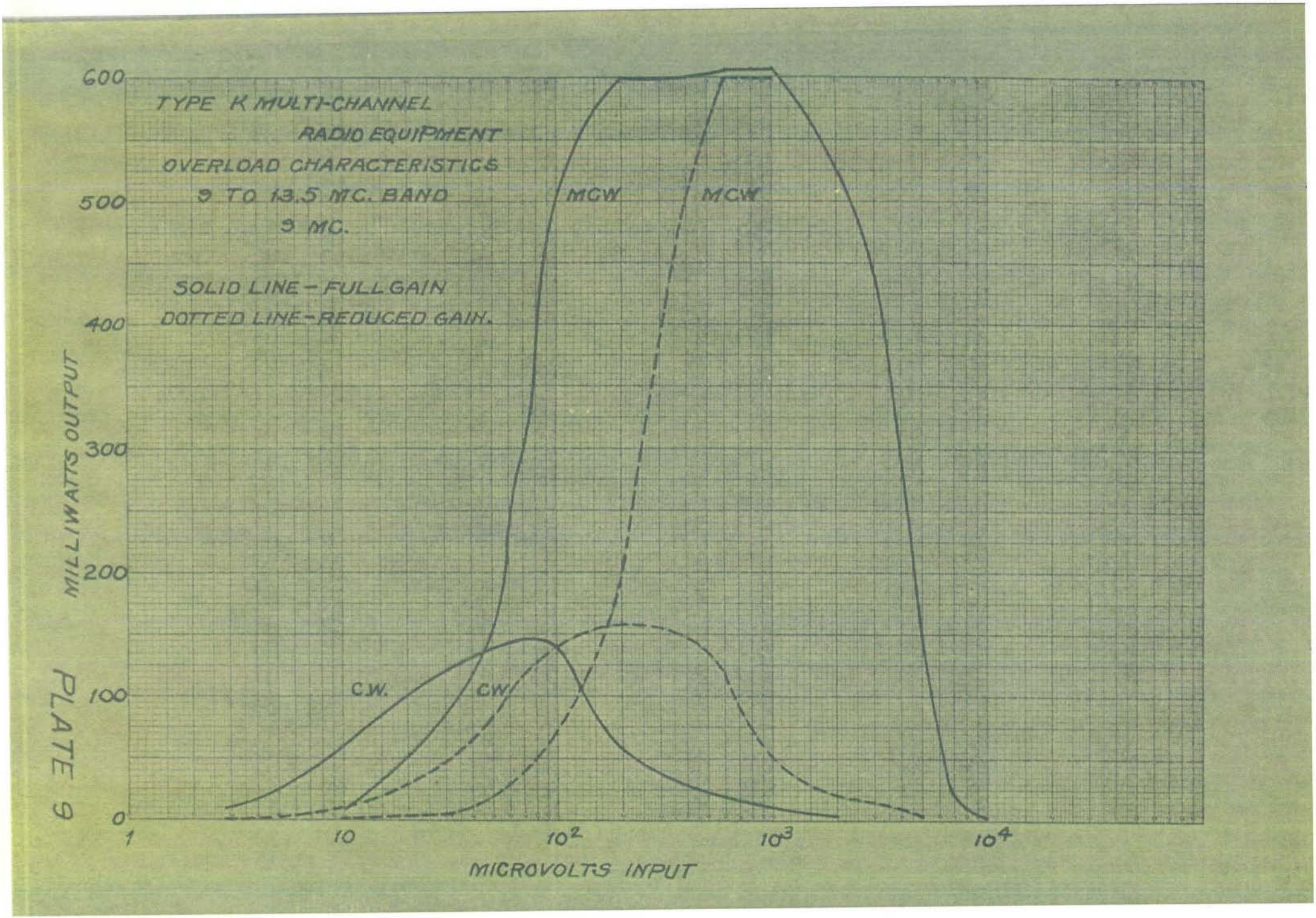
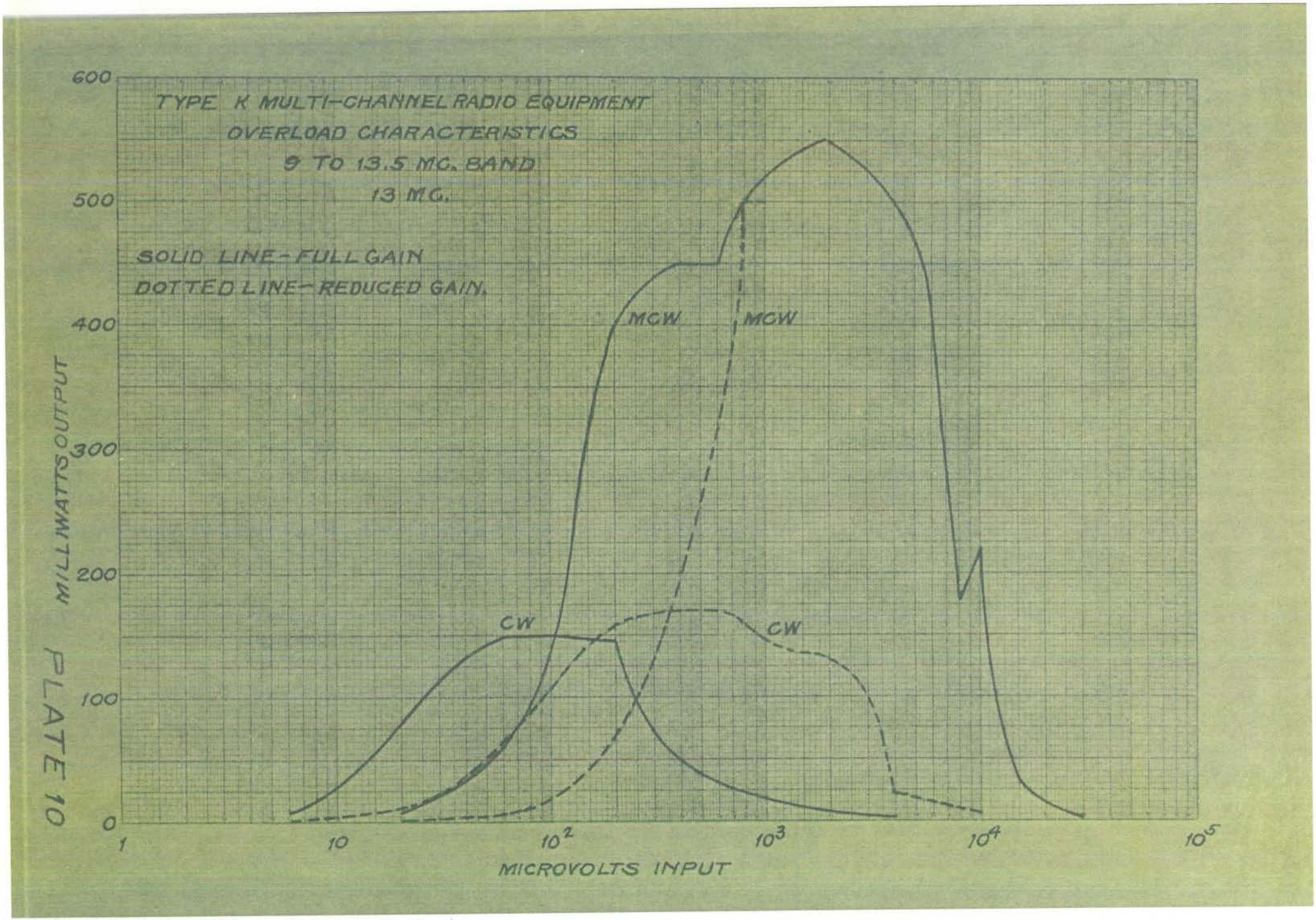

TYPE K MULTI-CHANNEL
RADIO EQUIPMENT
OVERLOAD CHARACTERISTICS
9 TO 13.5 MC. BAND
9 MC.
SOLID LINE - FULL GAIN
DOTTED LINE - REDUCED GAIN.
MCW
MCW
C.W.
C.W.
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
MICROVOLTS INPUT

PLATE 9


TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTICS
9 TO 13.5 MC. BAND
13 MC.
SOLID LINE - FULL GAIN
DOTTED LINE - REDUCED GAIN.
MCW
MCW
CW
CW
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT
PLATE 10

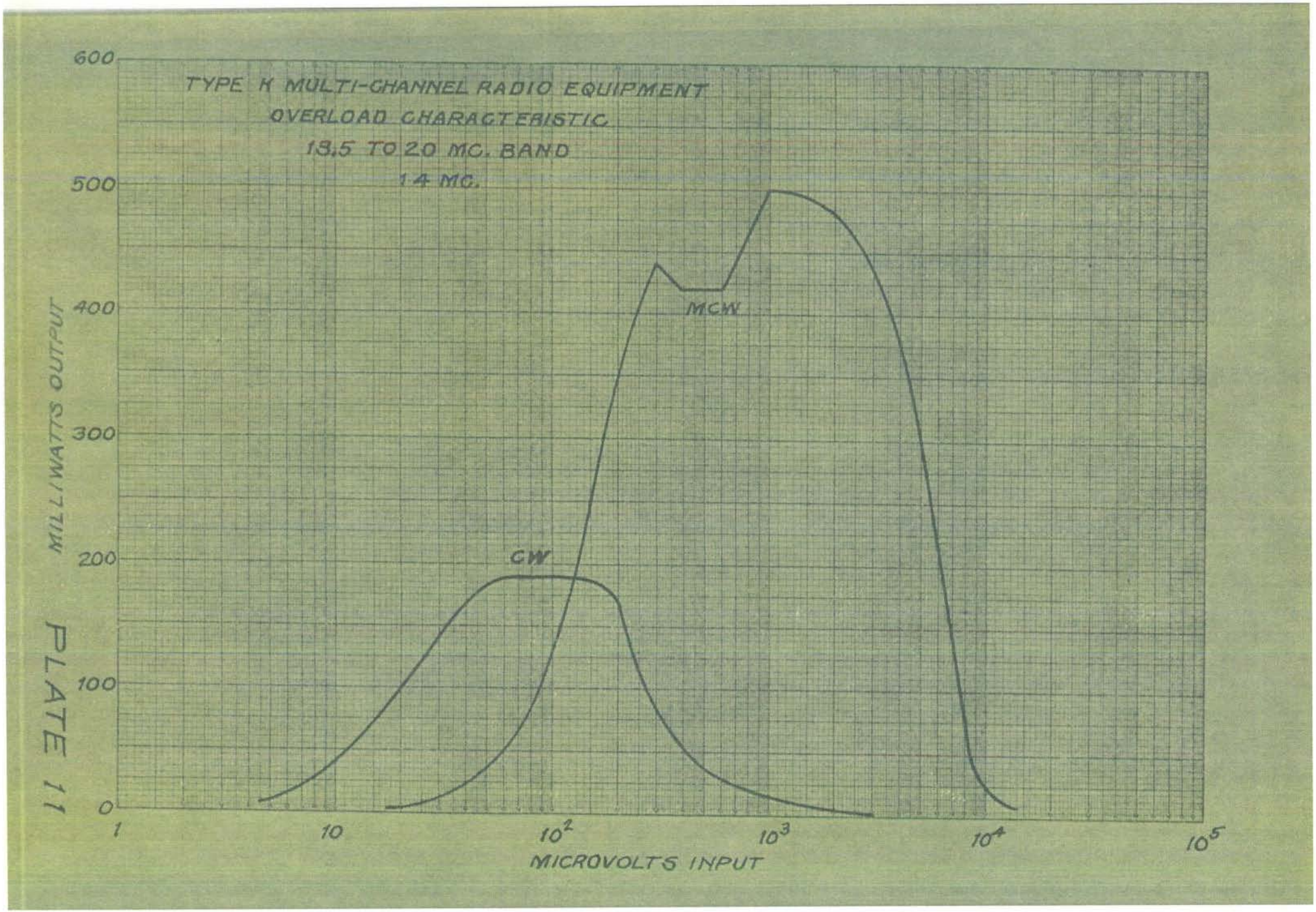

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
13.5 TO 20 MC. BAND
14 MC.
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
MCW
CW
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT

PLATE 11

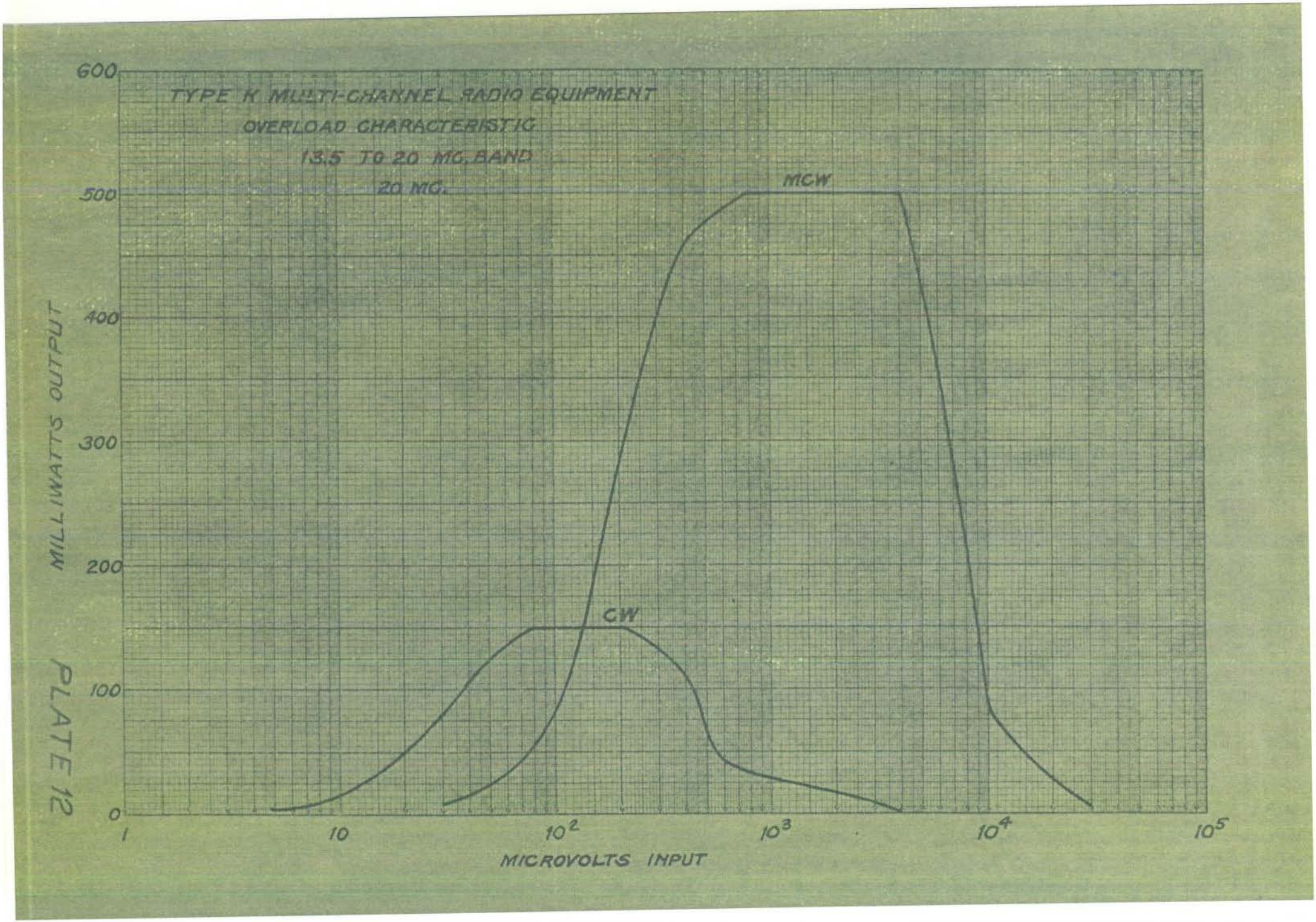

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
13.5 TO 20 MC. BAND
20 MC.
MCW
CW
600
500
400
300
200
100
0
MILLIWATTS OUTPUT
1
10
10^2
10^3
10^4
10^5
MICROVOLTS INPUT

PLATE 12

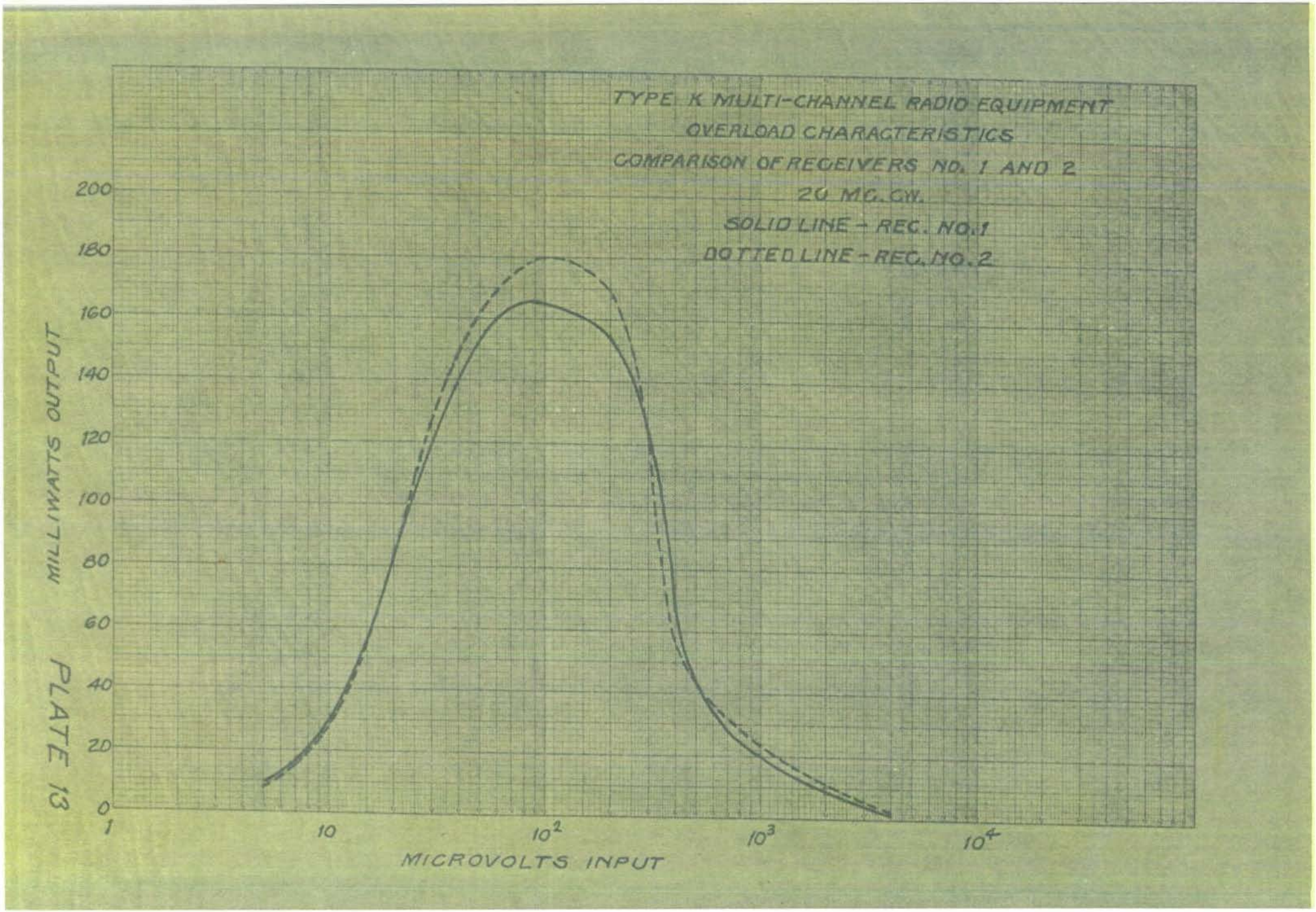

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTICS
COMPARISON OF RECEIVERS NO. 1 AND 2
20 MC. CW.
SOLID LINE - REC. NO. 1
DOTTED LINE - REC. NO. 2
MILLIWATTS OUTPUT
200
180
160
140
120
100
80
60
40
20
0
1
10
10^2
10^3
10^4
MICROVOLTS INPUT

PLATE 13

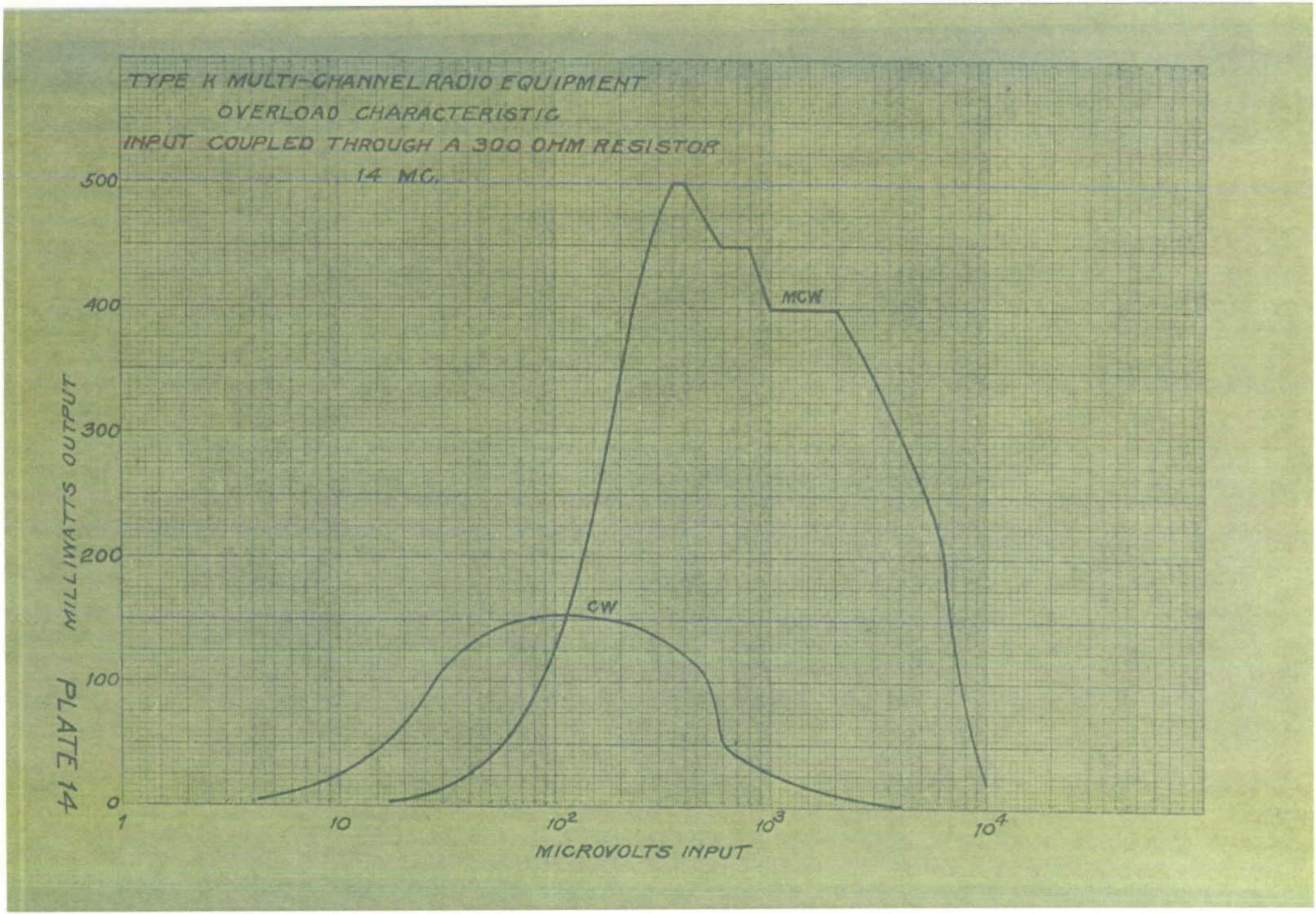
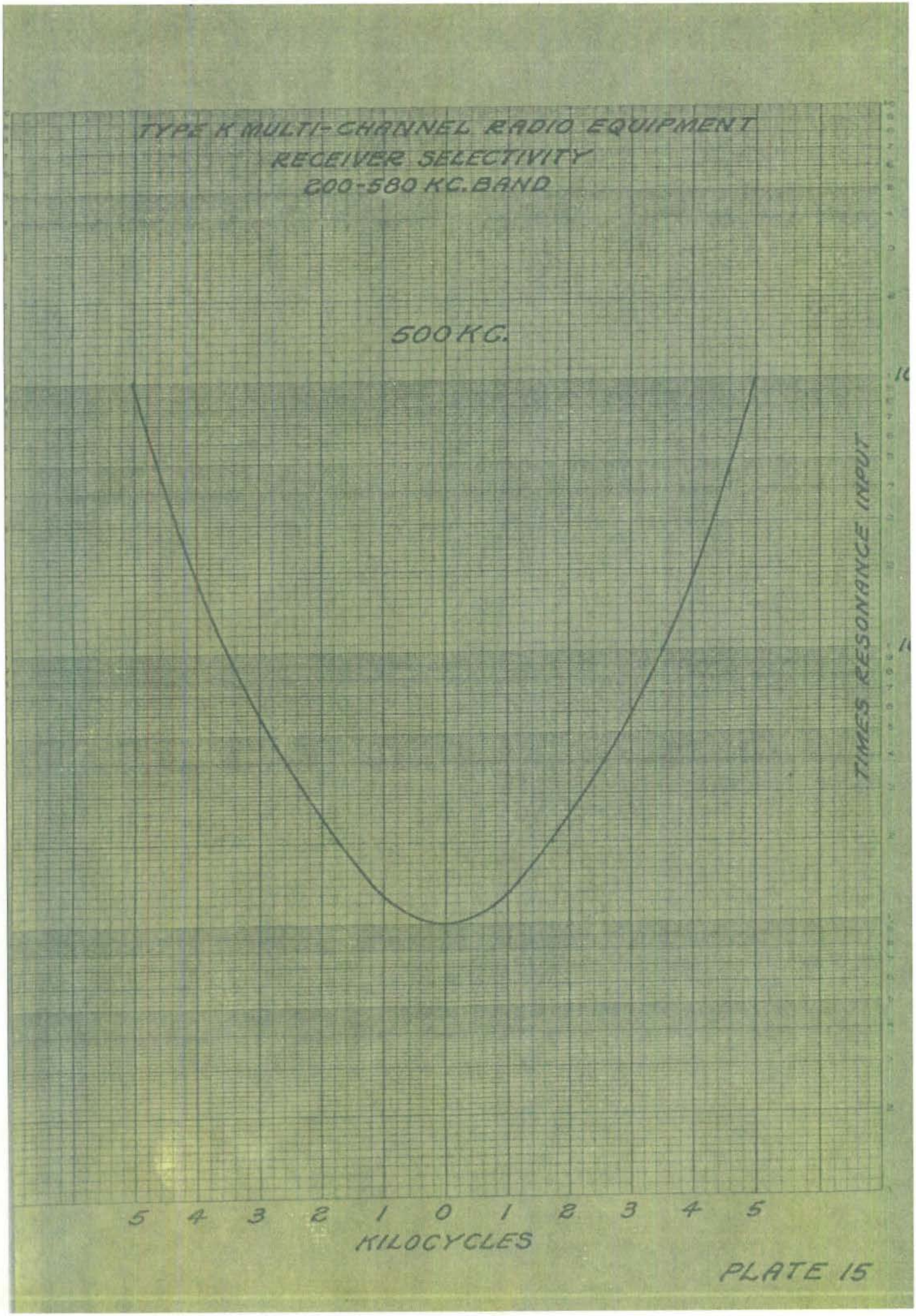

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
OVERLOAD CHARACTERISTIC
INPUT COUPLED THROUGH A 300 OHM RESISTOR
14 MC.
500
400
300
200
100
0
MILLIWATTS OUTPUT
MCW
CW
1
10
10^2
10^3
10^4
MICROVOLTS INPUT

PLATE 14


TYPE K MULTI-CHANNEL RADIO EQUIPMENT
RECEIVER SELECTIVITY
200-580 KC. BAND
500 KC.
TIMES RESONANCE INPUT
5 4 3 2 1 0 1 2 3 4 5
KILOCYCLES
PLATE 15

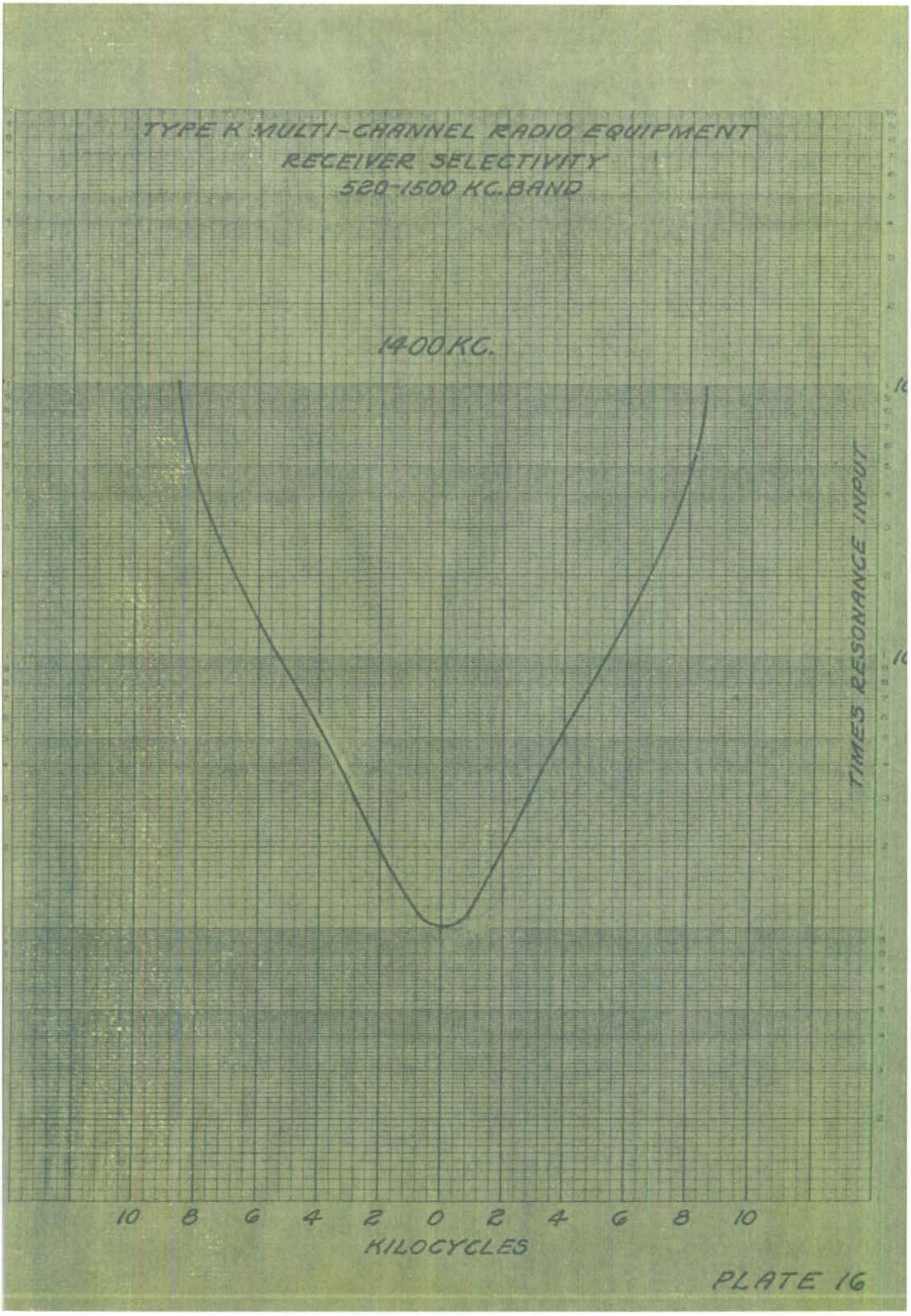

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
RECEIVER SELECTIVITY
520-1500 KC. BAND
1400 KC.
TIMES RESONANCE INPUT
10 8 6 4 2 0 2 4 6 8 10
KILOCYCLES

PLATE 16

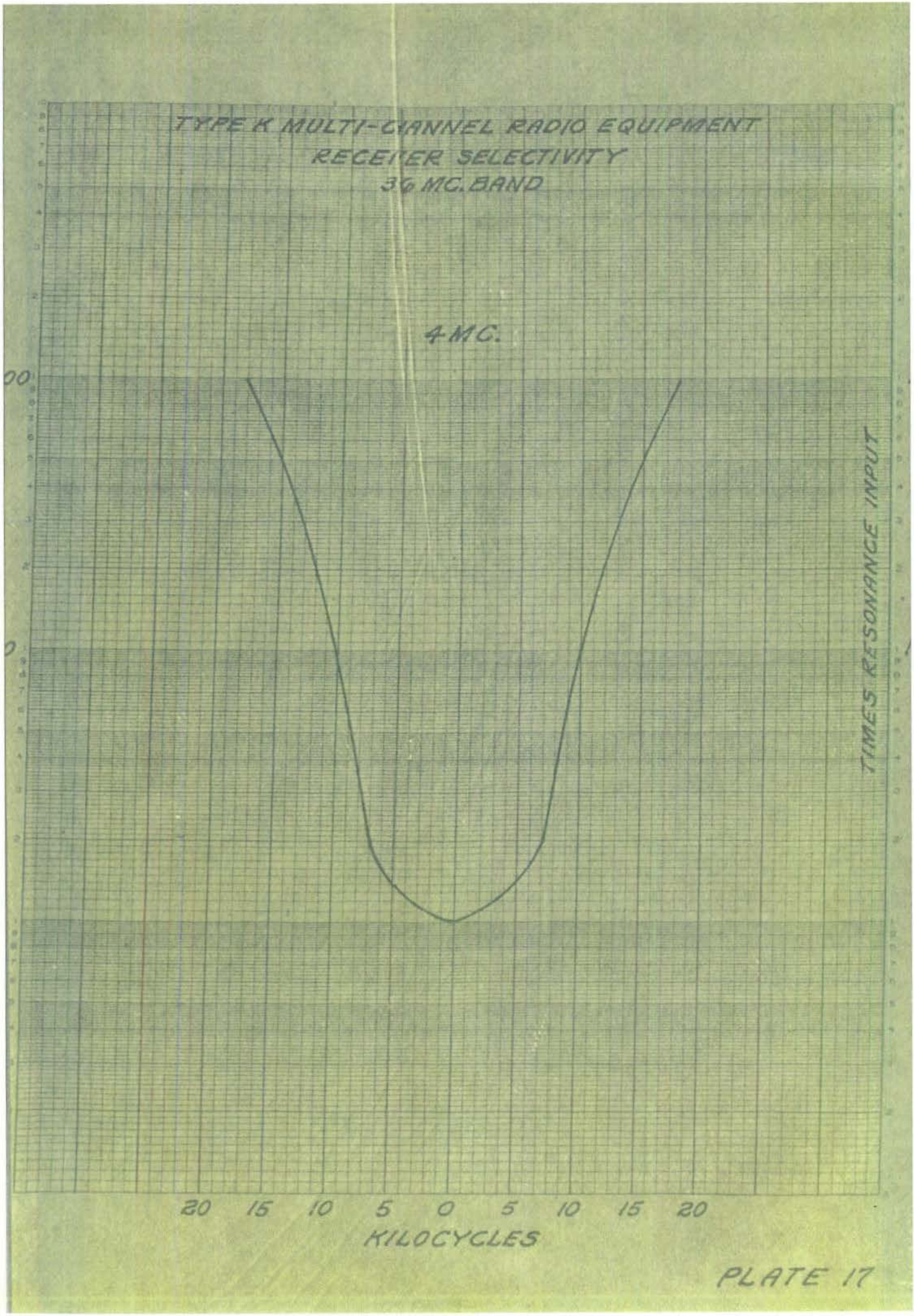

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
RECEIVER SELECTIVITY
36 MC. BAND
4 MC.
TIMES RESONANCE INPUT
20 15 10 5 0 5 10 15 20
KILOCYCLES

PLATE 17

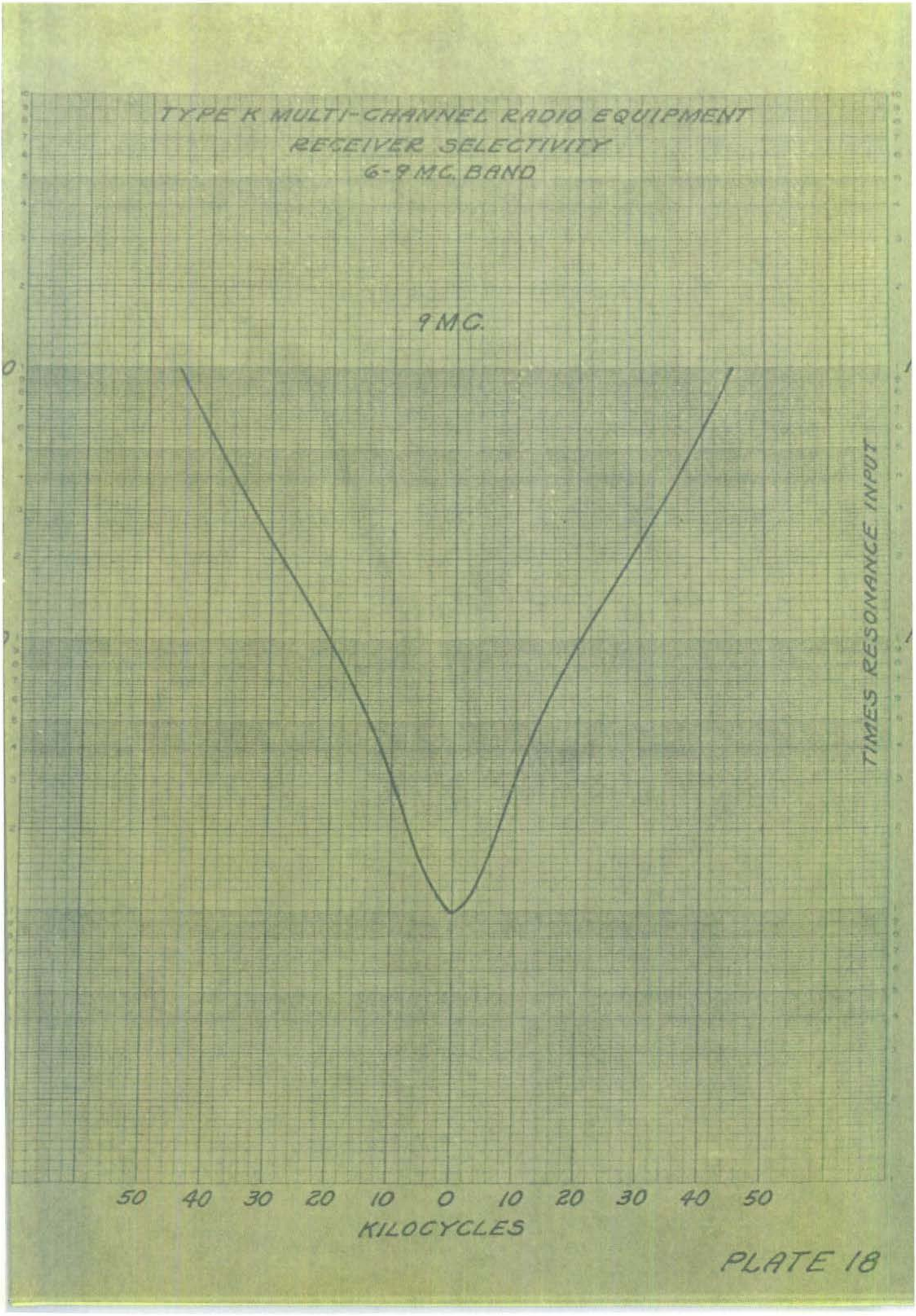
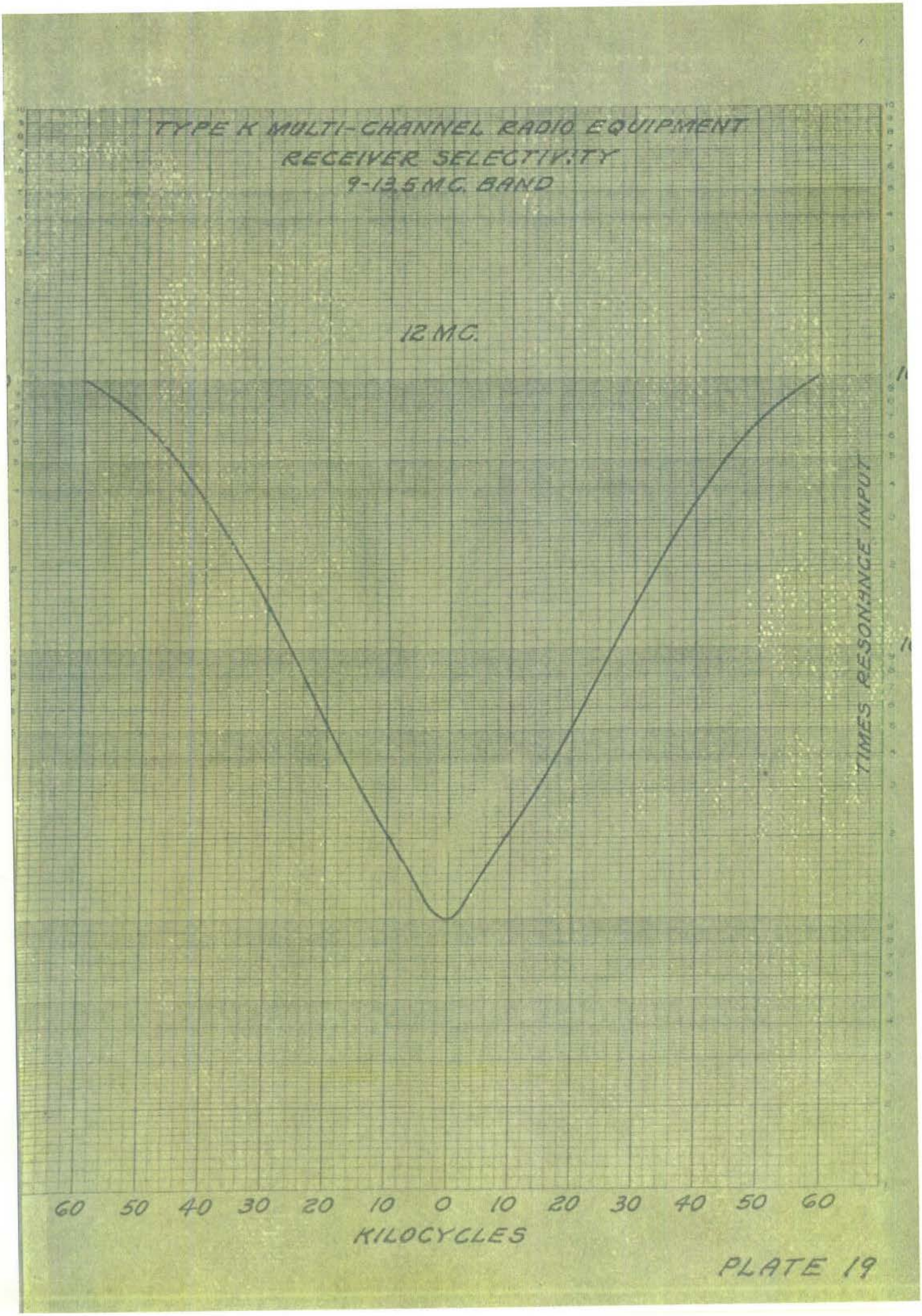
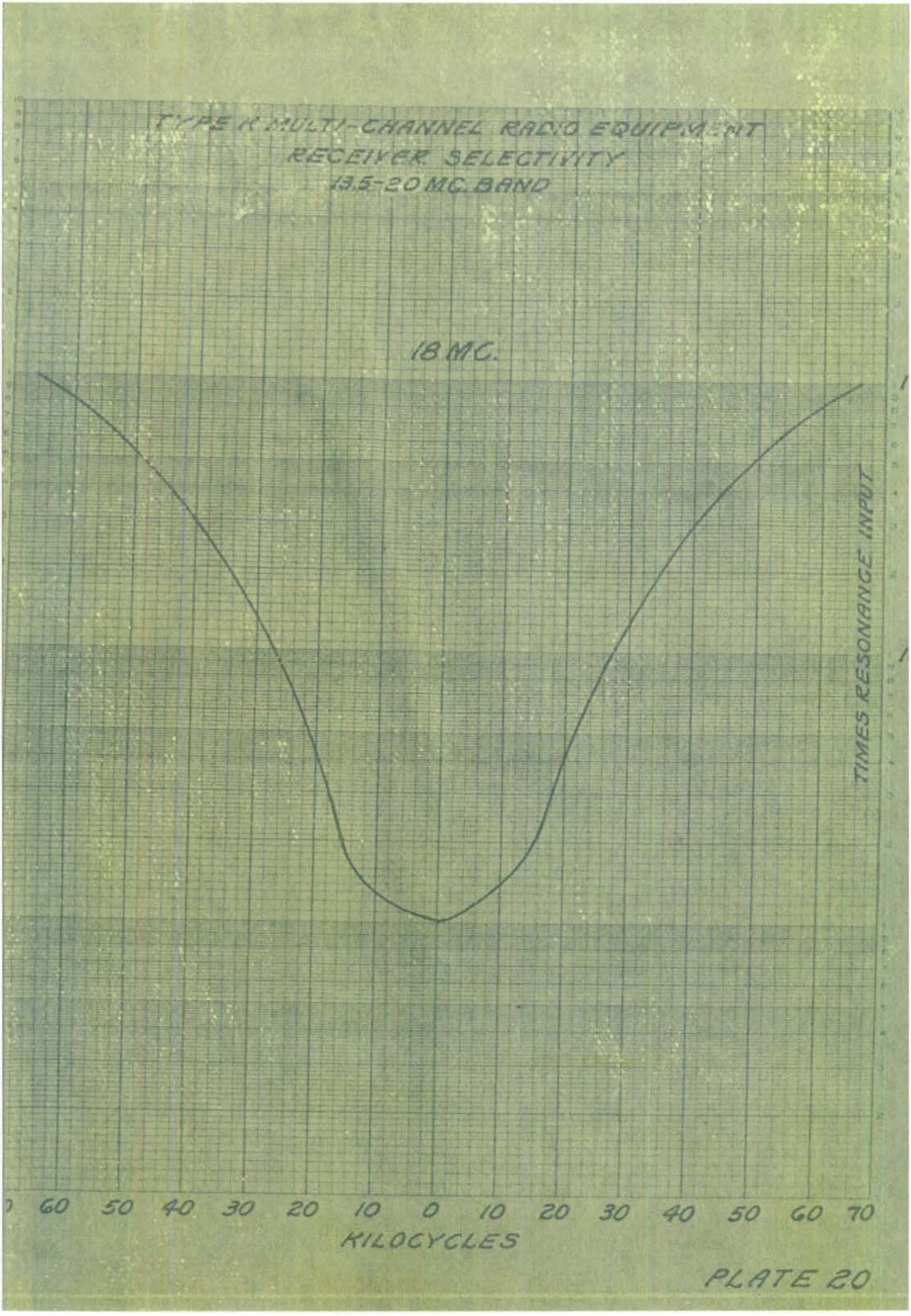

TYPE K MULTI-CHANNEL RADIO EQUIPMENT
RECEIVER SELECTIVITY
6-9 M.C. BAND
9 M.C.
TIMES RESONANCE INPUT
50 40 30 20 10 0 10 20 30 40 50
KILOCYCLES

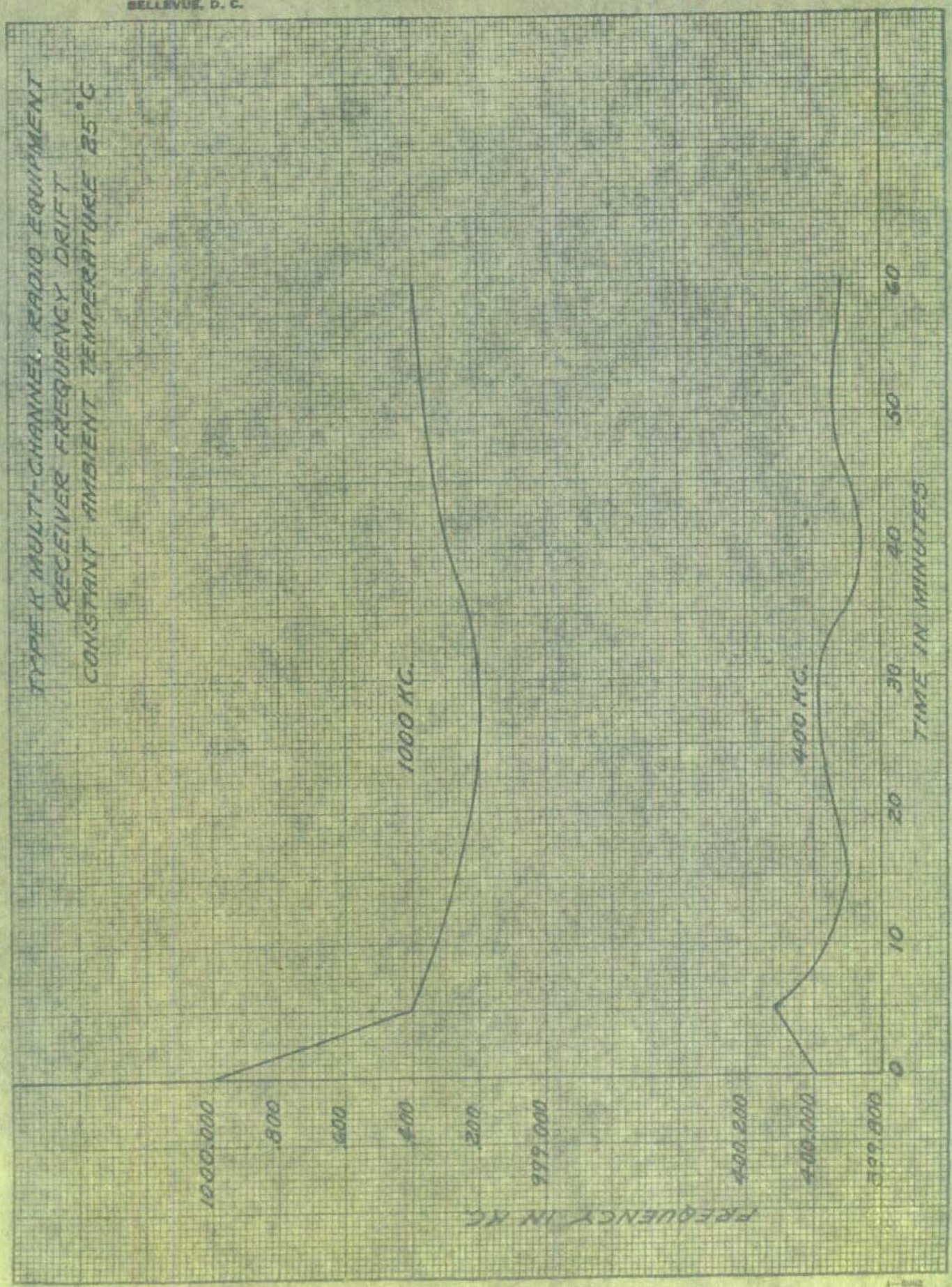
PLATE 18


TYPE K MULTI-CHANNEL RADIO EQUIPMENT
RECEIVER SELECTIVITY
9-13.5 M.C. BAND
12 M.C.
TIMES RESONANCE INPUT
60 50 40 30 20 10 0 10 20 30 40 50 60
KILOCYCLES
PLATE 19


TYPE K MULTI-CHANNEL RADIO EQUIPMENT
RECEIVER SELECTIVITY
13.5-20 MC. BAND
18 MC.
TIMES RESONANCE INPUT
60 50 40 30 20 10 0 10 20 30 40 50 60 70
KILOCYCLES
PLATE 20

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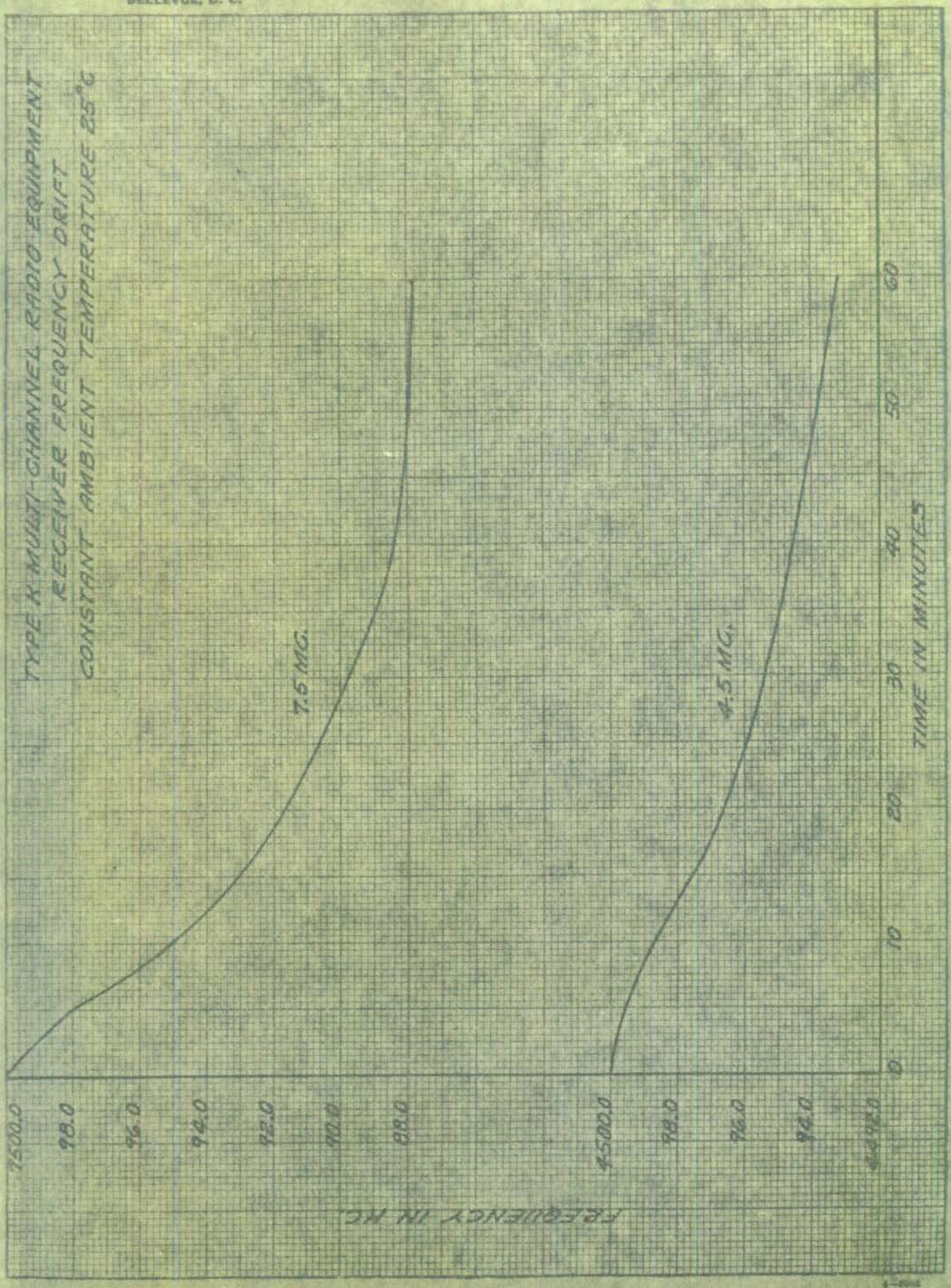


SHEET

PLATE 21

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BELLEVUE, D. C.

DATE

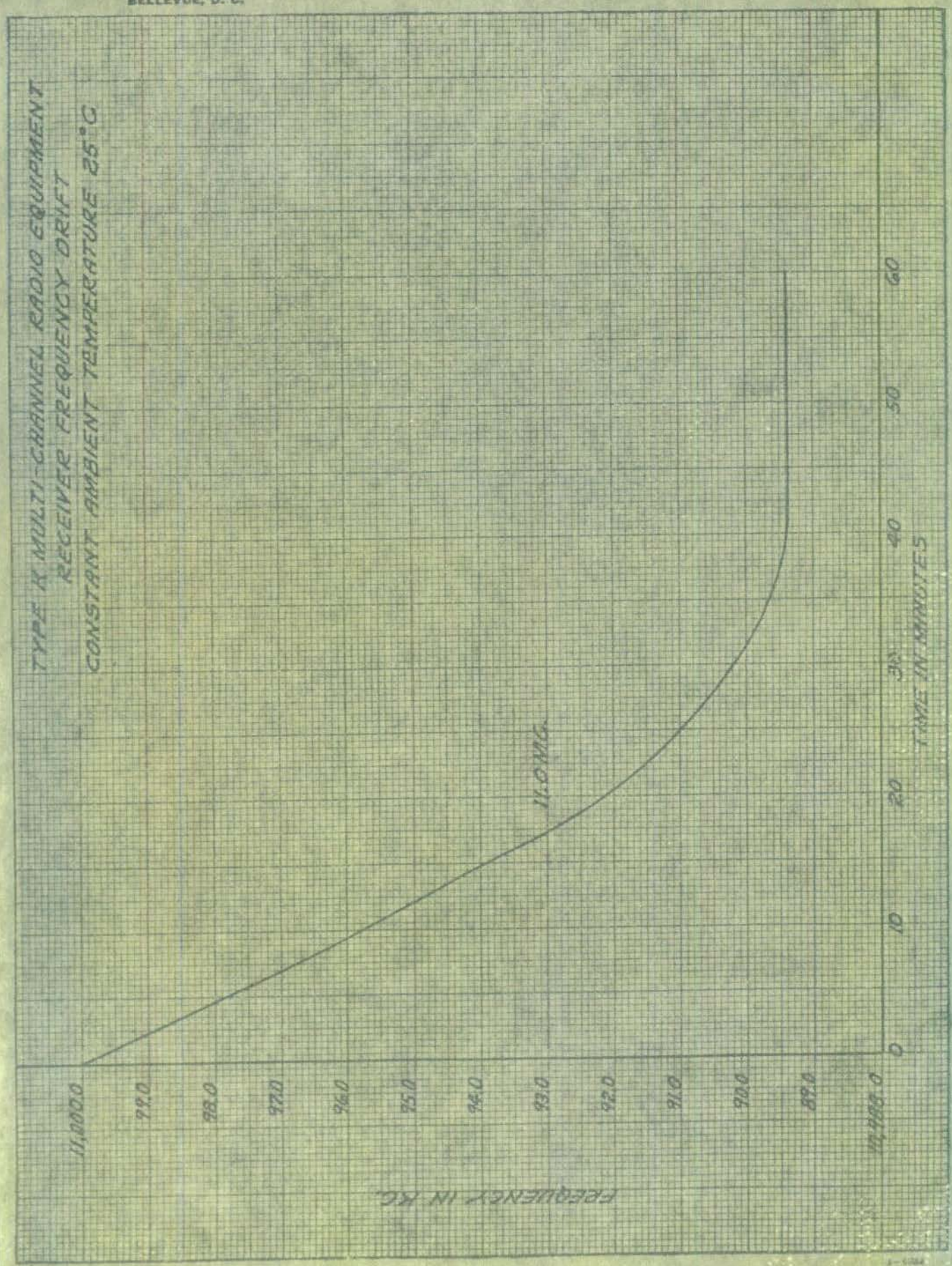


SHEET

PLATE 22

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BELLEVUE, D. C.

DATE

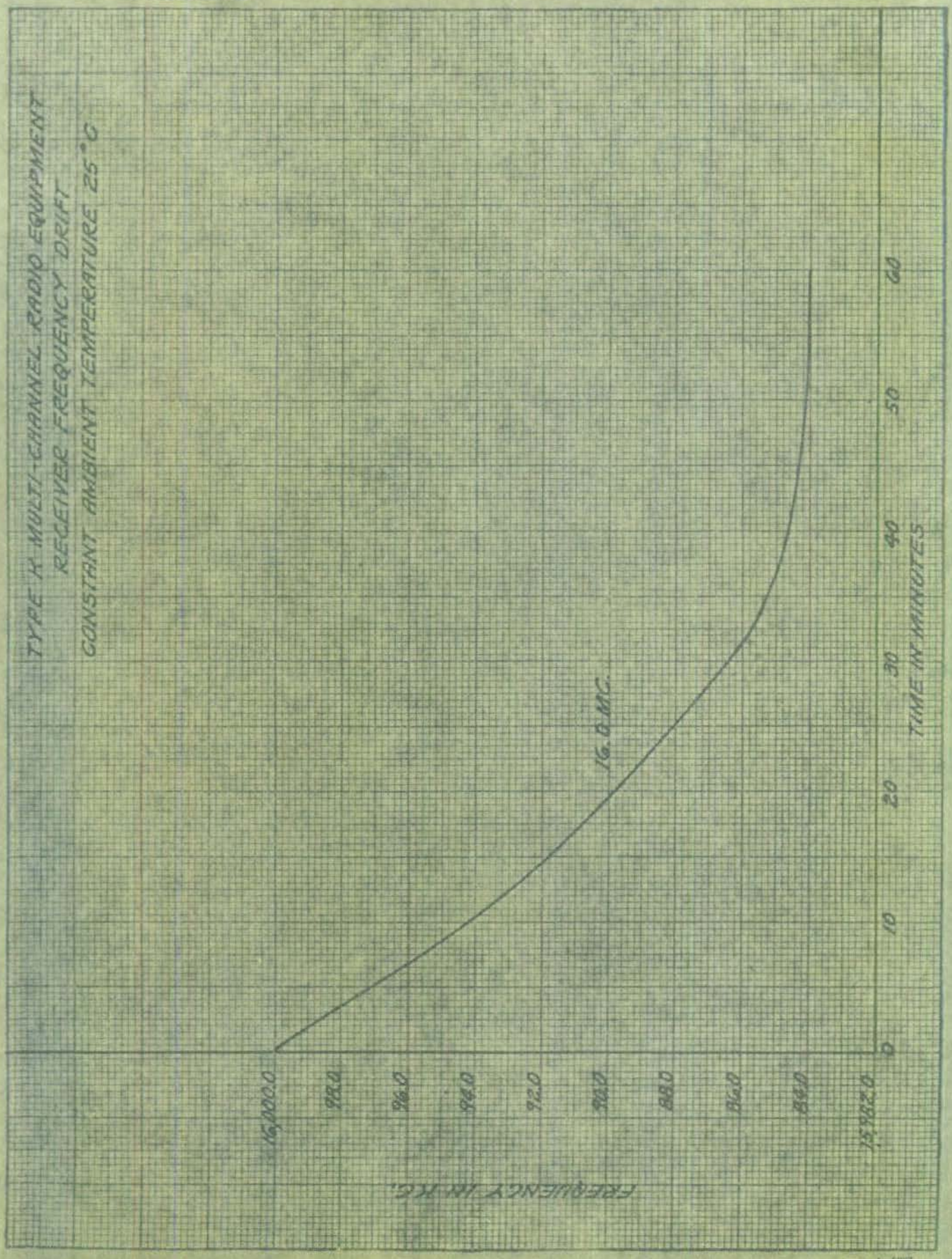


SHEET

PLATE 23

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

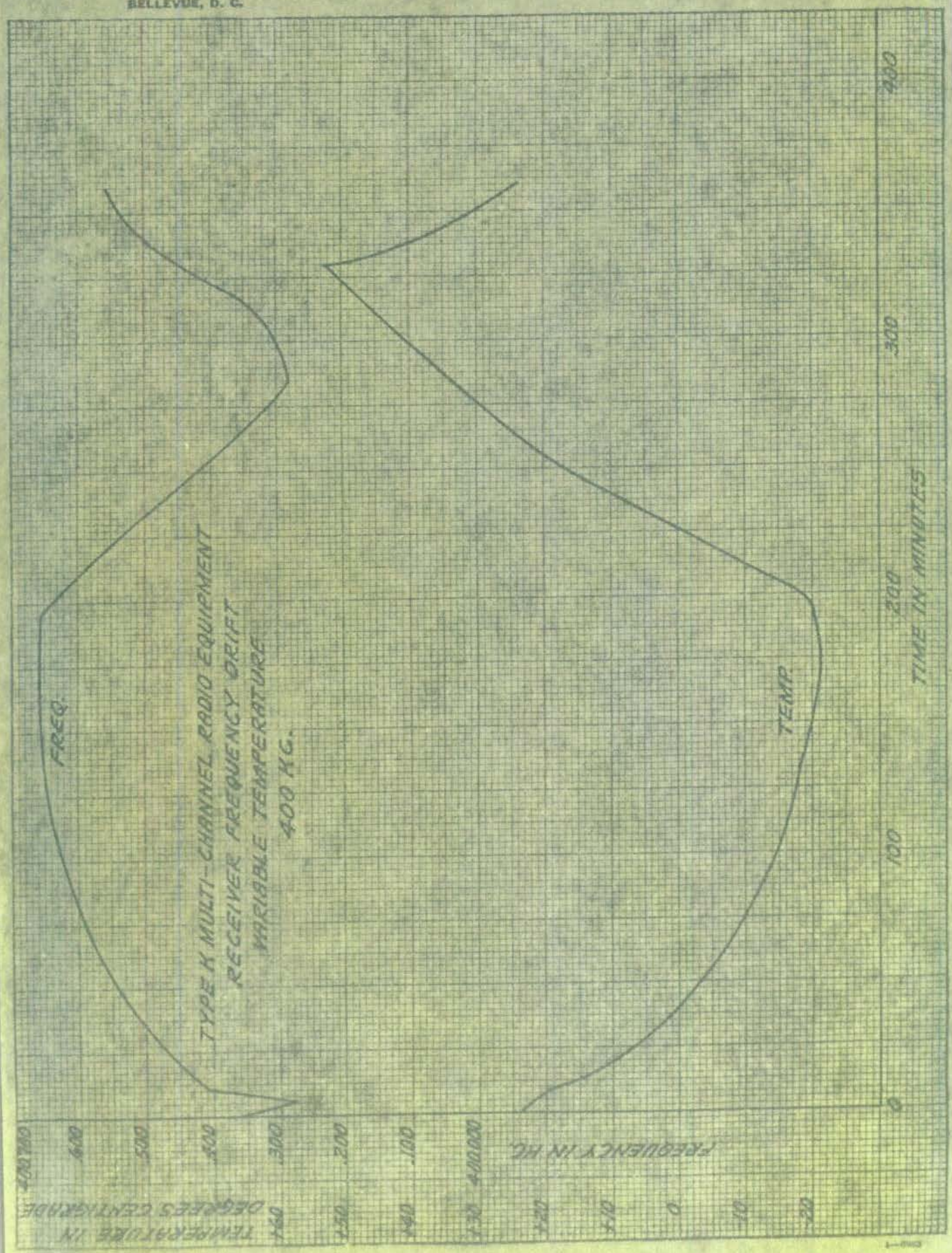


SHEET

PLATE 24

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DATE

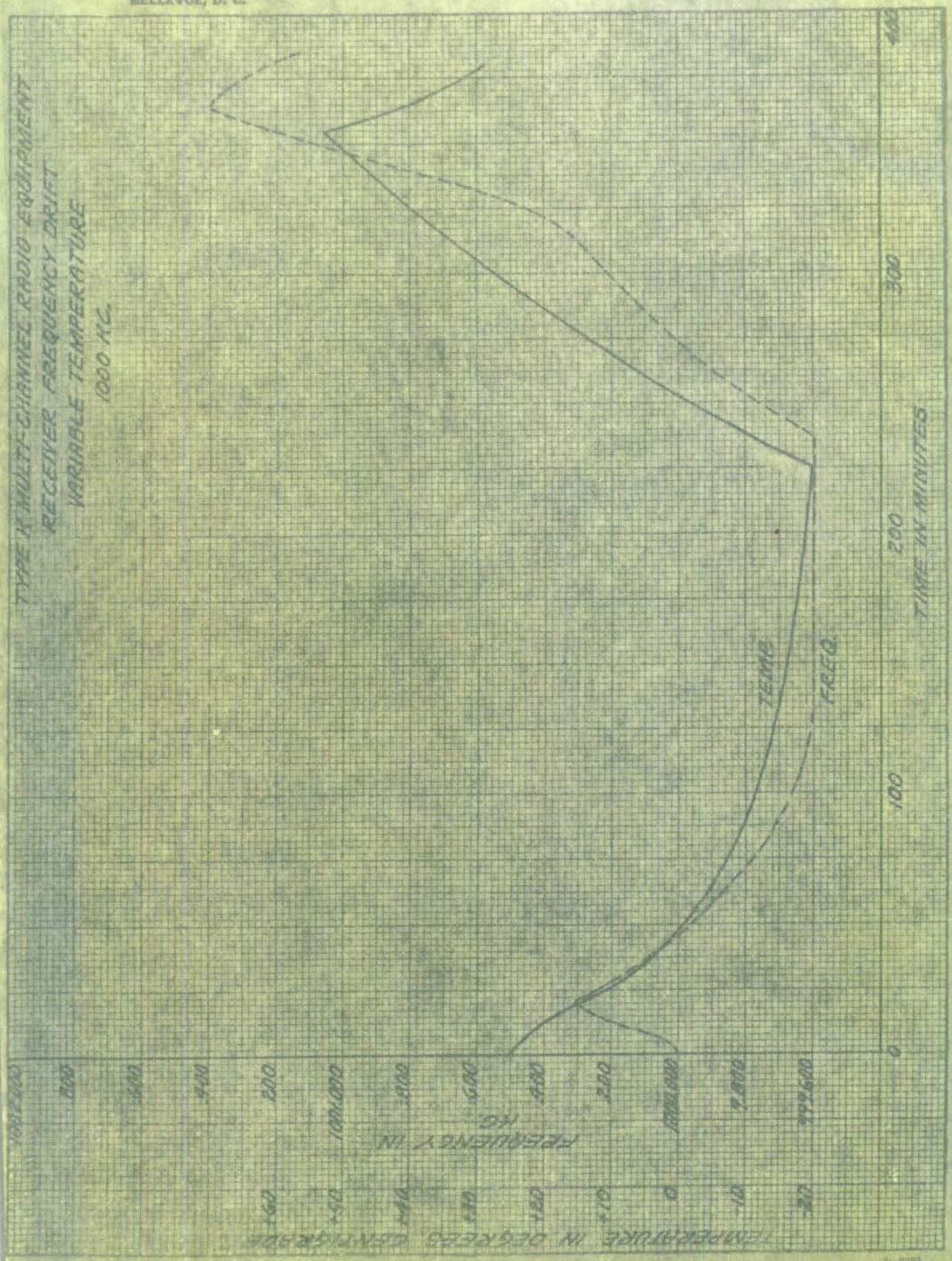


SHEET

PLATE 25

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DATE

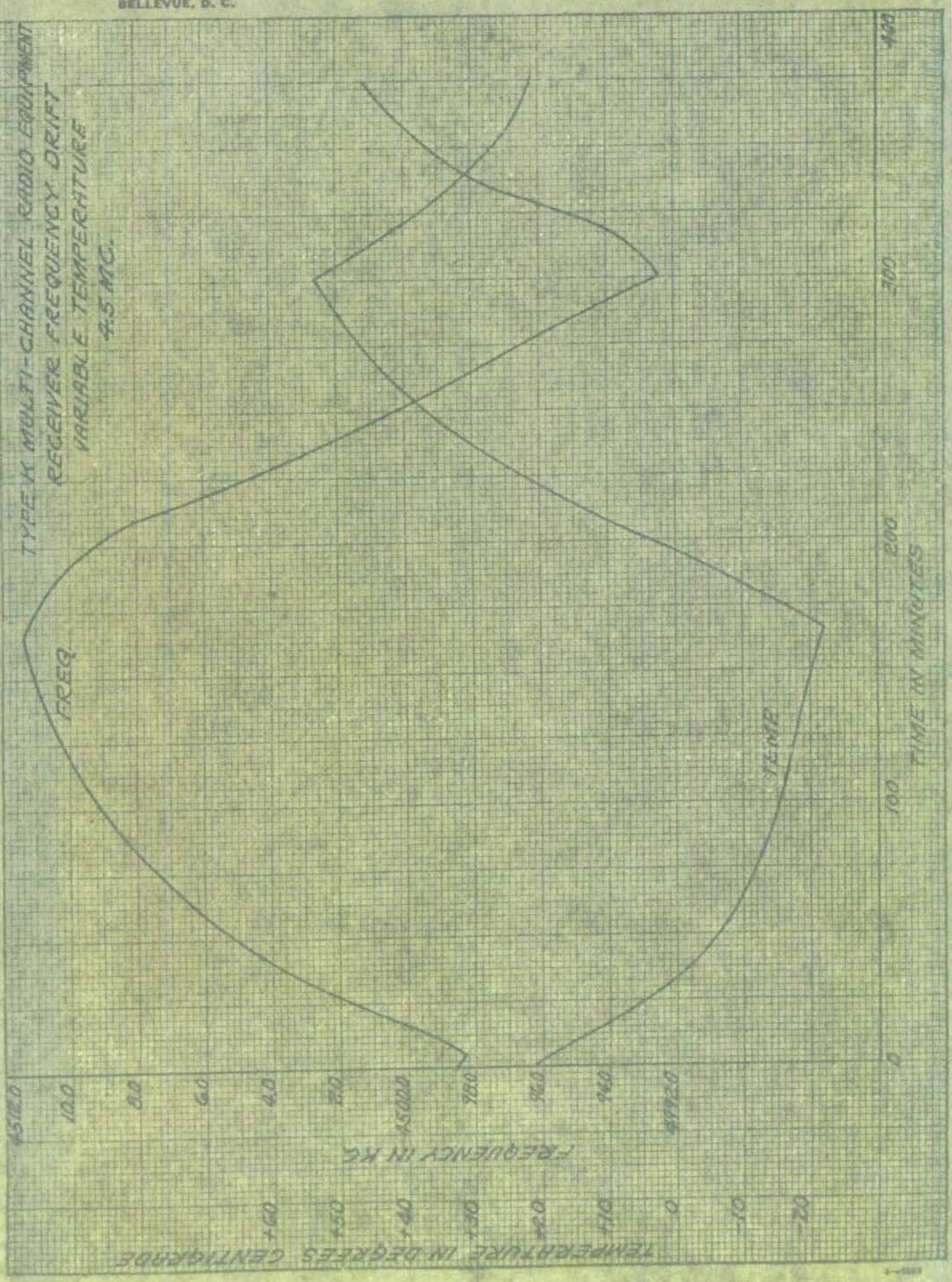


SHEET

PLATE 26

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BELLEVUE, D. C.

DATE



SHEET

PLATE 27

U. S. NAVAL RESEARCH LABORATORY
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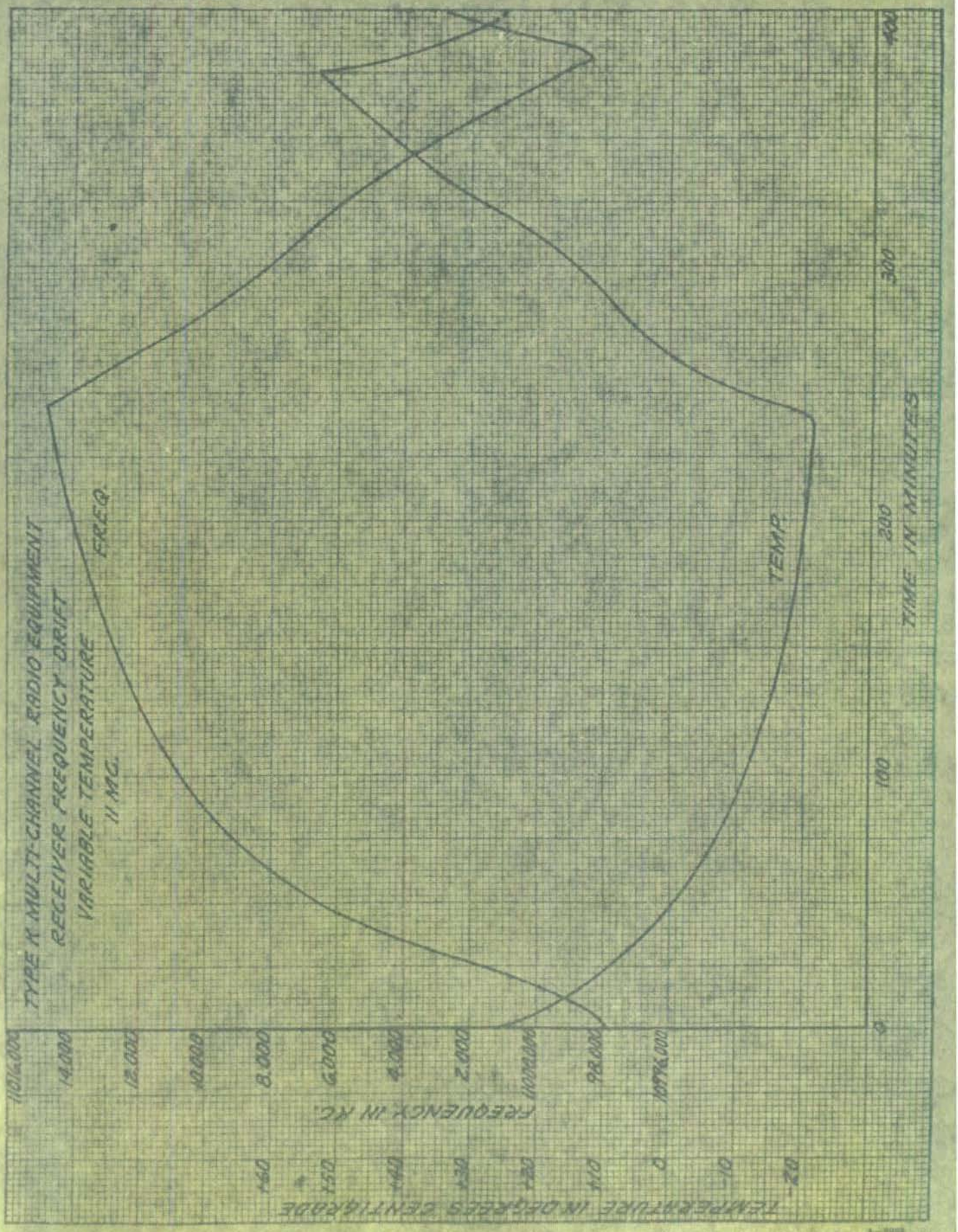
DATE

SHEET

PLATE 28

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DATE



SHEET

PLATE 29

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

SHEET

PLATE 30

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

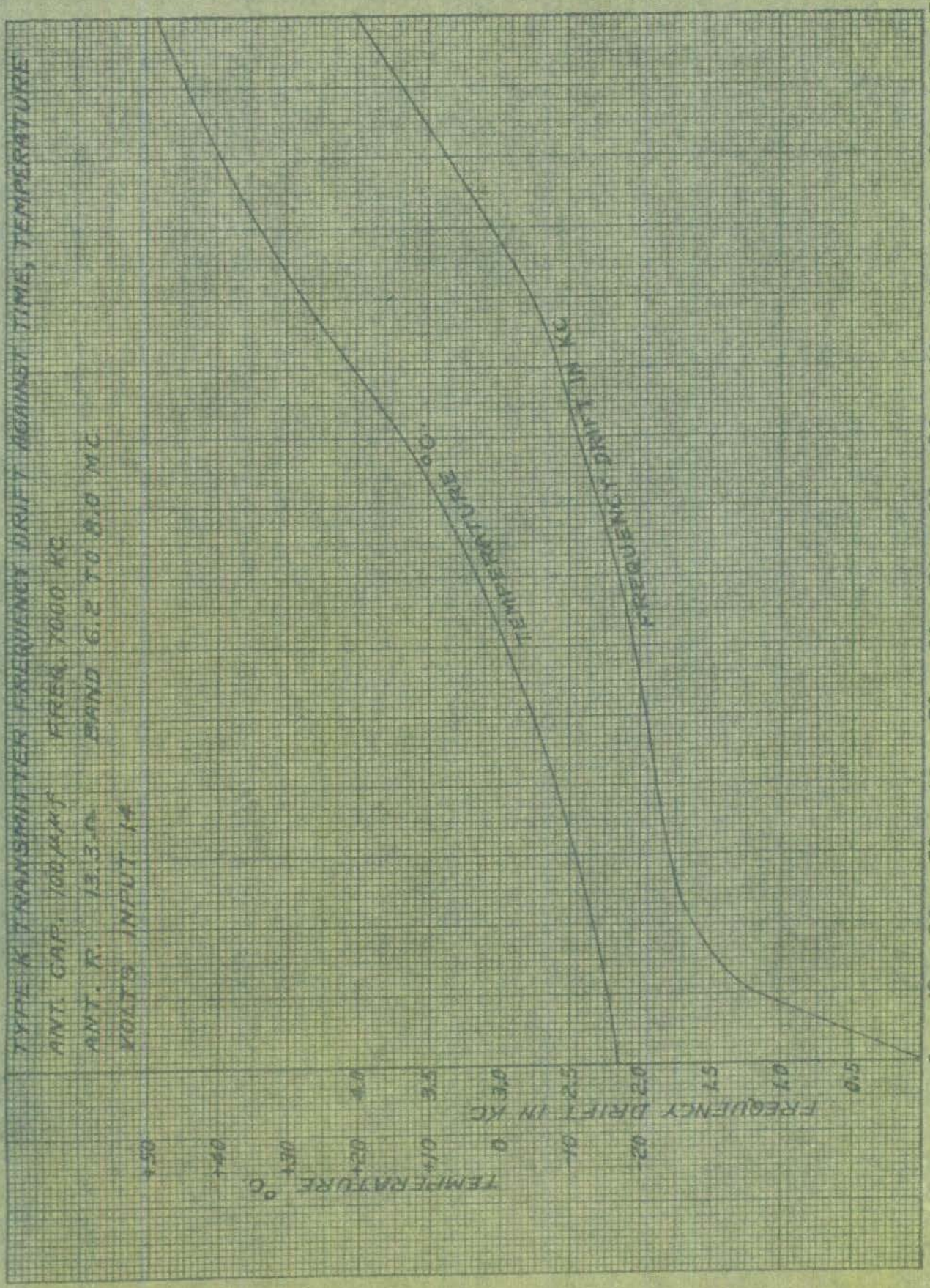


PLATE 31

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

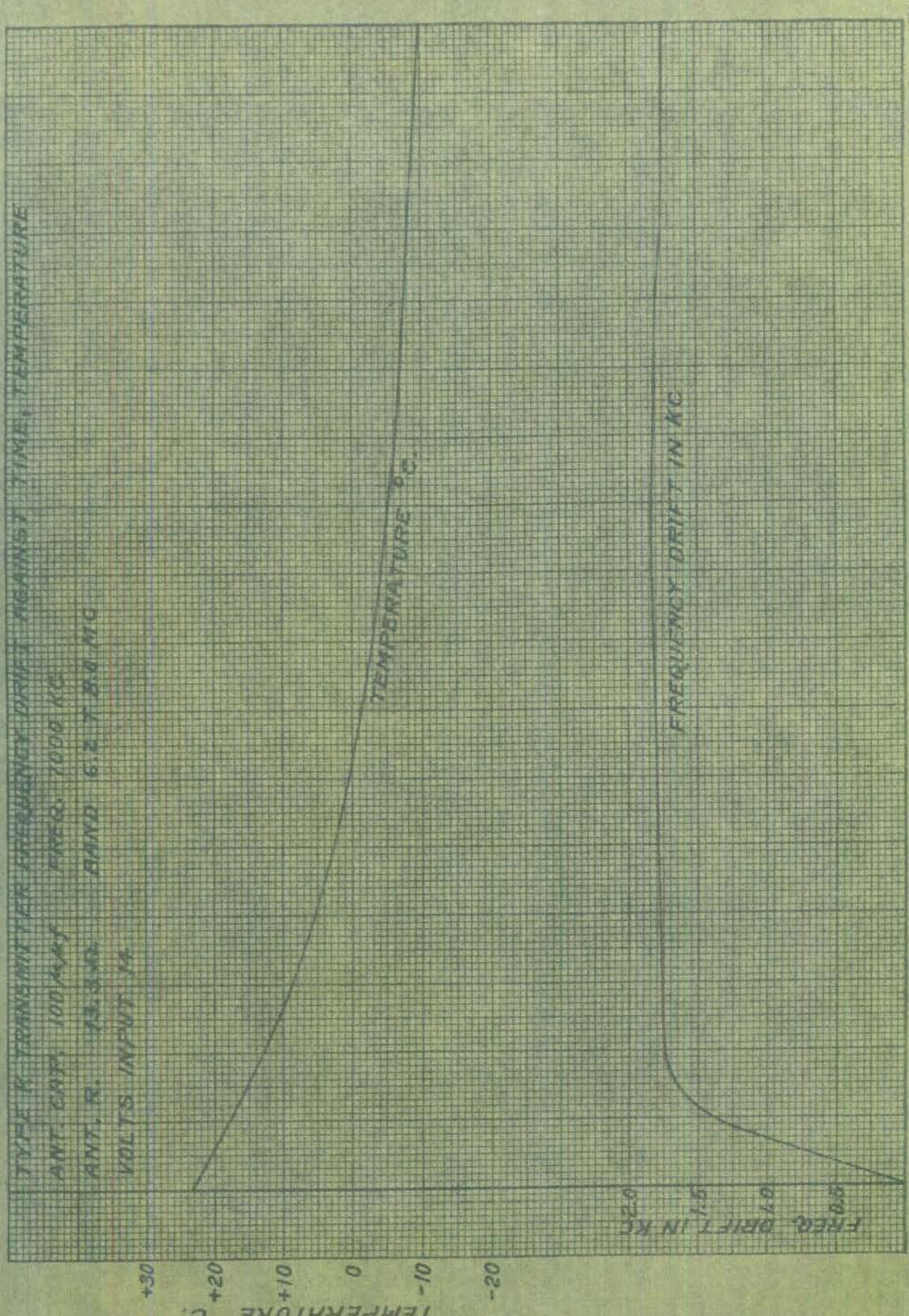


PLATE 32

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

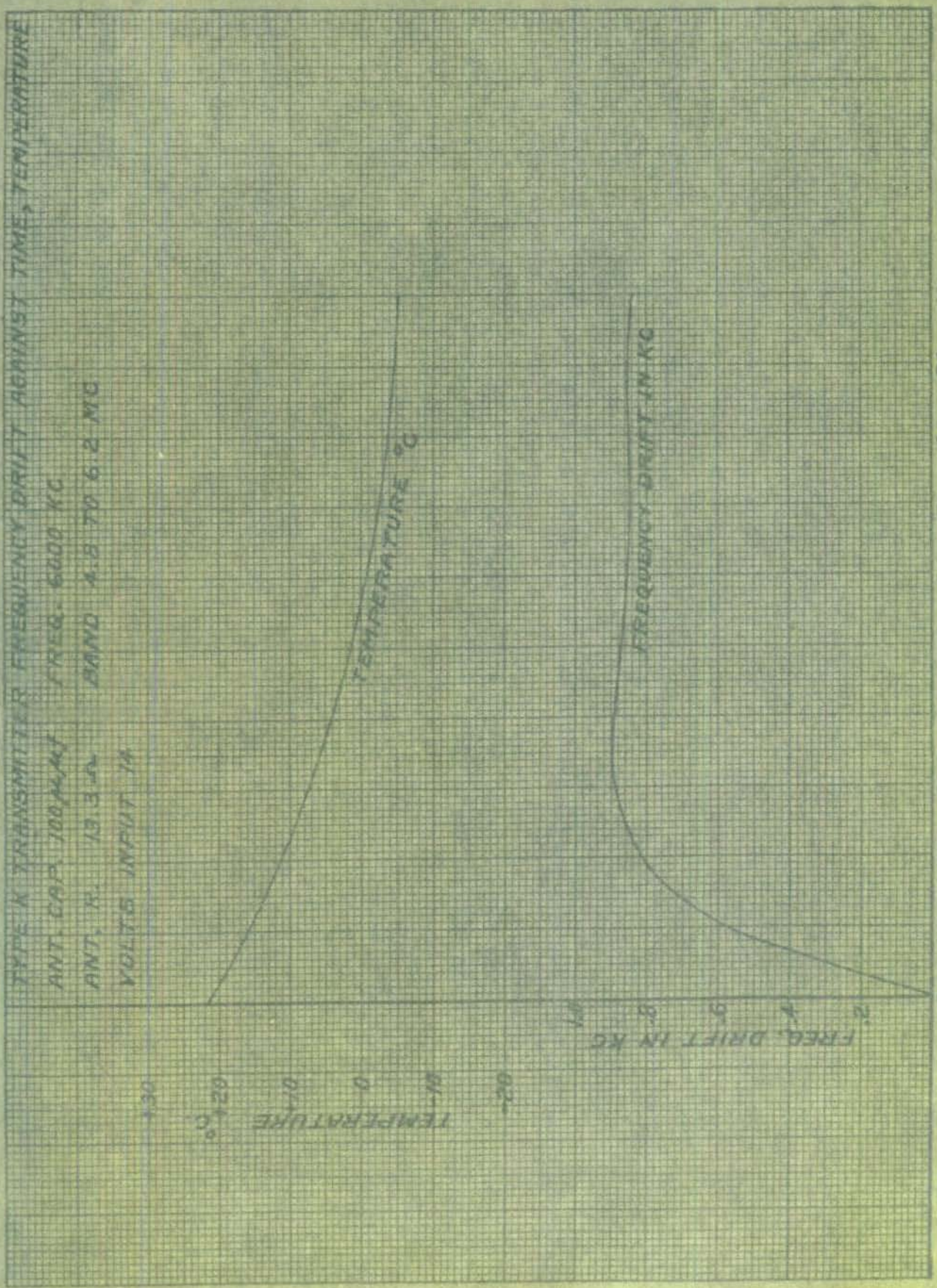


PLATE 33

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

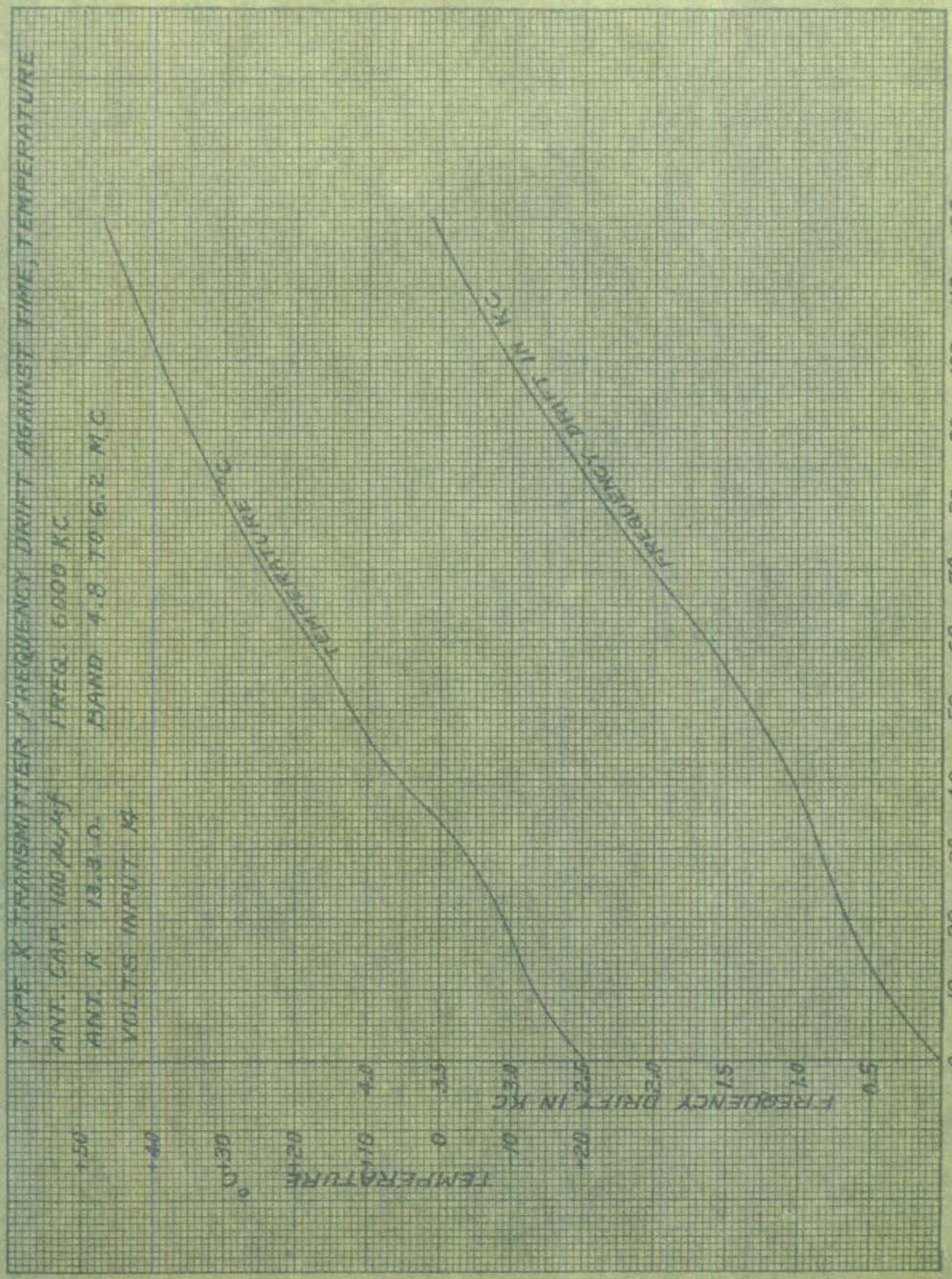


PLATE 34

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

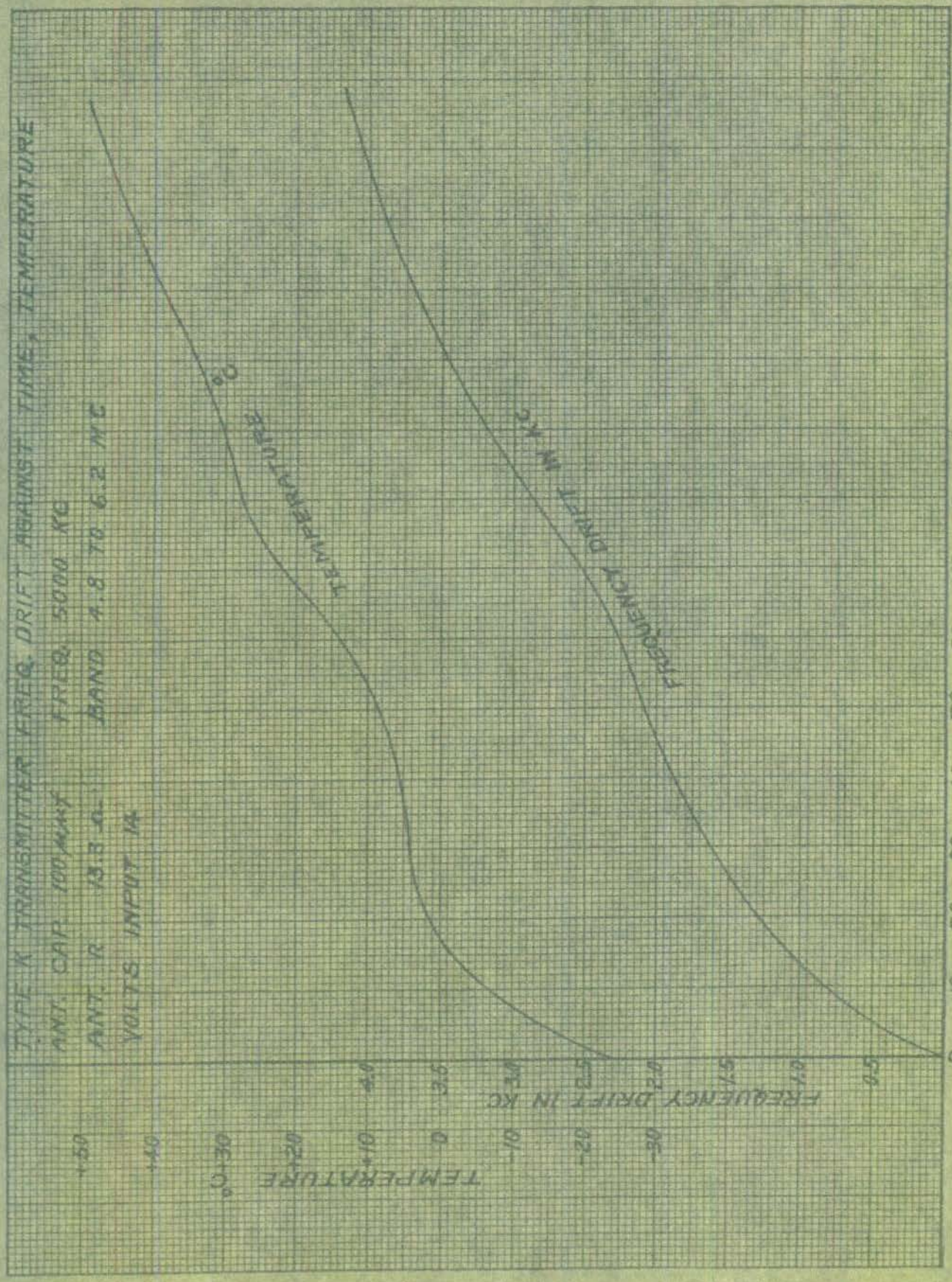


PLATE 35

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

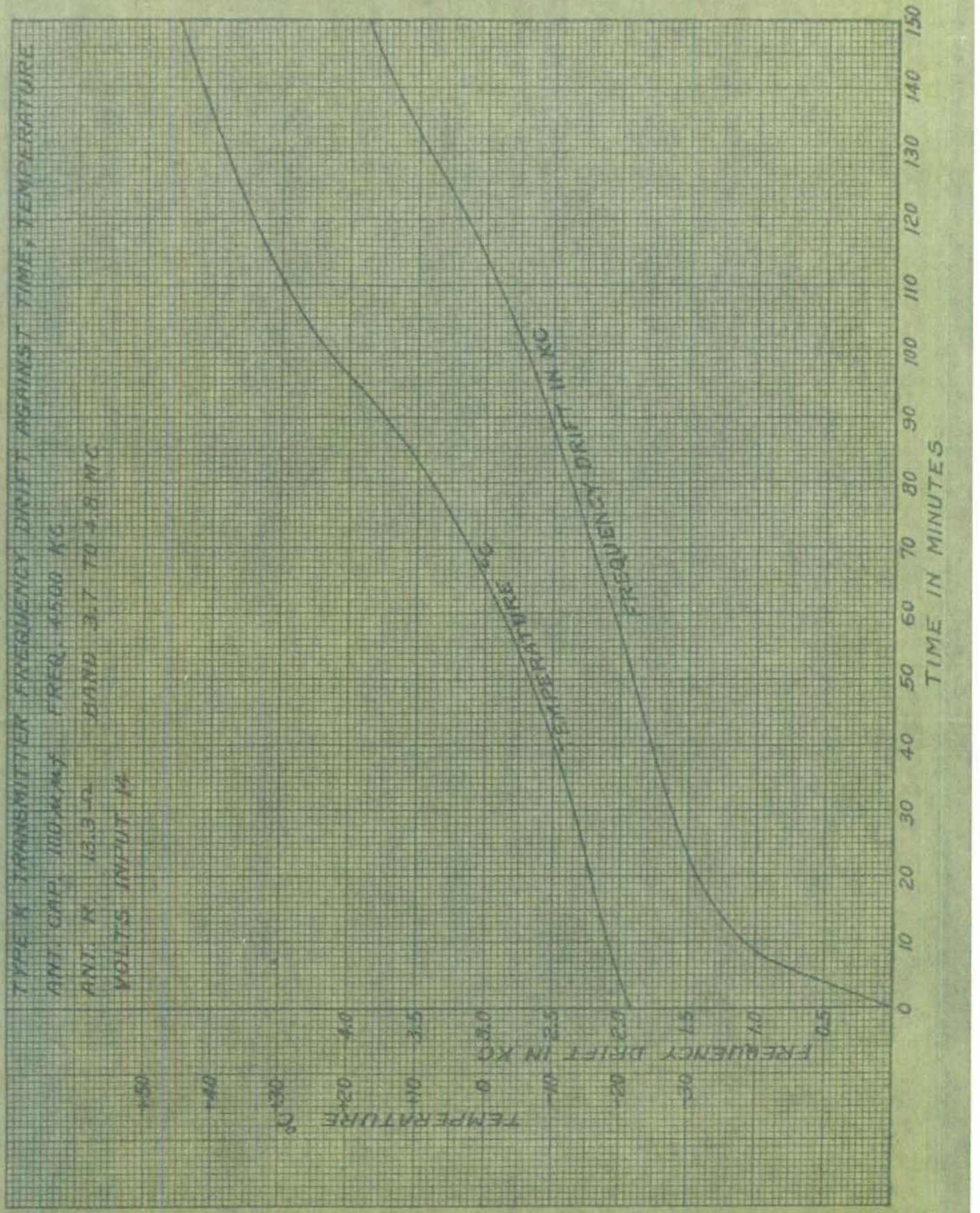


PLATE 36

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

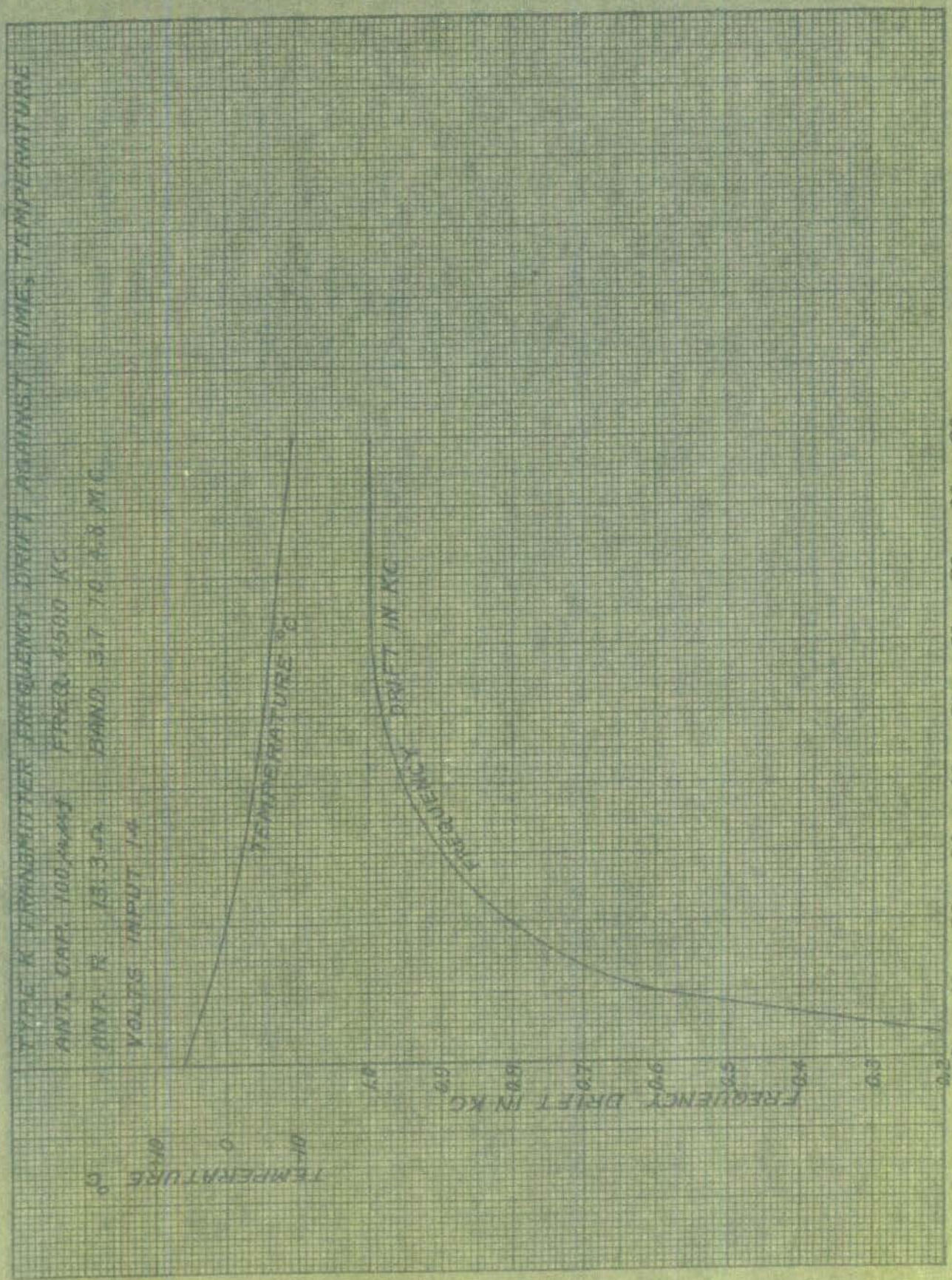


PLATE 37

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

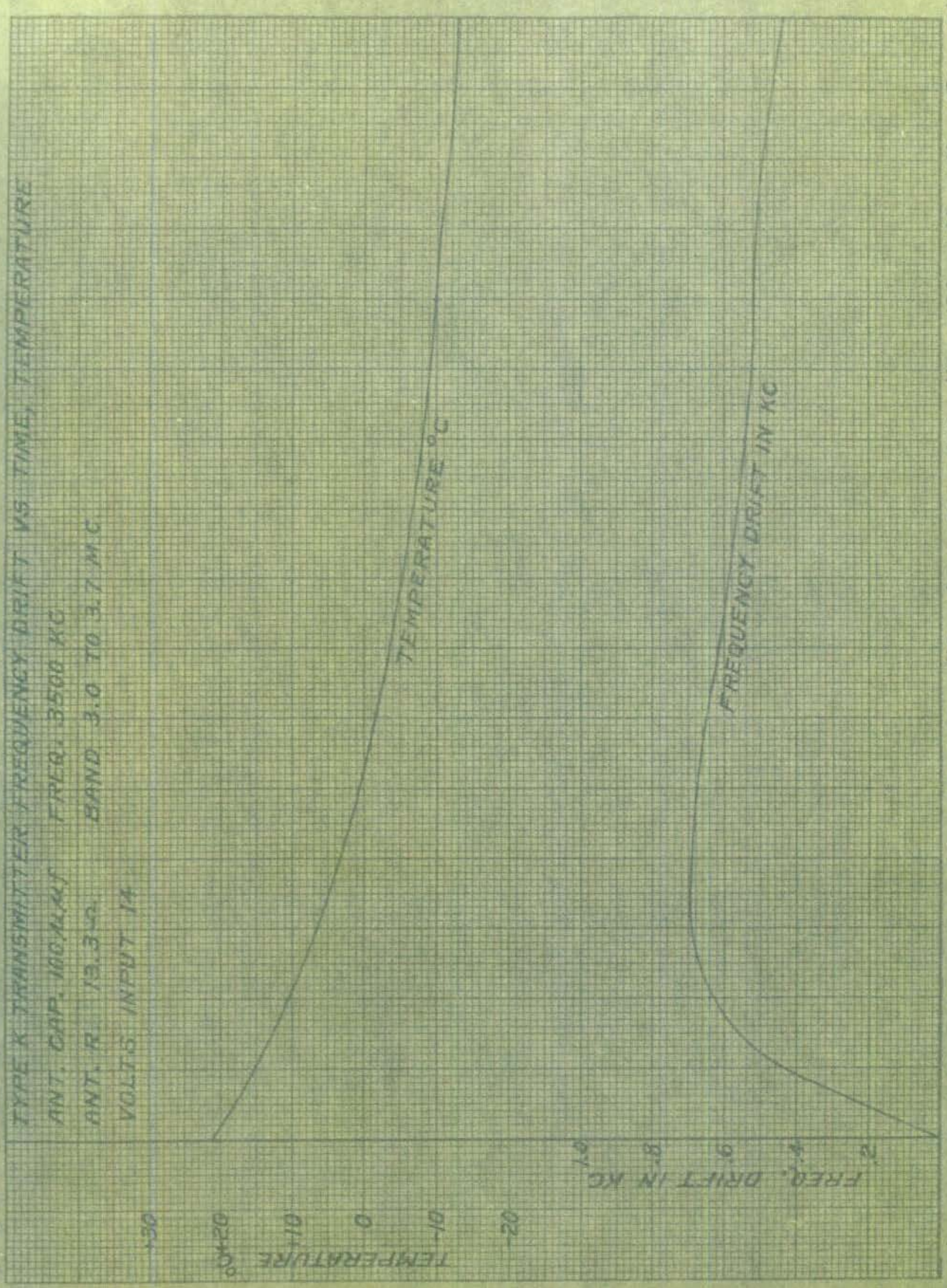
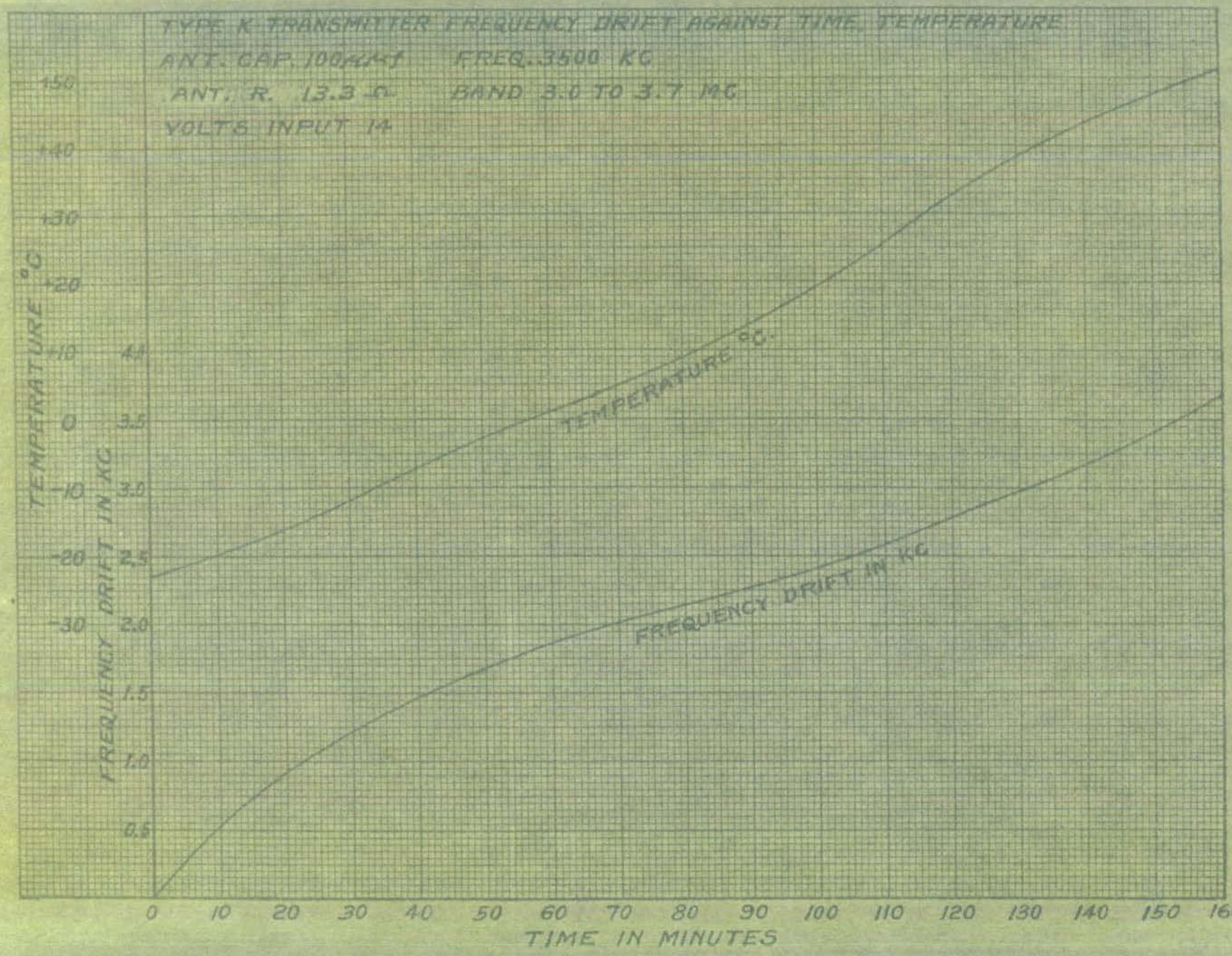


PLATE 38



U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D.C.

DATE

PLATE 39

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D.C.

DATE

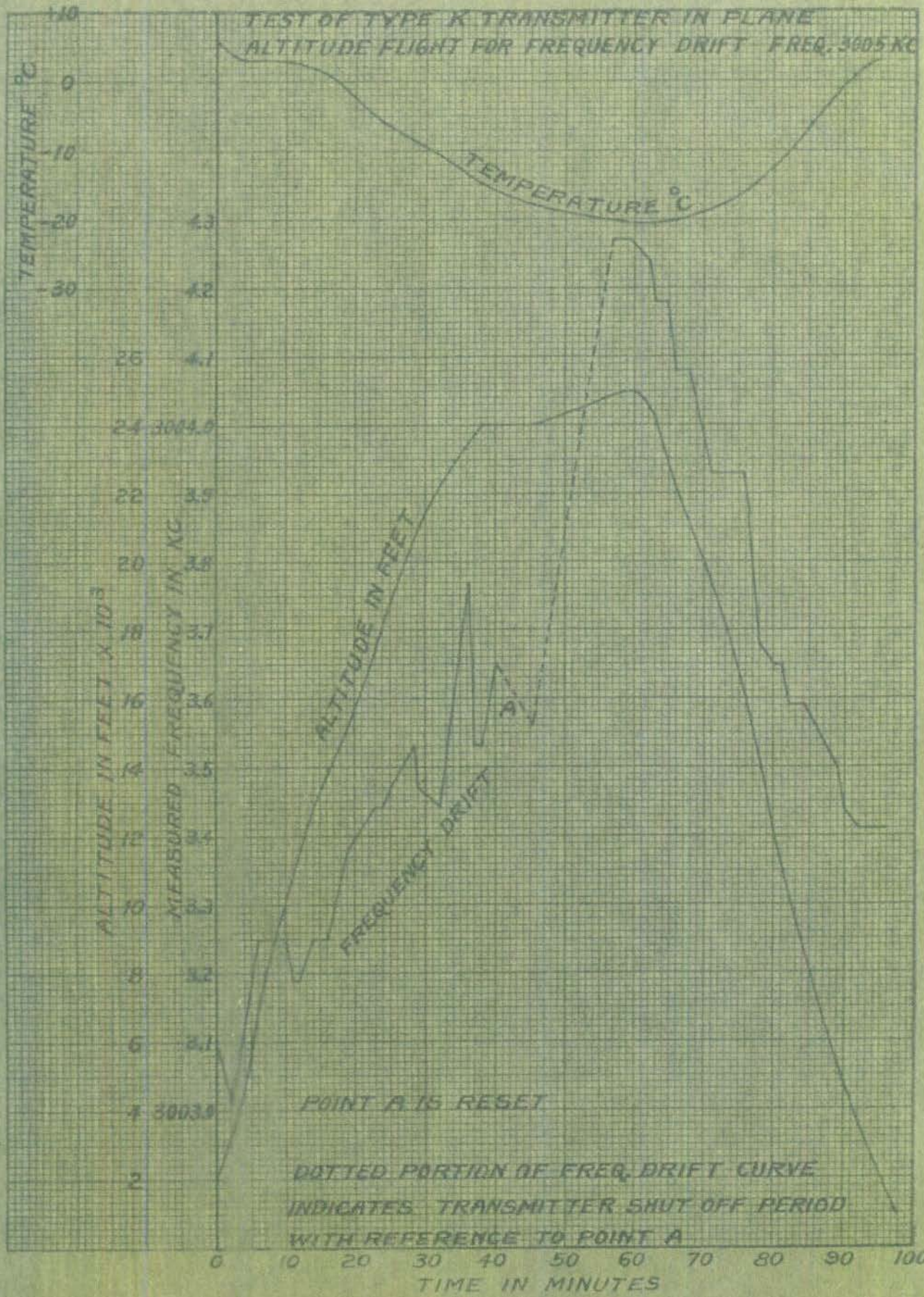


PLATE 40

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

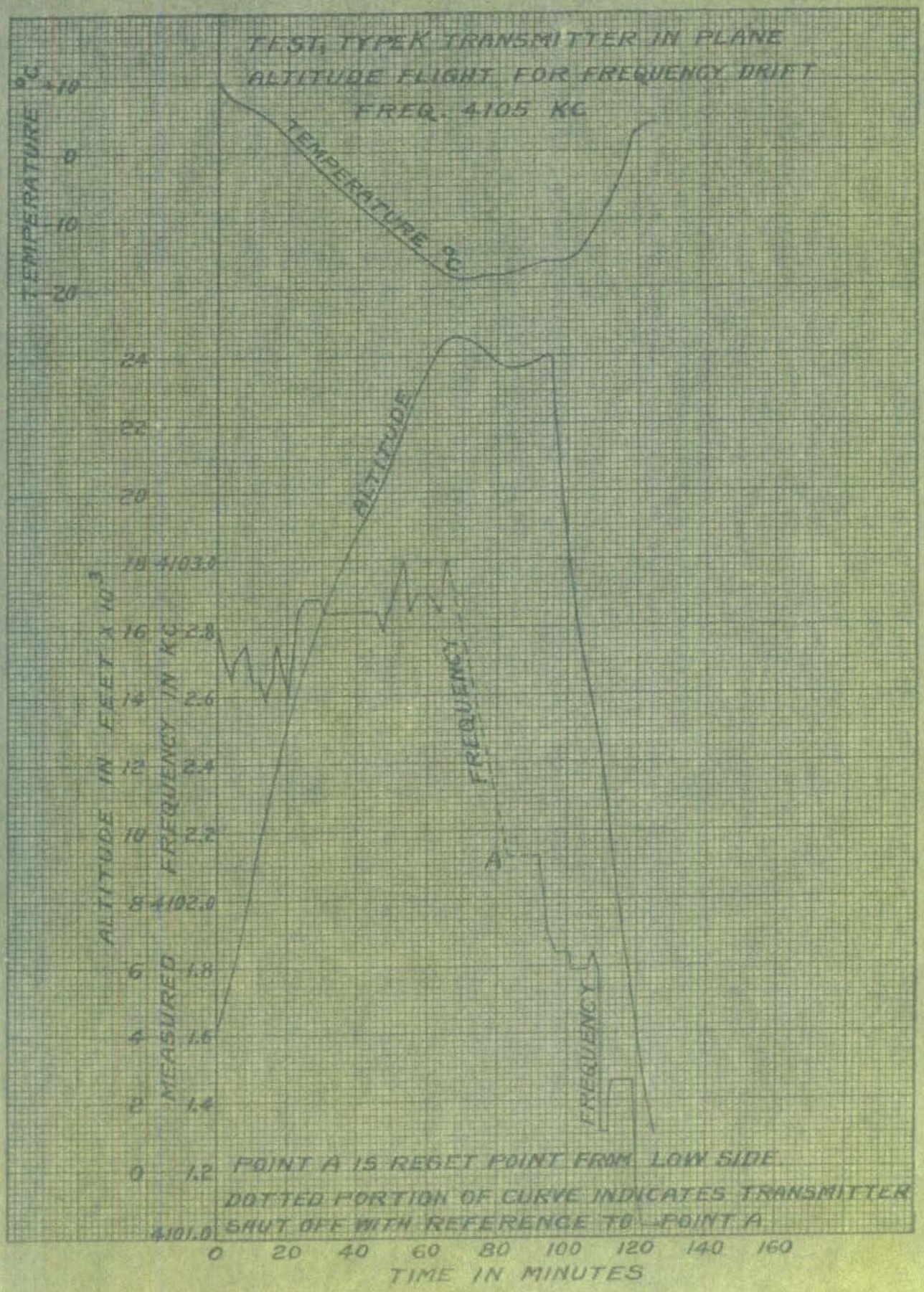


PLATE 41

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

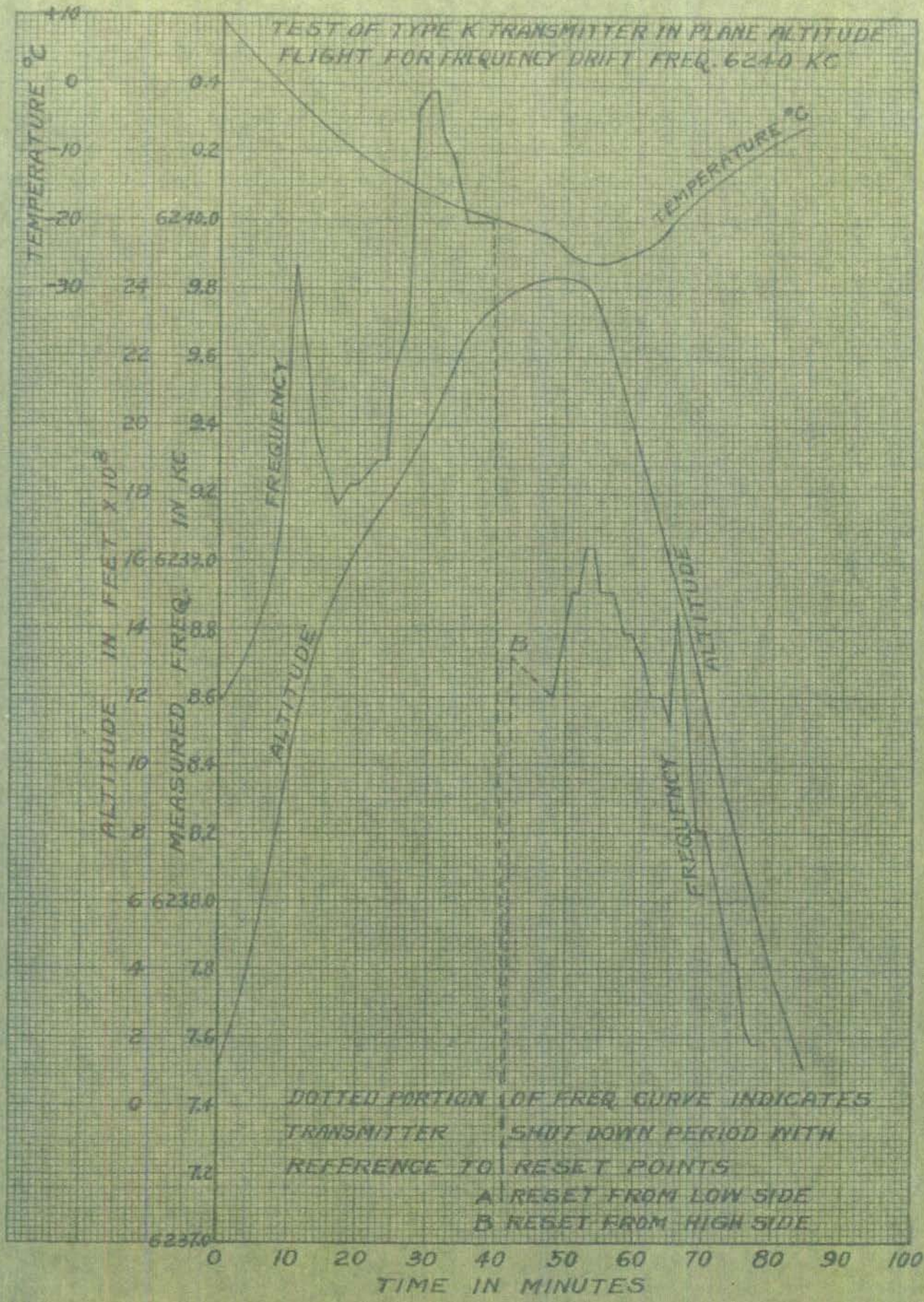


PLATE 42

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

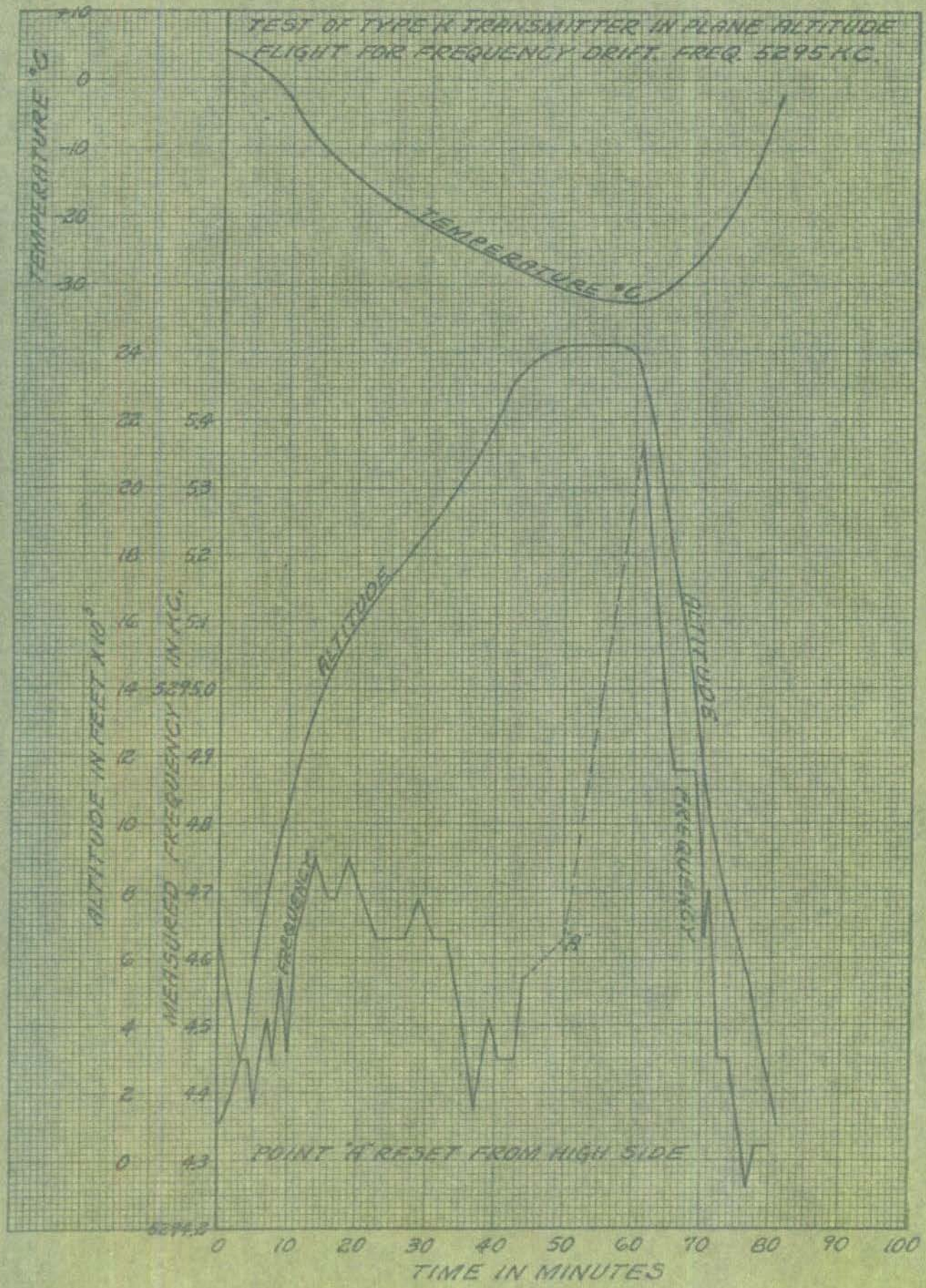


PLATE 43

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

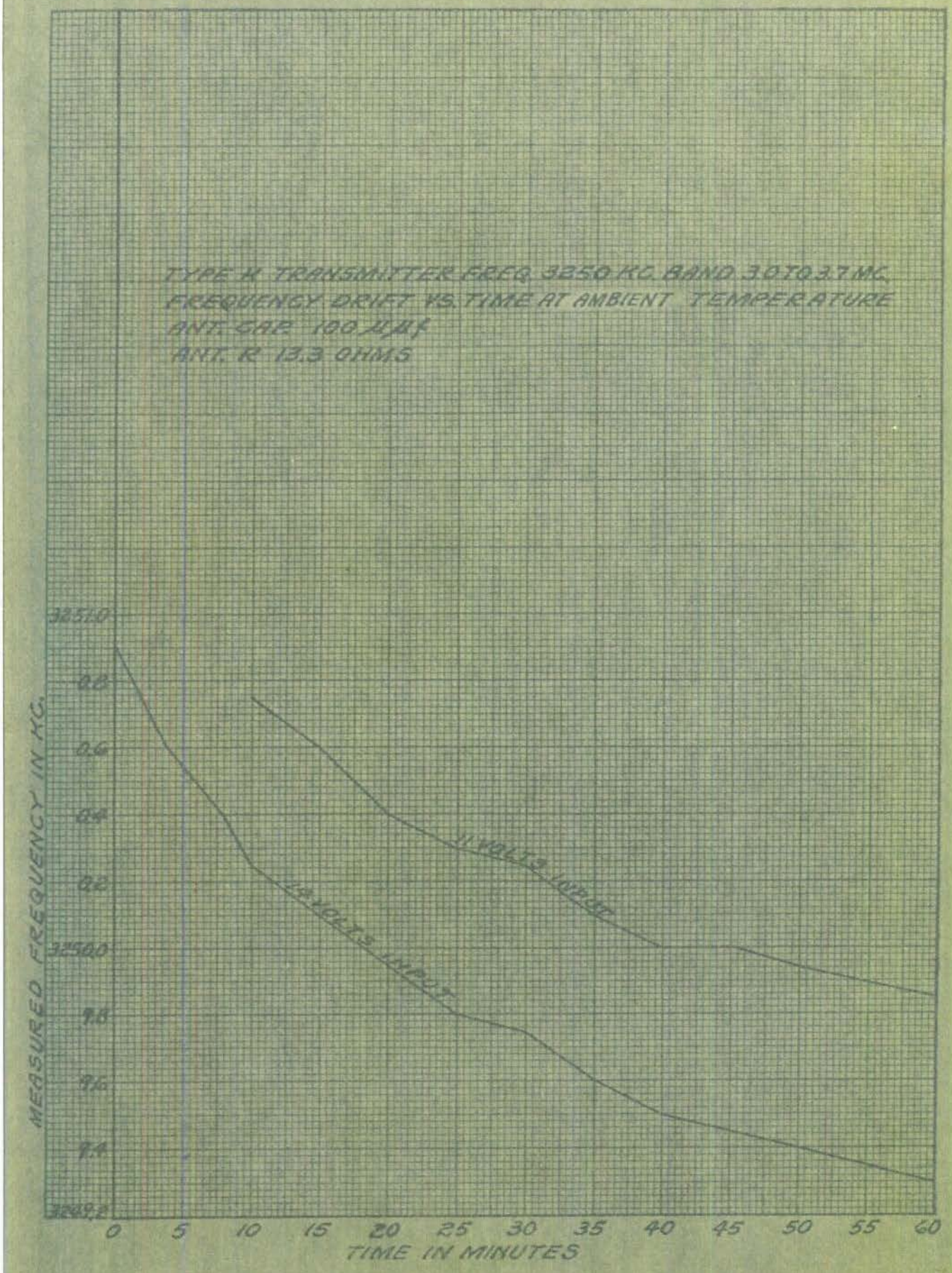


PLATE 44

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

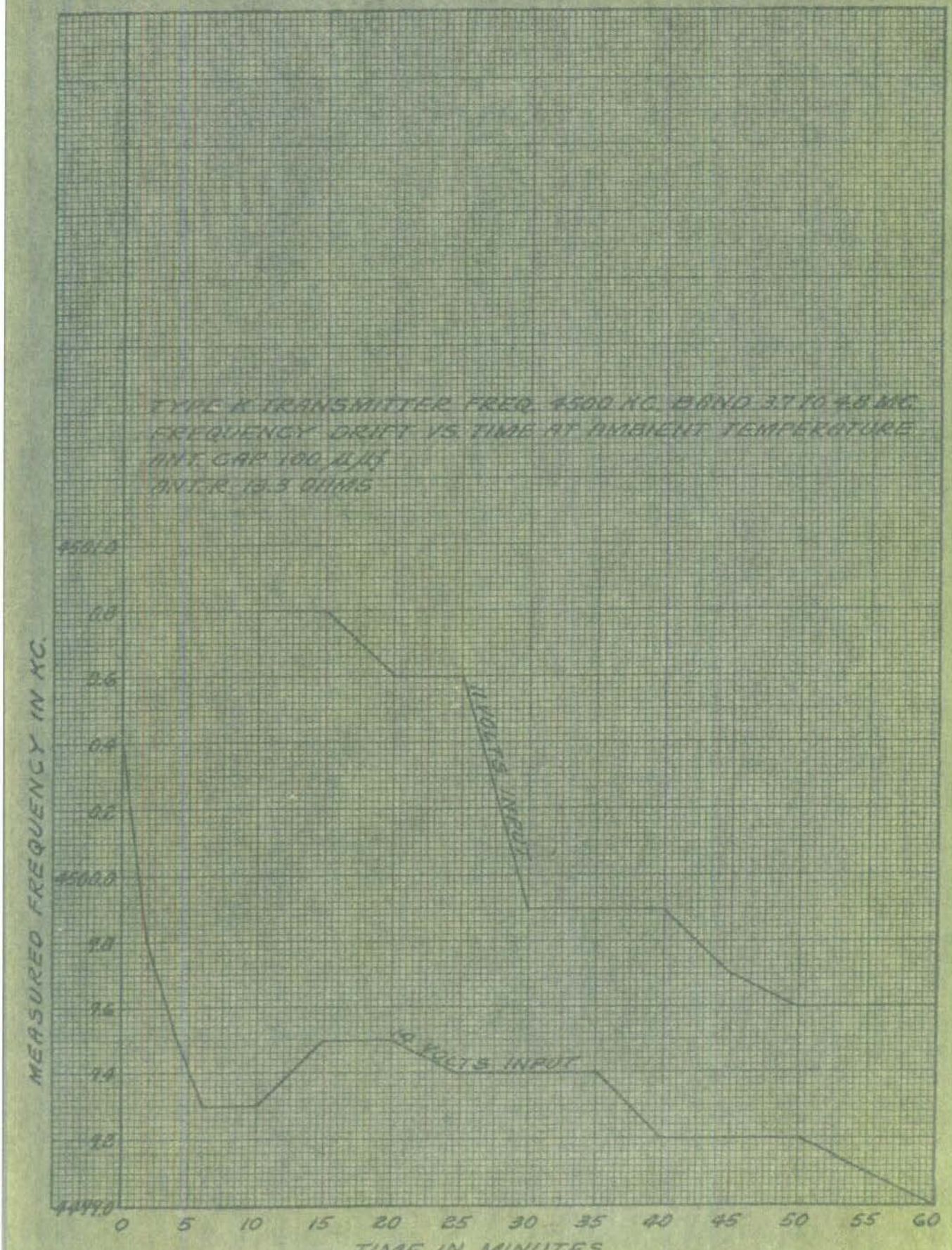


PLATE 45

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BELLEVUE, D. C.

DATE

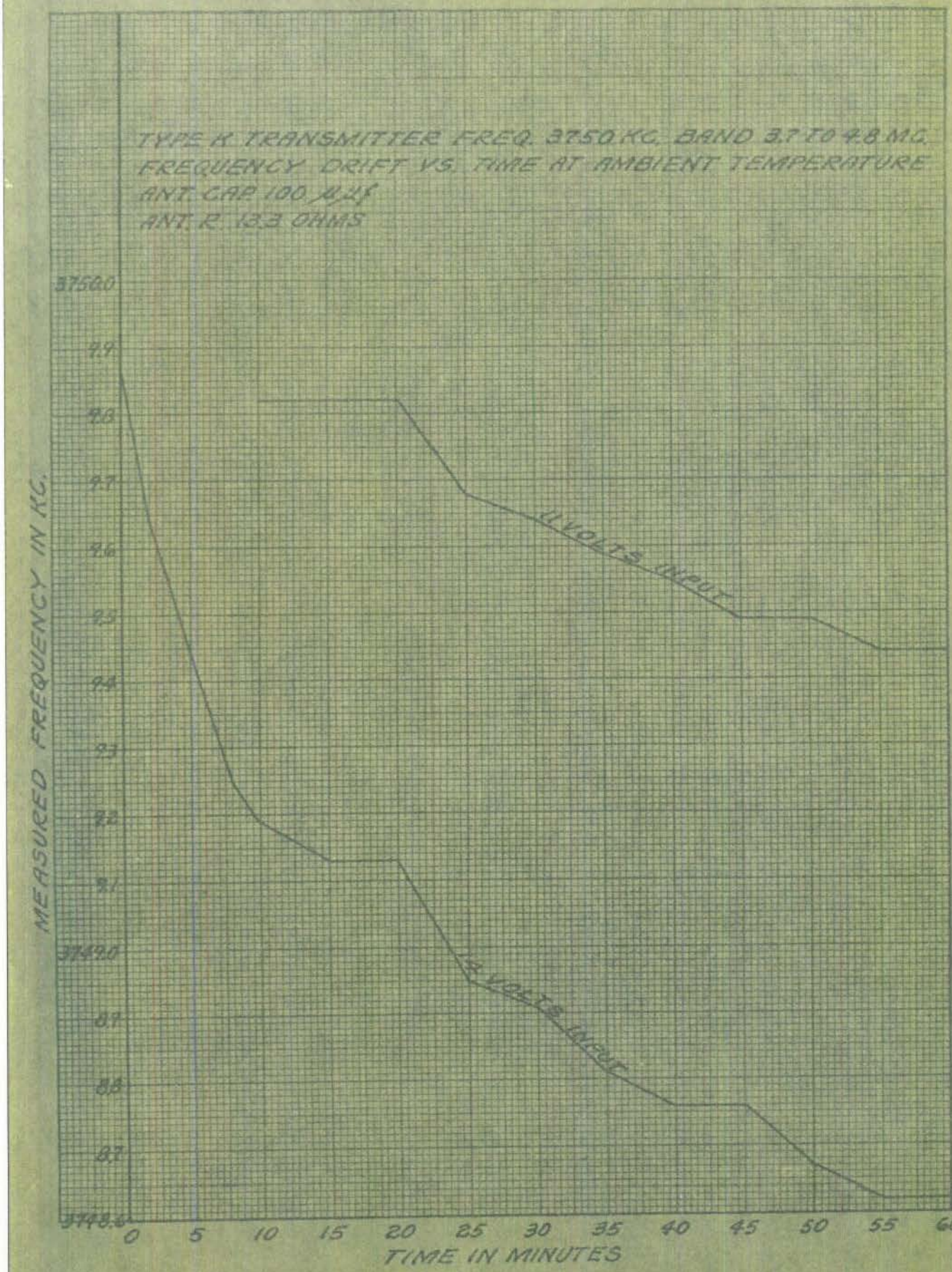


PLATE 46

BELLEVUE, D. C.

DATE

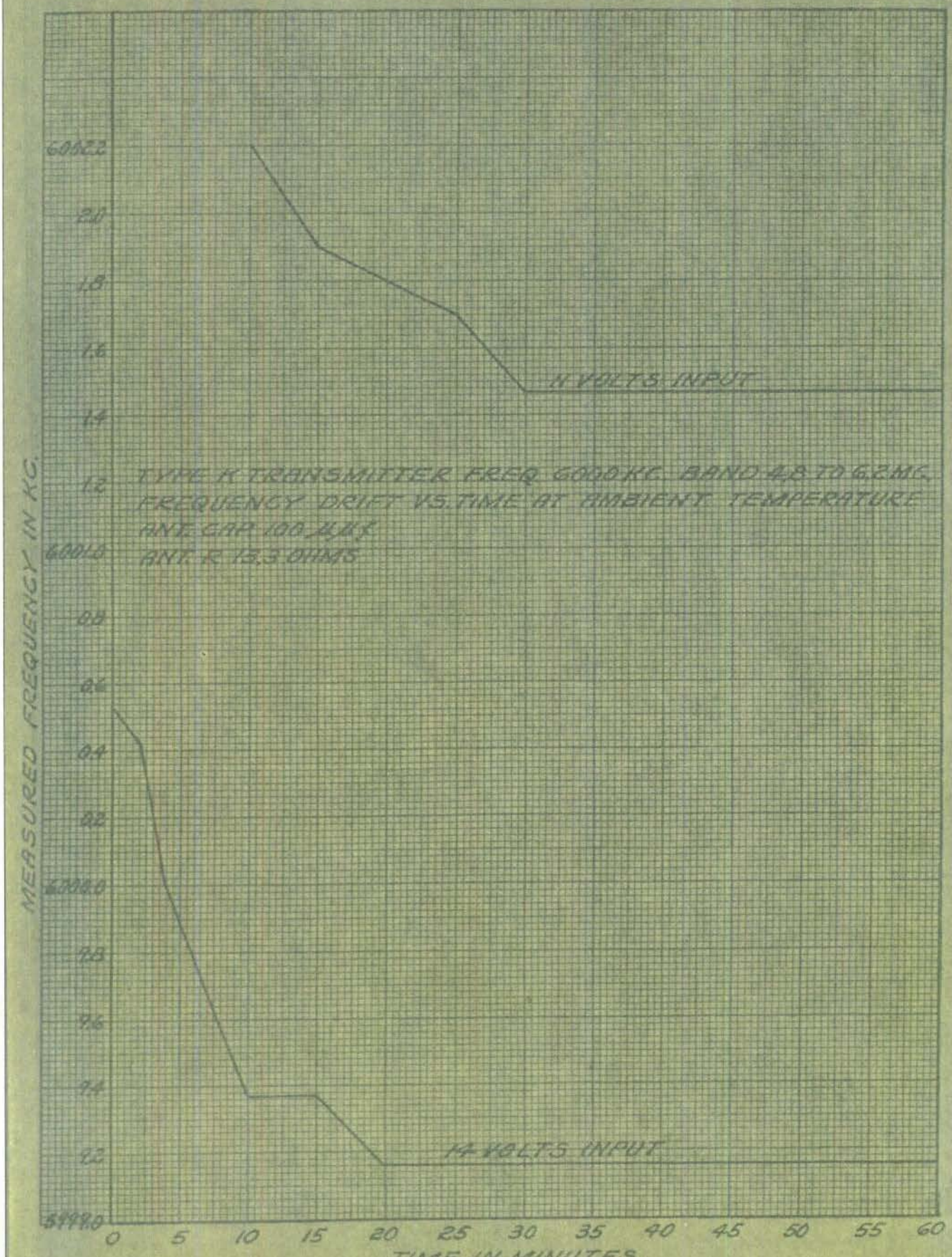


PLATE 47

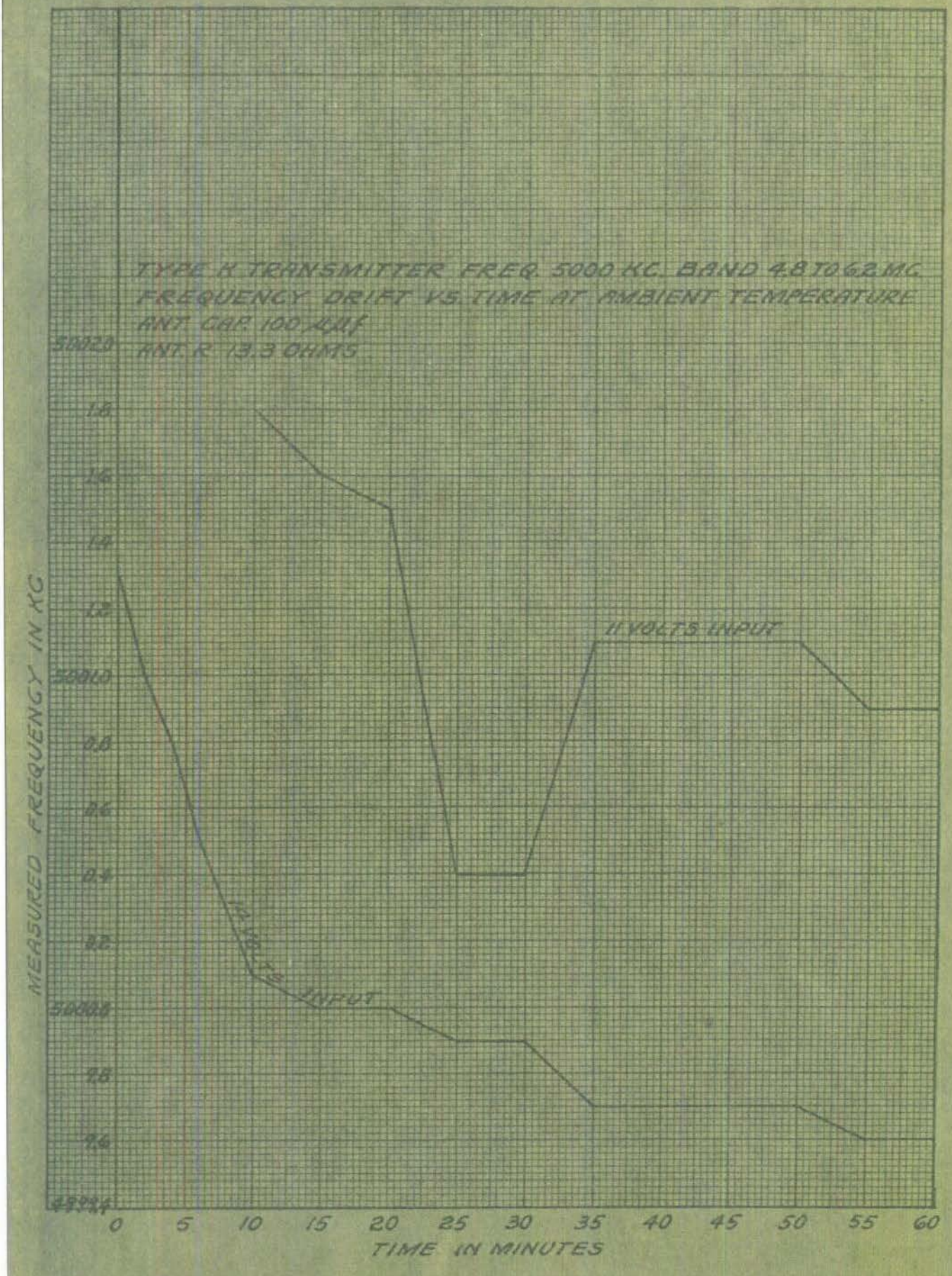

TYPE K TRANSMITTER FREQ. 5000 KC. BAND 4.8 TO 6.2 MC.
FREQUENCY DRIFT VS. TIME AT AMBIENT TEMPERATURE
ANT. CAP. 100 Mmf
ANT. R 13.3 OHMS
MEASURED FREQUENCY IN KC
11 VOLTS INPUT
TIME IN MINUTES
0
5
10
15
20
25
30
35
40
45
50
55
60

PLATE 48

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

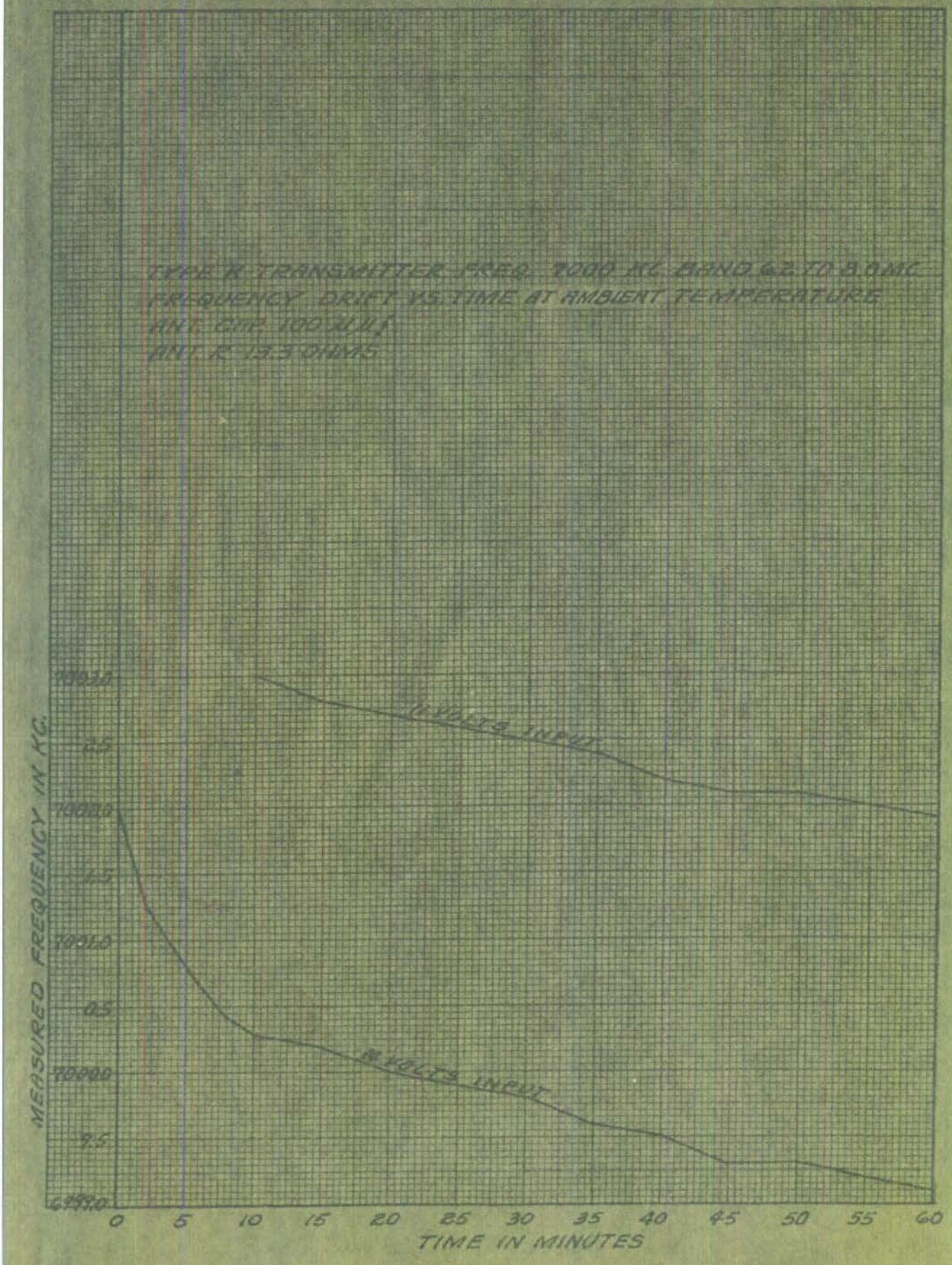


PLATE 49

Table 75

Type K Multi-Channel Radio Equipment

CW Start and Steady Output Power

Antenna Resistance 24.3 ohms

Band mc	Freq kc	Ant.Cap. uuf	Start Ant.Amps	Steady Ant.Amps	Watts Start Power	Watts Steady Power
3.0-3.7	3350	46	0.72	0.72	12.60	12.60
	3350	50	0.89	0.76	16.90	14.90
	3350	75	0.92	0.76	20.60	14.90
	3350	117	0.76	0.73	14.90	12.95
	3350	228	0.76	0.75	14.90	13.68
3.7-4.8	4250	45	0.74	0.70	13.35	11.90
	4250	50	0.79	0.72	15.20	12.60
	4250	75	0.74	0.72	12.35	12.60
	4250	117	0.72	0.72	12.60	12.60
	4250	228	0.63	0.62	9.65	9.35
4.8-6.2	5500	28	0.8	0.8	15.55	15.55
	5500	50	1.02	0.96	25.30	22.38
	5500	75	0.98	0.95	23.30	21.95
	5500	117	1.01	0.97	24.80	22.82
	5500	228	1.06	1.00	27.40	24.30
6.2-8.0	7100	28	0.85	0.85	17.55	17.55
	7100	50	1.15	1.08	32.10	27.20
	7100	75	1.18	1.10	33.80	28.40
	7100	117	1.18	1.10	33.80	28.40
	7100	228	1.18	1.14	33.80	31.50

[redacted]

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NDC/bag

U. S. NAVAL AIR STATION

F42-1/46-52(7)/NA6
(203) Serial #39089

ANACOSTIA, D.C.

15 June 1939

[redacted]

From: Commanding Officer.
To: Director, Naval Research Laboratory.

SUBJECT: Aircraft Radio - Aircraft Radio Corporation Type K equipment - Confidential Contract C-NOs-64476 - Report of Test and Inspection.

References:
(a) Bueng. Conf. letter C-S-500-677 (12-3-R7) of 12 December 1938.
(b) Bueng. Conf. letter C-NOs-64476 (1-4-R6) of 10 January 1939.
(c) Bueng. Conf. letter C-NOs-64476 (1-4-R1) of 12 January 1939.
(d) Bueng. Conf. letter C-NOs-64476 (1-23-R1) of 24 January 1939.
(e) Bueng. Conf. letter C-NOs-64476 (1-23-R1) of 24 January 1939.
(f) NRL Conf. letter C-F42-1/43 of 19 January 1939.
(g) Bueng. Conf. Memo. of 7 February 1939.
(h) Bueng. Conf. letter C-NOs-64476 (1-4-R1) of 3 May 1939.
(i) NAS, Anacostia Conf. ltr. F42-1/46-52(7)/NA6(98) #39045 of 22 March 1939.

Enclosures:
(A) Photograph AN-53197 - Type K Radio Equipment - Composite View of equipment.
(B) Photograph AN-53198 - Type K Radio Equipment - Composite view of equipment showing 4 receivers and 2 transmitters.
(C) Photograph AN-53199 - Type K Radio Equipment - Four remote-controlled receivers on mounting chassis; front view.
(D) Photograph AN-53200 - Type K Radio Equipment - Four remote controlled receivers on mounting chassis; side view.
(E) Photograph AN-53201 - Type K Radio Equipment - Four receivers on mounting chassis; back view.
(F) Photograph AN-53202 - Type K Radio Equipment - Four receiver mounting chassis with two receivers mounted.

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Enclosures:

(G) Photograph AN-53203 - Type K Radio Equipment - Four Receiver mounting chassis.

(H) Photograph AN-53204 - Type K Radio Equipment - Two receivers showing local and remote control features in place.

(I) Photograph AN-53205 - Type K Radio Equipment - Two receivers showing local and remote features.

(J) Photograph AN-53206 - Type K Radio Equipment - Receiver (top view); cover and dynamotor removed.

(K) Photograph AN-53207 - Type K Radio Equipment - Top view of receiver; covers removed.

(L) Photograph AN-53208 - Type K Radio Equipment - Bottom view of receiver.

(M) Photograph AN-53209 - Type K Radio Equipment - Two transmitters and mounting chassis.

(N) Photograph AN-53210 - Type K Radio Equipment - Top view of transmitter; cover removed.

(O) Photograph AN-53211 - Type K Radio Equipment - Bottom View of transmitter.

(P) Photograph AN-53212 - Type K Radio Equipment - Mounting chassis for two transmitters.

(Q) Photograph AN-53213 - Type K Radio Equipment - Modulator unit and mounting chassis; side view.

(R) Photograph AN-53224 - Type K Radio Equipment - Modulator unit with dynamotor removed - top view.

(S) Photograph AN-53225 - Type K Radio Equipment - Remote Control unit for two receivers and four transmitters; front view.

(T) Photograph AN-53226 - Type K Radio Equipment - Remote Control unit for four receivers and four transmitters; front view.

(U) Photograph AN-53227 - Type K Radio Equipment - Remote control box with front panel removed.

(V) Photograph AN-53228 - Type K Radio Equipment - Remote control box; back view.

(W) Photograph AN-53229 - Type K Radio Equipment - Side view of remote control box and extension control box with cables.

(X) Photograph AN-53354 - Type K Radio Equipment - Receiver bottom view with r.f. coils removed.

(Y) Photograph AN-53355 - Type K Radio Equipment - Receiver top view with cover and dynamotor removed.

(Z) Photograph AN-53356 - Type K Radio Equipment - Interphone unit complete with cables and control boxes.

(AA) Photograph AN-53419 - Type K Radio Equipment - Two transmitters and two receivers installed in F3F-3 airplane #1462.

(BB) Photograph AN-53420 - Type K Radio Equipment - Two unit control box installed in F3F-3 airplane #1462.

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Enclosures: (CC) Photograph AN-53369 - Type K Radio Equipment - Schematic wiring diagram - Type K Multi-channel radio equipment.
(DD) Photograph AN-53368 - Type K Radio Equipment - Schematic Wiring Diagram Type K Interphone Equipment.
(EE) Photograph AN-53421 - Diagramatic sketch of complete type K equipment, direction finder and crystal frequency indicator.
(FF) Photograph AN-53422 - Diagramatic sketch of GP-3 transmitter, RU-5A receiver, K interphone unit, direction finder and crystal frequency indicator.
(GG) Photograph AN-53463 - Comparison of Aircraft radio equipment.

1. General Information.

A. The Aircraft Radio Corporation Type K equipment, shown by enclosures (A) to (Y) inclusive, was delivered to this station for test and inspection in accordance with confidential contract C-NOs-64476.

B. This letter reports the findings in conformity with references (a) to (f) inclusive.

2. Description of Equipment.

(a) General.

The equipment is a new type developed to meet the demands of the naval aircraft radio service as now fulfilled by the GF and RU series equipment. One complete equipment consists of 6 superheterodyne receivers (to cover the r.f. band from 200-1500 and 3000-20000 kilocycles), 4 master oscillator-power amplifier transmitters (to cover the r.f. band from 3000-8000 kilocycles), a modulator unit, an antenna relay unit, a two band control box, a four band control box and a complete set of cables. The equipment, as submitted, was not designed to operate with the existing direction finders, crystal frequency indicators, and GP series transmitters and, at the Bureau's request, the manufacturer on 25 April, 1939, submitted an interphone-power unit. While this interphone-power unit is not a part of the equipment covered by the contract, tests were conducted and the findings are reported herein.

(b) Receivers.

The superheterodyne receivers, with tuning dial directly calibrated in frequency, are designed for either local or remote control. Tuning is accomplished by a detachable local tuning knob which is replaced by a flexible shaft for remote control. MCW and CW reception with either automatic or manual gain control is available by the proper selection of switches. The volume and switch controls of each receiver are mounted on

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a removable panel which is left in place for local operation and which is replaced by a plug on the control box when using remote control. An antenna alignment control is mounted on each unit, and when the receiver input circuit is aligned with a given antenna no further adjustment is required. Loop input coupling terminals, in addition to the antenna terminal, are provided on the two receivers covering the frequency spectrum from 200-1500 kilocycles. The receiver power supply is obtained from an individual dynamotor mounted on the receiver chassis. Two receiver racks were furnished, one accommodating two receivers and the other four receivers. Each rack carries a small junction box equipped with pressure contact power plugs which engage the receiver receptacles. Mounted on the rack are the fuses, current and voltage jacks for checking the receiver current, and the local receiver output jack.

(c) Transmitter.

Each transmitter contains the circuits necessary for generating, monitoring and amplifying radio frequency power for Voice, CW, and MCW transmission. The carrier frequency is continuously adjustable within each band. The master oscillator contains temperature compensation for correcting frequency drift. Each transmitter contains a piezoelectric indicator for checking the transmitter frequency at one point against the frequency of the crystal resonator. Resonance with the frequency of the crystal is indicated on a cathode-ray indicator tube and a screwdriver adjustment is provided for resetting the master oscillator circuit to the crystal frequency when the calibrated dial is set to the correct frequency. The power amplifier is coupled to the antenna by means of a tapped coil and fine adjustment of the antenna circuit is obtained by a variable air condenser. The master oscillator frequency tuning control with calibrated dial, antenna condenser control, antenna ammeter, and antenna binding posts are all mounted on the front panel. The rack design is the same as for the receivers.

(d) Modulator.

The modulator is a separate unit containing the transmitter dynamotor, filter, tone oscillator and the transmitter and intercommunication system audio amplifier.

(e) Control Box.

The two types of control boxes consist of (1) a two-band box designed for remote control of two receivers and one to four transmitters, and (2) a four band box designed for four receivers and one to four transmitters. The controls are:

1) Tuning control for each receiver with directly calibrated removable dial.
2) Volume control for each receiver.
3) "Manual", "Auto" and "Off" switch for each receiver.
4) "CW" and "MCW" switch for each receiver.

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5) Receiver output selector switch.
6) Four position transmitter selector switch.
7) Transmitter "On-Off" switch.
8) "Radio-ICS" switch for connecting the microphone and modulation circuits to either the transmitter or the intercommunication circuits.
9) Two microphone jacks.
10) Two headphone jacks.
11) Remote key jack.
12) Built-in telegraph key.
13) Recall signalling button.
14) "Voice-CW-Tone" switch.

(f) Extension control box.

The extension control box contains:

1) Microphone jack.
2) Headphone jack.
3) Remote key jack.
4) Built-in telegraph key.
5) Recall signalling button.

(g) Interphone Unit.

The unit, although not furnished as a part of the contract, is required as a source of supply for the radio accessories, such as the type LM series crystal frequency indicators and the direction finders. The sample unit submitted by the contractor contains a dynamotor, an audio amplifier and the necessary number of cable receptacles to take power from a battery source and to supply power for the radio accessories. The "On-Off" switch, and the microphone and telephone jacks are mounted on the unit.

3. Vacuum Tube Lineup.

The vacuum tubes used in the equipment are:

(a) Transmitter

Master Oscillator	One-A2079
Power Amplifier	Two-A4107
Resonance Indicator	One-QF48

(b) Modulator

Tone Oscillator	One-QF103
Modulator	One-A4107
Voltage regulator	One-S467

(c) Receiver

R.F. amplifier	One-6K7
Mixer	One-6K8
I.F. amplifier	Two-6K7
Detector-Oscillator	One-6R7
Audio amplifier	One-1278

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(d) Interphone

Audio amplifier One-1278

Total number of vacuum tubes - 14.

4. Test Objects.

The equipment was examined and tested to determine the following characteristics:

(a) Dimensions and weights.
(b) Vacuum tube line-up.
(c) Mechanical ruggedness.
(d) Installation facilities.
(e) Loop and antenna alignment.
(f) Altitude breakdown tests.
(g) Altitude frequency drift and reset tests.
(h) Break-in operation.
(i) Flight interphone and sidetone level.
(j) Flight selectivity check.
(k) Flight distance test.
(l) Interference between receivers.
(m) Comparison in flight of RU and K receivers.
(n) Cross-modulation in flight.
(o) Image frequency in flight.
(p) Transmitter harmonic radiation.
(q) Accessibility.
(r) Resetability.
(s) Operation with existing radio equipment.
(t) Airplane to airplane communications.

5. History of Tests.

The type K aircraft radio equipment was ground and flight tested by this station from 3 January, 1939 to 18 May, 1939. A brief history of the tests follows:

3 January - Two complete sets of equipment consisting of 12 receivers, 8 transmitters and two modulators were delivered by Aircraft Radio Corporation.

3-6 January- Mechanical inspection.

6-13 Jan. - One equipment bench tested; other equipment installed and flight tested in SU-2 airplane #9104.

13 January - One complete set of equipment turned over to Naval Research Laboratory.

16 January - Bench test of antenna circuit.

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17 January - Flight test to Philadelphia.

18 January - Continued antenna circuit investigation. Checked weights and dimensions.

19-27 Jan. - Both ground and flight tests, which included comparison of type K and type RU receiver performance in flight and on ground; receiver and transmitter temperature runs; transmitter operation on various types of fixed antennas.

30-31 Jan. - Equipment removed from SU-2 airplane and installed in XSBU-1 airplane #9222.

1 February - Inspection of equipment by Army.

2-6 Feb. - Bench tests checking circuit design.

7 February - Flight test checking image frequency.

8-14 Feb. - Bench test checking mechanical features, receiver noise levels, audio characteristics, keying clicks, band overlaps.

14 February -Inspection of equipment by Army.

15 Feb. to 3 March - Flight tests checking break-in operation, sidetone level, image frequency, direction finder operation, altitude breakdown, and comparison of K receivers vs RU receivers.

2 March - Inspection of equipment by Army.

3-6 March - Bench tests to determine cause of altitude breakdowns.

7-8 March - Flight tests checking altitude break-down.

9 March - Distance flight test.

10 March - Flight tests checking receiver operation up to 20 mo.

13-15 March- Inspection of equipment by Army. Bench tests of receiver loop homing operation.

16 March to 20 April - Flight tests checking direction finder operation, homing loop operation, altitude breakdown, reset and frequency drift, transmitter harmonic checks, receiver image frequency checks, remote control operation.

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21-27 April	- Second equipment received from NRL and installed in JE-1 airplane #9222. Flight tests to check two plane operation, homing and interphone operation.
25 April	- Interphone-power unit delivered for test.
28 April to 1 May	- One equipment returned to NRL. Bench test of interphone-power unit.
2 May	- Flight Test of interphone-power unit.
3-13 May	- Bench test of interphone-power unit for operation with GP series transmitters, direction finders and LM series crystal frequency indicators.
4-5 May	- Equipment removed from XSBU-1 airplane. Photographs taken.
11 May	- Equipment installed in F3F-3 airplane #1462.
15-17 May	- Distance flight of equipment.
16 May	- Interphone-power unit delivered to NRL.
18 May	- Equipment removed from F3F-3 airplane and tests completed.

6. Flight Tests.

A. Altitude and Reset Tests.

The transmitter altitude and reset tests were conducted with, and the results will be reported by, Naval Research Laboratory.

B. Harmonic Tests.

The transmitters were checked for r.f. harmonic radiation when operating into a standard half-"Vee" antenna and with the exception of one transmitter the harmonics were below 50 db with respect to the fundamental. The exception was the third harmonic of the transmitter operating on 5295 k.c. which was 30.5 db below the fundamental. This harmonic radiation is excessive and the contractor should investigate and correct.

C. The high frequency receivers, especially the bands from 9000 to 20000 kilocycles, are very difficult to tune to a given frequency due to the absence of a vernier and to the fact that the dials are marked only at intervals of one-tenth megacycles. The dials should be engraved every 50 kilocycles, and where it is possible without congestion, at every 25 kilocycles.

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7. Flight Installation and Time.

The type K equipment was tested in flight 108.5 hours involving 81 flights. Installations were made in type SU-2 airplane #9104, Type XSBU-1 airplane #9222, JE-1 airplane #0795, and F-3F3 airplane #1462.

8. Dimensions and Weights.

The maximum overall dimensions and weights for the equipment are:

Equipment	Size - inches			Weight	
	Depth	Width	Height	Lb.	Oz.
Receiver with local tuning control	11-7/16	4-7/8	5-3/4	8	14
Twin-Receiver rack	13-1/4	11-1/16	3-13/16	1	14
Twin-Receiver mounting	10-3/4	11-3/4	1-3/4	-	14
Twin-Receiver rack and mounting	13-1/4	11-3/4	4-1/2	2	12
Twin-Receivers, rack and mounting	13-1/4	11-3/4	7-1/4	20	8
Four-receiver rack	13-1/8	20-7/8	3-3/4	3	9
Four-receiver mounting	10-3/4	21-1/2	1-7/8	1	4
Four-receiver rack and mounting	13-1/8	21-1/2	4-5/8	4	13
Four receivers, rack and mounting	13-1/8	21-1/2	7-1/4	40	5
Receiver dynamotor (part of receiver weight)				2	14
Transmitter	10-1/2	5-3/8	7-7/16	8	4
Twin-Transmitter rack	12-5/8	12-1/4	4-7/16	2	-
Twin-Transmitter mounting	9-5/8	12-13/16	1-3/4	-	14
Twin-transmitter rack & mounting	12-5/8	12-13/16	5-1/4	2	14
Twin transmitters, rack & mounting	12-3/4	12-13/16	8-15/16	19	6
Transmitter dynamotor (part of transmitter weight)				8	10
Modulator	10-3/8	9-11/16	6-7/8	19	8
Modulator mounting	11-1/8	9-5/8	1-11/16	-	12
Modulator and mounting	11-1/8	9-11/16	8	20	4
Two-Unit Control Box	2-5/8	6-1/8	7-5/16	2	8
Four-Unit Control Box	2-5/8	6-1/8	10-1/4	3	12
Extension Control Box	1-11/16	4-3/16	3-3/16	-	7
Antenna relay unit	3-3/16	3-3/8	2-5/8	-	12
Interphone	8-1/2	5-3/4	5-1/2	4	2
Interphone and dynamotor	8-1/2	5-3/4	5-9/16	7	-
Interphone, dynamotor & mounting	8-7/16	5-3/4	7-1/16	7	10
Interphone mounting				-	10
Interphone dynamotor				2	14
Interphone control box	4-7/32	3-1/8	1-5/8	-	6

9. Comparison of Equipment.

The data tabulated in enclosure (GG) are a break-down of the K, GF-4 and preliminary XGQ radio equipments. It is very difficult to present a composite picture of each equipment in which are listed all the advantages and disadvantages. However, it is believed, that a study of the tabulated data plus a knowledge of each equipment, as obtained from this report and previous reports, will serve as a means for determining the utility of each type of equipment. The "weight summary" of each equipment, in this tabulation, is a presentation of facts, with no attempt made to enumerate the desirable or undesirable features.

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10. Mechanical Comments.

A. General.

1. Screws should be secured by lockwashers or equivalent rather than by varnish or lacquer.

2. The voltage test jacks should be designed so that the Weston Model OE Test lead plug will be held securely.

3. Covers for the fuses, jacks, and "antenna coupling" should be hinged or fastened to the respective unit in a manner such that the cover cannot become lost or accidentally dropped.

4. It is difficult to set up a transmitter or a receiver frequency. The panel dial index marks should be "Vee" shaped.

5. All shielded connecting cables should be rubber covered.

6. (a) All set screws used in the equipment are the Bristo type which requires a special wrench. A Bristo wrench should be affixed to the inside of the case or covers of each transmitter and receiver. This type of set screw is a definite improvement over the slotted type set screw.

(b) Two set screws should be used to secure all knobs, etc.

7. The internal wiring should be made with flame-proof wire meeting the Navy requirements.

8. (a) All cable plugs and receptacles should be identified.

(b) All cable terminals should be numbered. The numbers should be moulded on both sides of all plugs and receptacles.

(c) The cable plugs cannot be removed for servicing without replacement of the plug shell. The cable plug shell design used on the Interphone-power unit cables should be incorporated on all cables.

(d) Provide a guide or suitable marking for aligning the cable plug with the receptacle.

(e) Change design of 6 and 7 terminal plugs so that they are not interchangeable.

9. (a) The "ground" terminal post should be removed from the transmitters and receivers. An accessible ground terminal post should be provided on the mounting rack of each major unit.

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(b) The hole in the "ground" and "antenna" terminal posts should be increased from 0.0935" to at least 0.1285". A wire cannot be readily inserted in the present hole.

10. Wax should be removed from all plug terminal inserts; especially, those mounted on mica insulation. Several cases of poor contact have occurred.

11. (a) Provide a hole in mounting studs of dynamotors, covers, etc. for safety wires.

(b) The locking feature of transmitter, receiver, modulator and interphone unit mounts should be designed to permit the use of safety wire.

12. All relays are unprotected against gas fumes. Adequate protection should be provided.

13. (a) The dynamotors should be marked with arrow for direction of rotation.

(b) The dynamotors should be marked to indicate position for insertion on the rack.

(c) Consideration should be given to making the dynamotor waterproof.

14. Standard telephone jacks are used for providing means to check the currents in the major electrical circuits. This method of checking current is not considered safe when checking the current in the high voltage circuit, where voltage as high as 650 volts exist.

15. (a) The telephone jacks are located too close together to permit the simultaneous use of two plugs as specified by NAF drawings 38611 and 38861.

(b) The current jacks, if standard telephone jacks are used, should be designed to take plugs specified by NAF drawings 38861 and 310572.

16. The excessive quantity of oil used on all bearings of shafts, condensers, pivot points, etc. should be omitted.

17. Hexagonal nuts should be used to secure the dynamotor Lord mounts.

18. The tuning knobs for the transmitters and receivers should be secured by locknuts or equivalent.

19. All relay contact arms should be rigidly secured to prevent misalignment.

20. Connections made to taps on the r.f. coils should be mechanically locked prior to soldering.

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21. All tube sockets and cable receptacles should be mechanically locked to prevent turning.

22. The snap slides should be made larger and of greater strength.

23. The guards for all knobs should be knurled to prevent slippage of the hand.

24. Eliminate spun-in brass rivets (some even unplated) where contact is made with aluminum.

25. Lead washers should be used when securing parts to ceramic material.

26. All cable plugs and mechanical linkage controls connecting to the control boxes should be designed for right angle adapters. The space required back of the control boxes in the present design is about 6 inches and this distance is too great for cockpit installation. Even with adjustable right angle adapters considerable difficulty will be encountered in making the installation.

27. Receivers and transmitters slide into the racks on top of rivet heads and, when in position, the units are raised off the rear rivets by the plug and socket feature. This system gives a three-point suspension. It is recommended that two guide pins, or equivalent, on each side of the plug be used to hold the units securely to the racks.

28. All nameplates should conform to Navy specifications.

29. At least three types of screws are used in assembling the equipment, i.e., 3-48, 4-36, and 4-40. Standardization of size and threads is considered necessary.

30. Fixed condensers should be mounted so the capacity value can be determined by visual inspection.

31. The vacuum tube socket design is not considered satisfactory. The tubes work loose from vibration, the socket is mechanically weak, and the contact surfaces have no wiping action. An improved design is recommended. The Amphenal type #5 socket with a low loss base is suggested for consideration.

32. Wires should be mechanically clamped to the terminals prior to soldering.

33. All dials should be pinned to the gear hubs.

34. All dynamotor bearings should be of an improved design.

B. Transmitter

1. The tuning dial nut should be locked with a lock washer or equivalent.

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2. (a) The crystal receptacle and holder should be polarized.

(b) The crystal holder should be held securely in place.

(c) The crystal cover screws should be locked or staked.

3. The small enamel wire inside the antenna loading coil is too weak mechanically. Increase diameter of wire.

4. To cover the full range of the antenna tuning condenser requires over 30 turns of the knob. This knob is too small in diameter. Improve the design.

5. The chassis opening to the antenna coil should be increased in width at least 1/4 inch (on the side nearest to the antenna ammeter). Present opening too small for accessibility.

6. Plating on the bare wire, used on the r.f. coils, should be improved to eliminate flaking.

7. Clearance between M.O. condenser mounting and M.O. coil terminal, which projects through the chassis, should be increased.

8. All dials should be calibrated beyond the specified frequency range at least 2 minor divisions (20 kc) at each end of the band.

9. The M.O. inductance tuning screw and knob should be identified and an adequate locking feature provided.

10. The clearance to ground should be increased to the bare wire connecting the P.A. grids to the M.O. coil.

11. Provide a danger plate on the antenna coupling door and the rear horizontal door.

C. Modulator Unit.

1. Clearance between the test jacks and the chassis should be increased.

2. Vitreous resistors should be mounted securely to prevent rotation.

3. Wires to relays should be mechanically secured.

4. Rubber grommets are not considered as satisfactory. Replace with a permanent bushing similar to that used in the receiver.

D. Receiver Unit.

1. Black nickel plated screws should be used to replace white nickel plated screws in which a black lacquer has been applied on the screw head.

2. All dial nuts should be held in place with lock washers or equivalent.

3. All unplated brass, such as the local volume control shaft and bushing, should be protected against corrosion.

4. All nuts, such as "CW-MCW" switch nuts, should be staked or locked in an approved manner.

5. All control knobs should be increased in size especially the "antenna align" and "tuning" knobs.

6. Receiver output switch in receiver rack should be marked "Phone Local - Remote" not "In-Out".

7. All jacks, such as "cathode", should be identified.

8. Local output jacks should be more accessible.

9. Vernier control of the high frequency receiver tuning dials is necessary.

10. Increase clearance between chassis and coil case for the bare antenna lead connecting "align input" condenser to "antenna" coil socket.

11. Increase clearance to 200 mmfd condenser #4513 dwg 5941-4-A leads. Condenser is located on top of the r.f. oscillator coil socket, just back of the main tuning condensers.

12. All r.f. and i.f. coils plug-in socket features should be eliminated and all leads adequately soldered.

13. All tuning knobs should be secured with lock-nut or equivalent.

14. Slight movement of the receiver mechanical linkage near the receiver detunes the receiver. Correct.

15. All receiver dials should state whether the dials are calibrated in kilocycles or megacycles.

E. Control Boxes.

1. All jack and switch nuts should be staked.

2. All controls, such as key and recall switches, should be identified.

3. Upper contact of key and recall switches should have positive pressure against the stem.

4. Set screws in output shaft are too close to the teeth on the split gear. Relocate.

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5. Word "transmitter" should be engraved over "on-off" switch nomenclature.

6. The transmitter "on-off" switch should be mounted on the front panel.

7. (a) Stray light from the indicator lamps leaks out through the microphone and telephone jacks. Eliminate.

(b) The indicator lights are beneficial only at night and their utility is questionable.

(c) Present design of lamp and socket is entirely too large. If lights are retained Kollsman Instrument Lamp Type 71A should be considered.

(d) Design of transparent cover for light should permit replacement if it becomes broken.

8. Corrosion is present at the terminals to which the resistors are connected to the "mic" jacks. Correct.

9. The "MCW-CW" switch engraving should be changed to "CW-MCW" to conform with the receiver local control.

10. Relocate the "key" jack near the front, in line with the "mic" and "Tel" jacks.

11. The hand key has no tension adjustment but the design is considered satisfactory.

11. ELECTRICAL COMMENTS.

A. General Information.

1. The microphone relay current through the microphone switch is 0.4 amperes at 14.5 volts.

2. The transmitter tone oscillator frequency is approximately 1000 cycles.

3. The battery ripple voltage in the receivers output circuit is too low to be measured.

4. D.C. current in telephone circuit, receiver on auto or manual with maximum volume, is 0.1 ma and at minimum volume is 0 ma.

5. Break-in Operation

(a) With both transmitter and receiver tuned to the same frequency (checked at 6390 kc) and the receiver on maximum volume, CW-Manual, the break-in operation was satisfactory to at least 25 words per minute.

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(b) With both transmitter and receiver tuned to the same frequency (checked at 6390 kc) and the receiver on maximum volume, CW-Auto, the receiver recovery time was approximately 2 seconds.

6. There was no image frequency interference noticed in flight when flying over broadcast stations WRC (950 kc, 5 kilowatts) and WMAL (630 kc, 0.5 kilowatt). A weak image frequency indication was obtained from NAS Anacostia, approximately 500 watts power, when the transmission was on 7915 and 9140 kc.

7. There was no cross modulation observed when checked in flight with broadcast stations WRC, WMAL, WOL and WJSV.

8. The ICS level, with two pairs of telephones, is approximately 3 to 5 volts. This level is satisfactory.

9. The receiver frequency overlaps and conversion frequencies are approximately:

Receiver Range kc	Approximate overlap-kc Low End	Approximate overlap-kc High End	Conversion Frequency kc
200-580	4	12	90
520-1500	9	30	239
3000-6000	70	95	1415
6000-9000	355	190	2830
9000-13500	150	270	4200
13500-20000	290	370	4200

10. The transmitter crystal frequencies are:

Transmitter Range kc	Approximate Overlap-kc Low End	Approximate Overlap-kc High End	Crystal Frequency kc
3000-3700	23	15	3105
3700-4800	36	54	4135
4800-6200	60	45	5000
6200-8000	45	55	6600

11. Power output comparison type K vs. GF-4 Transmitters.

Dummy Antenna			Power output - Watts					
			CW		MCW		Voice	
Frequency kc	Resistance ohms	Capacity mmfd	GF-4	K	GF-4	K	GF-4	K
3000	1.0	68	-	4.5	-	2.2	-	1.2
3000	1.0	86	1.0	-	0.5	-	0.4	-
3000	1.0	100	2.2	6.2	1.0	2.9	0.8	1.5
4385	2.0	70	3.4	13.0	1.6	7.4	1.3	3.4
6240	2.0	80	6.0	15.2	3.5	8.0	2.4	5.0
8000	4.0	110	16.0	34.0	9.0	16.0	4.8	10.0
8000	10.0	Inf.	-	17.4	-	7.3	-	2.5
8000	10.0	240	12.1	-	5.6	-	2.5	-

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Optimum Operating Data

Frequency kc	Dummy Antenna Resistance ohms	Dummy Antenna Capacity mmfd*	Power output - watts CW GF-4	CW K	MCW GF-4	MCW K	Voice GF-4	Voice K
3000	4	345**	16	11.3	9.0	5.5	4.8	2.2
3000	4	125	-	15.9	-	7.8	-	3.4
8000	10	130	-	36.1	-	19.6	-	10.0
8000	10	160	19.3	-	12.1	-	4.6	-

NOTE: * Optimum capacity for given resistance and particular set.
** Optimum capacity for GF-4 set.

12. The interphone power output characteristic is as follows:

Load Impedance ohms	Frequency cycles	Output - milliwatts Input volts of 0.5	1.0	1.5
600	300	13	32	68
600	1000	20	47	80
600	3000	17	37	71
300	300	26	61	120
300	1000	39	85	135
300	3000	32	70	120
200	300	35	84	165
200	1000	58	120	195
200	3000	50	115	165
50	300	88	195	-
50	1000	130	275	425
50	3000	115	260	390

13. Type K Receiver MCW Sensitivity Data

Output Impedance - 600 ohms, power supply voltage - 14.6 volts.
Volume control maximum

Output power - MW	Sensitivity-Microvolts MVC 10	MVC 50	AVC 10	AVC 50	Freq kc	Noise level mw
One receiver	4.3	11.5	12	100	250	2-3
Four receiver-Input in parallel	6.3	17.0	16	150	250	
Four receivers-Input and output in parallel	14.0	36.0	84	2300	250	
One receiver	5.0	11	10	100	6000	0.5
Four receivers-Input in parallel	6.4	14	13	170	6000	
Four receivers-Input and output in parallel	12.0	30	60	8000	6000	
One receiver	37	83	62	760	20000	Weak
Four receivers-Input in parallel	37	90	63	760	20000	
Four receivers-Input and output in parallel	67	170	370	100000	20000	

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14. Loop Operation - Bearing Sharpness Comparison.

The bearing sharpness comparison test was determined by tuning the RU-4 and K receivers to the Washington Range (332 kc) using a fighter airplane type loop. The data obtained were:

Receiver Output-mw	Loop angle from homing position-degrees RU-4 Receiver	K Receiver
Loop to receiver cable - Pair stranded hook-up wire 18" long.		
25	4	5
5	1	1
2	0	0
5	1	1
25	4	7
Loop to receiver cable - Type K shielded loop cable 17" long.		
25	11	28
10	7	15
5	5	9
2	3	3
1	0	0
2	3	5
5	6	12
10	8	17
25	12	32

B. Recommended Electrical Improvements.

1. The "Call" button system should be redesigned to eliminate the direct current from the telephone circuit. The "call" button current in the type K equipment varies from 60 to 115 ma and demagnetization of the telephone can be expected.

2. The side tone level was checked in flight and a satisfactory level for a number of observers varied from 0.2 volt to approximately 1.2 volts (two pairs of telephones in the circuit) with the average level at approximately 0.5 volt. The higher levels were obtained by observers in the front cockpit of the airplane. It is recommended that the side tone level be set to give approximately 1.2 volts into a 300 ohm load with microphone input voltage at 1.5 volts.

3. The microphonic tendency of the receiver vacuum tubes, observed during the flight testing should be eliminated.

4. When switching the control from "ICS" to "Transmit" position, there is a delay from 10 to 15 seconds before transmission is possible, due to the use of indirectly heated cathode vacuum tubes. It is recommended that the circuit be modified in order that the transmitter selector will be instantly ready for operation.

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5. All the r.f. and i.f. coils in the receivers are of the push-in socket type. This arrangement is not considered satisfactory from the service viewpoint. It is expected that salt water corrosion and oxidation will effect the sensitivity and selectivity. It is recommended that the design be modified to the extent that all connections are of the soldered type.

6. The antenna relay function of grounding the receiver antenna contact before the transmitter antenna contact is closed should be improved. When checked in flight the time interval between the two operations was too short.

7. The transmitter microphone and throttle switch control circuits are the same as used with the type GF equipment. This method is not entirely satisfactory since in a two place installation with throttle switch control both microphones can be active when only one microphone circuit is closed. It is suggested that the contractor be requested to recommend improvements in the control circuits.

8. The operating personnel are subject to r.f. burns from the transmitter antenna r.f. ammeter. Provide adequate protection.

9. The transmitter antenna r.f. ammeter insulation to the chassis should be increased.

10. The dynamotor high voltage current when operating the transmitter on CW transmission is in excess of 200 ma and the dynamotor is only rated for 160 ma. Correct.

11. Protection should be provided to the receiver antenna series condenser against excessive voltages such as obtained from precipitation static etc.

12. The two low frequency band receivers (200-580) and 520-1500 kc) have been designed for operation with either an antenna or a loop antenna and there is no means whereby one or the other can be selected as desired by the operator. The installation of two receivers covering the same frequency band will be necessary if homing and general reception is required in the same frequency band. It is recommended that an "antenna-loop" selector switch for local and remote operation be installed in the two lower-frequency-band receivers.

13. The receiver local oscillator radiation interference has been reduced to a value where general reception is practicable when operating two receivers adjacent to each other. The contractor should continue, however, investigating the problem to determine what additional improvements can be made to reduce the reradiation of the local oscillator. Tests with two receivers mounted on a rack unit when operating on "Manual-CW", maximum volume, with a 300 ohm output impedance and battery voltage of 14 volts gave:

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#1 Receiver Set to	#2 Receiver Set to	#1 Receiver Output volts	Equivalent Input to #1 Receiver microvolts
16 MC	11.8 MC	0.9	1.4*
16 MC	11.8 MC	5.5	47.0**
16 MC	-	0.1	0 ***

NOTE: *Antenna terminals of both receivers grounded.
**#1 receiver connected to antenna, #2 receiver antenna terminal grounded.
***#1 receiver connected to antenna; #2 receiver power shut off.

14. Resistor wattage ratings should be increased where overloading occurs, such as the resistors in the tone-oscillator plate circuit of the modulator.

15. The control box indicator lights are only useful during night operation; for day operation they are of no benefit since it is difficult to determine when they are "on". If they are retained, the brilliancy should be reduced to approximately half the present value for more satisfactory night operation.

16. Crystal twinning should be eliminated. The 3105 kc crystal gives a slight resonant indication on the cathode ray indicator tube at 3157 kc.

17. The transmitter crystal should be ground to frequencies corresponding to even divisions of the main tuning dial. This requirement should improve the accuracy of the transmitter frequency settings. As an example, 3105 kc is the frequency of the crystal provided for the 3000-3700 kc transmitter and the tuning dial is marked at 3100 and 3110; therefore, the operator must estimate the mid-position to set the transmitter on 3105 kc for calibration.

18. The tuning knob rotation is the same as the dial rotation; clockwise rotation giving decrease in frequency. To obtain clockwise rotation for increased frequency effect will require the units to be redesigned with possibly an increase in size.

19. It is not possible to receiver strong r.f. signals satisfactorily. This condition was noted when receiving signals emanating from another airplane while flying in formation. The following table was obtained during a bench test, with the 550-1500 kc receiver set on "Manual-MCW", with an output impedance of 300 ohms and a battery voltage of 12.3 volts. An inspection of the table shows for a r.f. signal of 44 microvolts, the receiver output varies from 500 to 0.1 milliwatts for 155 degrees rotation in the receiver volume control; whereas, for a r.f. signal of 100,000 microvolts, the receiver volume control rotation is only 20 degrees. A volume control range equivalent to the RU series receiver range is believed to be adequate.

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TABLE

R.F. Input mv	Volume Control Degrees	Receiver Output mw
7.5	315(maximum)	20
7.5	180	0.1
15	315	100
15	165	0.1
44	315	500
44	160	0.1
280	200	500
280	125	0.1
1400	170	500
1400	105	0.1
34000	120	500
34000	85	0.1
100,000	105	500
100,000	100	150
100,000	90	8
100,000	85	0.1

20. There is no provision in the extension control box for adjusting the receiver volume level. It is recommended that an independent volume control be provided in the extension control box and that the receiver output circuit be modified to the extent that the volume level in the extension control box, as set by the operator's control box, is at a higher level than the operator's level. This can be accomplished by adding a fixed resistor in series with the operator's control box receiver output circuit.

21. The current test jack should have the tips polarized "positive".

22. Very few failures occurred in the equipment during the tests. They consisted primarily of:

(a) Arcing from transmitter antenna ammeter to case.
(b) Arcing between the windings of the transmitter power amplifier coil and antenna loading coils.
(c) The condenser across the primary of the receiver output transformer failed due to high surge voltages.
(d) Cable failure due to lead breaking at the cable plug.
(e) Dynamotor roller bearing failure.

23. The use of high voltage electrolytic condensers is questioned.

24. The overload characteristics of the receivers on "Manual-CW" are not satisfactory as overloading occurs at too low a level.

25. The cw oscillator is too weak.

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26. The random noise level of the low frequency receivers is too high. A comparative check between the K and RU-4 receivers tuned to a CW carrier, in the broadcast band, maximum volume, Manual-MCW (also see paragraph 11.A13) gave:

Random noise level from K receiver - 1.2 volts
" " " " RU-4 " - 0.3 "

12. INTERPHONE-POWER UNIT COMMENTS.

A. The interphone-power unit, as submitted, was not adaptable for supplying power to the existing aircraft crystal frequency indicators and direction finders; however, with minor modifications in the electrical circuits, and the use of the interphone control box, the unit has been converted so the existing radio accessories do not have to be altered. The unit, as modified, can also be used with the GP-3 transmitting equipment as an ICS and side tone amplifier with only one modification in the GP-3 unit; namely, the removal of the ICS transformer, which is located in the GP-3 operator's control box. The modifications, see enclosure (CC), made in the unit, to attain the above results were:

(a) Place a wire jumper from terminal #2 to terminal #6 of each power outlet receptacle.

(b) Change wire connected to terminal #5 to terminal #1.

(c) Place a wire jumper from terminal #5 to terminal #3.

B. The mechanical comments in paragraph 10 applicable to this unit should apply.

C. It is recommended, when the unit is modified as stated above for use with the radio accessories, that an "On-Off" switch be installed on the top of the interphone control box for starting the dynamotor.

D. The audio fidelity of the amplifier has a rising characteristic to approximately 20,000 cycles. All frequencies above approximately 3000-4000 cycles should be rejected from the output circuit.

E. The output impedance peaks at approximately 100 ohms. Satisfactory operation is possible when operating this unit with either the RU or K receivers.

F. The unit will deliver approximately 90 milliwatts of power with an audio input signal of 1.2 volts. The output power level is satisfactory.

G. Satisfactory operation was obtained with the model LM, LM-2, RDF-1A and DU equipments. A check of the high voltage gave:

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Type Set	High Volts	H.V. Current-ma
IM	222	11.0
IM-2	218	11.6
RDF-1A	225	6.0
DU	237	2.4

H. Three identical type power receptacles are recommended. Two for supplying power to the radio accessories, such as direction finders and crystal frequency indicators, and one for controlling the GP type transmitters.

13. RECOMMENDATIONS

The recommendations listed in paragraphs 6, 9, 10, 11 and 12 are in addition to those tabulated herein.

A. It will be extremely difficulty to mock-up the transmitter-receiver control box. The unit, as submitted, requires a six inch space back of the box and for a four receiver and transmitter box there must be sufficient clearance for the insertion and removal of 7 cables, 4 mechanical linkages and 8 replacable lights. In order that the 6 inch space can be reduced the contractor should provide right angle cable plugs, and mechanical linkages. Where mechanical linkages of the straight type are specified, the specifications should require the 6 inch space be reduced to at least 4 inches and preferably to 3 inches. Tests should be conducted by Naval Research Laboratory to ascertain if satisfactory receiver operation can be obtained with mechanical linkages beat on a 3 or 4 inch radius.

B. The design of the transmitter antenna loading and coupling circuit has been improved over the circuit used in the GF series equipment when operating into a fixed antenna; however, this improvement has meant that inefficient operation is obtained when operating into a trailing wire antenna. Nevertheless, it is recommended that the present method of coupling be retained in order that the maximum output can be obtained from the fixed type antennas.

C. The two low frequency (200 to 1500 kc) receivers antenna alignment condensers are too large. Alignment of the fixed types of antenna is impossible below approximately 250 kc for the 200-580 range receiver and approximately 590 kc for the 520-1500 range receiver. This defect should be corrected.

D. The receiver output, when operating on "CW-Manual" and "Auto", is inadequate. Overloading occurs on the "CW-Manual" position with an output of approximately 90 milliwatts; in the "CW-Auto" position the maximum output is approximately 70 m.w. The contractor should investigate and correct the cause for the overload and low output.

E. The excessive key clicks present in the receiver output, when keying the transmitter, should be reduced. Peak voltages of approximately 14 volts were noted.

F. Excessive temperatures exist within the transmitter.

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A temperature of 113° C was noted on top of the power amplifier and antenna loading coil and 81° C on top of the piezo crystal during an hour run while keying MO's. Adequate cooling should be provided.

G. Tests indicate that the shielded loop to receiver cable is electrically inefficient and that the receiver loop input circuits are inferior to the model RU-4 receiver input circuits. See paragraph 11A14. Improve.

H. The use of metal and special types of vacuum tubes is questioned; however, no failure of tubes occurred during the tests. Their use in future equipments of this type is subject to the Bureau's approval.

I. It is recommended that all future receiver specifications require the receiver output level reduced, without introduction of transients, during the period that the associated transmitter power-antenna relay is closed.

J. If it is anticipated that a right-left indicator is required for direction finders, it is r ecommended that consideration be given to the problem at this time. For this purpose an additional converter unit would be required and it would be desirable to provide ganged tuning with the two low-frequency receivers and the converter unit.

K. The comments listed in reference (i) still apply.

L. It is recommended that the two complete equipments procured under contract C-NOs-64476 be sent to the service for further test and comments.

14. CONCLUSIONS

A. The equipment, as a whole, has been very well designed. It is exceptionally flexible from the point of view of meeting the many requirements of the naval service and has the additional advantages of simplicity of operation and not requiring a calibration chart to set up a given frequency.

B. All component parts used in the equipment are designed for compact size. This involves special development and design by the contractor who might be the only source of supply for replacements.

C. The interphone-power unit, submitted by the contractor and discussed elsewhere in this report, is required when radio accessories are to be used. Enclosure (EE) is a diagrammatic sketch showing the cable layout when using the K equipment, the interphone-power unit, the direction finder and the crystal frequency indicator. Enclosure (FF) is a similar type of sketch showing the interphone-power unit with the RU series receiver, the GP-3 transmitter, the direction finder and the crystal frequency indicator.

Classification changed from CONFIDENTIAL
To UNCLASSIFIED
By authority of 1550-156/42
File No. _____ Dated 3/31/42

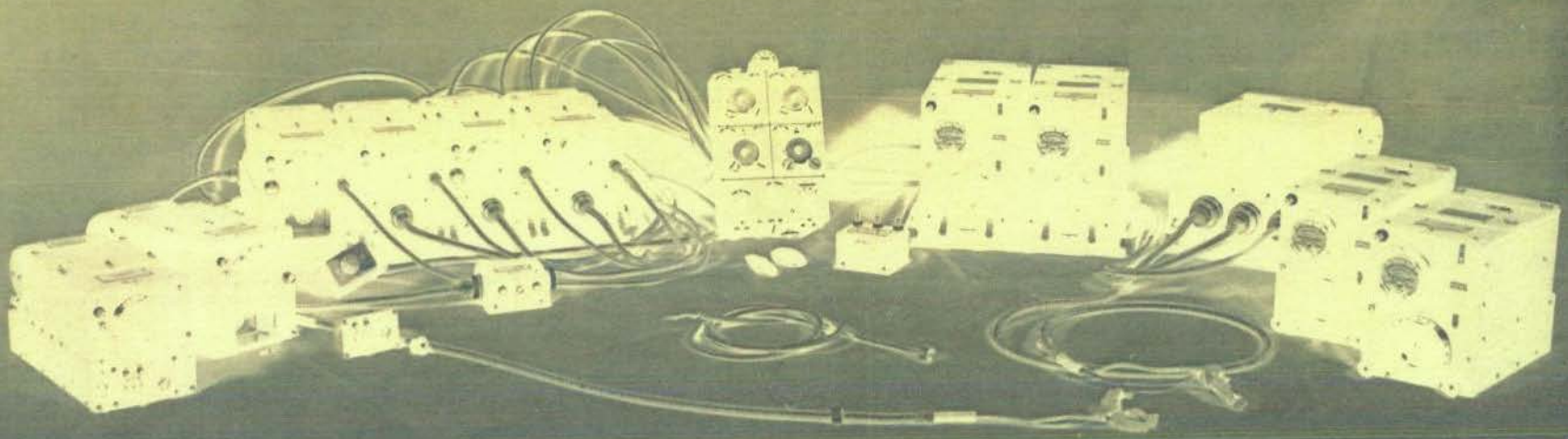
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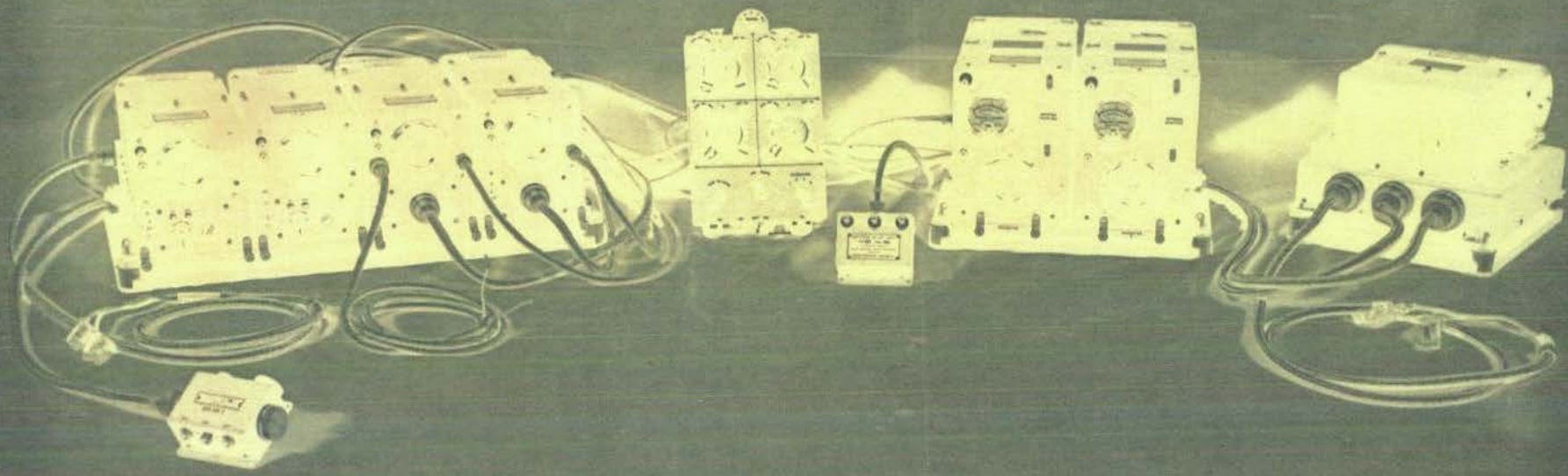
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TYPE K RADIO EQUIPMENT ENCLOSURE ( ) AN-53197 OFFICIAL NAVY PHOTOGRAPH
Composite view of equipment [redacted])4/20/39 NOT TO BE USED FOR PUBLICATION

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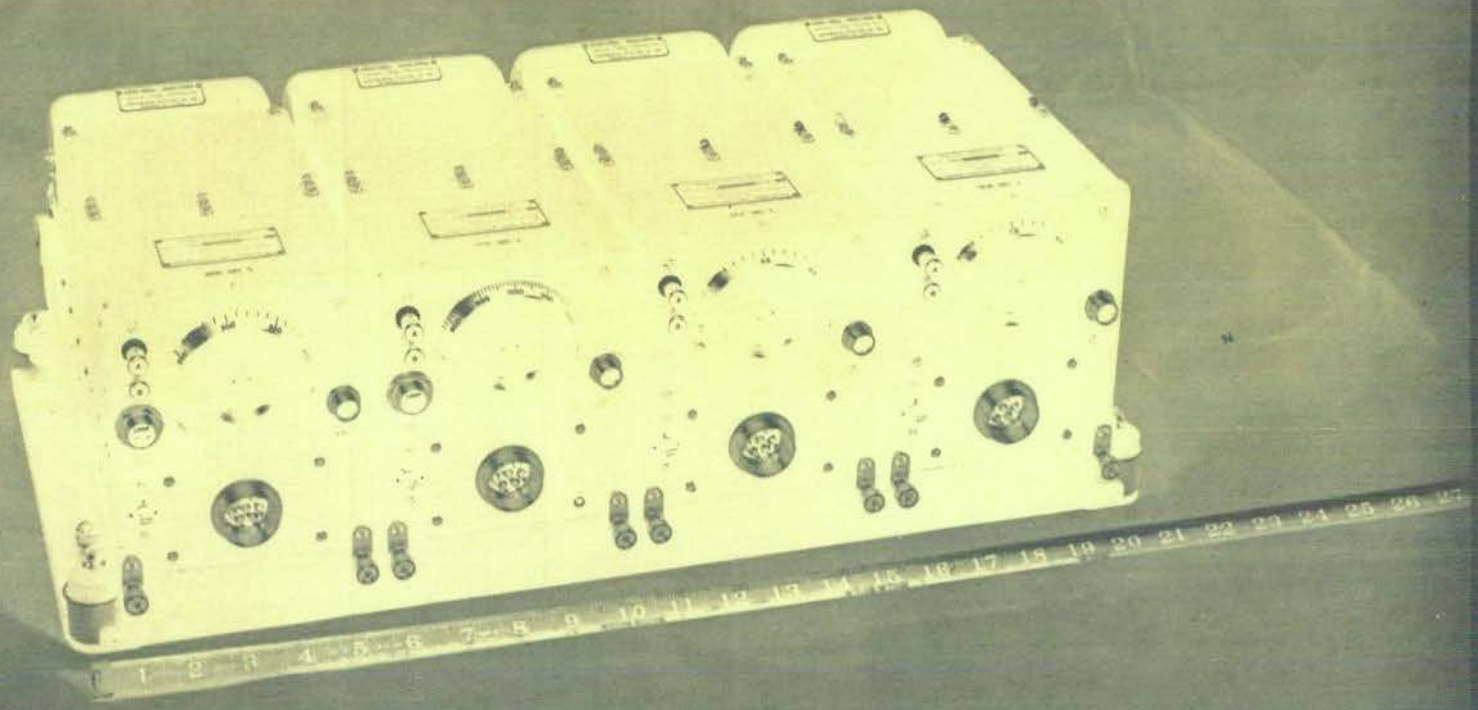


TYPE K RADIO EQUIPMENT
Composite view of equipment showing 4 receivers and 2 transmitters
***

AN-53198
4/20/39

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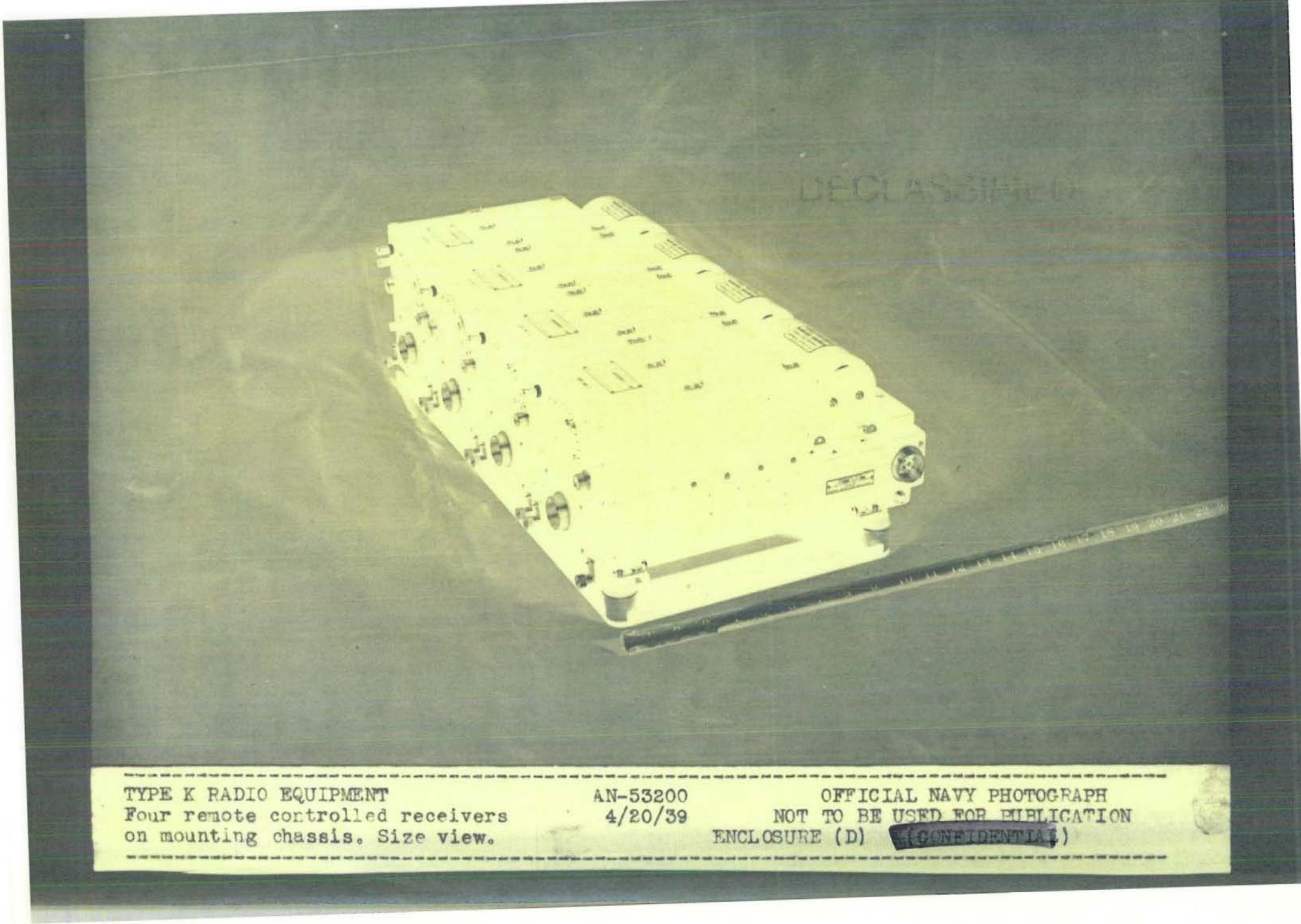
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TYPE K RADIO EQUIPMENT
Four remote-controlled receivers on mounting chassis. Front view.

AN-53199
4/20/39

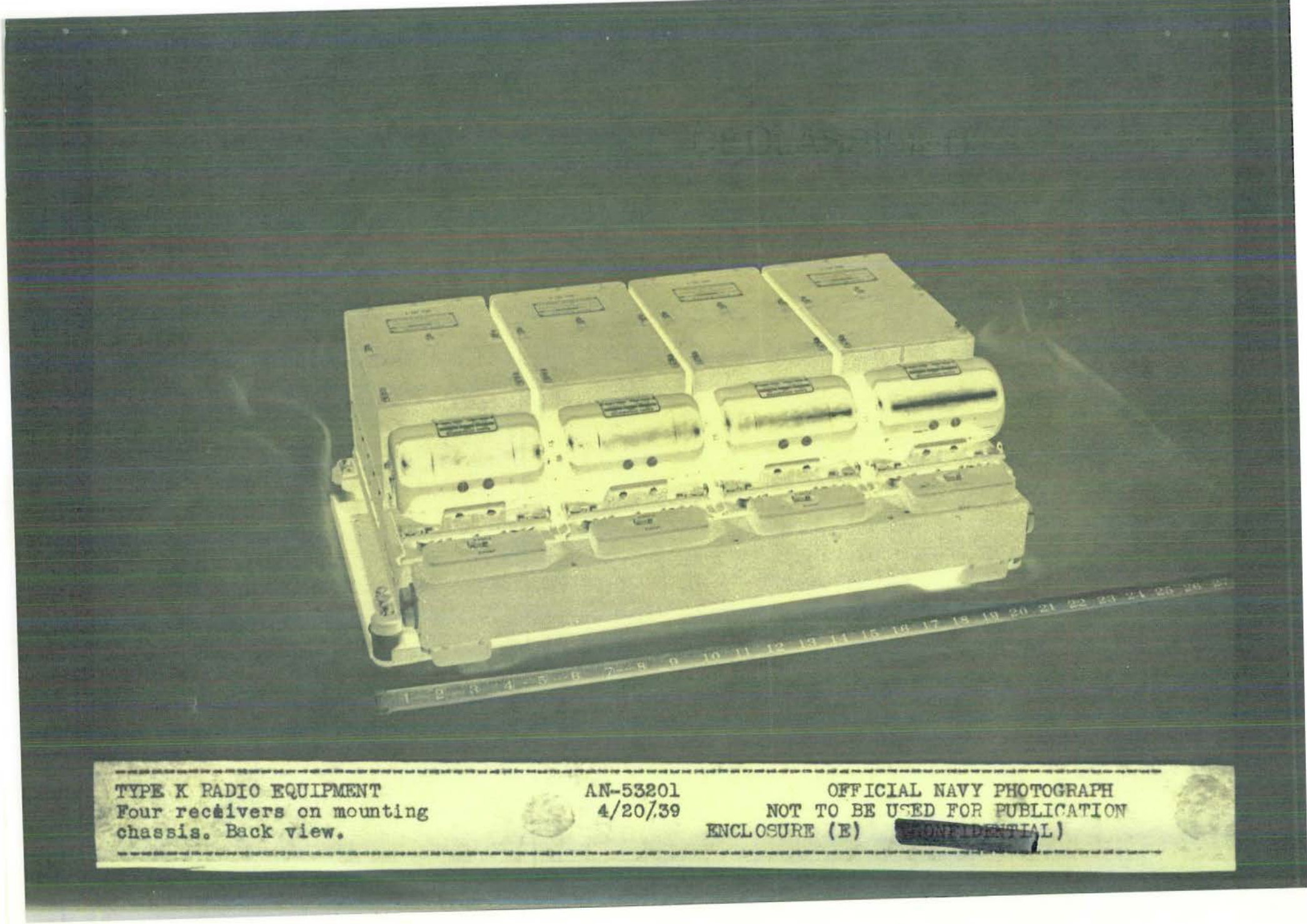
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TYPE K RADIO EQUIPMENT
Four remote controlled receivers on mounting chassis. Size view.

AN-53200
4/20/39

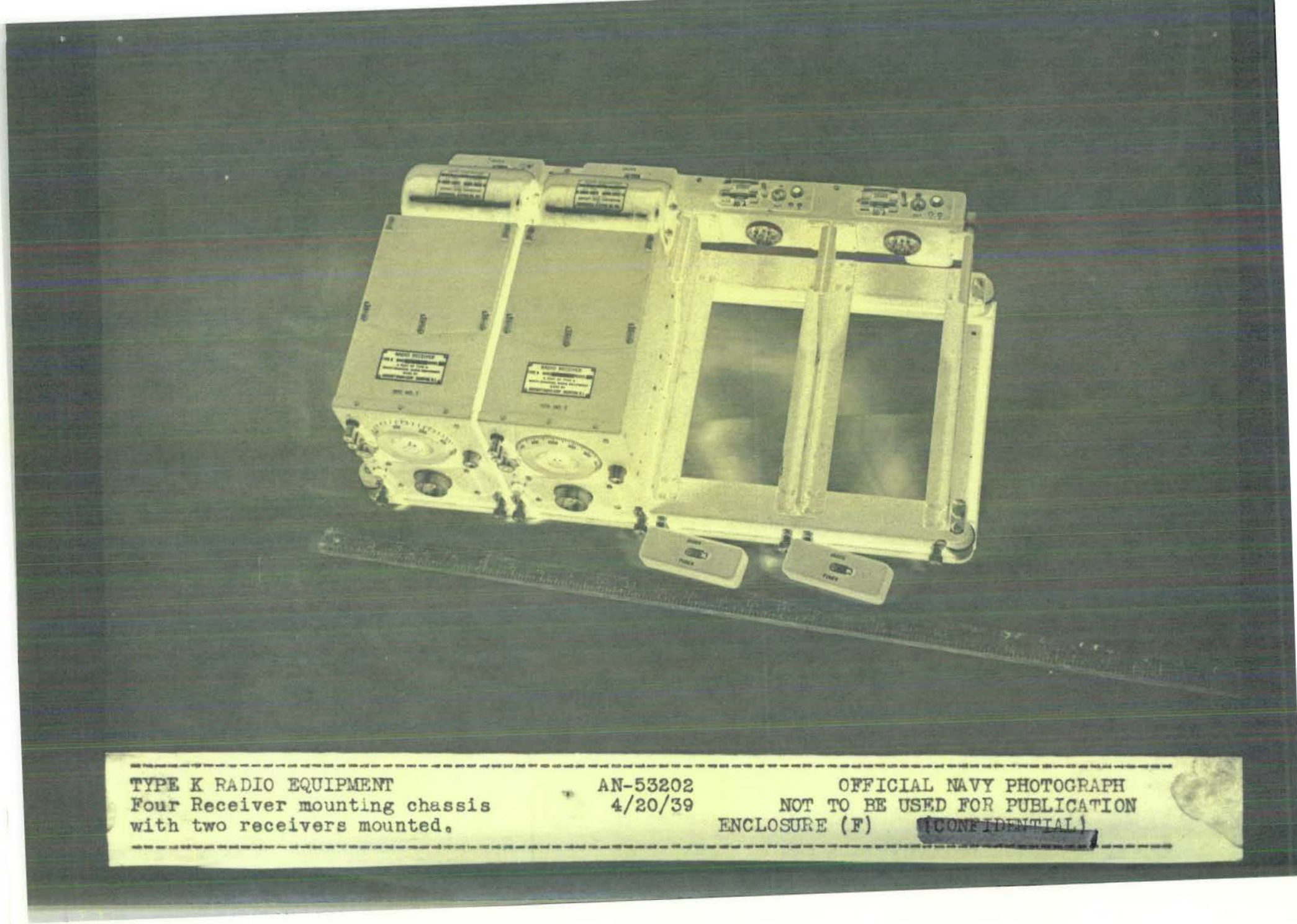
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TYPE K RADIO EQUIPMENT
Four receivers on mounting chassis. Back view.

AN-53201
4/20/39

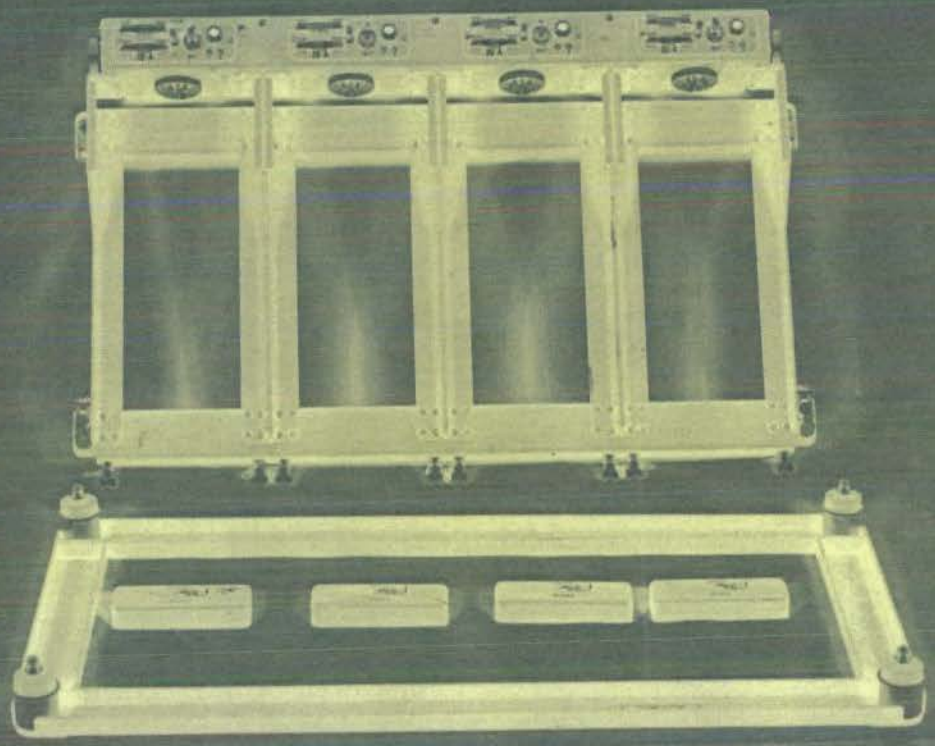
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TYPE K RADIO EQUIPMENT
Four Receiver mounting chassis
with two receivers mounted.

AN-53202
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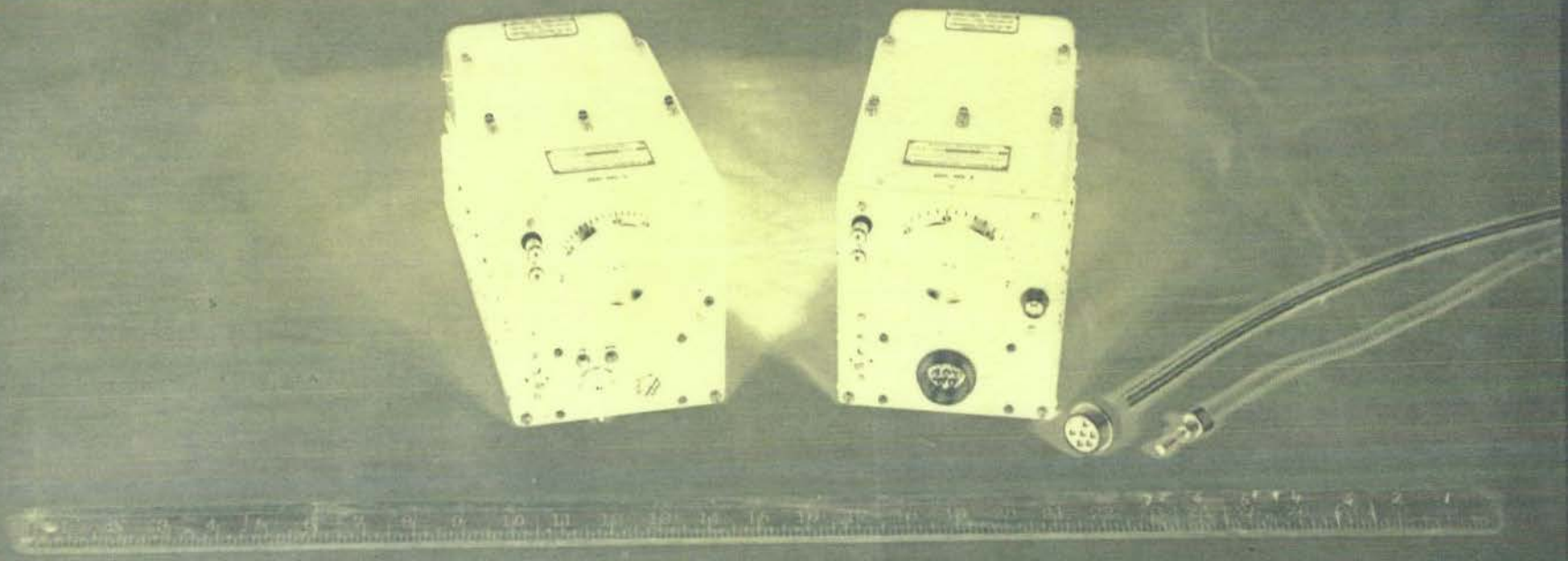


TYPE K RADIO EQUIPMENT
Four receiver mounting chassis.

AN-53203
4/20/39

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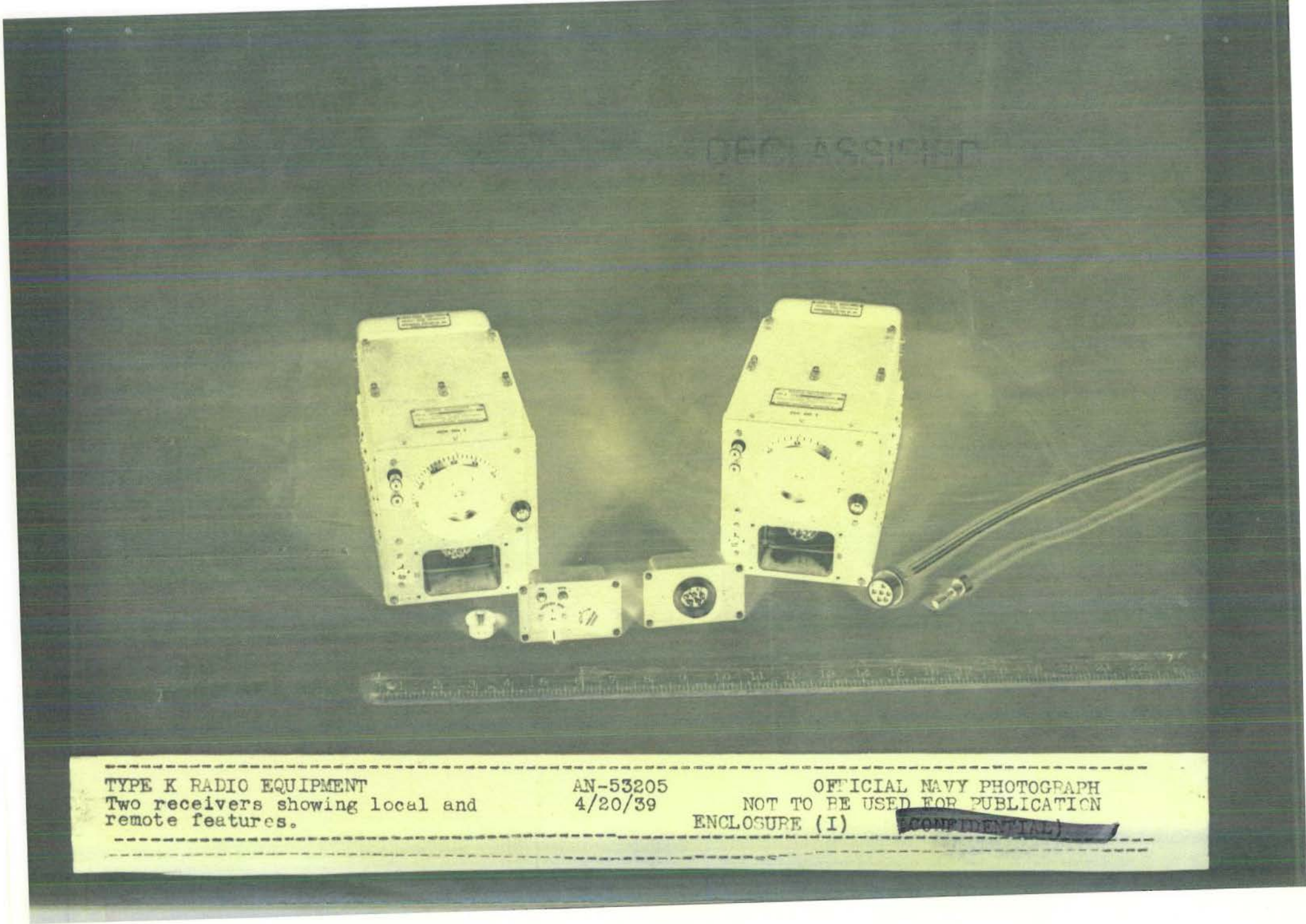
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TYPE K RADIO EQUIPMENT
Two receivers showing local and remote control features in place.

AN-53204
4/20/39

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ENCLOSURE (H) (CONFIDENTIAL)

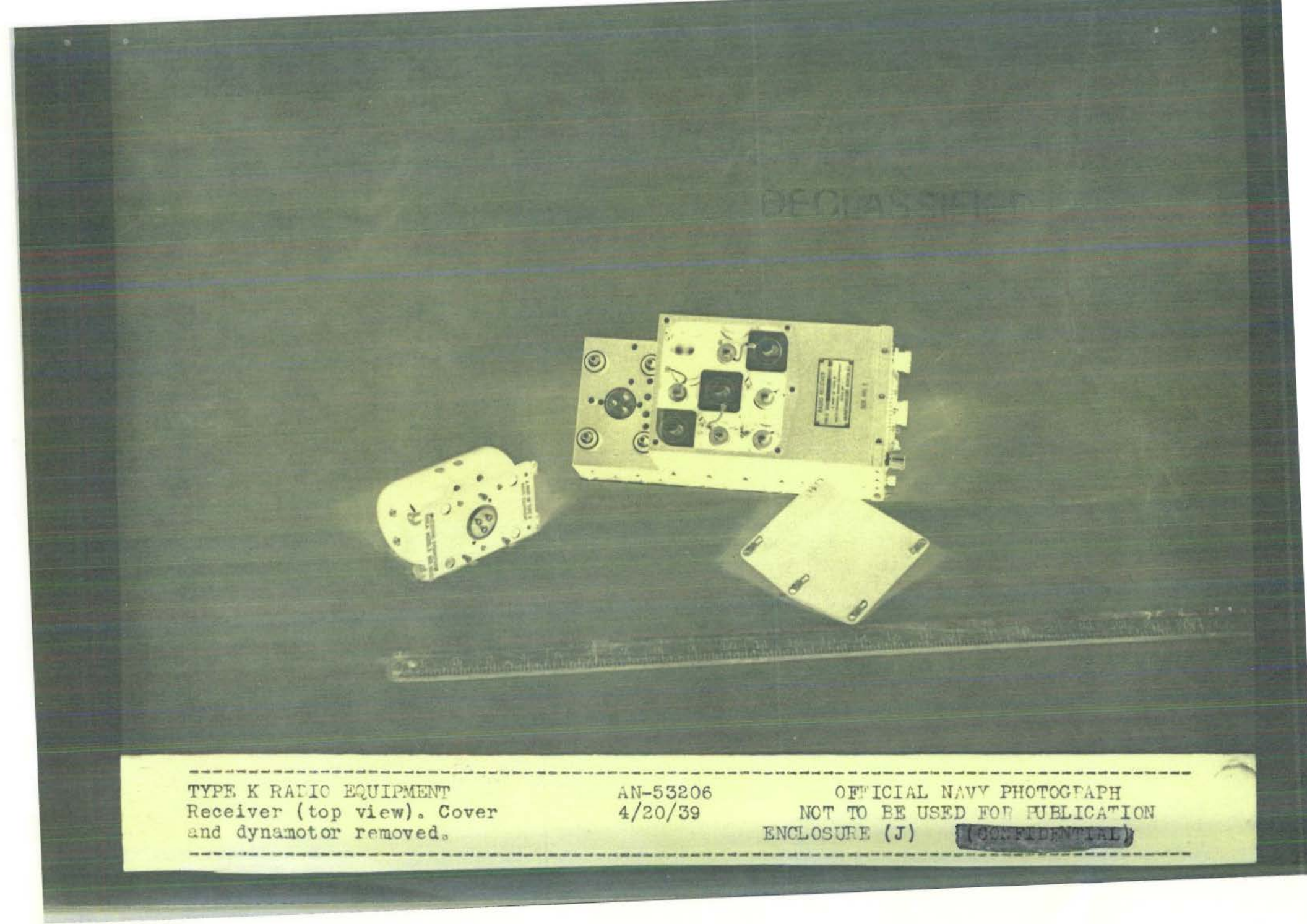


TYPE K RADIO EQUIPMENT
Two receivers showing local and remote features.

AN-53205
4/20/39

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ENCLOSURE (I)

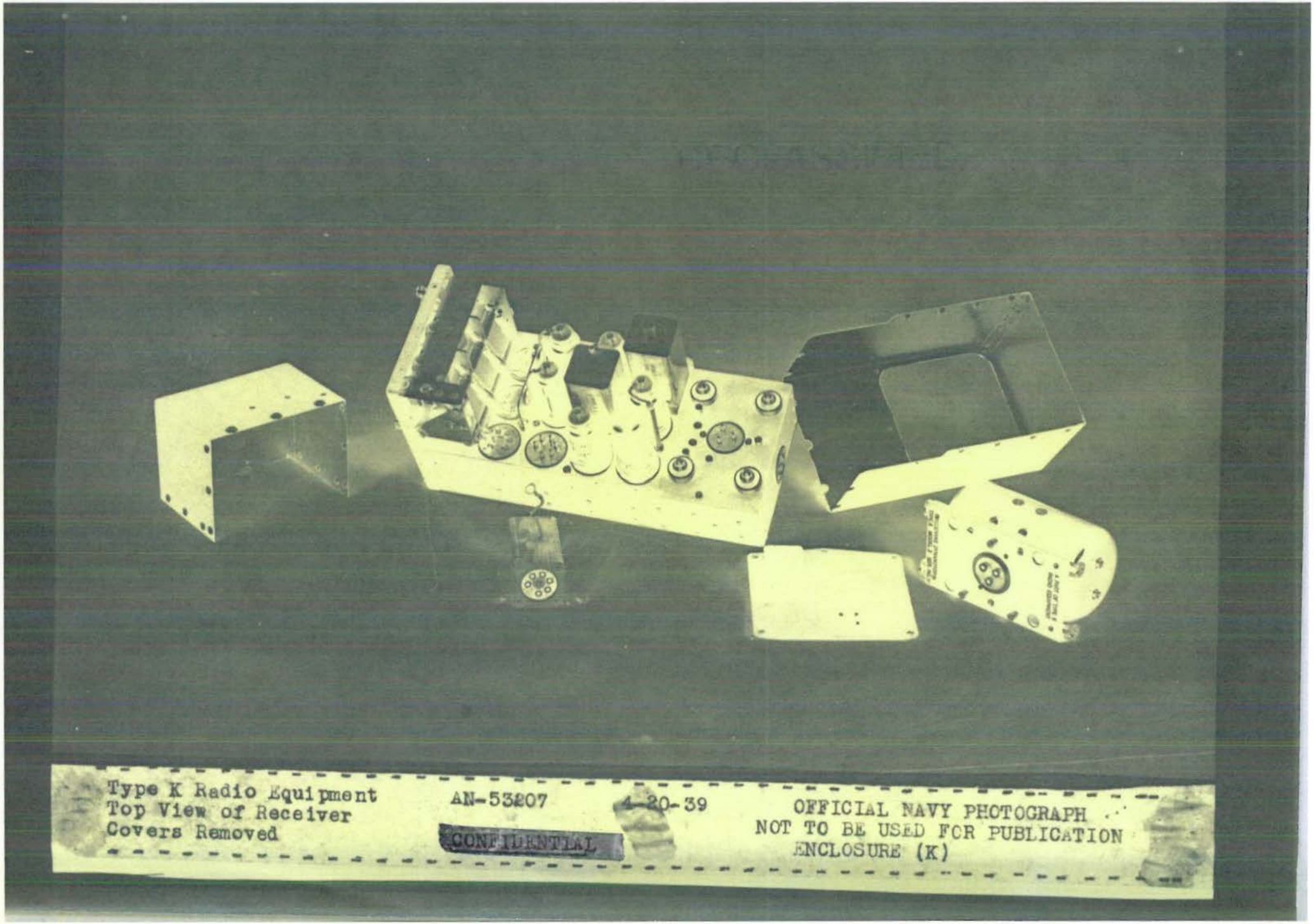
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TYPE K RADIO EQUIPMENT
Receiver (top view). Cover and dynamotor removed.

AN-53206
4/20/39

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NOT TO BE USED FOR PUBLICATION
ENCLOSURE (J) (CONFIDENTIAL)



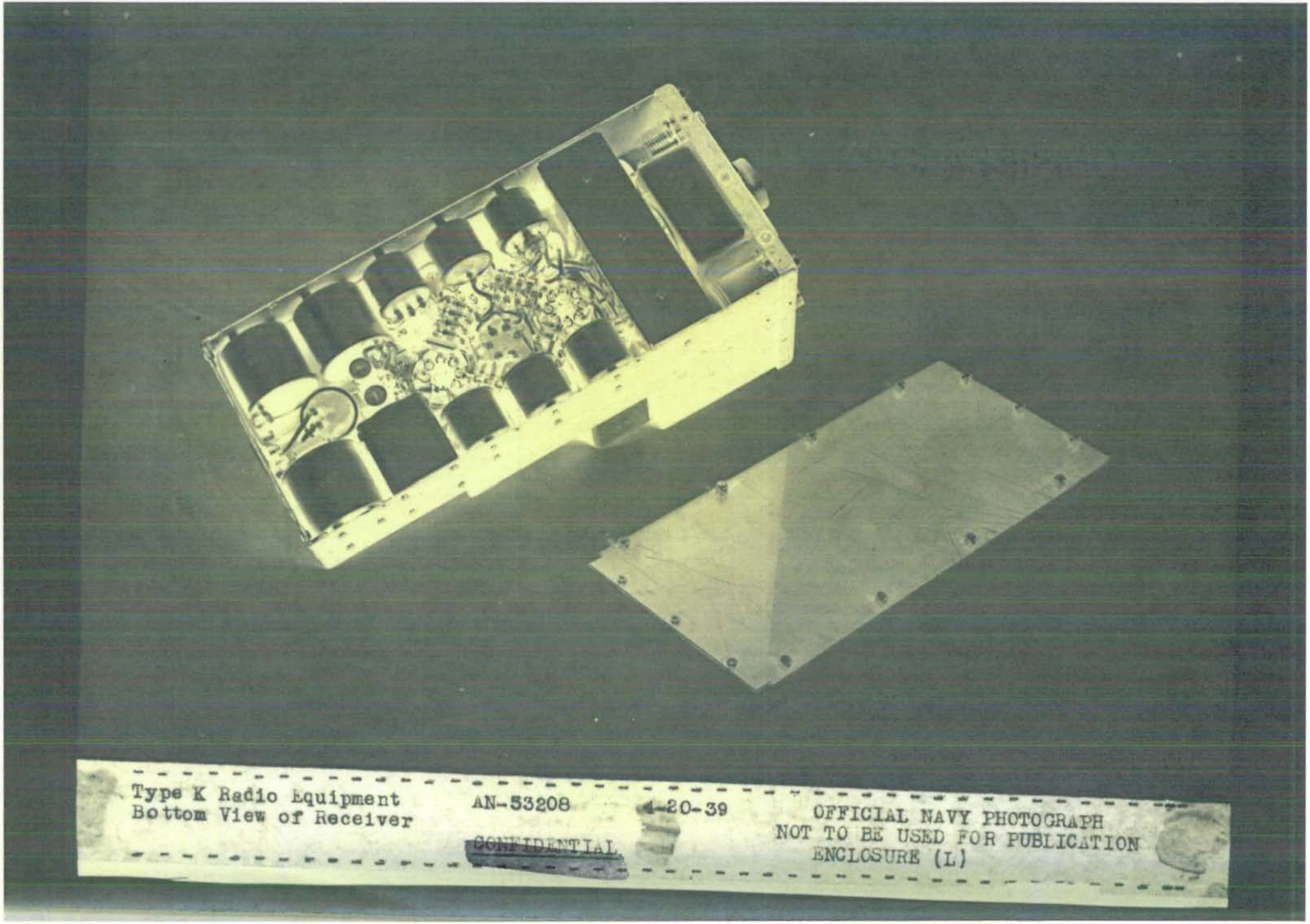
Type K Radio Equipment
Top View of Receiver
Covers Removed

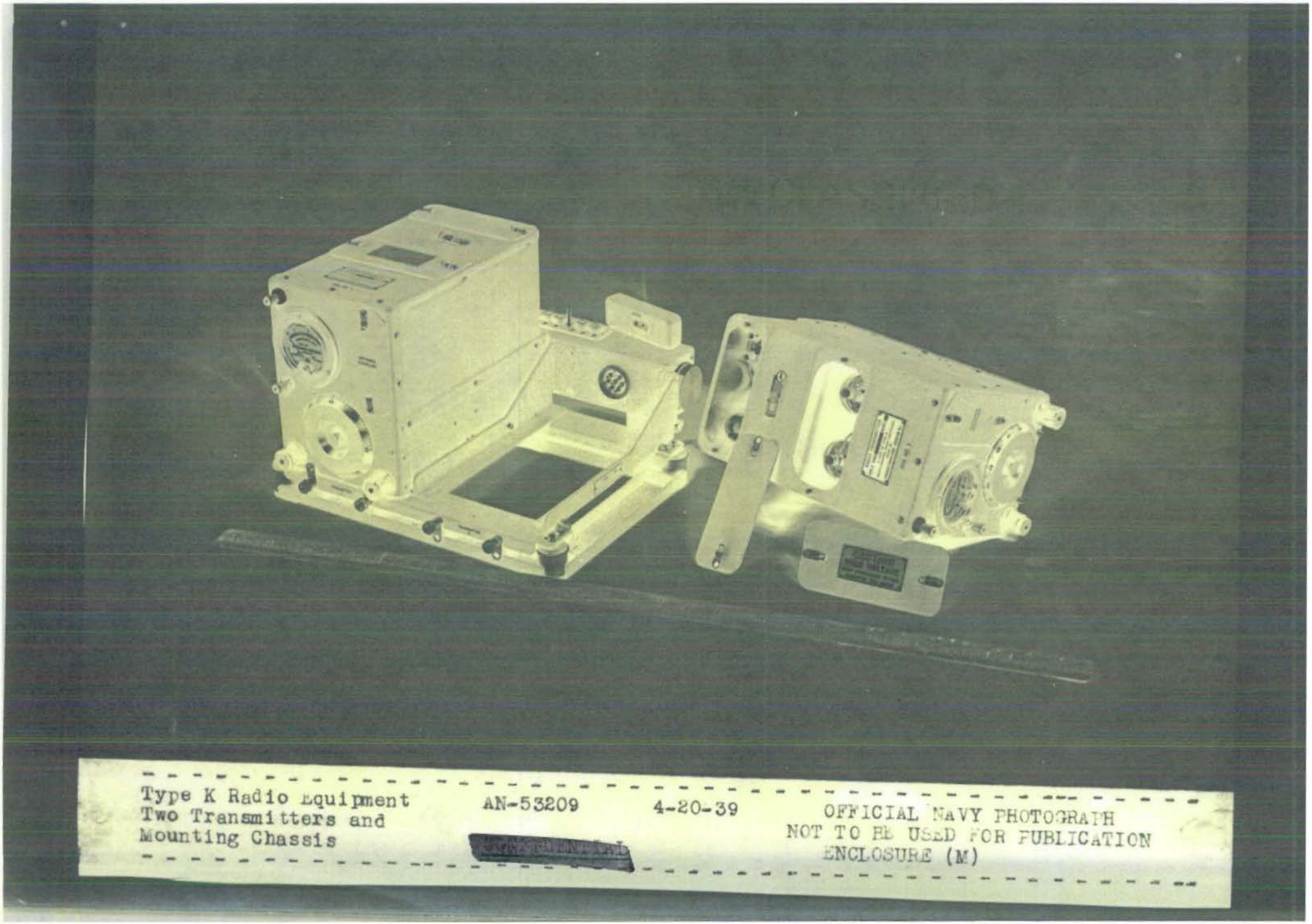
AN-53207

4-20-39

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NOT TO BE USED FOR PUBLICATION
ENCLOSURE (K)


Type K Radio Equipment
Bottom View of Receiver
AN-53208
4-20-39
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OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (L)

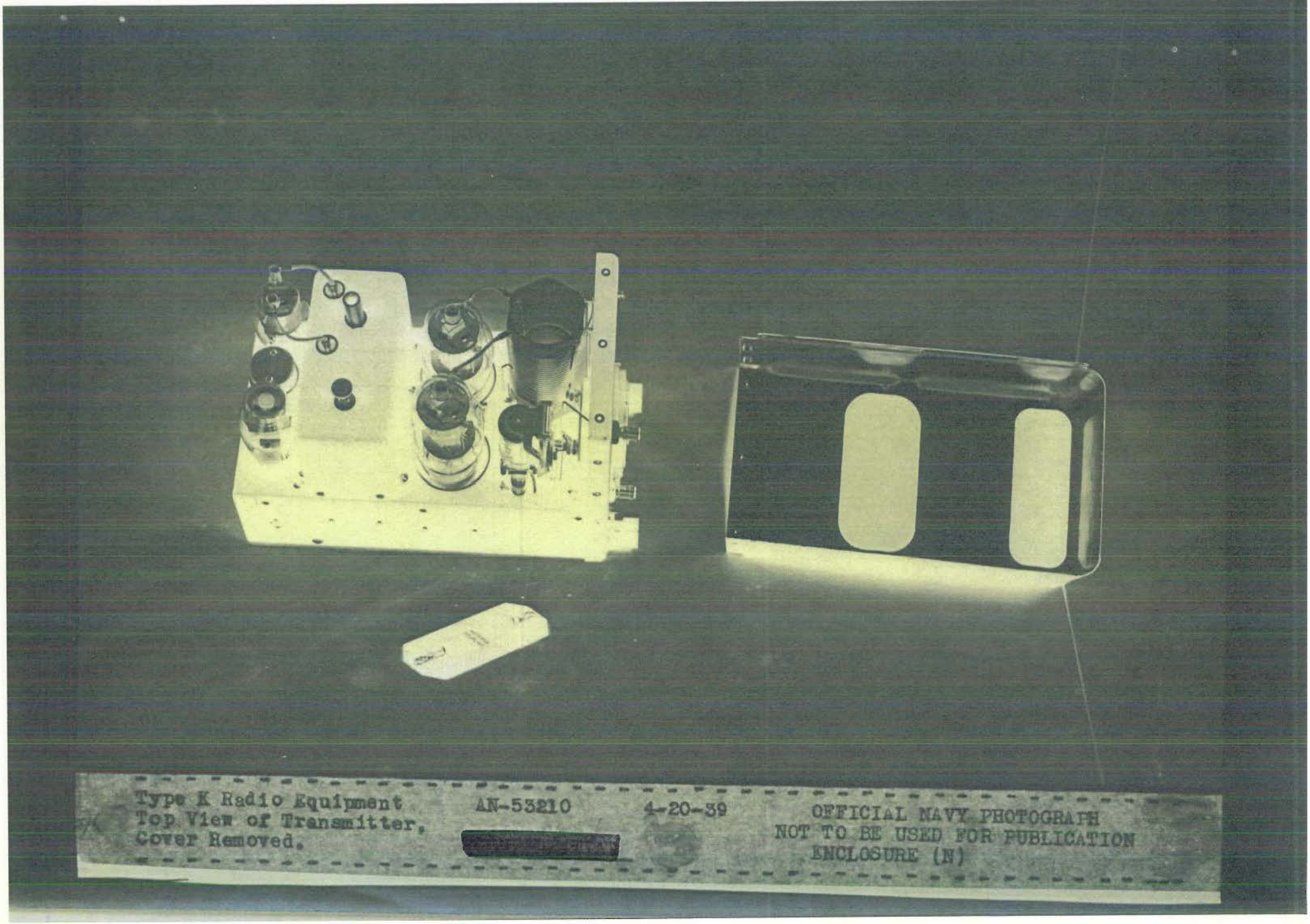


Type K Radio Equipment
Two Transmitters and
Mounting Chassis

AN-53209

4-20-39

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ENCLOSURE (M)

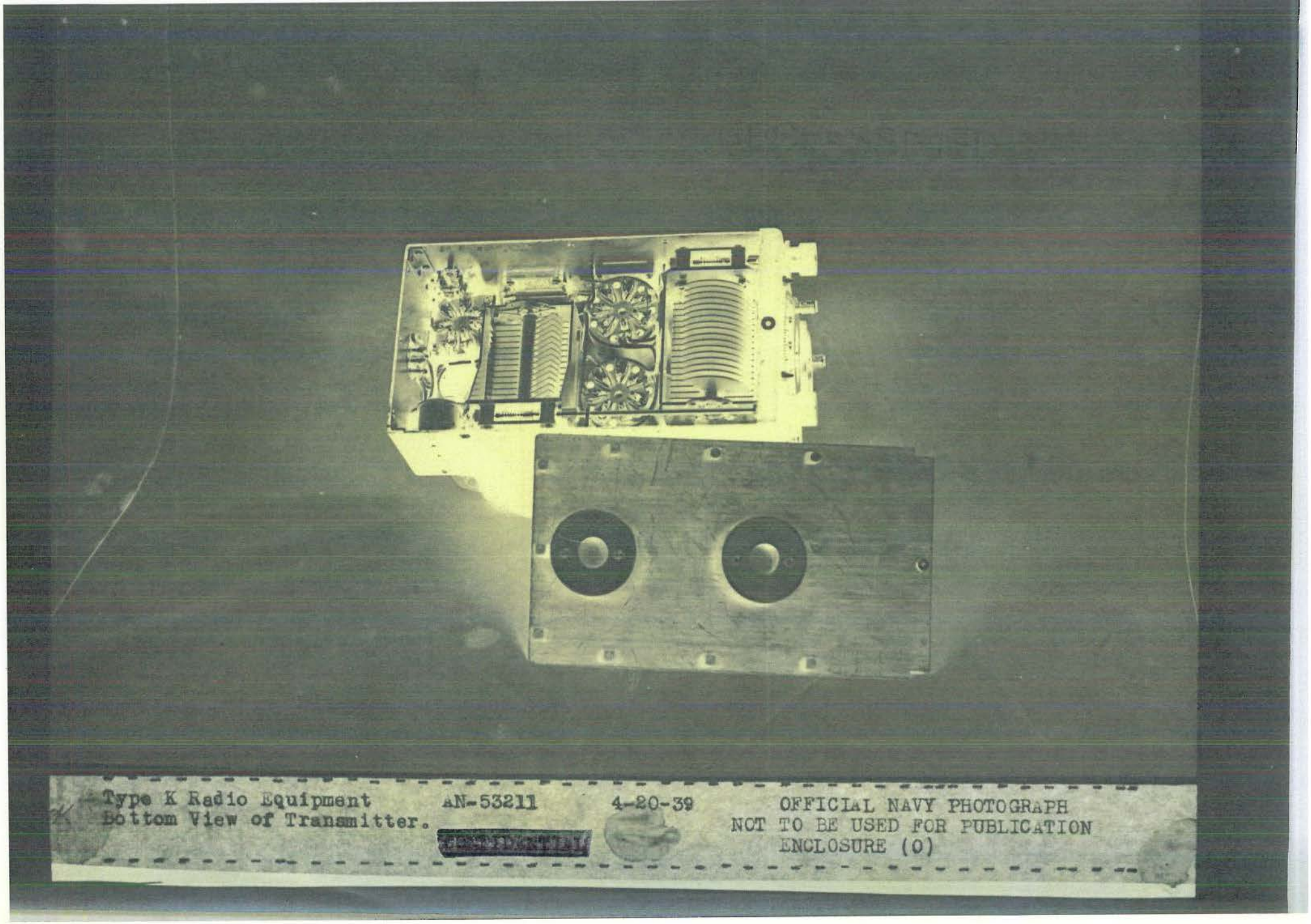


Type K Radio Equipment
Top View of Transmitter,
Cover Removed.

AN-53210

4-20-39

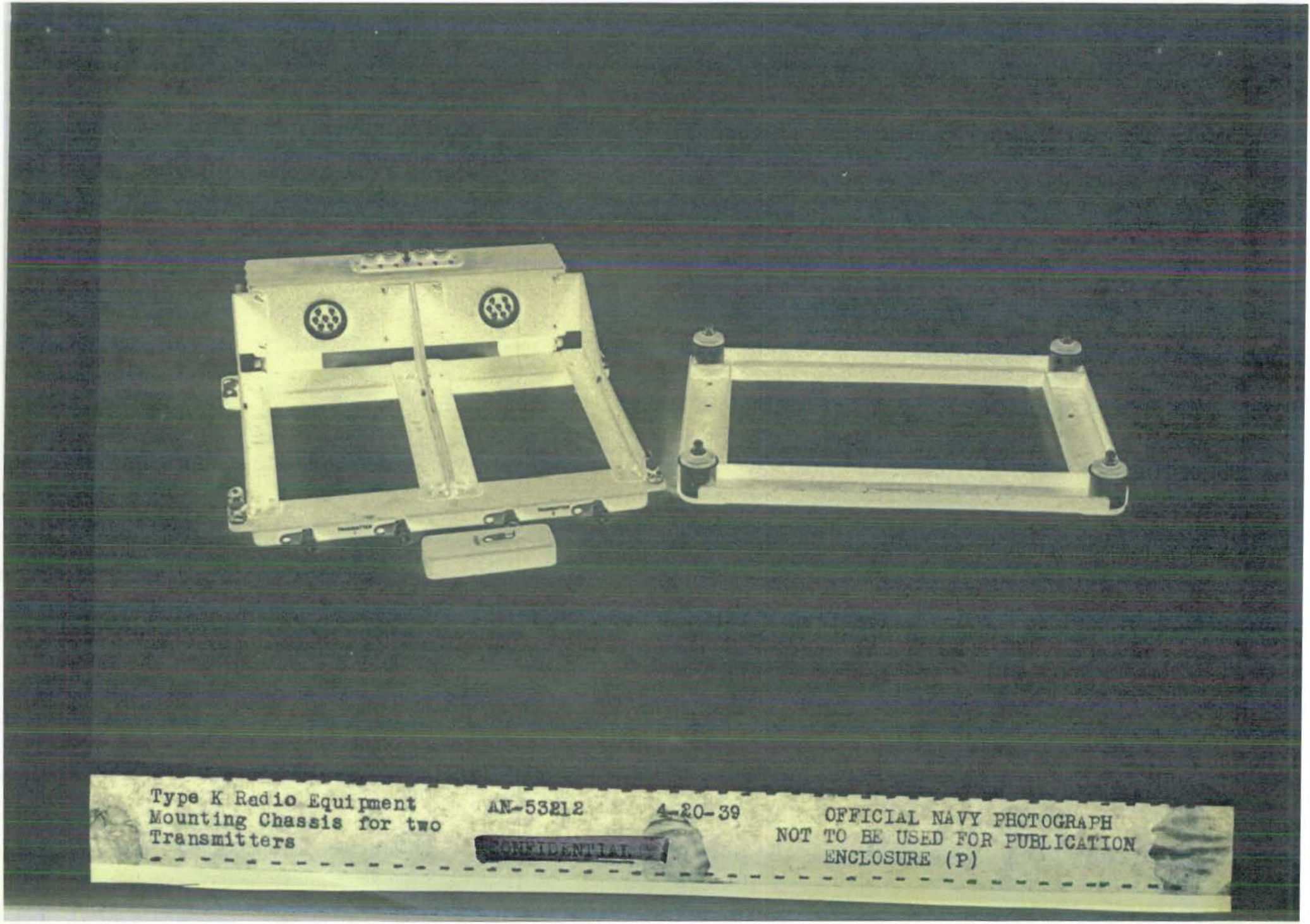
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (N)



Type K Radio Equipment aN-53211 4-20-39
Bottom View of Transmitter.

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OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (O)



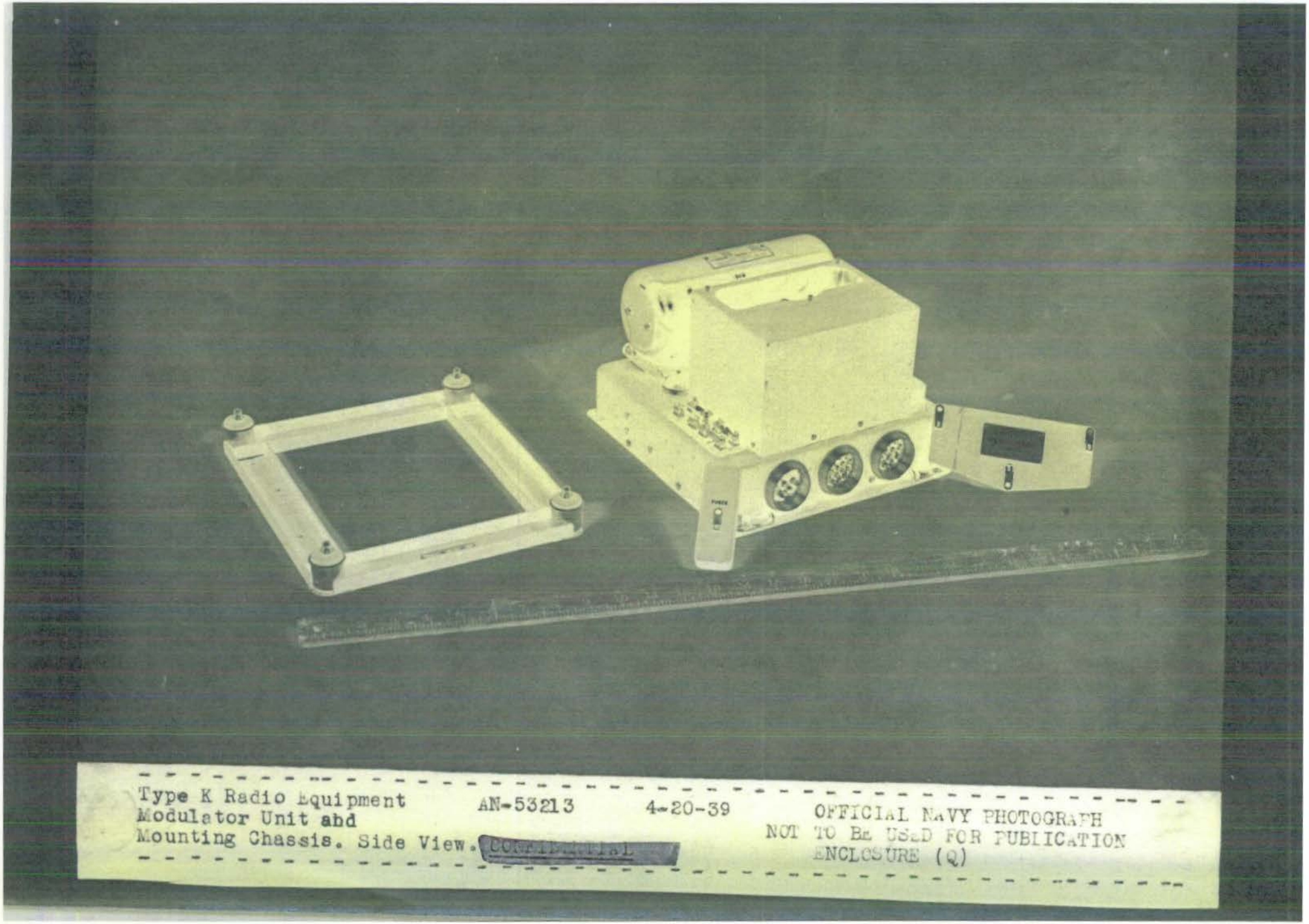
Type K Radio Equipment Mounting Chassis for two Transmitters

AN-53212

4-20-39

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NOT TO BE USED FOR PUBLICATION
ENCLOSURE (P)

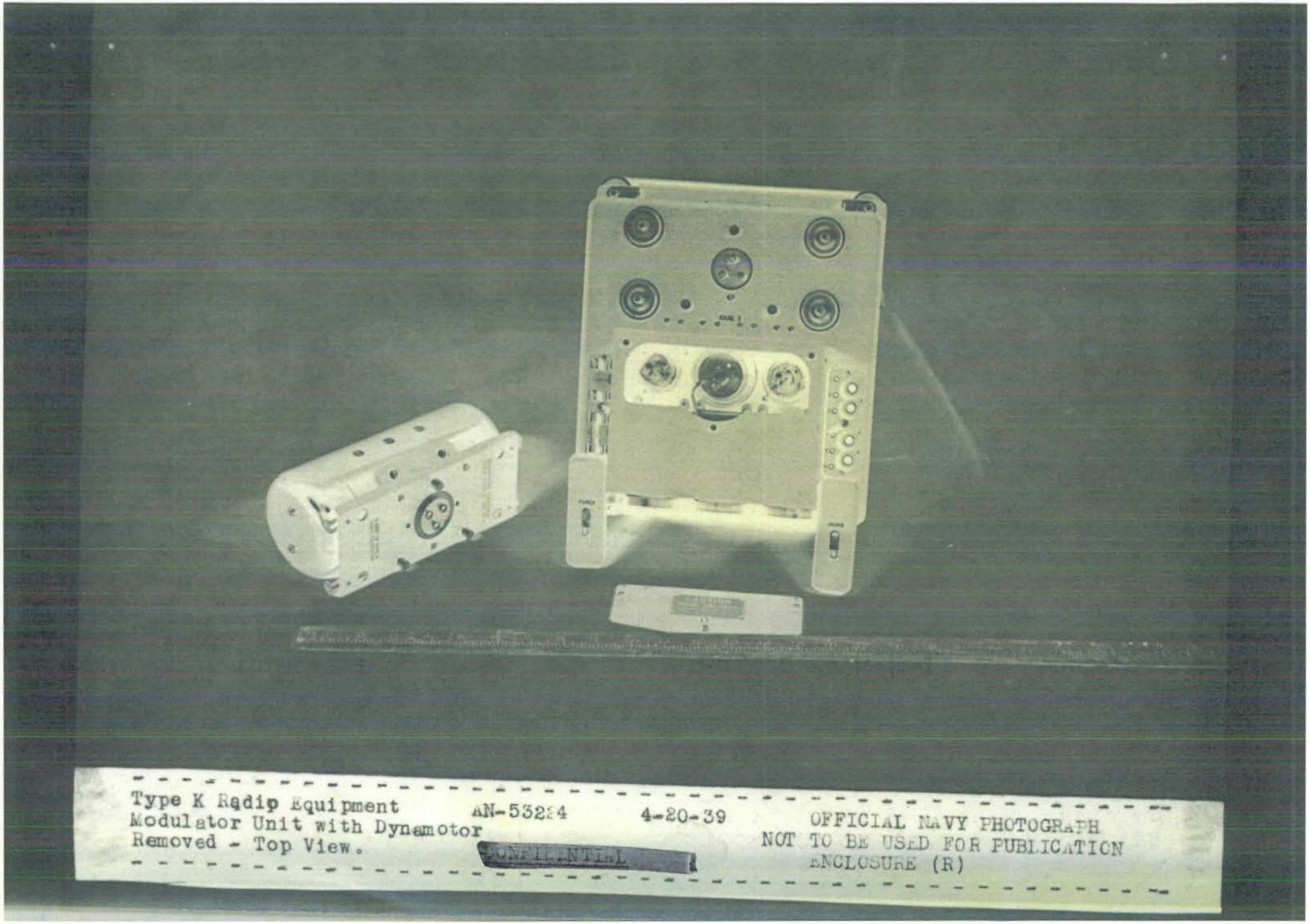


Type K Radio Equipment Modulator Unit abd Mounting Chassis. Side View. CONFIDENTIAL

AN-53213

4-20-39

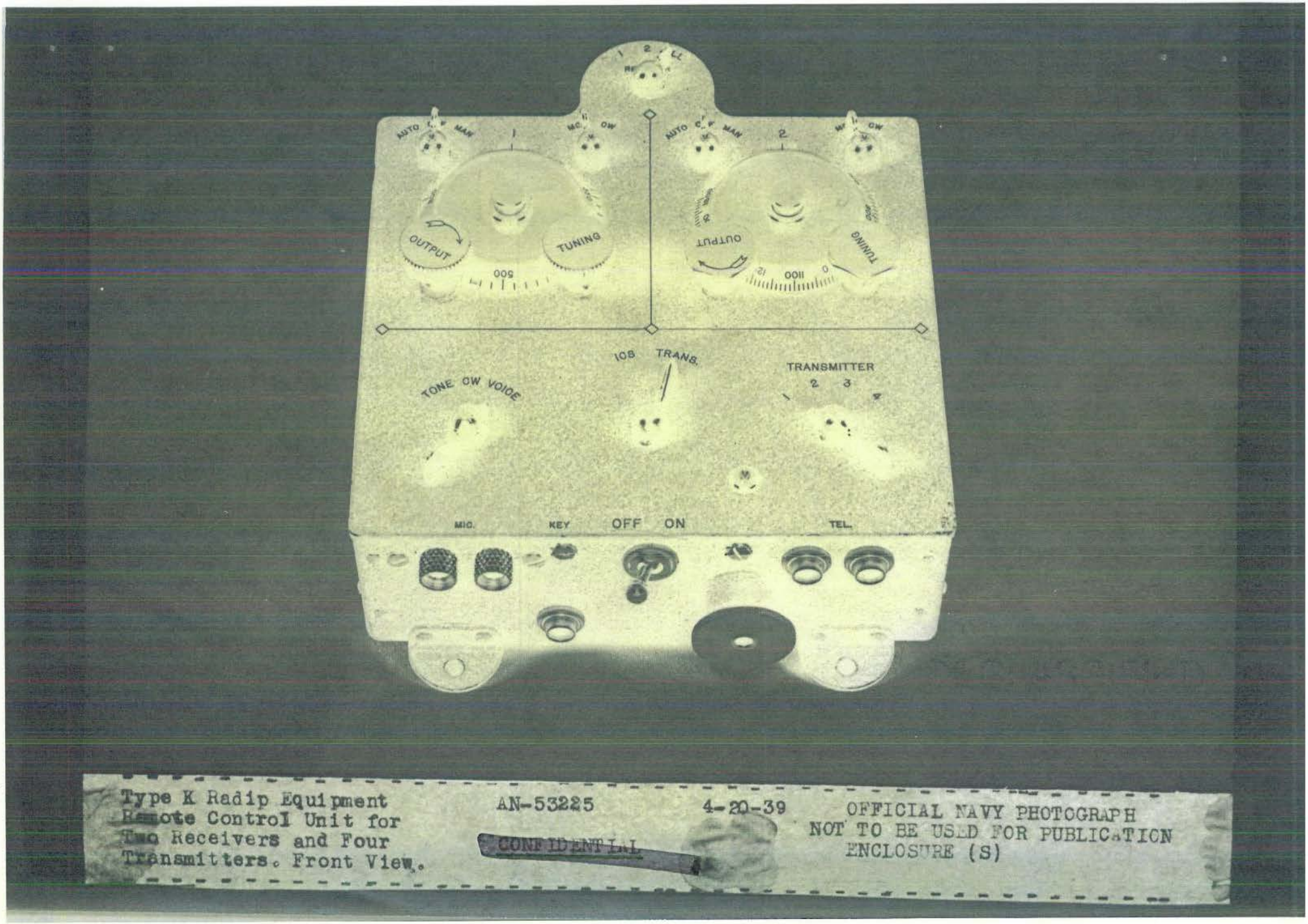
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (Q)



Type K Radip Equipment AN-53224 4-20-39
Modulator Unit with Dynamotor
Removed - Top View.

CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (R)



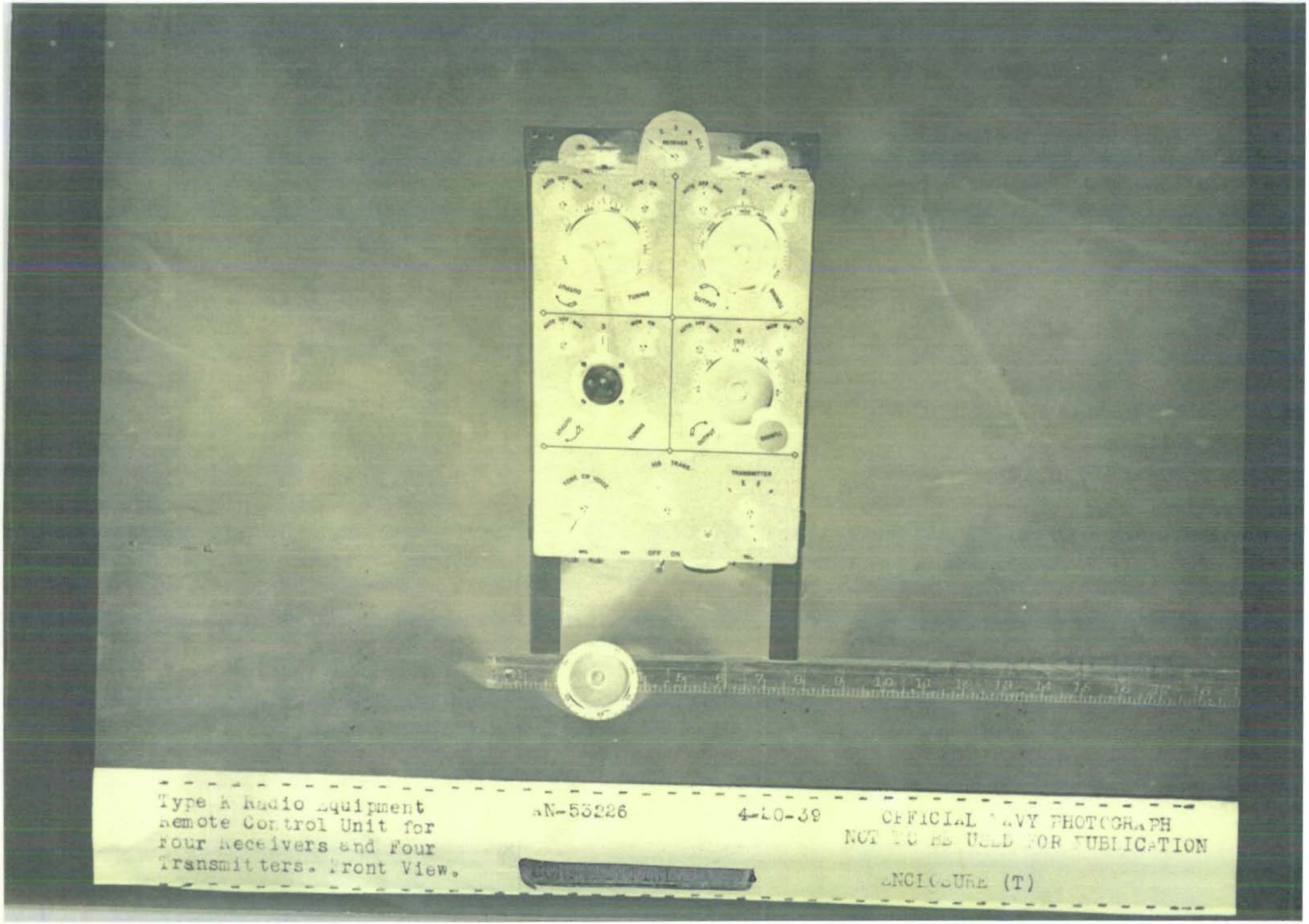
Type K Radip Equipment Remote Control Unit for Two Receivers and Four Transmitters. Front View.

AN-53225

4-20-39

CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (S)



Type K Radio Equipment Remote Control Unit for four Receivers and Four Transmitters. Front View.

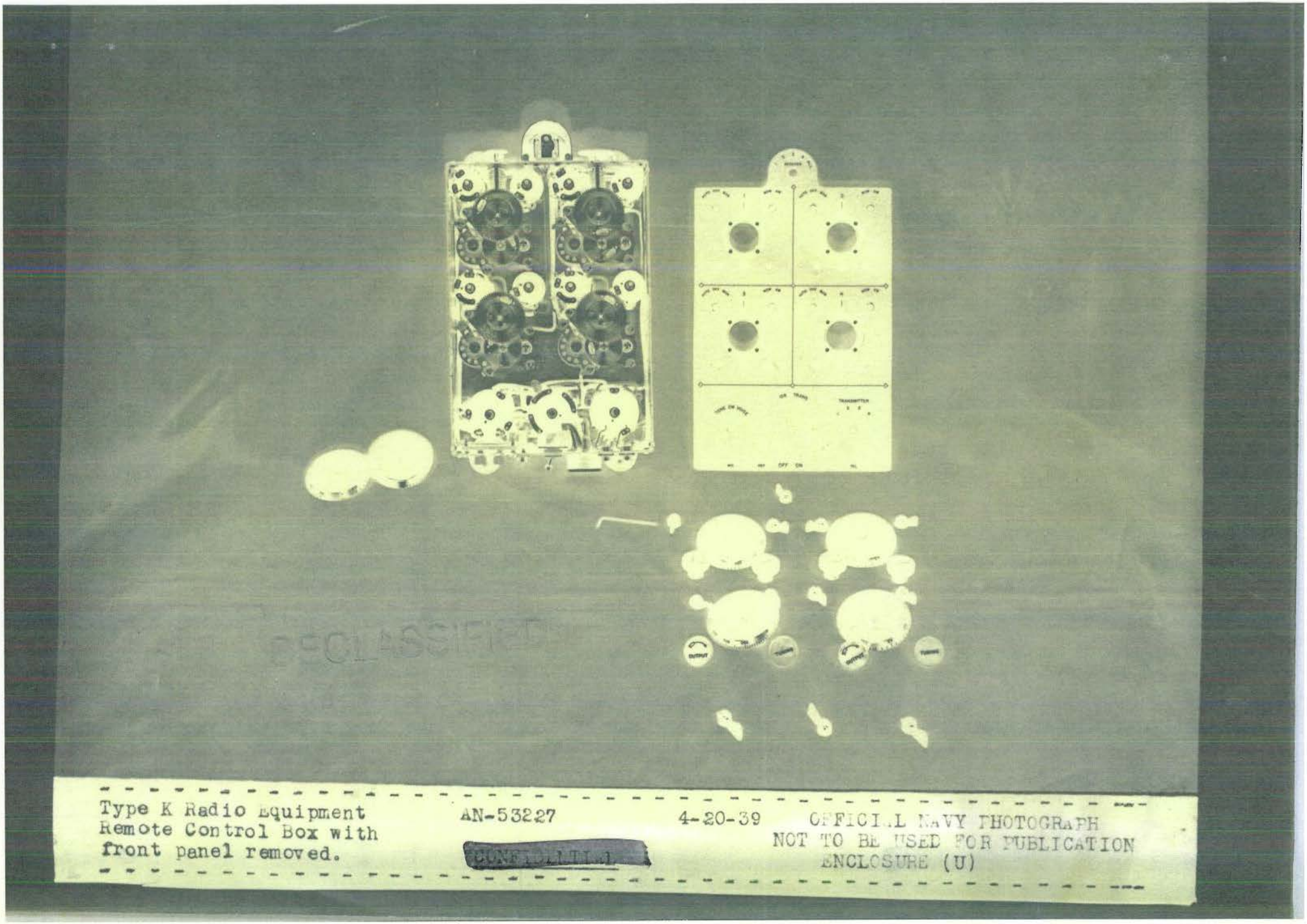
aN-53226

4-20-39

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

CONFIDENTIAL

ENCLOSURE (T)



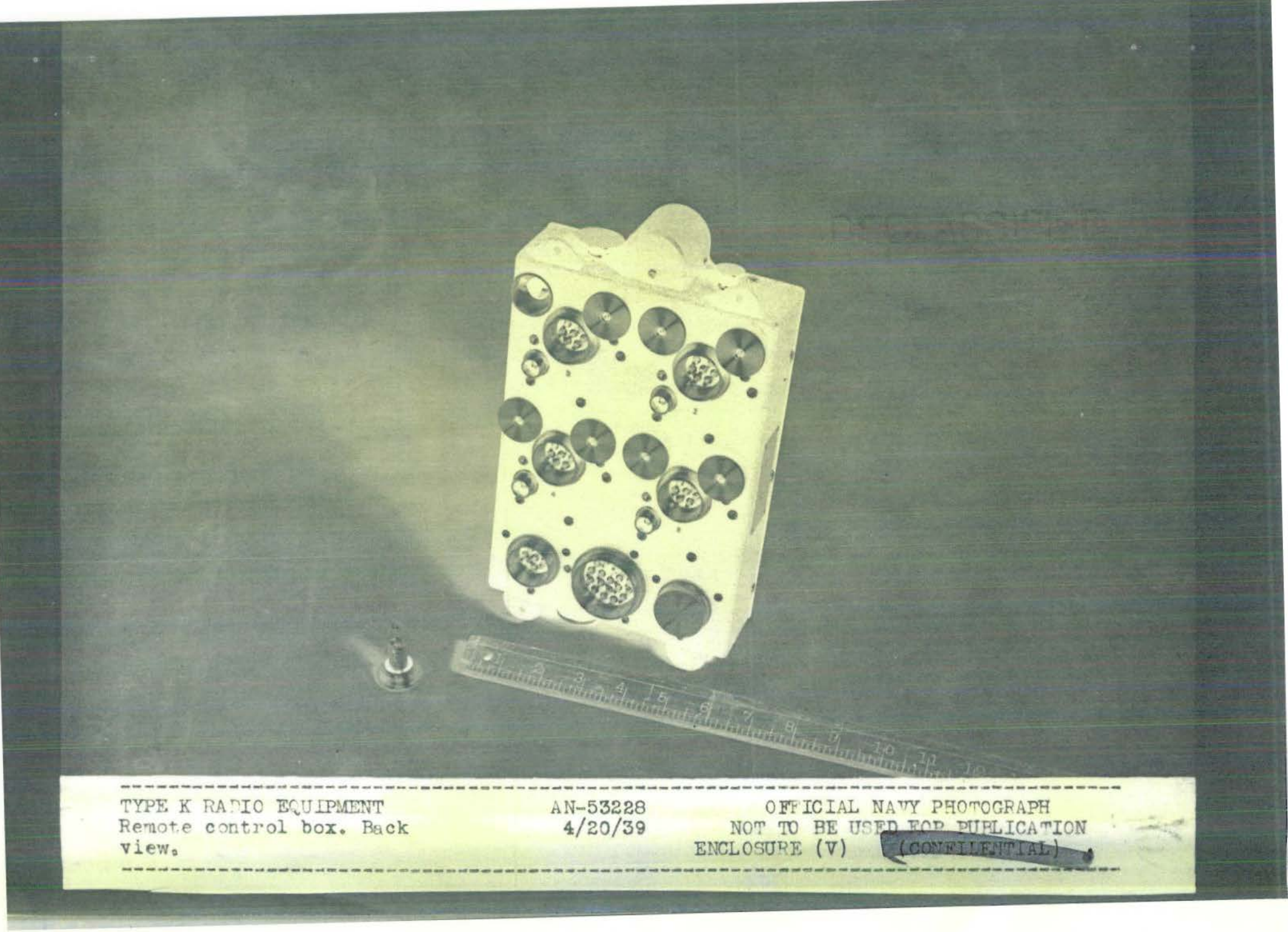
Type K Radio Equipment
Remote Control Box with
front panel removed.

AN-53227

4-20-39

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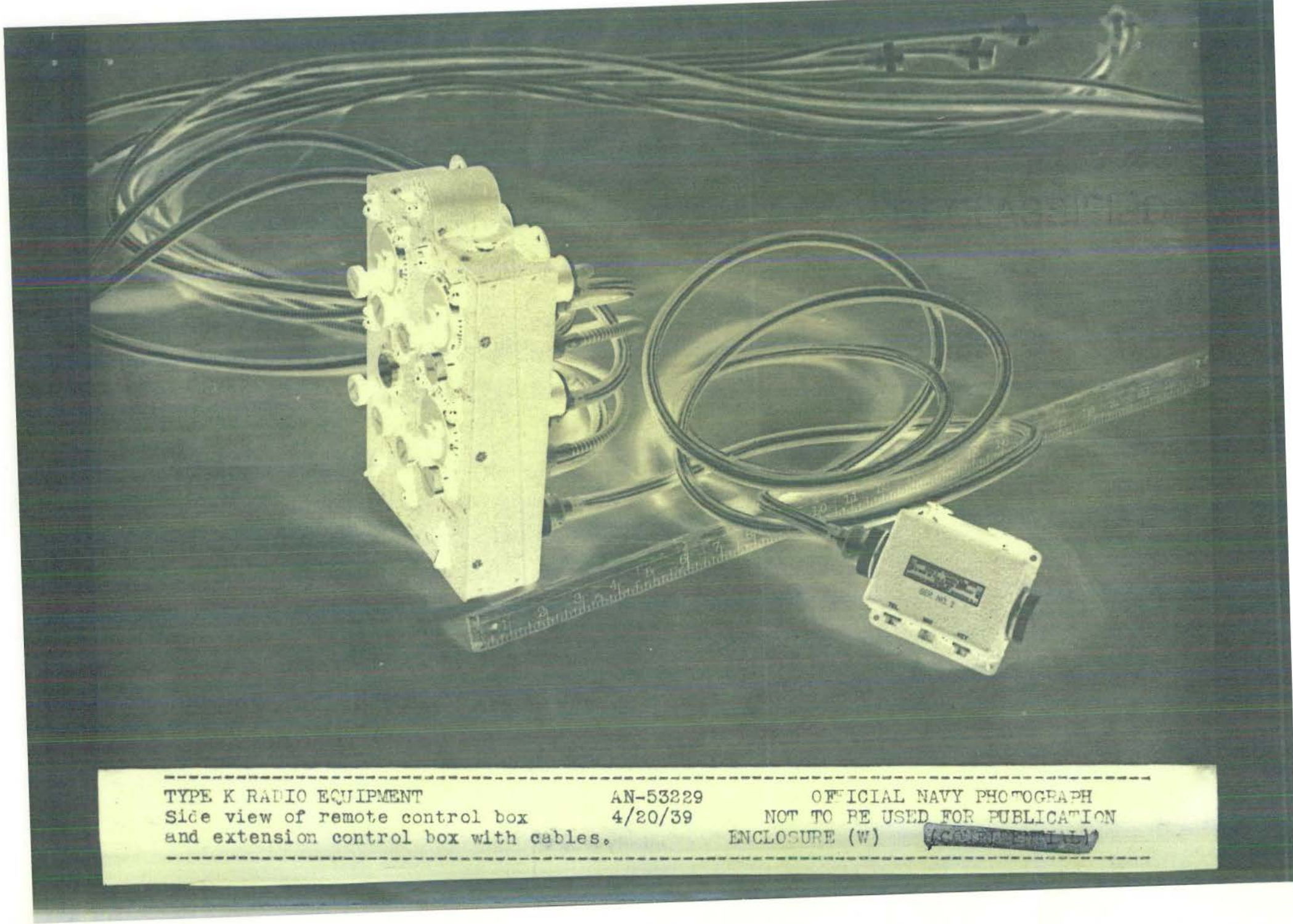
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (U)



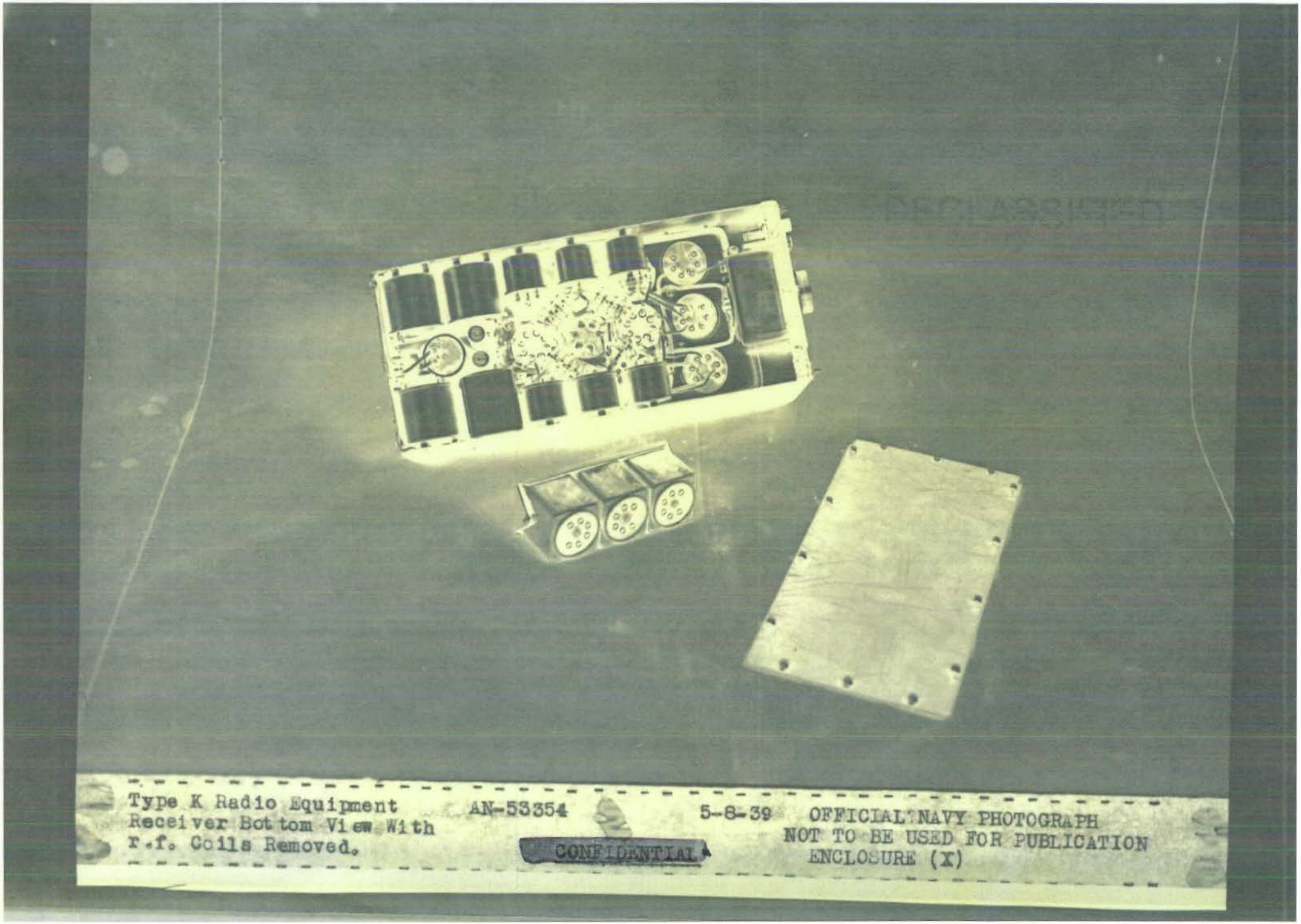
TYPE K RADIO EQUIPMENT
Remote control box. Back view.

AN-53228
4/20/39

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (V) (CONFIDENTIAL)



TYPE K RADIO EQUIPMENT — AN-53229 — OFFICIAL NAVY PHOTOGRAPH
Side view of remote control box and extension control box with cables. — 4/20/39 — NOT TO BE USED FOR PUBLICATION
ENCLOSURE (W) (CONFIDENTIAL)



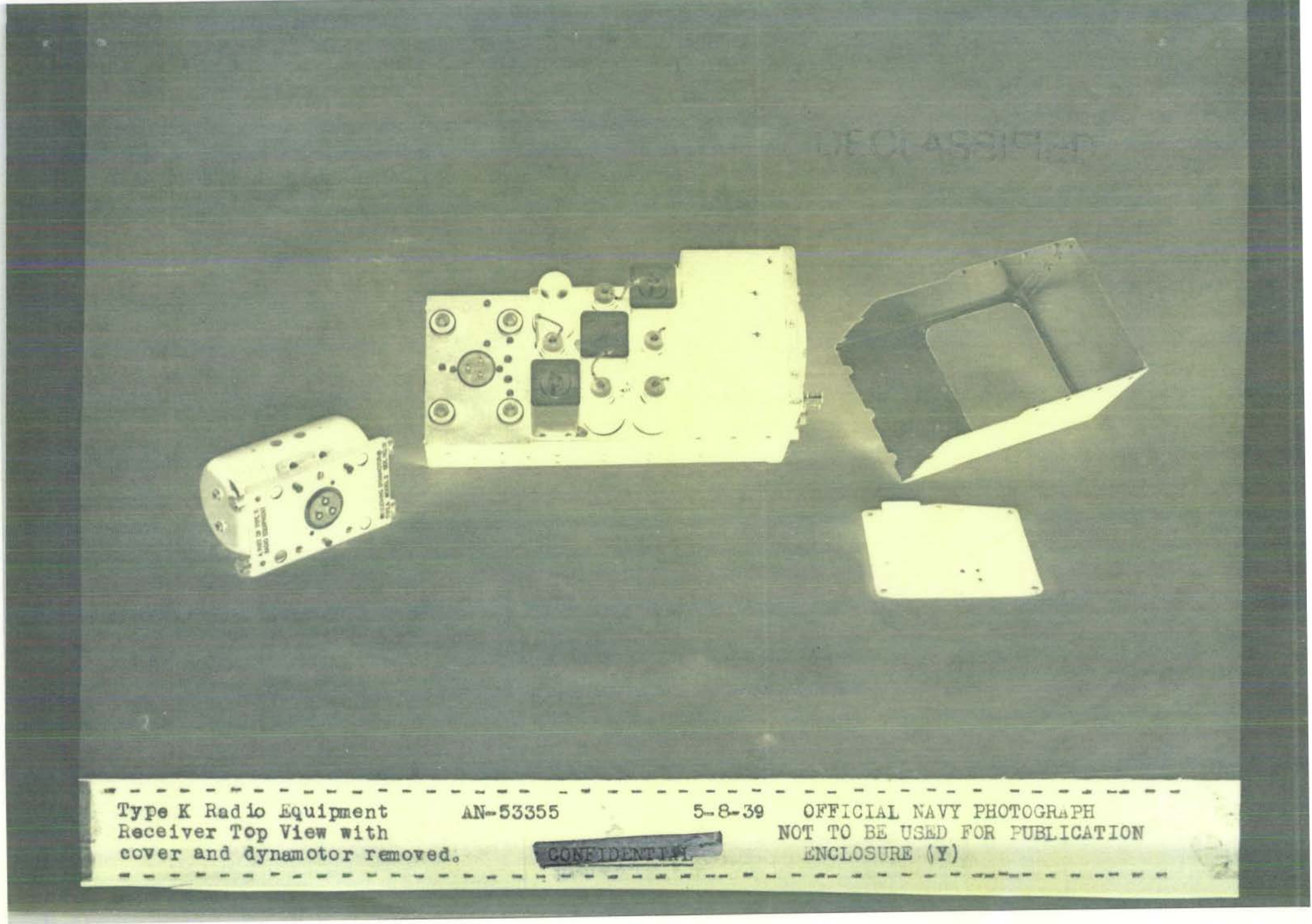
Type K Radio Equipment
Receiver Bottom View With
r.f. Coils Removed.

AN-53354

5-8-39

CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (X)



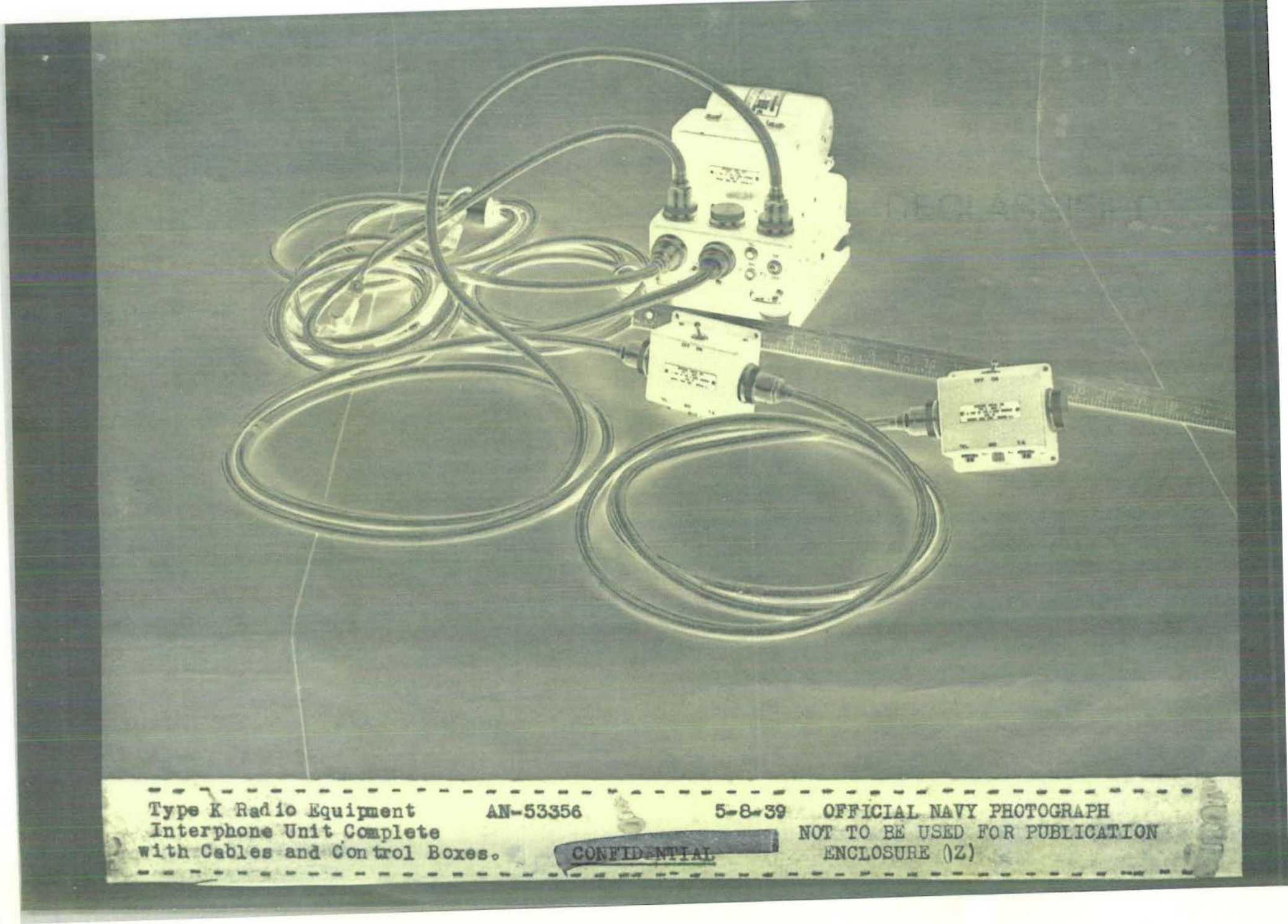
Type K Radio Equipment Receiver Top View with cover and dynamotor removed.

AN-53355

5-8-39

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (Y)

CONFIDENTIAL



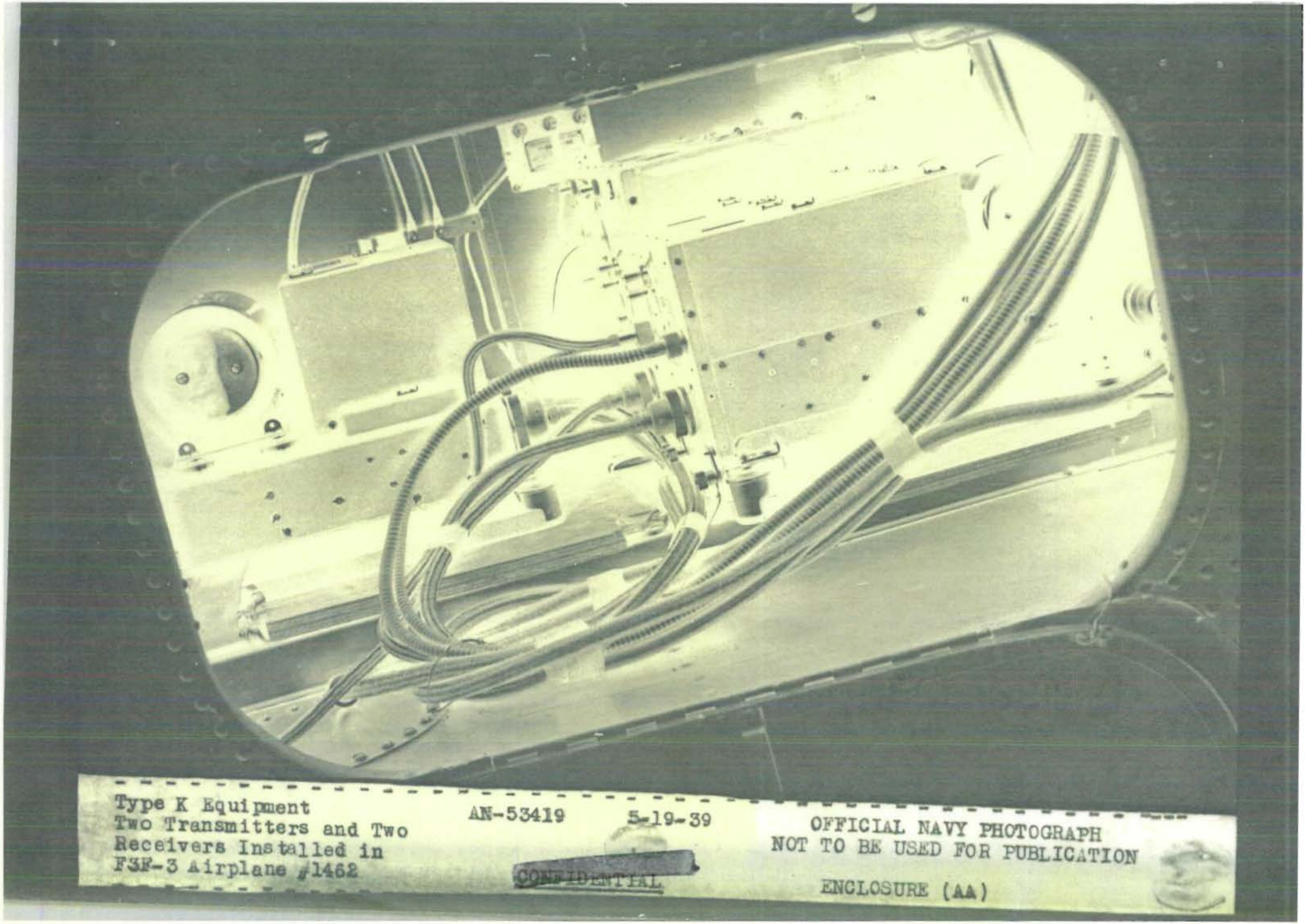
Type K Radio Equipment Interphone Unit Complete with Cables and Control Boxes.

AN-53356

5-8-39

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ENCLOSURE (Z)

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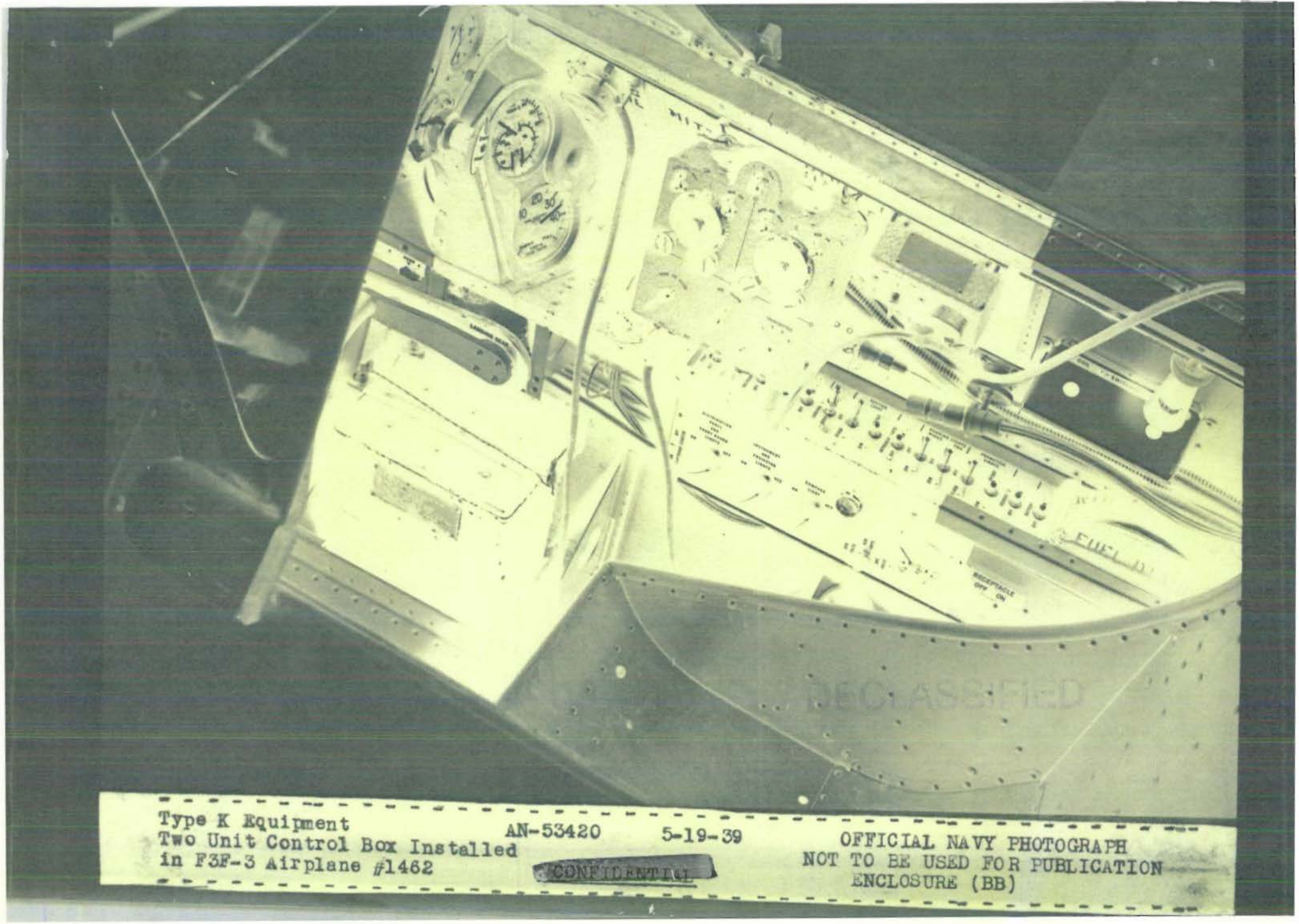
Type K Equipment
Two Transmitters and Two
Receivers Installed in
F3F-3 Airplane #1462

AN-53419 5-19-39

CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (AA)



Type K Equipment
Two Unit Control Box Installed
in F3F-3 Airplane #1462

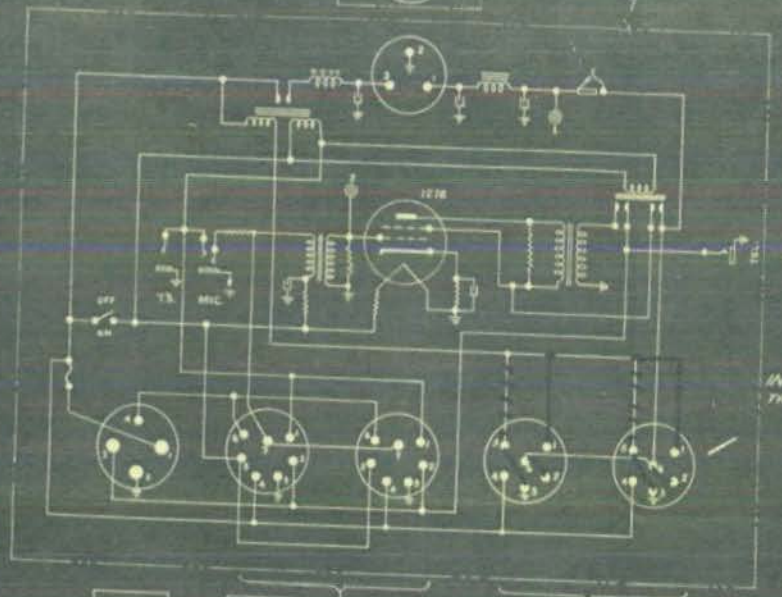
AN-53420 5-19-39

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OFFICIAL NAVY PHOTOGRAPH
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ENCLOSURE (BB)

Type K Interphone Equipment





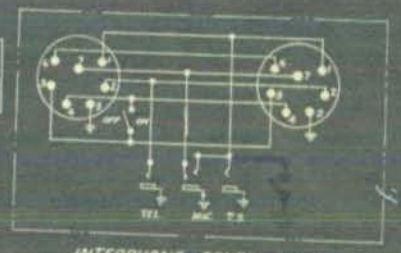
INTERPHONE-POWER SUPPLY
TYPE A MODEL 1

TO RECEIVER OUTPUT JACK

TO INTERPHONE CONTROL BOXES OR CONTROL BOXES OF TRANSMITTERS WITHOUT BUILT-IN INTERPHONE.

POWER OUTLETS:
PIN #3 = GROUND
PIN #4 = #12 V
PIN #6 = #250 V, 50 m.a. WHEN PIN #3 IS CONNECTED TO GROUND.

POWER INPUT CABLE TO AIRPLANE BATTERY OR TYPE-K RECEIVER BACK.



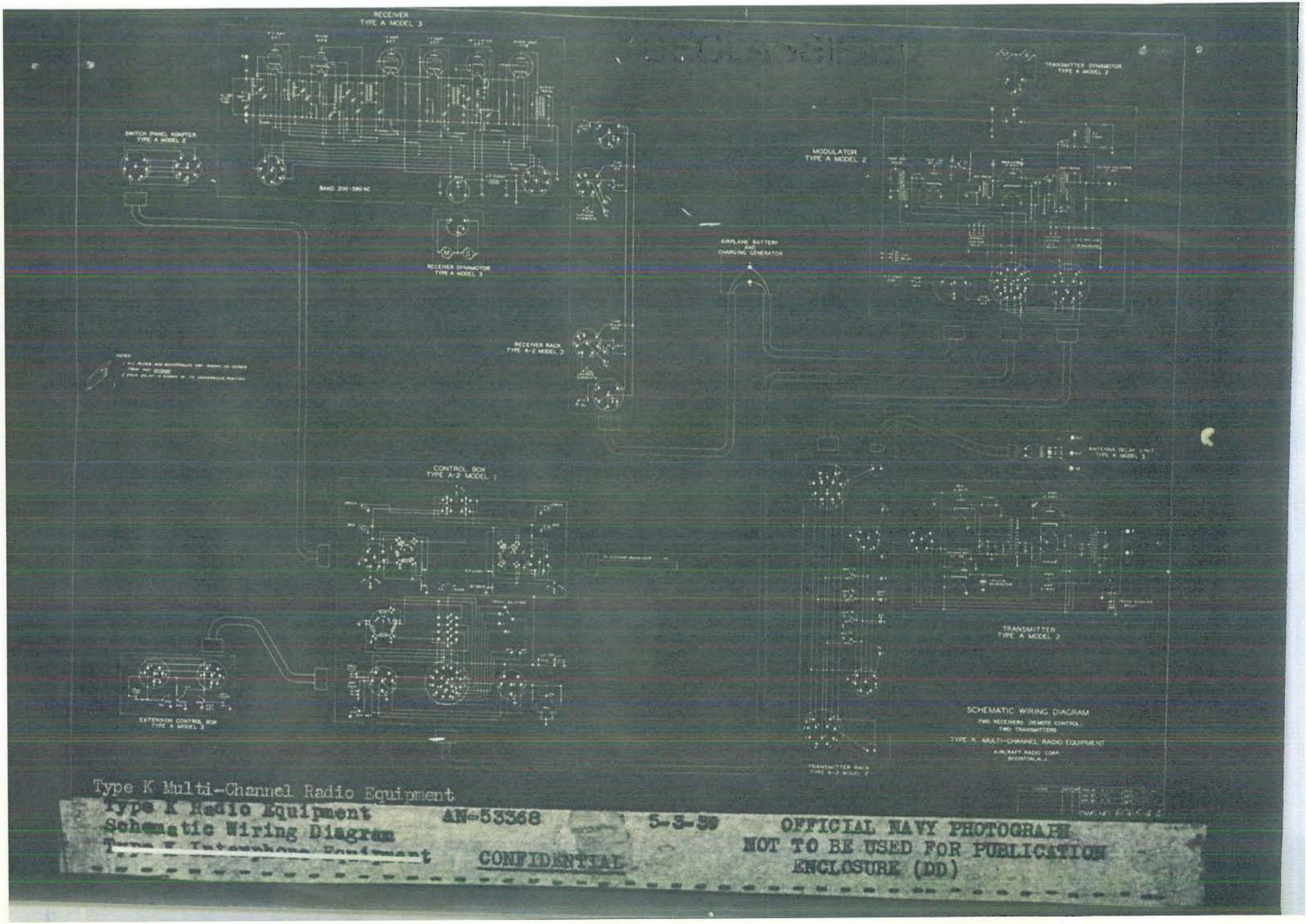
INTERPHONE CONTROL BOX
TYPE A MODEL 1

NOTES:
1. ALL RECEPTACLES ARE SHOWN AS VIEWED FROM THE OUTSIDE.
2. RELAYS ARE SHOWN IN THE NON-ENERGIZED POSITION.
3. WITH LOCALLY CONTROLLED TYPE K RECEIVERS THE TELEPHONE PLUG CONNECTION TO RECEIVER OUTPUT JACK MAY BE OMITTED PROVIDED THE POWER INPUT CABLE IS PLUGGED IN THE RECEIVER BACK.

SCHEMATIC WIRING DIAGRAM INTERPHONE SYSTEM
MAT:
FINISH:
SCALE:
DIMENSION TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMAL DIMENSIONS .XX ± FRACTIONAL DIMENSIONS ±

AIRCRAFT RADIO CORP.
BOONTON, N. J.

DWG. NO. 6284-3-A

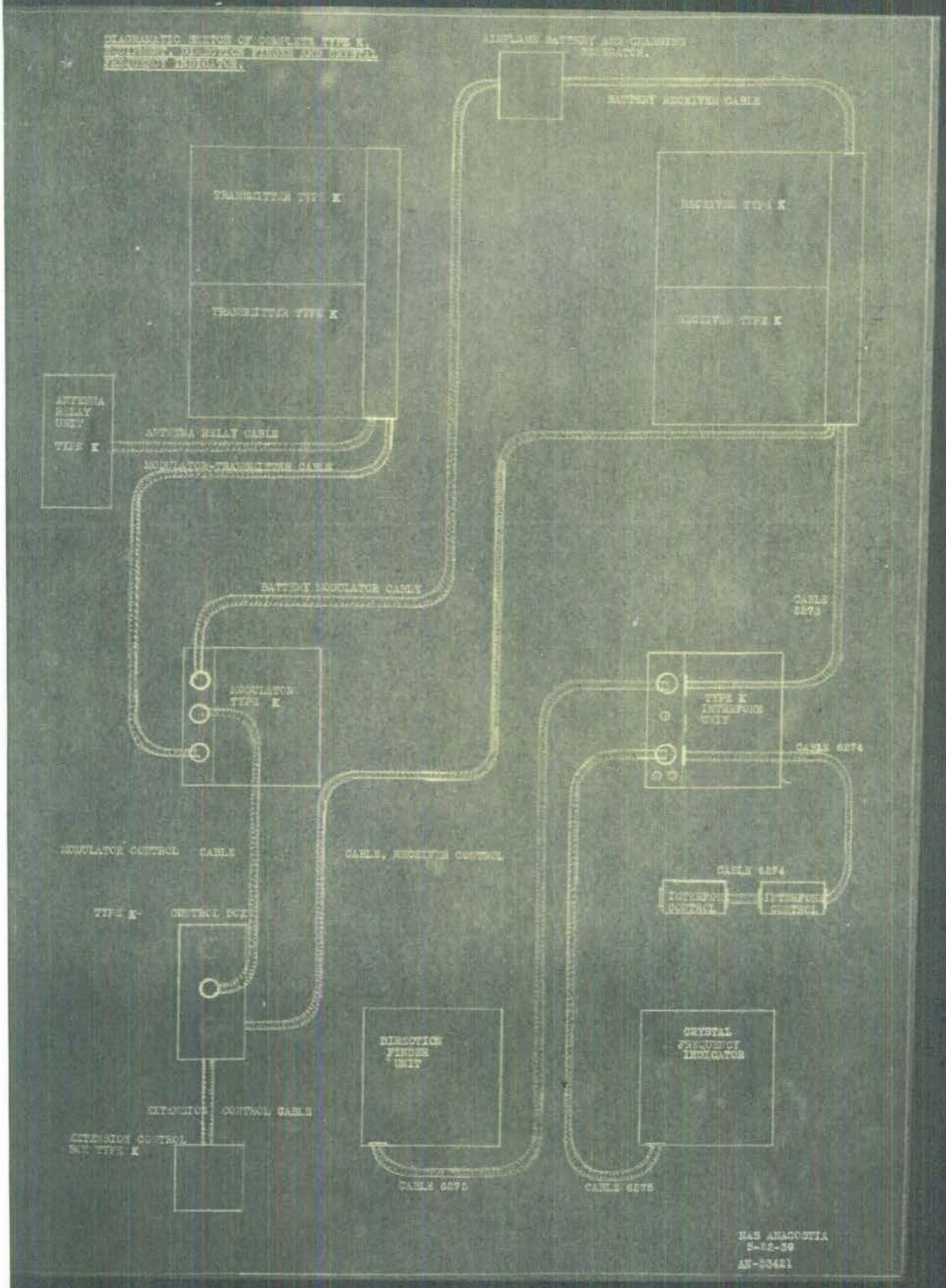


Type K Multi-Channel Radio Equipment

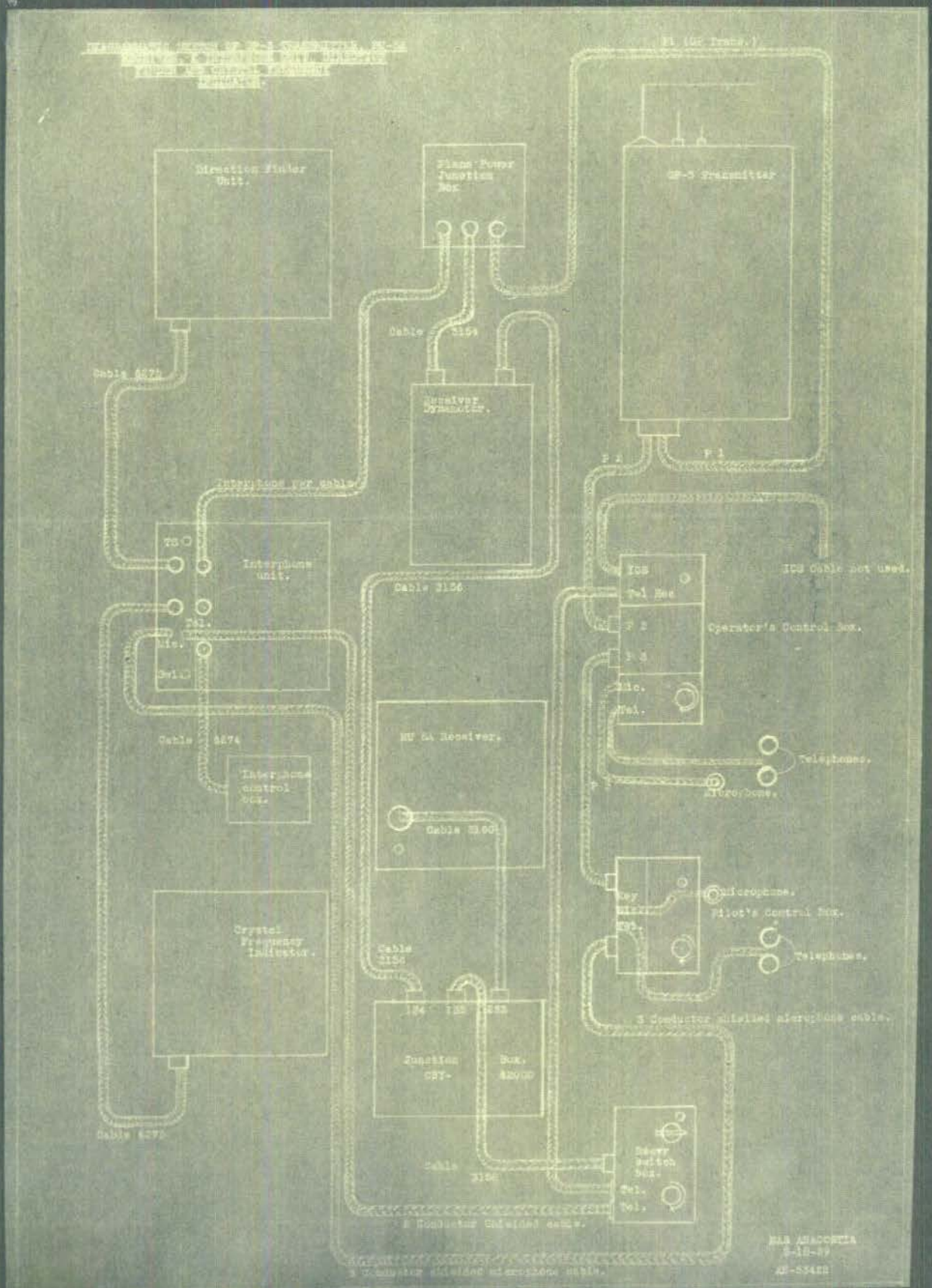
Type K Radio Equipment AN-53368 5-3-50 OFFICIAL NAVY PHOTOGRAPH

Schematic Wiring Diagram CONFIDENTIAL NOT TO BE USED FOR PUBLICATION

Type K Intercommunication Equipment ENCLOSURE (DD)


AIRPLANE BATTERY AND CHARGING GENERATOR.
BATTERY ARCHIVER CABLE
TRANSMITTER TYPE K
TRANSMITTER TYPE K
RECEIVER TYPE K
RECEIVER TYPE K
ANTENNA RELAY UNIT TYPE K
ANTENNA RELAY CABLE
MODULATOR-TRANSMITTER CABLE
BATTERY MODULATOR CABLE
CABLE 6875
MODULATOR TYPE K
TYPE K INTERPHONE UNIT
CABLE 6874
MODULATOR CONTROL CABLE
CABLE, RECEIVER CONTROL
CABLE 6874
INTERPHONE CONTROL
INTERPHONE CONTROL
TYPE K- CONTROL BOX
DIRECTION FINDER UNIT
CRYSTAL FREQUENCY INDICATOR
DIRECTION CONTROL CABLE
EXTENSION CONTROL BOX TYPE K
CABLE 6875
CABLE 6875
NAS ANACOSTIA
5-12-39
AN-33421

Encl.(EE)


Direction Finder Unit.
Plane Power Junction Box
GP-5 Transmitter
P1 (to Trans.)
Cable 3154
Cable 3172
Receiver Dynamotor.
Interphone unit.
P 2
P 1
ICS
Tel Rec
P 2
P 3
Mic.
Tel.
ICS Cable not used.
Operator's Control Box.
Telephones.
Microphone.
Cable 3174
Interphone control Box.
MF & A Receiver.
Cable 3160
Pilot's Control Box.
Telephones.
Crystal Frequency Indicator.
Cable 3156
3 Conductor shielded microphone cable.
Junction Box.
Cable 3170
Safety Switch Box.
Tel.
Tel.
2 Conductor shielded cable.
3 Conductor shielded microphone cable.
NAA ANACOSTIA
8-18-39
AF-53422

Encl.(FF)

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SECURITY INFORMATION

AN-SG963-AV

(CC)

Equipment with mountings	Frequency range megacycles	Optimum power per set Output watts	Optimum power per set Input watts	Dimensions-inches Height	Width	Depth	Weight Lbs.	Ozs.
TYPE K EQUIPMENT								
Two transmitters	3.0-3.7 & 3.7-4.8 or 4.8-6.2 & 6.2-8.0	160	4.5 to 34.0	8-13/16	12-13/16	13-3/4	19	6
Modulator				8	9-11/16	11-1/8	20	4
Four receivers	0.2-0.38; 0.38-1.5; 3.0-6.0; 3.0-6.0; 6.0-9.0; 9.0-13.5; 13.5-20.0	38		7-1/4	21-1/2	13-1/4	40	5
Two unit control box				7-5/16	6-1/8	8-5/8	2	8
Four unit control box				10-1/4	6-1/8	8-5/8	3	12
Extension control box				3-3/16	4-3/16	1-11/16	0	7
Antenna relay unit				2-5/8	3-3/8	3-3/16	0	12
One receiver	As desired	38		7-1/4	11-3/4	13-1/4	20	8
Complete set of cables and mechanical linkages for two transmitters and four receivers remote controlled less extension box							11	9
Complete set of cables and mechanical linkages for two transmitters and two receivers remote controlled less extension control box							8	3
Complete set of cables and mechanical linkages for one transmitter and one receiver remote controlled less extension control box							6	8
One transmitter (estimated)	As desired	160	4.5 to 34.0	8-13/16	6-1/8	12-3/4	10	0
One receiver (estimated)	As desired	38		7-1/4	6	13-1/4	10	6
Interphone & dynamotor less mounting		38		5-5/16	5-3/4	6-1/2	7	0
Interphone, dynamotor and mounting				7-1/16	5-3/4	6-7/16	7	10
Interphone less dynamotor and mounting				5-1/2	5-3/4	6-1/2	4	2
Interphone mounting							0	10
Dynamotor							2	14
Interphone control box				1-5/8	3-1/8	4-7/32	0	6
Complete set of cables for one control box							3	14
Complete interphone unit							11	14
MODEL CF-4 EQUIPMENT								
One transmitter	3.0-3.675 or 3.675-4.525 or 4.0-7.35 or 7.35-9.05	145	1.0 to 16.0	7-13/16	6-5/8	13-1/4	11	11
One receiver	0.195-0.290 & 0.290-0.435 or 0.54-0.83 & 3.0-4.525 or 0.54-0.83 & 6.2-7.7 or 0.4-0.6 & 6.0-9.05	109		7-5/8	7-1/4	15-11/16	14	10
Transmitter control box				3-11/16	5-1/8	2-7/16	0	11
Receiver switch box				3-11/16	5-1/16	2-3/8	0	15
Dynamotor				6-1/16	9-1/2	8-5/8	13	8
Junction box				7-3/8	5-1/2	2-13/16	2	2
Antenna relay				2-11/16	3-1/8	3-1/16	0	13
Receiver remote tuner				2-1/2	3	6	0	15
Complete set of cables							8	11
MODEL XCO EQUIPMENT								
Transmitter	3.0-7.0	350-400	15 to 35	10-1/4	11-3/4	19-1/8	41	0
Receiver	0.18-1.5 & 1.8-15.0	58		7-5/8	9-1/4	14-3/4	24	0
Transmitter dynamotor				9-1/4	6-1/8	8-3/4	24	7
Transmitter control box				3-7/8	5-7/8	3-1/16	1	0
Receiver control box				4-5/8	3-5/16	6-1/4	2	4
Receiver dynamotor				7-1/2	4-3/8	7-3/8	9	12
Homing loop				17-1/4	4-5/8CD	12-3/8	4	0
Cables complete							89	8
Mechanical linkages							6	0
WEIGHT SUMMARY								
Type K Complete equipment less extension control box.								
Two receivers & two transmitters							71	8
One receiver & one transmitter(estimated)							49	14
Four receivers & two transmitters							98	0
Four receivers & four transmitters (estimated							117	0
One receiver, one transmitter and interphone unit (estimated)							61	12
Two receivers, two transmitters & interphone unit							83	6
Four receivers, two transmitters & interphone unit							107	14
Four receivers, four transmitters & interphone unit							128	14
Model CF-4 Complete equipment(Less extension control box)								
One transmitter and one receiver							54	0
Model XCO Complete equipment								
Equipment less homing loop (estimated							136	0
Equipment with homing loop							141	15