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NRL Report No. R-1694
Test of Model 500D Radio Telephone Equipment (50 watt)
Manufactured by - Jefferson-Travis Co., New York City

REPORT NO. R-1694

DATE 11 February 1941

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SUBJECT

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BY

NAVAL RESEARCH LABORATORY

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NAVY DEPARTMENT

Report on

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NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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SECTION I

AUTHORIZATION

1-1. The tests herein reported were authorized by Bureau of Ships letter S67/43 (10-19-DR6) of October 23, 1940. This letter assigned Bureau of Ships Prob. T5-37C to cover the tests on the Jefferson-Travis Model 500D Radio Telephone Equipment.

OBJECT OF TEST

1-2. The object of the tests was:

(a) To examine the equipment for the purpose of determining its ability to withstand the rigors of Naval usage.

(b) To determine the performance of the equipment when subjected to the various conditions likely to be encountered in the Naval Service.

(c) To ascertain what changes or modifications are necessary or desirable in the equipment to insure satisfactory operation under Naval Service conditions.

ABSTRACT OF TESTS

1-3. The tests herein reported were conducted with a view of determining the potentialities of the equipment under Naval conditions of operation. Briefly, inspection and tests were conducted as follows:

(A) TRANSMITTER.

General examination of equipment.

(1) Check of vacuum tubes employed and method of mounting.
(2) Inspection of panel controls.
(3) Investigation of tuning methods.
(4) Accessibility, ease of adjustment, and protective features.
(5) Wiring.
(6) Insulation.
(7) Weights and dimensions.
(8) Physical construction, ventilation, corrosion resisting measures, etc.
(9) Examination of switches, resistors, fuses, capacitors, etc.
(10) Mounting and shock-proofing methods.
(11) Handset controls and mounting.
(12) Connection facilities.
(13) Power equipment.

[redacted]

Operational data and tests.

(1) Power output determination.
(2) Effect of ambient temperature variations.
(3) Effect of humidity.
(4) Effect of vibration and inclination.
(5) Locked key operation for one hour.
(6) Remote Control facilities.
(7) Modulation characteristics.
(8) Break-in method.
(9) Power required for operation.
(10) Variation in supply line voltage.
(11) Effect of short circuiting or open circuiting antenna system.

(B) RECEIVER

General examination of equipment.

(1) Electrical inspection of circuits, etc.
(2) Mechanical inspection of components, controls, etc.
(3) Instruction Book.
(4) Spare Parts.

Operational Data and Tests

(1) Listening Tests on Antenna.
(2) Laboratory measurements in shielded room.
    (a) Sensitivity and Noise Output.
    (b) Image Ratio.
    (c) I.F. Response.
    (d) Selectivity.
    (e) Resonant Overload.
    (f) Effect of Modulation Depth.
    (g) Gain Control Range.
    (h) Radiation of Oscillator Frequency.
(3) Effects of Temperature Variations.
(4) Effects of Humidity Variations.
(5) Effects of Vibration.

[redacted]

Conclusions

(a) In general, the overall performance of the transmitter portion of the equipment is inferior to that found in other equipment constructed under Navy specifications; but the performance is satisfactory when judged by less exacting standards.

(b) The equipment is adapted for voice emission only, and voice signals of reasonably good quality are furnished by the apparatus.

(c) A high degree of frequency stability is assured, since low temperature coefficient crystals are employed as a governing factor.

(d) The power output is appreciably less than the rated value of 50 watts when operated into an actual antenna whose characteristics approach those found on some Naval craft. The deficiency in power output is an inherent penalty of the relatively simple types of P.A. tuning and antenna coupling circuits.

(e) A number of modifications are indicated to be necessary to improve operation and maintenance of the transmitter circuits. Additionally, improvements in wiring and connection arrangements are necessary in order to assure better performance.

(f) During the course of the tests it was noted that reasonably few failures occurred; that the necessity of servicing was infrequent; and in such respects the functioning of the equipment was comparable to that found in some apparatus constructed under Navy specifications.

(g) The construction differs in some cases from the customary Naval practice, and in most instances the kinds of component parts (including tubes) employed differ considerably from standard Navy parts. Thus few spare or renewal parts will be available on shipboard unless specifically stocked for this equipment.

(h) As a power unit there has been supplied an <u>intermittent</u> duty dynamotor. In order to be suitable for Naval use, the complete equipment should be designed for <u>continuous</u> duty. All parts of the equipment exclusive of dynamotor are presumably designed for continuous duty.

(i) Compared with other receivers tested, the Jefferson-Travis 500D has good sensitivity on band 1, and poor sensitivity on band 10. It has relatively good selectivity. On band 1 the image ratio is above 4000 and is relatively poor on band 10.

(j) The AVC characteristics are very poor. The action of the noise gate is apparently satisfactory.

(k) The audio-frequency output is non-linear with changes in depth of modulation.

[redacted]

(l) The receiver has excessive radiation of the oscillator frequency at the antenna terminals.

(m) The receiver was not apparently affected to any great extent by exposure to high humidity, although under conditions of high humidity at cold start, the receiver was comparatively slow in recovering its sensitivity.

(n) Variations in temperature did not have any appreciable effect on normal receiver operation. The controls, however, did not function satisfactorily at the low temperatures.

(o) Vibration seemed to adversely affect the sensitivity of band 10. The audio output was noticeably distorted during vibration.

(p) Many changes would be necessary to bring the receiver section of the Jefferson-Travis 500D equipment up to the usual requirements of Naval Service.

[redacted]

Recommendations

The tests herein recorded indicate that certain corrective procedure and remedial measures are necessary in the event that the Jefferson-Travis Model 500D Radio Telephone Equipment is adopted for use in the Naval Service. Included herein will also be a specific recommendation for each item listed in the Summary of Defects of this report. Following each statement there appears the paragraph numbers of this report where each matter is discussed in detail. Accordingly, it is hereby recommended:

(1) That suitable instruction books be furnished for the equipment; that certain of the equipment's features be adequately discussed in the instruction book. 1-7, 2-6, 2-11(c), 2-27(c), 2-40, 2-44.

(2) That the Bureau give consideration to approving certain tubes of the equipment which are not of Navy standard type. 2-2

(3) That adequate precautions be taken in preparing the equipment for shipment in order to assure that no damage will occur in transit. 2-4

(4) That improvements be effected in the stop mechanism of the main power switch to assure that no failures will occur. 2-5(e)

(5) That a rugged and durable cord for the handset be employed; that the handset cord be securely anchored at each end to prevent the disruption of electrical connections by the application of accidental strains. 2-5(f)

(6) That the securing means of the handset bracket be improved; that changes in the design of the handset bracket be effected in order to allow it to adequately secure the handset regardless of whether the Remote Control Unit is mounted horizontally or vertically. 2-5(f), 2-13(b), 2-14, 2-23

(7) That precautions be taken to assure that the holes in the hinged sub-panel arrangement properly align with the studs of the main framework; that enough clearance be provided at the bottom of the hinged sub-panel to allow it to be opened or closed without striking the top of the converter unit. 2-7(a)

(8) That suitable high-voltage warning signs be provided. 2-7(b)

(9) That cabled groups of leads be suitably anchored to the chassis. 2-8(a)

(10) That all electrical connecting leads which are frequently flexed employ stranded wire of a suitable type. 2-8(b)

(11) That radio frequency wiring of the rigid, self-supporting type be employed; that a more suitable form of radio frequency insulation be employed at points where radio frequency leads pass through the chassis. 2-8(c)

(12) That the electrical connections between the converter brushes and suppressor condensers be modified in a manner to overcome the defects herein indicated, and arranged in a manner to minimize the possibility of breakage. 2-8(d)

(13) That the matter of increasing the physical strength of the terminal boards be considered; that lock washers be employed on terminal board connection screws in a manner to assure that all electrical connections remain tight. 2-9(b), 2-15

(14) That the Bureau give consideration to approving the mechanical structure of the equipment, even though ferrous materials are used extensively for non-electromagnetic purposes. 2-11(a)

(15) That the necessary steps be taken to assure that no oil will leak from the converter bearings during inclinations up to 45°; that consideration be given to the use of a converter employing grease-packed ball bearings. 2-11(c), 2-24

(16) That dynamotors be employed of a type which are suitable for <u>continuous</u> duty at ambient temperatures as high as 50° C. 2-11(d) (1)

(17) That the Bureau decide if the fuses employed in the input line are acceptable; that suitable fuses be employed in the output circuits of the dynamotor and converter; that fuse mountings be permanently marked with suitable information as to the ratings of fuses employed. 2-12(b), 2-43

(18) That a suitable antenna ammeter of Navy standard type be incorporated; that the function of the antenna binding post be permanently marked. 2-12(d), 2-12(e)

(19) That suitable grommets be used at points where leads pass through the outer shields of the Transmitter-Receiver Unit and the Remote Control Unit; that permanent markings be added to indicate the function, the polarity, and the voltage applied to the incoming power connections; that the function of the ground connection be permanently marked; that more satisfactory terminal arrangements be employed for the ground and incoming power connections; that the cabled leads from the dynamotor-convertor assembly to the terminal board on the main framework be lengthened; that the ends of these cabled leads be securely anchored to the units to prevent accidental disruption of connections. 2-15(a), 2-15(b), 2-15(c)

(20) That the necessary steps be taken to assure that no flashover occurs at the high-voltage commutator of the dynamotor upon starting. 2-16(c)

(21) That modifications be effected to allow the optional use of voice relay or manual carrier control; that the voice relay sensitivity control be located on the front panel of the control unit. 2-16(d)

(22) That no efforts be made to improve the power output of the equipment by modifications to the tuning and antenna coupling features of the equipment, even though rated power output was not obtainable on three kinds of antennas which will likely be employed in the Naval Service; that the Bureau obtain information from the manufacturer as to the difficulty encountered in obtaining optimum power output when all ten channels are in use, with the object of having more data at hand as to the feasibility for use of the equipment in the Naval Service. 2-17(b)

(23) That a push-button selector system be employed which is capable of functioning properly at any ambient temperature between +50° and minus 15° C; that the necessary steps be taken to assure proper operation of the automatic selector system at any line voltage between +10% and -25% of a normal line voltage of 115 volts; that the necessary steps be taken to assure that two or more push buttons will not "stick" in a downward position; that the instruction books plainly indicate that manual carrier control is to be employed when the automatic frequency selector system is in operation, whenever the equipment is used under conditions where a high audible noise level is present; that a more rugged, durable, and reliable automatic selector system be employed; that consideration be given to providing manual frequency switching arrangements in the event of failure of the automatic selector system. 2-18, 2-22(c), 2-27(a), 2-27(c), 2-27(e), 2-27(f)

(24) That changes be effected of such nature to assure that the dynamotor starting system will properly function at any line voltage between the limits of +10% and -25% of a normal value of 115 volts. 2-22(b)

(25) That the oscillation suppressor resistor in the P.A. plate circuit be provided with an improved supporting means; that the necessary steps be taken to assure that no resistor connections break loose during conditions normally encountered on Naval craft. 2-25(a), 2-25(b)

(26) That the Bureau give consideration to the approval of the use of plastic bases on the Type 807 tubes; that all tubes employed be designated by distinct circuit symbol markings; that suitable permanent markings be affixed to the chassis in the region of each tube socket to indicate the type of tube required and the circuit symbol number of the tube; that such steps as are necessary be taken to permit convenient replacement of the crystal oscillator tube. 2-26(a), 2-26(b), 2-26(c), 2-26(d)

(27) That permanently engraved numbering be applied to the front panel of the control unit beside each push button to designate the channel number, and the celluloid windows be left blank for the application of appropriate information; that permanent numbering be applied beside the crystal plug receptacle and on the antenna clips to correspond with the channel number markings of the Remote Control Unit. 2-28

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(28) That the Bureau give consideration to the approval of the crystal holders. 2-29

(29) That the top of the hinge pin of the swinging chassis be provided with a suitable head; that all hinge securing screws be provided before shipment. 2-30

(30) That the necessary steps be taken to allow the placing of antenna clips on adjacent turns of the coil in the double spaced region without the danger of producing a short circuit. 2-31

(31) That a suitable switch for controlling the filaments of the modulator and transmitter tubes be provided on the front panel of the Control Unit; that this switch be marked to indicate its function. 2-32

(32) That the Bureau inform the manufacturer as to the type of nameplates required. 2-33

(33) That all major component parts be provided with permanent and durable symbol markings. 2-34

(34) That the P.A. tuning-antenna coupling condenser be provided with a suitable locking device to prevent accidental movement. 2-35

(35) That the connection details of the dynamotor and converter fields be included on the wiring diagrams of the equipment. 2-36

(36) That the necessary steps be taken to assure that no flash-over occurs in the antenna tap switch. 2-38

(37) That a suitable low voltage rectifier be added for energization of the microphone circuit. 2-39

(38) That a suitable locking device be added to the volume control of the modulator to prevent accidental movement. 2-40

(39) That a suitable and satisfactory contact system be employed on the dynamotor starting relay. 2-41

(40) That a relay and associated circuits provided to function in conjunction with an automatic ringer device be eliminated unless it is the intention of the Bureau to employ equipment with automatic ringers in the Naval Service. 2-42

(41) That consideration be given to providing a sufficient number of suitable spare parts for the equipment. 2-45

(42) That the Bureau give consideration to providing a suitable absorption wavemeter for use in adjusting the output circuits of the transmitter. 2-46

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DECLASSIFIED

(43) That suitable retaining chains, or other securing means, be employed in conjunction with the seven knurl-headed screws used in securing the cover of the Transmitter-Receiver Unit. 2-47

(44) That the receiver crystals be of such a frequency as to provide an intermediate frequency output from the first detector which will fall in the center of the I.F. amplifier channel.(par. 3-9(a)).

(45) That the wiring be done in such a manner that removal of tube sockets will not disturb any components. (par. 3-9(b)).

(46) That electrolytic condensers be replaced by condensers meeting the requirements for Naval Service. (par. 3-9(d)).

(47) That condensers and resistors be mounted so that they will not be affected by vibration or shock. (par. 3-9(e)).

(48) That ceramic or wax-treated tube sockets be used in all r.f. circuits. (par. 3-9(f)).

(49) That insulation on transformer terminal strips be treated to prevent creepage under conditions of moisture condensation. (par. 3-9(g)).

(50) That I.F. and R.F. transformers be wound on non-hygroscopic forms, and that I.F. transformers be made more easily tunable. (par. 3-9(h)(i)).

(51) That paper condensers meeting requirements for Naval Service be substituted for the cardboard-covered paper condensers now used. (par. 3-9(j)).

(52) That selector switches be adequately protected against creepage, and the rotary selector switch have ceramic insulation. (par. 3-9(k)).

(53) That neither condensers nor resistors be mounted on other components or sockets. (par. 3-9(l)).

(54) That all terminal strips be wax-treated to prevent creepage. (par. 3-9(m)).

(55) That the lightning arrestor, if retained, be made more rugged to prevent possibility of accidental misadjustment. (par. 3-9(n)).

(56) That the sensitivity and image ratio on band 10 be improved. (par. 3-9(o)).

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(57) That the AVC and detector circuits be improved, so as to give better characteristics. (par.3-9(p); 3-6(c)).

(58) That the second detector circuit be changed, if possible, to give a more linear response with modulation depth variations. (par. 3-9(q)).

(59) That the cause of excessive radiation of the receiver oscillator be determined and corrected. (par. 3-9(r)).

(60) That the cause of vibration affecting both quality and sensitivity of the receiver be determined and corrected. (par. 3-8, 3-9(s)).

(61) That all controls that are lubricated employ a suitable lubricant which will not change its viscosity in the temperature range of -15° to +50°C. enough to affect the operation of the controls to any considerable extent. (par. 3-9(t)).

(62) That tubes be mounted vertically according to practice. (par. 3-9(u)).

(63) That the crystal sockets employed in the equipment be replaced by standard Navy type sockets. (par. 3-9(v)).

(64) That ferrous lockwashers and screws be adequately protected against corrosion. (par. 3-9(c)).

MATERIAL UNDER TEST

1-4. The material under test consisted of the following units and parts:

1 - Model 500D Radio Telephone Equipment manufactured by the Jefferson-Travis Company of New York City. The equipment under test bore serial No. 1588. The frequency range of the equipment is not indicated on the nameplate or elsewhere, but it is believed to cover a band of from 2,000 to 3,000 kcs. The equipment operates from a 115-volt, d-c power line, and is adapted for voice emission only.

1 - Remote Control Unit with interconnecting cable attached, Model 500. A handset is provided with a Remote Control Unit, which is Western Electric Type F1W.

No crystals were supplied with this equipment. However, three crystals were obtained from another Jefferson-Travis type of telephone equipment, which were capable of functioning with their Model 500D equipment. The crystals used in the tests are described below:

Transmitter Crystal Frequency	Receiver Crystal Frequency	* Serial No.
2350	2806	643
2670	3122	567
2738	3194	316

1 - Complete set of tubes as follows:

4 - 807's
2 - 6N7's
2 - 6SK7's
3 - 6F8-G's
1 - 6H6
2 - 6V6's
2 - 6K7's
1 - 6L7
2 - 6SQ7's
1 - 6C8-G
1 - 5V4-G

1-5. Refer to Plates TR-1 to TR-4 for photographs of the Jefferson-Travis Model 500D Equipment. A study of these views gives a good idea of the design of the equipment.

1-6. The equipment described above was received at this Laboratory on October 7, 1940.

[redacted]

METHOD OF TESTS

1-7. The equipment upon receipt was carefully unpacked and examined for damages in transit. No instructions were received with the equipment, but subsequently the manufacturer furnished wiring diagrams of various parts of the equipment. With the aid of these diagrams and a study of the actual equipment, the apparatus was placed in operation.

Transmitter

1-8. The general construction of the transmitter was examined and the component parts were inspected in so far as was possible without resorting to completely dismantling the equipment or destruction of the various parts.

1-9. The transmitter was adjusted to operate at the frequencies of the crystals available. Measurements of power output were made by means of a dummy antenna load consisting of a 32-volt, 50-watt incandescent light. The base of the lamp used was removed in order to minimize capacity losses. A photronic cell, rigidly anchored at a definite distance from the lamp load, and a microammeter to measure output of the photronic cell were used to measure the quantity of power delivered. A quick-acting, low capacity switch was used to transfer the lamp load from the transmitter to a 60-cycle calibrating source, in order that the various parts of the load and measuring equipment would be maintained at temperature equilibrium. A precision type of wattmeter was used to determine the exact power required to produce the same photronic cell deflection which was obtained from the output of the transmitter.

1-10. The complete equipment was placed in a special test chamber and subjected to variations in ambient temperature and relative humidity. The equipment was fully loaded into a dummy lamp load of the type described in the foregoing paragraph during these tests. Provision was made to check the output frequency of the transmitter at stated intervals during the course of the various tests conducted in the test chamber. The ambient temperature was varied between the limits of +50° C. and -15° C. The relative humidity was varied between the limits of approximately 30% and 95% at a temperature of approximately +40° C.

1-11. The ability of the equipment to withstand vibration was determined by mounting the complete apparatus on a vibration test platform which was capable of producing vibrations of varying degrees of amplitude and frequency. The equipment under test was kept under constant observation, and voice signals were transmitted at stated intervals. The voice signals were monitored by means of a suitable receiver. The complete equipment was also operated upon a moving platform undergoing a continuous inclination of 45° on either side of the vertical. The equipment was mounted so that the 45° inclination was from side to side for a part of the test, and was similarly inclined from front to back during another portion of the test.

During the inclination tests, the equipment was kept under constant observation, and the emitted signals were checked as indicated previously in this paragraph during the vibration tests.

1-12. The equipment was operated into a real antenna whose fundamental frequency was approximately 2900 kcs. In some instances, series condensers were inserted to alter the antenna characteristics, and full particulars as to antenna conditions will be subsequently indicated in this report in conjunction with the particular test under discussion.

Receiver

1-13. The receiver section of the equipment was examined, first from the electrical viewpoint, with most of the information being derived from the circuit schematic diagram; second, from the mechanical and structural viewpoint, by visual inspection. The results of these examinations are given in pars. 3-1 and 3-2.

1-14. No comparative listening tests were conducted between this and other similar receivers.

1-15. The receiver characteristics were measured in a shielded room, using a standard signal generator (Measurements, Inc., Model 65, Serial 70) and a standard dummy antenna (General Radio Type 418G). The audio output was measured by means of an output meter (General Radio Type 583A, Serial 64). The sensitivity of the receiver was measured at full gain, since the noise level on loud speaker operation was very low. A value of signal plus noise output of 40 milliwatts was chosen as being far enough below the AVC threshold point at 30% modulation. Noise output was also measured, both with modulation off and with carrier off. Selectivity was measured at the same constant output level, with the input frequency varied at various input levels to give the same output reading on both sides of the frequency of maximum response. Image ratio was determined by measurement of the input at the image frequency necessary to give 40 milliwatts output. This value of input was divided by the input for 40 milliwatts output at the desired frequency to give the image ratio. The I.F. response was measured as the input at the I.F. peak frequency (456 Kc.) necessary to give 40 milliwatts output.

A resonant overload characteristic measurement was made, with inputs from 0.4 microvolt to 2 volts. Noise level with modulation off was measured for each point. Two resonant overload characteristics were taken with noise gate at half maximum and maximum positions. The effect of various carrier modulation percentages was determined in terms of AF output at 400 cps. The attenuation of the gain control was measured at the point of minimum output. The voltage appearing at the antenna binding post due to the receiver oscillator was measured by substitution. The output caused by this undesired voltage in another receiver, coupled to the antenna post of the Jefferson-Travis equipment through 5,000 ohms resistance, was measured. The standard signal generator was then substituted for the Jefferson-Travis receiver, and the input necessary to give the same output from the measuring receiver was determined.

This measurement was made at the fundamental, second harmonic, third harmonic, etc., of the oscillator frequency.

The results of the above measurements are described in par. 3-6 (a to f) and are shown on Plates R-1, R-3, and R-4, and Tables R-1, R-2, R-3, and R-4.

1-16. The equipment was set up in the temperature and humidity chamber, as described in pars. 1-10, 2-18, 2-19, and 2-20. Since the transmitter output load was left connected to the antenna post of the equipment throughout the temperature-humidity tests, a 5,000 ohm non-inductive resistor was used to protect the signal generator from the transmitter antenna voltage during operation of the transmitter. Changes in gain and noise level were measured during the course of the tests described in the above-mentioned paragraphs, and as given in par. 3-7. Results of the tests are shown in Plates R-5, R-6, and R-7, and Tables R-5, R-6, and R-7.

1-17. The equipment was set up for vibration test, as described in pars. 1-11 and 2-23. The receiver was checked for changes in gain or functioning, with the results given in par. 3-8.

1-18. No receiver frequency measurements were made during the temperature, humidity, and vibration tests, other than the signal generator dial settings, due primarily to lack of time and the unavailability of precision frequency measuring equipment during the test period.

DATA RECORDED

1-19. The data recorded during the tests are shown in the appended tables and plates. Tables or plates with the prefix "TR" refer to the equipment as a whole. Those with a prefix "T" refer to the transmitter only, while those with the prefix "R" cover receiver tests.

[redacted]

SECTION II

TRANSMITTER DESIGN, CONSTRUCTION, AND CIRCUITS

2-1. Vacuum Tubes. The Jefferson-Travis Model 500D Radio Telephone Equipment employs 14 vacuum tubes in the transmitter circuits in the following manner:

(a) One Type 6F8-G tube as a crystal-controlled master oscillator.

(b) One Type 6V6 tube as a buffer amplifier.

(c) Two Type 807 tubes in parallel as a power amplifier.

(d) Two 6SK7 tubes in push-pull as the input stage of the modulator circuit.

(e) Two Type 6N7 tubes in push-pull as an intermediate stage of amplification of the modulator circuit. These tubes are of twin triode type, and the triode circuits in the individual tubes are in parallel.

(f) Two Type 807 tubes in push-pull as the output stage of the modulator circuit.

(g) One 6H6 duplex diode tube is employed as an AVC device, and as a controlling means for operation of the voice relay governing tube. One of the diode circuits rectifies a portion of the audio power and applies it as a biasing potential to the input stage. Presumably, there is thereby provided both AVC action and peak limiting properties to prevent over-modulation. The other half of the diode tube rectifies a portion of the audio power, and this rectified component is applied as a bias to the grid of the tube to be described below in a manner to control the action of the voice relay.

(h) One 6F8-G tube as a device for controlling the operation of the voice relay. This tube is of the twin triode type, and the two triode circuits are operated in parallel.

(i) One Type 6SQ7 is employed in the automatic crystal selector mechanism. This tube is a duplex diode-triode. The automatic selector circuit involves a bridge arrangement, and unbalanced voltages from the bridge actuate the grid of the triode circuit of this tube and amplify the unbalance voltage. The two diodes are operated in parallel and are arranged to rectify the output of the triode circuit and deliver a voltage which serves as a bias for the 6F8-G, discussed below.

[redacted]

(j) One Type 6F8-G tube is actuated by the diode circuit of the tube described in par. 2-1(i), and is provided with a relay in its plate circuit which is adapted to operate the two "stepper" relays which operate the automatic selector system. The Type 6F8-G tube is a twin triode, and the two triode circuits are connected to operate in parallel.

2-2. A review of the types of tubes used in the equipment as listed in the foregoing paragraph will indicate that there are Navy Standard equivalent tubes in all cases except the following. These are types 6SK7, 6N7, 6V6, and 6SQ7. Attention is invited to the fact that the 6V6-G tube is of Navy Standard type. However, its equivalent in the metal tube, namely the 6V6, has not yet been adopted by the Navy. It may appear that the 6V6-G tube could be substituted for the 6V6. But, if this be done, it may be necessary to add a tube shield to get the desired performance. It is suggested that the Bureau give consideration to approving the types of tubes employed in the equipment in the event that the Jefferson-Travis Model 500D Radio Equipment is ultimately adopted for Naval use.

2-3. The tube sockets in most instances are made of plastic insulation and are securely fastened to the sub-panel. Ceramic tube sockets are used in the output stage of the modulator circuit and the radio frequency power amplifier. No shock mounting devices or tube base clamps are provided, but no damage to tubes was noted during the vibration or inclination tests. The tube sockets are of a type which grip the base pins firmly, and there appears to be no tendency for the tube to work loose.

2-4. Upon delivery, it was noted that one of the Type 807 modulator tubes was broken. Adequate packing precautions should be taken by the manufacturer to assure that no damages of this nature take place in transit. It may prove necessary or desirable to remove all tubes from equipment during shipment, and pack them separately, in order to assure that no breakage will occur during transportation.

2-5. <u>Panel Controls.</u> No controls are provided on the transmitter-receiver unit proper. All controls are located on the Control Unit. For a view of the Control Unit, refer to Plate TR-1. It is the smaller of the units shown therein. A description of the controls is given in the following sub-paragraphs.

(a) A push-button type of automatic frequency selector mechanism is provided. Ten push buttons are included; that is, the equipment may be automatically adjusted to any of ten frequencies. This mechanism controls the tuning of both the transmitter and receiver. A means is provided for designating the channel number, or output frequency, or other appropriate information, in the case of each of the ten buttons.

Suitable information may be written in ink on celluloid windows adjacent to each button. Four incandescent light bulbs are provided underneath the main panel to illuminate the markers at night. The lights employed operate at 6.3 volts and are believed to be the equivalent of Navy Type TS-53 lamps.

(b) A 2-position switch is provided for the following purpose: When in one position the loud speaker is energized from the receiver. When set at the other position, two conditions are provided for; when the handset is on its hook, the automatic ringer circuits are in use; but when the handset is removed from its hook, the receiver output is fed to the earphone of the handset rather than to the loud speaker. Attention is invited to the fact that no automatic ringer unit was provided with the equipment submitted to this Laboratory.

(c) A volume control is provided to adjust the audio level delivered to the loud speaker or to the handset headphone, depending upon which means of reception is employed.

(d) A knob is provided for adjusting the noise suppressor circuit. This control is labeled "Gate".

(e) A power switch marked "on" and "off" is employed. Upon delivery the movement of this switch was restricted to two positions. However, during the course of the tests, the stop on this switch failed, and it was found possible to rotate the switch through a number of positions. It was found that every third position applied power, but in the other two positions the power was removed. The necessary steps should be taken to provide a suitable and durable stop mechanism to assure that the motion of the power switch is restricted to only two positions; that is, <u>on</u> and <u>off</u>.

(f) Additionally, a Western Electric Type F1W handset is provided. The length of the cord for this member is 3' 10". The type of cord used appears to be of the same quality as used on the ordinary telephone. It is believed that this cord is hardly durable enough to withstand the usage normally found under Naval shipboard conditions. A more substantial rubber-covered cord would be more suitable for the purpose. Additionally, it should be securely anchored at each end to prevent strains, which are normally encountered on a vessel rolling and pitching on a rough sea, from disrupting electrical connections.

A bracket is provided for securing the handset when not in use. A double contact cradle switch is included as a part of the mounting bracket. Clamping means are provided in the mounting bracket to secure the handset when not in use. Although the handset did not "jump" from its mounting when subjected to vibration or inclination, from all indications it was at the point of being displaced therefrom; and it is believed that a more suitable piece of apparatus would be provided if a more definite and positive securing means were employed.

2-6. Tuning. The transmitter is adjusted to a given frequency merely by depressing the appropriate button on the Control Unit. The operation of a button unbalances a bridge arrangement which energizes the input circuit of a vacuum tube arrangement and controls a relay system, which by a ratchet and pawl mechanism advances a group of ganged, multiposition, rotary switches to the appropriate point. By this operation both the transmitter and receiver circuits are tuned. In so far as the transmitter portion is concerned, only two of the rotary switches apply to transmitter tuning. One switch inserts the appropriate crystal in the circuit, and the other switch adjusts the inductance of the antenna loading coil to the proper value. The output circuit of the crystal oscillator circuit is of the untuned type and is presumably adjusted to produce crystal oscillations and to give a suitable excitation voltage for the buffer stage at all crystal frequencies normally employed in the equipment. Likewise, the buffer amplifier is of the untuned type. The only adjustments which are necessary for the tuned circuits are found in the case of the antenna circuit. Within the transmitter the antenna coupling circuit consists of a variable condenser and an inductance variable by steps, these two members being connected in series. One side of the condenser is at ground potential. One end of the loading coil attaches to the high-potential end of the tuning condenser, and the other end of the loading coil connects to the antenna. Thus the antenna-to-ground circuit is completed by an inductor and capacitor in series. The radio frequency output of the P.A. stage is impressed across the variable condenser. Heretofore, this condenser has been referred to as a tuning condenser; and it may be seen that this may not be strictly the case, for it is a kind of combined tuning and coupling condenser. This variable condenser is not controllable from the front panel and is operated as a sub-panel adjustment by means of a screwdriver. Removal of the nameplate gives access to the screwdriver adjustment. Although no instruction book was furnished, one does not gather from a circuit analysis that it is the intention to vary this condenser as the frequency is changed; that is, some compromise setting is found which is suitable enough for the purpose in the case of all output frequencies. The antenna loading coil circuit is adjusted by affixing ten adjustable clip leads to the appropriate point along the coil. In the case of these ten clip leads, each is separately adjusted for each of the ten channels. Thus upon installation of the equipment, these antenna taps are to be individually adjusted; and, presumably, there will be no occasion to readjust them, unless the crystals are replaced with others of different frequency.

2-7. Accessibility and Protection of the Personnel.

(a) For a view of the equipment, refer to Plates TR-1 to TR-4, inclusive. It may be seen that most of the parts of the equipment are accessible for replacement or adjustment. Ready access to the Control Unit is gained by removal of four nuts and withdrawing the front panel. Referring to the transmitter-receiver unit proper, its cover may be taken off by the removal of seven knurl-headed thumb screws. With the cover off, it is easily possible to replace tubes, exchange crystals, retune the antenna circuit, and make other necessary adjustments. The equipment may be made more accessible by the removal of seven nuts and the opening of the door-like sub-panel arrangement as illustrated in Plate TR-4. It was noted that the holes in the hinged front did not perfectly align with the studs in the main framework; and when restoring the hinged front to the closed position, it was necessary to lift and manually align the holes and studs in order to close up this assembly. Also, the bottom of this swinging member drags over the top of the converter during opening or closing. More clearance is necessary at this point. The assembly which holds the dynamotor and converter may be detached from the main framework by removal of six round-headed machine screws. It is thereby possible to pull this portion from the main framework and turn it upward for an examination of the relays, resistors, and other parts underneath. Fuses are located at the front of the converter unit and may be readily replaced after the front cover has been removed. A study of the photographs appearing in Plates TR-1 to TR-4, inclusive, will indicate that a number of parts are closely grouped together and should it be necessary to replace some member, such as a condenser, in some instances the unsoldering of a group of resistors, several connecting leads, or other parts would be necessary. This fact is pointed out because, in this respect, the equipment does not compare favorably with most equipment constructed specifically for Naval use. But it is believed that most of the parts could be replaced without too great difficulty, and it is therefore not suggested that a complete reconstruction of the equipment be undertaken to overcome this difficulty.

(b) No high voltage warning signs or interlocking safety switches are provided in the equipment. In order to lessen such hazards, since potentials as high as 600 volts d-c are used in the equipment, it is suggested that two warning signs be provided.

[redacted]

On the outside of the front cover of the main unit, a prominent sign should be affixed with a red background, indicating that dangerous voltages are present when the main cover is removed. On the main sub-panel of the major unit another similar sign should be provided warning the personnel to break the incoming power leads before attempting any servicing or adjustment inside the equipment.

2-8, Wiring.

(a) Much of the internal wiring is done with commercial, color-coded flexible wire which has been cabled together wherever possible. In some instances these cables are not anchored securely throughout their run, and consequently may shift enough to cause fatigue and breakage of the wires and chafing of the insulation. A more adequate clamping and securing means is advocated to overcome such difficulties. Most of the wiring is securely crimped and does not depend upon solder for mechanical support. All soldered joints have been given a coat of red lacquer.

(b) Attention is invited to the arrangement of cabled leads connecting to the various units with the terminal boards of the main assembly, as shown in Plate TR-4. It is apparent that these cabled leads will be flexed from time to time as the hinged chassis is opened or closed. A few of the wires employed in the cabled arrangement are stranded, but a number of solid wire conductors are used. It is believed likely that the solid conductors will ultimately break from fatigue, due to the amount of bending which will be experienced in this location. In order to overcome this difficulty, suitable stranded leads should be employed for this application.

(c) It is noted that in some instances the radio frequency wiring is installed in a manner comparable with other wiring used for power connections. Self-supporting bus or a rigid type of wiring is preferable for the purpose. In some instances it is noted that the only insulation provided for radio frequency leads passing through the panel is the insulation originally on the wire, augmented by a short length of spaghetti. A low-loss grommet form of insulation or a ceramic bushing would be preferable for the purpose.

(d) It is noted that the leads connecting the interference suppressor condensers C-60 and C-61, which are used across the brushes of the input side of the rotary converter, pass through the brush holder caps, and are soldered to the pig-tail termination of the brush.

One of these leads broke loose during the course of the tests, and it was found quite difficult to make a repair; that is, it was not easy to insert this lead through the cap and solder it to the pigtail and spring termination. Also, these leads make removal of the brushes difficult, and it must be expected that from time to time the brushes will be withdrawn for examination. Means of connecting these suppressor condenser leads to some permanent part of the brush holder are highly desirable.

2-9. <u>Insulation.</u>

(a) Phenolic and other plastic types of insulation are used in many places in the design of the radio frequency circuits. Additionally, ceramic and other low-loss types of insulation are employed in a few places. The P.A. Tuning-Coupling condenser is insulated with a ceramic material, probably Isolantite. The antenna loading coil is of the self-supporting type and employs strips of clear plastic material molded to it at certain points to insure rigidity. The plastic material used for the purpose is probably Amphenol, or some other similar substance.

(b) For insulation in power circuits a plastic material is used, which is presumably of the phenolic type. Terminal boards are included in this classification. In equipment constructed specifically for Naval use, insulation of this type is usually not permitted where the voltage exceeds 500 volts. This material should prove suitable since the highest voltage employed is 600 volts normal, which does not exceed the indicated limit greatly. In some cases with high line voltage the potential of the dynamotor does rise to 730 volts. The terminal boards used are in no wise as substantial as those commonly used in most Naval apparatus. They are in the form of strips about 3/4" wide and 3/32" in thickness. Also, it is feared that a reasonably strong twist on the screwdriver would tear the terminal loose from the board. This did not occur during the tests, but pains were taken not to subject the terminal board to too severe a strain when tightening connections.

2-10. <u>Weights and Dimensions.</u> The weights and dimensions of the various units are given in Table TR-1. Attention is invited to the fact that it is not possible to install the equipment in the space indicated therein, for a clearance of approximately 3" around the sides, top, and bottom of the equipment is necessary to give access to removable knurl-headed screws and to admit leads and cables for electrical connections at the bottom of the major unit.

[redacted]

2-11. General Physical Construction.

(a) Both the transmitter and receiver are assembled on a common chassis. Iron, steel, or other magnetic materials are liberally used throughout the design of the equipment. A good portion of the framework, covers, etc., are made of these materials, and it is apparent that this is not for electromagnetic purposes. In equipment constructed specially for the Navy, the use of iron and steel is usually prohibited, except for electromagnetic purposes. All exterior surfaces of the equipment are provided with a gray-wrinkle finish. At many points the interior is provided with a similar finish. The same type of finish is used on the outer covers of the dynamotor and converter. Certain of the internal component parts, such as transformers, etc., are provided with a flat gray finish. The main subpanel of the transmitter receiver unit proper is provided with an anodyzed finish. The equipment as a whole, as well as the internal parts, gave no indications of corrosion after being subject to exposure to 95% humidity at 40° C. for periods totaling approximately three hours, excepting as discussed in par. 3-2(1) herein.

(b) No forced ventilating measures are employed in the equipment, and component parts are cooled merely by natural air circulation. Sixteen ventilating louvers are placed in the cover of the Transmitter-Receiver Unit, eight being located on each side. On the sides, four louvers are at the top, and four others at the bottom. Additionally, six 1" holes are cut in the top of the cover for ventilating purposes. These holes are covered with wire gauze. There were no evidences of overheating of any of the component parts during the course of the tests. Attention is invited to the fact that the six holes in the top do not permit a drip-proof arrangement.

(c) The equipment is designed for operation from a 110-volt, d-c source. Two power units are provided inside the main assembly. One is a rotary converter, which converts the input power to 110-volts, 60 cycles a-c. The output of this machine is used to supply tube filaments, the receiver power pack, control circuits, panel lights, etc. The other power unit is a dynamotor, which delivers 600 volts d-c as a power source to the plate circuits of the transmitter tubes. The rotary converter is in continuous operation when the power switch is <u>on</u>. However, the dynamotor operates only when the handset is off its hook. Contacts on the cradle switch of the handset control the operation of the dynamotor. The dynamotor is provided with grease-packed ball bearings.

End bells and retainer caps must be removed before grease can be added. Directions as to the type of lubricant, frequency of lubrication, and the details as to the means of applying lubricant should be provided in an instruction book. The converter is provided with oil cups. During the tests of the effects of inclination upon the equipment, it was noted that one of the bearings leaked oil. Suitable steps should be taken to overcome this difficulty. In the Naval Service, machines with grease-packed ball bearings have been found preferable to those lubricated with machine oil, and if possible, a converter should be used, employing bearings of the same type as used on the dynamotor. Similar information, as previously indicated in conjunction with the dynamotor, should appear in the instruction book regarding lubrication of the converter.

(d) Nameplate data on the dynamotor and converter units are as follows:-

(1) The dynamotor was manufactured by the Pioneer Corporation of Chicago, Illinois. The input circuit is rated at 110 volts, 4.1 amperes, d-c. The output circuit is rated at 600 volts, 500 milliamperes, d-c. The speed of the machine is 4,000 R.P.M., and the unit is designed for <u>intermittent</u> duty. The temperature rise on the windings is indicated to be 40° C. The dynamotor bears Type No. RA3, and No. 19532, and another marking appears on its nameplate, namely "S.S. 1563", but the significance of this designation is not known. Attention is invited to the fact that the dynamotor is designed for <u>intermittent</u> duty only. In order to be suitable for the Naval Service, this unit should be designed for <u>continuous</u> duty, at ambient temperatures as great as +50° C. The usual Naval practice permits no intermittent duty electrical machinery.

(2) The rotary converter was manufactured by the Janette Company of Chicago, Illinois. The input circuit is rated at 115 volts, 2.5 amperes, d-c. The output circuit is rated at 110 volts, 1.36 amperes, a-c. Additional output markings appear, as follows: 60 cycles; 85% power factor; single phase; KVA, 0.15. The speed of the unit is 3600 R.P.M. The manufacturer's type No. is CA18. The number of the unit is 298545.

(e) Additional details as to the structure of the equipment have already been given in par. 2-7(a) of this report.

[redacted]

2-12. Component Parts

(a) Various types of resistors are used in the equipment, none of them being equipped with ferrule mountings. Composition resistors of the one-half-watt and one-watt sizes are included, but larger resistors are of the wire-wound, coated variety. Except for the composition resistors, leads are not relied upon for mechanical support except as indicated in par. 2-25(a) of this report.

(b) Two fuses are employed in the equipment. These fuses are placed in the incoming power leads and are mounted on plastic insulating blocks. They are immediately accessible when the front cover is removed. These fuses are of the glass-enclosed type manufactured by the Littelfuse Company and are rated at 10 amps. They are 1-12" long and 3/8" in diameter over the ferrules. It is not known whether fuses of this type and rating are normally stocked on shipboard. It is suggested that the Bureau give this matter consideration with a view of providing replacements. The fuse positions are not marked with information as to the rating in voltage and amperage of the fuses. Durable markings of this nature should be applied.

(c) Capacitors used in the transmitter portion of the equipment include small, molded, plastic case types of condensers, as well as paper encased condensers. Additionally, a few electrolytic condensers are employed. Some of the condensers were manufactured by Cornell-Dublier, but it was impossible to determine the manufacturer of other units. In general, the condensers are so located as to make their replacement possible without serious disassembly.

(d) No electrical measuring instruments are employed in the equipment. However, phone tip jacks to plug in meters have been provided to read certain tube currents. Arrangements have been made to plug in a meter to read the cathode currents of each of the three audio stages in the modulator unit. Additionally, jacks have been provided for the insertion of a meter to read both the radio frequency power amplifier cathode current and rectified grid current. An antenna ammeter would prove very helpful to the operating personnel in checking the operation of the transmitter. It is suggested that such an instrument be provided in all equipment of this type in the event that they are purchased by the Navy. A standard Navy type of ammeter should be employed.

(e) The antenna terminal is located at the right-hand side of the main transmitter chassis, and access to the connection may be obtained through a rectangular hole cut in the side of the front cover. The antenna terminal stud is insulated from the chassis by a ceramic insulator, probably Isolantite. The function of the antenna binding post should be indicated by a suitable permanent marking on the chassis.

2-13. Mounting and Shock-Proofing.

(a) Transmitter Receiver Unit. This unit is equipped with four Lord shock mounting devices. These mounts are located at the back of the main assembly. Thus this unit is equipped for bulkhead mounting, but is not arranged to be placed on a deck or a table. A number of holes are provided in the back of this unit to locate the shock mountings at various distances apart in so far as the vertical distances between the shock mounts are concerned. However, all the holes of the shock mounts at each side fall in the same vertical line. Thus the horizontal distance between the two pairs of shock mounts will always be the same, but the vertical distances between a pair may be adjusted to fit circumstances.

(b) Remote Control Unit. Four holes are provided in the back of this unit to allow mounting on a table or bulkhead. No shock mounts are employed. Attention is invited to the fact that in the arrangement provided, it is preferable to mount the Remote Control Unit on a table, rather than a bulkhead, for the handset bracket is best adapted to table mounting. If mounted on a bulkhead, the handset will stay in its holder. However, the mounting means does not seem any too secure. It would be preferable to provide a more secure means of mounting the handset and to employ means which will assure that the handset will stay firmly in place regardless of whether table or bulkhead mounting is employed.

(c) Dynamotor and Converter Units. As indicated in Plate TR-2, these members are housed near the bottom of the major unit. Both the rotary converter and the dynamotor are flexibly mounted with rubber washers.

2-14. Handset. A Western Electric Type F1W handset is provided. This handset is connected to the Remote Control Unit. A bracket is provided for holding the handset when not in use, and this bracket contains a double contact cradle switch, whose function has already been described in par. 2-11(c). A review of the information contained in pars. 2-5(f) and 2-13(b) indicates that improvements are necessary in the handset bracket to adequately secure it in place when the equipment is subjected to vibration and when the Remote Control Unit is mounted on a bulkhead.

2-15. Method of Connection. Plate TR-4 shows the terminal boards used in the equipment. Individual terminal boards are used in conjunction with the receiver, the transmitter, and modulator. An additional terminal board is used for interconnecting the Transmitter-Receiver Unit and the Remote Control Unit; and at one end of the same board, connections to the dynamotor and converter are provided. Terminal boards used are not of the form commonly employed in Naval apparatus. Actually, each board consists of two portions. One section is mounted to the main framework, and connections leave this board to other boards and circuits terminated on the major framework. The leads leaving other portions of the equipment, such as the receiver, the transmitter, the modulator, or Remote Control Unit, go to a separate terminal strip, which is, when connected, laid adjacent to the fixed terminal board; and the two portions are fastened together by a number of screws, which also form electrical connections. One terminal board and strip is provided with color-coded markings to readily indicate which portions of the interconnecting system are associated, in the only case where doubt would arise as to proper means of connection. Some difficulty was found in keeping good electrical connections between terminal strips and terminal boards and it was found necessary to retighten these connections at various intervals. In particular, difficulty was found in the connection to the dynamotor starting relay in the case of the contacts at the lower terminal board of the main assembly. This loose connection gave trouble throughout the course of the tests and was not located until the tests were virtually complete. No lock washers are used for the connecting screws, and locking devices of some nature should be provided to assure that troubles of this nature will not occur. Reference to par. 2-9(b) of this report indicates that the physical strength of the terminal board is much weaker than commonly used in most Naval applications.

(a) The cable connecting the Remote Control Unit with the transmitter-receiver unit includes 12 conductors, and about these conductors is placed a basket-woven metallic braid, which serves as a ground-return conductor for some of the circuits. Additionally, the high potential lead to the microphone button is individually shielded from all other conductors. The entire cable has a heavy rubber covering, which appears durable, and from all indications should be satisfactory for the purpose. No grommets are employed at the points where the interconnecting cable passes into the main framework of the Transmitter-Receiver Unit or the Remote Control Unit. Suitable grommets are necessary at these points, for it is likely that under Naval Service conditions, vibration and other factors incident to equipment afloat would cause chafing and damage to the cable. In addition, the cable should be securely fastened to both the Transmitter-Receiver Unit and the Remote Control Unit to prevent accidental strains from disrupting connections.

(b) Connections of the incoming power leads and the ground connection are in the form of solderless lugs. Considerable difficulty was encountered throughout the tests with loosening of all three of these connections. A more satisfactory means of making such connections is necessary. The function of the terminals used in connecting the incoming power leads and the ground lead is not indicated, and suitable durable markings should appear on the main framework to indicate their purpose. A polarity marking is provided for one of the power terminals, but it is in the form of red lacquer applied to the positive terminal. Some more permanent form of polarity marking should be applied. Additionally, the incoming power terminals should be marked to indicate the voltage of the source to be applied. Grommets should be employed at the points where power leads and the ground lead pass through the case to prevent chafing of the leads.

(c) On one occasion it was necessary to remove the assembly which holds the dynamotor, the converter, and their associated relays from the main framework. In this case it was also desired to keep these units connected into the circuit to observe their operation and action of the relays. Had the length of cabled wires connecting the power unit assembly with the main framework been 6" or 8" longer, it would have been much easier to perform this operation, and make a complete examination of parts, keeping the entire equipment in operation. In the Naval Service, no doubt this operation will occasionally be necessary; and the length of the cabled wires should be increased as indicated as a matter of convenience. Also, the group of cabled wires should be securely clamped to the main framework at some point near the terminal board to prevent the application of excessive strain to the terminal board. In the event that servicing is attempted in a rough sea, it would be easily possible to disrupt these connections if they are not securely attached to the main framework.

2-16. Description of Circuits. For information as to the tubes employed, refer to par. 2-1 of this report.

(a) Transmitter Circuits. The transmitter circuit consists of a crystal oscillator stage, an intermediate or buffer stage, and a power amplifier stage consisting of two type 807 tubes in parallel. The Master Oscillator and buffer amplifier output circuits are of the untuned type, which has been previously described in paragraph 2-6 of this report.

(b) Modulator Unit. Included therein are three stages of push-pull audio amplification. Additionally, voice relay circuits and AVC circuits are incorporated. Presumably, the AVC arrangement acts also as a peak limiter.

(c) Power Circuits. When the main power switch of the equipment is on, a relay is energized which starts the converter. The converter supplies power to various control circuits, vacuum tube filaments, and to the receiver. The dynamotor is not in operation unless the handset is removed from its hook. A safety relay is included which will not permit a dynamotor to start unless bias voltages, which are obtained from the receiver power pack, are applied to the transmitter tubes. The dynamotor has associated with it a relay arrangement and a limiting resistor to reduce the in-rush of current at the start; but it was noted that on starting the dynamotor, a considerable flash occurred at its high-voltage commutator, which from all indications appeared simultaneously with short circuiting the limiting resistor. The flash-over disappeared in a fraction of a second which was after the machine reached full speed. Arrangements were made to manually delay the closing of the contacts which short circuit the limiting resistor, and it was noted under these conditions that no undue sparking occurred at either commutator. The high-voltage commutator of the dynamotor has 42 segments, and the low-voltage one, 28. It is evident that extended life can hardly be expected from the dynamotor with a flash-over of the magnitude indicated each time it starts. Suitable means of overcoming this difficulty are necessary. If devices are included to delay the action of the short-circuiting relay contacts across the limiting resistor, from all indications adequate protection will be afforded.

(d) Voice Relay. Voice relay circuits are included in the equipment. For this reason no "press-to-talk" switch is provided on the handset. From all indications the voice relay closes in sufficiently a rapid manner to prevent chopping of a portion of the first spoken word. Additionally, the voice relay holds closed for a period approaching a second after speech into the microphone has ceased. The voice relay appeared to be slightly more sluggish in so far as closing is concerned at ambient temperatures of -15° C. However, there was no great difference in its action at this low temperature and at normal room temperature. The voice relay contains contacts which shift antenna connections from the transmitter to receiver and energize or de-energize the transmitter and receiver crystal circuits as necessary. A sensitivity control is provided for the voice relay, but it is a sub-panel screwdriver adjustment. Removal of the front cover of the transmitter receiver unit is necessary to make an adjustment. Although the exact range in sensitivity control was not measured, sufficient adjustment was present to either make the circuit so sensitive that very slight room noise would cause operation of the voice relay; or if the control were adjusted in the opposite direction, so low sensitivity was obtainable that shouting into the microphone would not cause voice relay action. It is considered that sufficient range in sensitivity has been provided. However, it was noted that on many occasions when the sensitivity control was set normally, that ordinarily encountered room noise level was sufficient to cause operation of the voice relay. When reception is being obtained, these extraneous noises operate the voice relay and render the receiver inoperative, so it is obvious that a portion of the message could be lost by undesired operation of the relay. Also, the signals delivered by the loud speaker are frequently sufficient to operate the voice relay unless the hand is clamped tightly over the microphone. It has also been noted that when reception on the earphones of the handset was being obtained, that sufficient noise was produced to operate the voice relay. Considering these factors, as well as other sources of noise which will be encountered on Naval craft, such as exhaust of engines, gunfire, etc., it is apparent that an equipment adapted for voice relay carrier control only, will not fulfill the needs of the Naval Service. In order to overcome these difficulties, it is suggested that the following circuit modifications be included in the event that apparatus is employed in the Naval Service. Circuit arrangements should be provided which permit the use of either voice relay carrier control, or manual carrier control operated by "press-to-talk" switch. This would make necessary the inclusion of a "press-to-talk" switch on the handset. It would also make necessary the addition of a 2-position switch to shift the carrier control from voice-relay to manual, or vice versa. This switch should preferably be located on the front panel of the Remote Control Unit, and its function plainly indicated by suitable marking. Additionally, the voice relay sensitivity control should also be located on the Remote Control Unit, and its setting be capable of adjustment by means of a suitable knob on the front panel. Thereby the operator would have under direct control the matter of whether voice relay or manual carrier control would be employed. It would also give opportunity to adjust the sensitivity of the voice relay to meet the particular conditions as to surrounding noise level. It is believed that a much more satisfactory arrangement would be provided in the event that these modifications are effected; and unless these changes are incorporated, the equipment cannot be considered suitable for certain Naval uses.

(e) Remote Control Features. As has been previously indicated, the equipment is adapted for Remote Control. For a view of the Remote Control Unit, refer to Plate TR-1; it is the smaller of the two units shown therein. In the equipment provided, a 23-foot, shielded, 12-conductor, interconnecting cable was furnished. Possibly a longer cable could be employed if necessary for the particular application.

However, no information has been furnished as to the maximum length of cable which may be used without encountering too much voltage drop. In a letter to this Laboratory of September 30, 1940, from the Washington representative of the Jefferson-Travis Company, it was indicated that the equipment was usable with two or more Remote Control Stations. An inspection of the wiring diagram does not lead to the conclusion that it would be possible to directly parallel two units and still obtain satisfactory operation. If the Bureau is interested in obtaining equipment operable from several Remote Control Stations, it is suggested that they inquire of the contractor all particulars pertaining to such an arrangement.

OPERATIONAL DATA AND PERFORMANCE

2-17. Power Output. The power output of the transmitter under various conditions is described in the following subparagraphs.

(a) Operation into Dummy Antenna. Refer to Table T-1 for information as to the power output of the equipment when loaded into a dummy antenna consisting of a 32-volt, 50-watt incandescent light bulb. The data shown therein were taken with the best possible compromise in setting of the P.A. tuning-coupling condenser and tap adjustment on the antenna load coil which would give optimum output at all three output frequencies. It may be seen that the P.A. cathode current is not the same in all instances, but this is the best compromise adjustment possible. No information was provided by the manufacturer as to the desired value of P.A. cathode current. However, referarence to a vacuum tube manual indicates that the pair of 807 tubes should most likely draw a cathode current in the neighborhood of 200 to 250 milliamperes. The observed values of P.A. cathode current fall in this region in all instances. It may be seen that the rated output (50 watts) is obtained at all three frequencies.

(b) Operation into Real Antenna. The equipment was operated into an actual antenna of the dimensions indicated in the third footnote of Table T-2. Not only was the equipment operated directly into this antenna, but in two instances series capacitors were inserted in the antenna lead to alter the effective capacitance of the antenna system. The data observed in conjunction with these tests are shown in Table T-2. As was described in the foregoing subparagraph, the best possible compromise in tuning adjustments was employed in connection with the tests into the actual antenna. It may be seen that in no instance does the power output reach the rated value of 50 watts, even if probable errors are considered, and it is estimated that the values are accurate to within ± 10%. It is also evident that it was not possible to load the power amplifier circuit in a manner which would cause the P.A. cathode current to fall within the limits of 200 to 250 milliamperes. It is therefore obvious that the full output capabilities of the output stage are not available. The failure of the equipment to deliver full power into an actual antenna is an inherent penalty imposed by the relatively simple circuits used in making P.A. tuning and antenna adjustments, coupled with the necessity of employing compromise tunings which will be reasonably efficient at several frequencies. Attention is invited to the fact that the process which must be undergone to make suitable compromise adjustments at all three frequencies was quite tedious and laborious. It is believed that had ten crystals been available, and had an effort been made to secure a suitable compromise adjustment for all frequencies, that considerable difficulty would have been encountered. But it may be possible that an operator thoroughly familiar with the equipment would be able to make the proper adjustments with less difficulty, and it is suggested that the Bureau contact the manufacturer with the object of learning further particulars in this respect.

(c) Effect of an Open-circuited or a Short-circuited Antenna. In apparatus constructed specifically for Naval use, a requirement is included that open-circuiting or short-circuiting the antenna shall cause no damage to the radio equipment. Some data have been taken on this subject which are shown in Table T-3. With any abnormal antenna condition, it may be noted that a considerable rise in P.A. cathode current is found. However, the increase in cathode current is not considered excessive, and in this respect the equipment compares favorably with other types of Naval transmitters designed for shipboard use.

2-18. Variation in Ambient Temperature. The data applicable to this test are shown in Table T-4; and additionally, the same data are shown in graphic form in Plate T-1. During the first portion of this test the equipment was maintained at an ambient temperature of 24° C. for a period of three-quarters of an hour. Thereafter the ambient temperature was abruptly increased to 50° C. and maintained approximately at this temperature for a period of two hours. Next the temperature was reduced with the object of ultimately stabilizing in the region of -15° C. However, a period of one and a half hours was required for the temperature transition. After reaching the temperature in the region of -15° C., the ambient temperature was held for a period of two hours. Thereafter the ambient temperature was again raised to approximately 50° C. as rapidly as possible. A period of one-half hour was required for this change. Humidity readings were taken at all temperatures appreciably above 0° C., and reference to Table T-4 will indicate that, in general, all humidity values were reasonably low. In addition, the transmitter output frequency, expressed in the form of beat note frequency against a standard crystal, was measured and this information is included in Table T-4. In the case of each two-hour stabilization period, the operation of various parts and circuits was checked at intervals in order to assure that they were still in good working order. Attention is invited to the first footnote appearing on the second page of Table T-4, which indicates that the transmitter circuits were operated only at short intervals and that during most of the test period the equipment was adjusted for reception. The maximum spread in beat note frequencies found during the course of the tests was 355 cycles. It may be seen that the average temperature coefficient of the crystal between the limits of +50° and -15° C. is 2.3 parts per million per degree Centigrade, which is reasonably low. No substantial change in power output was noted during the course of the tests. An examination of the equipment at the end of the test indicated no damage to component parts. Comment will now be offered as to the performance of parts and circuits under the extreme temperature conditions after the temperature had stabilized for a period of two hours. The voice relay functioned satisfactorily. However, at the low value of ambient temperature it gave appearances of being slightly more sluggish than at normal or high values of ambient temperature. The push-button selector system functioned in a satisfactory manner at +50° C., but became inoperative at -15° C. The necessary steps should be taken to assure that the push-button selector system will operate in a satisfactory manner over the indicated range in ambient temperature before its performance can be considered satisfactory for use in the Naval Service. It was also noted that certain receiver controls did not properly function at extreme temperatures. Full particulars will appear in Section III of this report.

2-19. Variation in Humidity. The performance of the equipment during these tests is shown in Table T-5. The same data are shown in graphic form in Plate T-2. The equipment was subjected to an ambient temperature of 40° C. at a humidity of approximately 30% for a period of approximately three-quarters of an hour. Then the humidity was abruptly raised to a value in excess of 90%, maintaining approximately the same ambient temperature; and conditions were held in this manner for a period of one hour. Thereafter the humidity was reduced to 30%, keeping the same ambient temperature in so far as was possible. Attention is invited to a statement inserted in the tabular data appearing in Table T-5 which describes a circuit failure. It is now believed that this interruption in operation was caused by the loose connection in the converter starting circuit as described in par. 2-15 of this report. Ultimately, normal operation was restored and the test was resumed, and the humidity was held constant at approximately 30% at an ambient temperature of 40°. The transmitter circuits were in operation during relatively short regular intervals, as indicated in footnote No. 1 of Table T-5. The output frequency of the transmitter was checked at regular intervals and is expressed in the form of beat note frequency, as shown in Table T-5. The maximum frequency change occurring after the end of the first portion of the test was only 45 cycles. No appreciable change in power output was noted during the course of the humidity test. An examination of the equipment at the end of the test indicated no damage, and no other detrimental effects were noted as a consequence of the humidity test. The push-button selector system functioned in a satisfactory manner at high values of humidity, and a suitable performance was afforded by the voice relay.

2-20. Effect of Prolonged Humidity. The equipment was operated for a period of one-half hour at an ambient temperature of approximately 40° C. and at a humidity of 30%. Thereafter the equipment was shut down and the humidity increased to a value approaching saturation and held under this condition for a period of two hours. Next the equipment was placed in operation to be checked for performance after being exposed to this high value of humidity while idle. The equipment performed in a satisfactory manner and appeared none the worse as a consequence of this test. A careful examination of component parts indicated no damage. No evidences of rust or corrosion were found at the conclusion of this test. Refer to Table T-6 for data observed during this test.

2-21. Locked Key Operation for One Hour. The data shown in Table T-7 cover this test. During this test the transmitter circuits were continuously energized. An ambient temperature in the region of 40° C. was employed, but reasonably low values of humidity prevailed throughout the test. The changes in frequency noted were not of particular consequence. No substantial change in power output occurred during the course of the test. An examination of the component parts at the end of the test indicated no damage, and no other detrimental effects were noted as a consequence of locked key operated for a period of one hour. Although the dynamotor is rated as an intermittent duty machine, it successfully withstood a test fully loaded for a period of one hour at an ambient temperature of 40° C.

2-22. Power Required from Supply Line and Variation of Supply Line Voltage. Pertinent data appear in Table T-8. Although the nameplate of the Jefferson-Travis equipment states that the operating potential is 110 volts d-c, in the Naval Service it is customary to use 115 volts instead of 110 volts. Hence the tests were conducted assuming a potential of 115 volts to be normal line voltage. The variation in various currents, potentials, powers, etc., is analogous to that found in equipment designed specifically for Naval apparatus. The question may arise as to why tests were conducted with line voltages as low as 88 volts. Where storage batteries are employed as a power source in the Naval Service, there are occasions where, in the case of practically discharged batteries, the line voltage falls to values in that region. It may be seen that variation in line voltage from +10% to -23.5% causes an output power variation greater than two to one. Reference to Table T-8 indicates that a power of nearly three-fourths of a kilowatt is required during transmission with the carrier on. It was also found that a maximum current of approximately 20 amperes was required by the equipment on starting.

(a) Additional tests with variation in line voltage indicated that the voice relay functioned satisfactorily, with line voltage variations, between the limits of +10% and -30%.

(b) The dynamotor starting circuit worked satisfactorily with line voltages 10% above normal. However, with an input voltage 10% below normal, on some occasions the relays associated with the starting arrangement will not close.

On some occasions it was noted that a potential of 105 volts was required to close these relays. But at other times it was found that an applied voltage of 101 volts was sufficient for the purpose. Changes should be effected so as to assure that these relays will close and function satisfactorily at any line voltage between -25% and +10% of normal value.

(c) The push-button selector arrangement functions satisfactorily at line voltages 10% above normal; but at potentials of 10% below normal, its action is sluggish and unreliable. With low line voltage, that is with a supply at 103.5 volts, on several occasions the automatic selector system ultimately adjusted itself to the wrong position. In order to be suitable for use in the Naval Service, the necessary steps should be taken to assure that this mechanism functions satisfactorily at all line voltages from 25% below normal to 10% above normal.

(d) In the three foregoing subparagraphs the statements have been based on the assumption that line voltages would be maintained to within the limits of -25% to plus 10% of normal line voltage (115 volts). Should it be the intention to install this equipment on Naval craft in which there are normally encountered line voltage variations greater than have been indicated herein, it is suggested that the Bureau inform the contractor as to what voltage variations will be found.

2-23. Vibration. By using the apparatus described in par. 1-11 of this report, the complete equipment was subjected to vibrations at a number of frequencies and amplitudes. The major unit was supported only by its shock-mounting devices. The equipment was subjected to the vibration test for a period of one hour. No damage or other factors detrimental to operation were observable. The automatic frequency selector system, voice relay circuits, dynamotor starting relays, etc., performed in a satisfactory manner. Voice signals of reasonably good quality were obtainable at all times. Although no tube locking devices are employed in the design, there was no tendency for the tubes to loosen and fall from their sockets. Such units as the dynamotor and converter showed considerable movement during the tests, as well as the main sub-panel and many of the components. The amplitude of the movement of many of the parts was considerably greater than observed in most Naval apparatus which is treated in a similar manner. But no parts came loose, and no electrical connections were disrupted. Attention is invited to the statement in par. 2-5(f), which indicates that the handset mounting is not too secure, although the handset did not fall from the bracket during vibration. Since no damage resulted, and good electrical performance was obtained during vibration, it is believed that the equipment is constructed in a manner to suitably operate in the presence of vibration, provided a more suitable handset bracket is employed.

2-24. Inclination. As related in paragraph 1-11 of this report, the equipment was subjected to inclination tests. The duration of the test was one hour, and during half the period the equipment was inclined from side to side and during the remainder, from front to back. Satisfactory performance was afforded at all times during the test. The action of the automatic frequency selector system, the voice relay, dynamotor starting relays, etc., were observed at various intervals throughout the test, and satisfactory operation was noted. Voice signals of good quality were obtainable at all times. The only observed detrimental effect of inclination was leakage of oil from one of the converter bearings, which has already been discussed in paragraph 2-11(c). If the suggestion contained in that paragraph relating to the employment of grease-packed ball bearings, in lieu of the type used, it is anticipated that no factors will be present which will abrogate the operation and performance of the equipment during inclination.

MISCELLANEOUS DATA AND INFORMATION

2-25. Additional comment is offered on the resistors used.

(a) In conjunction with the output radio frequency stage, two resistors, R-45 and R-46, are connected between the plates of the Type 807 tubes. Actually, these two resistors are contained in one unit provided with a center tap. Plate voltage connections are made at the center tap. Presumably, this center tapped resistor unit is employed to suppress spurious oscillations. This unit is supported merely by means of the pigtail connections to the caps of the Type 807 tubes. Although the arrangement withstood the forces encountered during vibration without disrupting the circuit connections or other detrimental effects, it is believed that too poor a means of mounting has been furnished to withstand indefinitely the rigors of conditions found afloat. A more positive and definite means of securing should be employed for this resistor unit.

(b) Toward the conclusion of the tests it was noted that the connecting lead to resistor R-69 in the bleeder circuit across the dynamotor had broken at the point where it enters this 1-watt composition resistor. Such changes as are necessary should be incorporated to eliminate this difficulty.

2-26. Further discussion of the tube complement and related factors are noted below:-

(a) All of the Type 807 tubes furnished with the equipment were equipped with plastic bases. Navy Specifications RE 13A 600C require ceramic bases on this type of tube, but it is understood that the Bureau is considering permitting the use of plastic type bases on the Type 807 tubes.

[redacted]

Record will be made that no factors detrimental to the employment of plastic base types of tubes were noted. It is suggested that the Bureau give consideration to this matter and inform the contractor if a ceramic base tube is required or whether a plastic base tube will be permitted.

(b) In the circuit designations appearing on the wiring diagrams of the equipment it is noted that two tubes bear the same circuit part designation, namely V-9. One tube bearing such marking is the crystal oscillator tube, and the other is the receiver rectifier tube. In order to eliminate confusion in servicing the equipment, each tube should have a separate and distinct circuit part number.

(c) In order to facilitate the replacement of tubes and various servicing operations, permanent and durable markings should be placed on the chassis in close proximity to each tube, indicating the type of tube, and the circuit designation part number in addition.

(d) The crystal oscillator tube is housed in a shielding arrangement which is provided with a small aperture for giving access to the tube for replacement. The opening provided is so small that it is quite difficult to insert or remove the tube. Such steps as are necessary should be taken to overcome this difficulty.

2-27. Additional comment is offered on the automatic frequency selector system as follows:-

(a) In the push-button selector system furnished it is possible to depress two or more buttons simultaneously and cause them to "stick" downward in a manner similar to that obtained when only one button is pressed. In case two or more buttons are pressed, the selector system at times stops at a place corresponding to one of the depressed buttons, but at other times it moves to a frequency corresponding to some other position. In case the equipment were being handled by an operator wearing heavy gloves, it is easily possible to accidentally depress two buttons when it was the intention to operate only one of them. Suitable means should be included to preclude the possibility of more than one button remaining in the downward position.

(b) It is possible to depress one of the buttons slightly and release a button previously depressed, and yet not move the depressed button far enough to cause it to "stick" in a downward position. In this case the automatic selector arrangement in some instances maintains a continuous stepping action and does not come to rest. On other occasions it was noted that this continuous operation takes place for a while, but after operating in this manner for a few seconds would ultimately stop on some crystal position. No means of easily overcoming this action can be suggested, and as a consequence no corrective measures are suggested.

(c) When the automatic selector system is in operation, successively the various channels are operable between selector step movements, and this condition persists for a period of a fraction of a second. If a sufficient noise level is present in the vicinity of the microphone to cause operation of the voice relay, successive emissions take place on all channels transversed by the selector system during the process. These undesired emissions might possibly cause interference with other communications, and also may serve to disclose the fact to an enemy that some craft bearing radio equipment is in the vicinity. If the manual means of obtaining carrier control is added to the equipment as suggested in par. 2-16(d) of this report, and the operator is careful to select manual carrier control during automatic tuning of the equipment, no difficulty from this cause will result. The instruction book should indicate the presence of these undesired emissions, and should warn the operator to employ manual carrier control when shifting channels in a region of high audible noise level.

(d) An investigation was made to determine if sparking relay contacts, or other factors incident to the selector system caused radio frequency interference. Excepting as to the matter discussed in the foregoing paragraph, it was found that no radio frequency noises were produced.

(e) It was noted that the automatic frequency selector system did not function as well toward the end of the tests as upon delivery. The stepper relays lost some of their original "snappy" action. At times it was noted that the pawl, which is relay operated, did not strike the toothed ratchet arrangement with sufficient force to advance it an entire position. Because of its weaker action, an extra stroke was required to advance all ganged parts to the proper position. A check of the line voltage at the time this action occurred indicated that normal line voltage was present. In order to produce satisfaction in the Naval Service a more rugged, durable, and dependable automatic frequency selector system is necessary.

(f) In the event that this equipment is ultimately adopted for use in the Naval Service, it appears desirable to provide means of manually advancing the selector system if a failure in the automatic mechanism occurs. It appears that it would be feasible to make the ganged multiposition switches, operated by the stepper relays, also controllable with a knob. The shaft of the ganged arrangement could be extended through the top of the assembly.

[redacted]

A portion of this shaft could be keyed or notched to provide for the application of a knob, with a pointer or marker, in some definite relationship with the contractors on the multi-position tap switches. Numbering could be placed about the periphery of the knob and on the main framework in such a manner that the frequency channel number would correspond with that indicated by marker on the knob. Thus in the event of the failure of the automatic selector system, an operator would be able to manually advance the ganged switches to the desired communication channel. It is realized that in the mechanical arrangements provided, it would be permissible to advance the knob in only one direction, and a suitable warning nameplate with an arrow should be applied, which would give all the particulars which must be observed during manual adjustment. It would be permissible to use a knob which is easily removable from the shaft and stow it among the spare parts except when needed. In order to incorporate this modification, a switch would be necessary to render the automatic devices inoperative during manual control. If these measures are included, a piece of equipment will be available which is capable of operation even though the automatic selector circuits fail. It is suggested that the Bureau discuss this matter with representatives of the contractor with the object of determining its feasibility.

2-28. As has been previously indicated, in the equipment under tests each of the ten channels is numbered in sequence, and these numbers appear on a celluloid window on the Remote Control Unit. It would be preferable to permanently engrave these numerical channel designations on the front panel of the unit and to leave the celluloid windows unmarked, so that appropriate information could be added in ink. For instance, each window could be marked with appropriate information as to the frequency of the channel or as to the transmitter frequency and receiver frequency in cases where transmission and reception took place at different frequencies. For the convenience of the Service personnel, suitable numbering to correspond with the numbering of channels on the Remote Control Unit should be provided beside each of the 10 socket receptacles into which a crystal is plugged. Such marking would be very helpful in placing the crystals in their desired location. Likewise, the antenna clips which fasten to the loading coil could be similarly stamped as to channel number. These clip leads and the crystal plug receptables are now color coded, but it is thought likely, that after considerable exposure to moist sea atmosphere, the color would not be entirely legible.

2-29. The crystal holders are the plug-in type and are made of some sort of plastic material. Two crystals are housed in each holder, one for the transmitter and the other for receiving purposes. A nameplate appears on each crystal holder, indicating the frequency of both cyrstals. The pins of the plug-in arrangement are of the same size and spacing as used in a conventional octal tube base. It is evident that the kind of crystal holder used is not of standard Navy type.

2-30. The hinge pin of the swinging chassis arrangement gradually works downward as the hinged member is opened or closed. At several intervals during the course of the tests it was necessary to knock it back in place by means of a hammer. If a suitable head were provided at the top end of the pin, this difficulty would be overcome, and it is suggested that this form of pin be provided in all equipment supplied to the Navy. Upon delivery, two screws which secure the hinge to the main framework were missing. Because of the missing screws the hinge work was weakened to an extent which made opening or closing of the swinging chassis very difficult. Care should be taken to include all necessary screws before the equipment is packed for shipment.

2-31. Referring to the antenna coil, the turns of which are closely spaced, the following structure is used to facilitate attaching the antenna clips: At one portion alternate turns are bent inward for a short distance, but the remainder of the turns are flush with the periphery of the coil. Thus over a short portion of the circumference, the turns are effectively double spaced at the point where clips are attached. In another region a similar arrangement is employed. However, the opposite alternate layers are pulled inward. Thus it is possible to vary an individual clip by steps of very nearly one turn; but at the point where clips are applied, double spacing is used. But it was noted that antenna clips could not be placed side by side on the adjacent turns, even though double spacing was used, without some danger of producing a short circuit between the ends of the clips. If the equipment was set up on ten channels, no doubt in some instances it would be necessary to place clips side by side. Some means should be provided for overcoming this difficulty in all equipments supplied to the Navy.

2-32. In the design provided, the filaments of all tubes in both the transmitter and modulator portions are energized when the main power switch is <u>on</u>. In the Naval Service there may be relatively long periods when it is desired to maintain a watch with the receiver, but when no transmission is contemplated. In order to save power and to conserve the life of the rotary converter, means should be included for shutting off of the above-mentioned filament circuits, if desired. This switch should be located on the front panel of the control unit, and suitable markings should be applied to indicate its function.

2-33. The nameplates provided on the equipment are of commercial variety only and do not fulfill the usual Navy requirements. It is suggested that the Bureau give consideration to the matter and inform the contractor as to what type of nameplates are necessary.

2-34. None of the component parts are provided with symbol marking tags. In order to facilitate repair and servicing, all major components should have been provided with suitable permanently affixed symbol designations which correspond with the numbering appearing on the wiring diagrams.

[redacted]

2-35. The P.A. tuning-antenna coupling condenser C-42 is provided with no locking device to prevent accidental movement. Although no difficulties of this nature were experienced, it is realized that vibration, inclination, shock and other factors incident to Naval equipment afloat, might cause an accidental shift in setting. For this reason a locking device is recommended.

2-36. It was noted that the wiring diagrams furnished with the equipment do not show the field circuits of either the dynamotor or the converter. To facilitate servicing the equipment, the connection details of the fields should appear in the wiring diagrams.

2-37. It should be understood that the design of the equipment makes it necessary in the normal course of operation, in the case of any one communication channel, to transmit and receive on predetermined frequencies corresponding with the crystals used on that particular channel. Thus as ordinarily used, the frequencies of transmission and reception are definitely restricted to what crystals are available in the particular crystal holder used in that channel. Or stated otherwise, the equipment differs from that ordinarily used in the Naval Service, since many other types of equipment allow transmission on one frequency and reception on any other at will. Of course, it would be possible to transmit on one channel and receive on another channel provided the automatic selector system is brought into play between every transition.

2-38. On several occasions a radio frequency flash-over occurred at at the tap switch of the antenna selector circuit. This was noted at two distinct places. A ring member of the tap switch, which carries a moving contractor, flashed over to the fixed contractors on the periphery. Additionally, the ring member also flashed-over to the central shaft which rotates this mechanism. More attention should be paid to spacings and other arrangements to preclude the possibility of this occurrence.

2-39. The microphone button is energized from the 600-volt dynamotor through the medium of a potentiometer and resistor combination. The button itself operates at 1.3 volts and 26 milliamperes. Failure of the voltage divider arrangement, and in particular R-61, would put the high voltage on the microphone, which would most likely destroy it. Also, the possibility of a high voltage being applied to some of the conductors of the handset is a distinct high voltage hazard. In order to overcome this difficulty, it is suggested that the microphone be energized from some type of low-voltage rectifier, such as one of the copper oxide type, which could be energized from an extra winding of the filament transformer. If this arrangement is provided, it will likely be possible to lighten the load on the dynamotor, which will prove helpful in prolonging its life. Extra contacts could be provided on the filament switch suggested in paragraph 2-32 of this report, to break the supply to the microphone rectifier when the transmitter circuits are inoperative.

2-40. By means of a cathode ray oscillograph, a study was made of the percentage of modulation obtainable. Upon delivery it was noted that when speaking directly into the microphone with a normal tone of voice, that positive and negative peaks of approximately 60% were obtainable. It was ultimately found that the modulator contained the volume control for adjusting the modulator output level. By making a suitable adjustment, substantially complete modulation was obtainable. However, the observed percentage of modulation was found to depend somewhat on P.A. loading, or more particularly, upon the value of plate current flowing in the radio frequency output stage; but it was possible to obtain a suitable compromise setting which gave reasonably high levels of modulation in all cases. A suitable locking device should be provided for the modulator audio volume control to prevent accidental misadjustment. This volume control is located inside the major unit, and access to the rear of the hinged chassis is necessary to make an adjustment. The instruction book should give all details for properly setting this volume control. Reception tests indicated that the quality of modulation was reasonably good. Plate modulating circuits are embodied in the design. Voice emission only is available in the equipment.

2-41. At the conclusion of the tests it was noted that the dynamotor starting contact of relay Re-7 was considerably burned. Although it had not proceeded to a degree which caused failure, it was believed, after an examination of the burned members, that extensive life would hardly be afforded by the contactor arrangement employed. A more durable and rugged contactor system is necessary for this application.

2-42. Although the equipment is adapted for use with the automatic ringer unit, no such device was included with the apparatus under test. One of the relays employed in the Transmitter-Receiver Unit functions in conjunction with the ringer unit only, and presumably has no other function. It is therefore suggested that the Bureau consider this matter, and in the event that no automatic ringer apparatus is to be employed, that the relay Re-3 and associated circuits be eliminated.

2-43. As has been indicated in par. 2-12(b) of this report, the only fuses employed are placed in the incoming power lines. As an added safety precaution, it is considered that fuses should be employed in the output circuits of the converter and dynamotor. Referring to the converter, a suitably rated fuse in either line will be sufficient. In regard to the dynamotor, a fuse should be provided in the positive lead as close to the brush as possible, suitably rated to withstand the dynamotor output voltage, and rated at approximately 50% higher than normal output current. The high-voltage fuse should be capable of opening the circuit under short circuit conditions without emitting flame, molten metal, or metallic vapors. All fuses should be located so that they are readily replaceable. Additionally, suitable markings should be applied to the chassis to indicate the ratings in voltage and current of replacements.

2-44. <u>Instruction Book</u>. As stated in par. 1-7 of this report, no instruction book was provided with the equipment. A suitable instruction book should be furnished which includes the information outlined below as well as other data which the manufacturer considers essential.

[redacted]

(a) The instruction book should be written to provide necessary information as to servicing, as well as operational adjustments.

(b) A complete description of electrical and radio frequency circuits should be provided, and simplified diagrams of various portions of the circuits would prove helpful. In particular, detailed information should be provided as to the mode of operation of the automatic channel selector mechanism, and complete servicing details should be provided.

(c) Full particulars regarding necessary or desirable adjustments for making the equipment function satisfactorily on a number of channels should be included. Such information will prove necessary for the guidance of the installation personnel. The discussion should include information as to the normal value of P.A. cathode current. As it will most likely be impossible to obtain the same cathode current on all the channels, some statement should appear as to permissible variation.

(d) Full particulars should appear as to the care of rotating electrical machinery involved. This should include full instructions regarding lubrication.

(e) The instruction book should include all information necessary for unpacking the equipment and all precautions necessary in installation.

(f) The instruction book should include a complete parts list, giving the symbol number of the part, a description of the part, its ratings, etc. In addition, the name of the manufacturer and the manufacturer's type number or model number, or other appropriate information, should appear.

(g) In the wiring diagrams furnished with the equipment, each unit or subdivision of the equipment was shown on a separate sheet. These diagrams may be helpful in the original wiring up of the equipment, but they are not very satisfactory for servicing work. A composite diagram of the complete equipment should be provided.

(h) The instruction book should also contain full particulars regarding certain features of the equipment as discussed in pars. 2-6, 2-11(c), 2-27(c) and 2-40 of this report.

2-45. Spare Parts. No spare parts were included with the equipment. Numerous component parts of such design and manufacture are employed, that it is unlikely that many replacement parts for this equipment would be available on Naval vessels. An inspection of component parts leads to the conclusion that they are not as rugged or durable as standard Navy parts; and accordingly, it is believed that component part failures will be somewhat

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more frequent than in Navy standard equipment. It is therefore suggested that the Bureau take steps to provide adequate spares.

2-46. During operation of the equipment into an actual antenna it was found quite possible to accidentally adjust the power amplifier antenna circuit to operate at the double of the excitation frequency, rather than at the excitation frequency. In order to eliminate the possibility of making an error in adjustment, the use of an absorption wavemeter was necessary. Such an instrument is considered essential for the installation personnel, for otherwise there is a chance of making a mistake in the original tuning adjustments of the equipment.

2-47. A suitable retainer device should be used in conjunction with the seven knurl- headed thumbscrews which secure the cover. These retainers are necessary to prevent loss of these thumbscrews.

SUMMARY OF DEFECTS

2-48. There are summarized below the various defects and difficulties encountered in the transmitter portion during the course of the tests. Included therein are certain matters which are of sufficient importance to warrant further consideration by the Bureau before the Jefferson-Travis Model 500D Radio Equipment should be considered suitable for use in the Naval Service. The list also includes a recapitulation of instances where the equipment does not embody the usual Naval practices in design and construction. At the end of each of the following statements there appears the paragraph number in the report which discusses the matter in detail.

(1) No instruction books were furnished with the equipment; certain factors should be discussed in detail in the instruction books. 1-7, 2-6, 2-11(c) 2-27(c), 2-40, 2-44.

(2) The equipment employs tubes for which there are no standard Navy equivalents. 2-2.

(3) One of the Type 807 modulator output tubes was broken in transit. 2-4.

(4) Stop mechanism on the main power switch failed. 2-5(e).

(5) Handset cord should be more durable; the cord should be securely anchored at each end to prevent disruption of connections by the application of accidental strains. 2-5(f).

(6) The securing means employed in handset bracket requires improvement; also, the bracket should suitably secure the handset regardless of whether the Remote Control Unit is mounted horizontally or vertically. 2-5(f), 2-13(b), 2-14, 2-23.

(7) Holes in hinged sub-panel arrangement do not properly align with studs in main framework; the bottom of the swinging sub-panel strikes the top of the converter unit during opening or closing. 2-7(a).

(8) No high voltage warning signs are provided. 2-7(b).

(9) Cabled leads require suitable anchoring to chassis. 2-8(a).

(10) Solid wire is used in a place where it will be flexed at intervals. 2-8(b).

(11) Some of the wiring employed in radio frequency circuits is not of a rigid, self-supporting type; better insulation is desirable at points where some of the radio frequency leads pass through the sub-panel. 2-8(c).

(12) Condenser lead passing through brush holder cap broke loose; a more convenient manner of making this connection is desirable. 2-8(d).

(13) Terminal boards appear rather frail for the purpose; some difficulty was found in keeping terminal board connections tight; no lock washers are employed on terminal board connection screws. 2-9(b), 2-15.

(14) Ferrous materials are extensively used for non-electromagnetic purposes. 2-11(a).

(15) Converter bearing leaks oil during 45° inclination; a machine provided with grease-packed ball bearings is preferable for the purpose. 2-11(c), 2-24.

(16) The dynamotor is an <u>intermittent duty</u> machine; in Naval applications, <u>continuous duty</u> machines are required. 2-11(d)(1).

(17) The fuses employed may not be normally stocked on shipboard; fuse mountings are not marked with suitable data as to ratings of fuses employed; as an additional factor of safety, suitable fuses should be placed in the output circuits of the dynamotor and converter. 2-12(b), 2-43.

(18) No antenna ammeter is provided; an antenna ammeter is considered essential as a check on the performance of the transmitter; function of antenna binding post should be marked. 2-12(d), 2-12(e).

(19) Grommets should be used at points where ground lead, incoming power leads, and control cable pass through the outer shields of the Transmitter-Receiver Unit and Remote Control Unit; function of incoming power leads should be marked, and this should include information as to the polarity of connections and the value of the input voltage to be applied; function of ground connection terminal should be marked; more satisfactory terminal arrangements should be used for ground and incoming power connections; cabled leads

[redacted]

from dynamotor-converter assembly to terminal board on main framework should be slightly longer and should be securely anchored to the units to prevent accidental disruption of connections. 2-15(a), 2-15(b), 2-15(c).

(20) A flash-over occurs at the high-voltage commutator of the dynamotor on starting. 2-16(c).

(21) A piece of equipment which is adapted for voice relay carrier control only is unsuitable for many Naval applications; modifications are necessary which will allow manual carrier control by means of a "press-to-talk" switch in addition to voice relay carrier control. 2-16(d).

(22) The rated power output of the equipment is not obtainable with three types of actual antennas; some difficulty is encountered in obtaining suitable compromise tuning adjustments for three output frequencies; it is thought likely that considerable difficulty would be found in making suitable compromise tuning adjustments on ten output frequencies. 2-17(b).

(23) Push-button selector system fails to function properly at an ambient temperature of -15° C.; on some occasions the push-button selector system failed to properly function with a line voltage 10% below normal; if two or more push buttons are simultaneously depressed, they will "stick" in a downward position; successive radio frequency emissions take place on all channels transversed as the automatic frequency selector system operates, if sufficient audible noise level is present to operate the voice relay; the general performance of the automatic frequency selector system deteriorated during the course of the tests; means of providing manual frequency switching arrangements are suggested for use in the event of failure of the automatic selector system. 2-18, 2-22(c), 2-27(a), 2-27(c), 2-27(e), 2-27(f).

(24) Dynamotor starting relay did not close on some occasions at a line voltage 10% below normal value. 2-22(b).

(25) One of the resistors should have a better supporting means; another resistor connection broke loose during the tests. 2-25(a), 2-25(b).

(26) Plastic bases are used on the Type 807 tubes; two tubes bear identical circuit symbol markings; suitable permanent markings should be affixed to the chassis in the region of each tube socket to indicate the type of tube required and the circuit symbol number of the tube; in the arrangement provided, replacement of the crystal oscillator tube is very difficult. 2-26(a), 2-26(b), 2-26(c), 2-26(d).

(27) Permanently engraved numbering should be affixed to the front panel of the control unit beside each push-button, designating the channel number, leaving the celluloid windows free for the application of appropriate information; crystal plug receptacles and antenna clips should be permanently numbered to correspond with the channel number markings on the Remote Control Unit. 2-28.

(28) The crystal holders used are not of Navy standard type. 2-29.

(29) The hinge pin of the swinging chassis gradually works downward as the hinged front is opened or closed; two screws which secure the hinge to main framework were missing on delivery. 2-30.

(30) Antenna clips may not be placed on adjacent turns of the double spaced winding of the antenna coil without danger of a short circuit. 2-31.

(31) An extra switch is needed on the front panel of the control unit to break the filament circuit of the modulator and transmitter tubes when desirable. 2-32.

(32) The nameplates do not fulfill the usual Navy requirements. 2-33.

(33) The component parts are not provided with symbol markings. 2-34.

(34) The P.A. tuning-antenna coupling condenser, C-42, is not provided with a locking device to prevent accidental movement. 2-35.

(35) The wiring diagrams do not show the field circuits of the converter and dynamotor. 2-36.

(36) A radio frequency flash-over occurred in the antenna tap switch. 2-38.

(37) The arrangement for supplying power to the microphone presents a high voltage hazard. 2-39.

(38) The volume control of the modulator is not provided with a locking device to prevent accidental movement. 2-40.

(39) The dynamotor starting contact system of relay Re-7 showed considerable "burning" at the conclusion of the tests. 2-41.

[redacted]

(40) Unless it is the intention to use equipment in conjunction with an automatic ringer device, the relay Re-3 and associated circuits should be eliminated. 2-42.

(41) No spare parts were provided. 2-45.

(42) An absorption type of wavemeter will be necessary to assure the correct adjustment of the P.A. Tuning-Antenna Coupling arrangements upon installation. 2-46.

(43) Retainer devices are necessary to prevent loss of knurl-headed thumbscrews used to secure the main cover. 2-47.

SECTION III

RECEIVER SECTION OF EQUIPMENT

3-1. Electrical Inspection. The equipment was given an electrical inspection and the following information obtained, in large part from the schematic circuit diagram. No instruction book was furnished, although the circuit diagrams were available.

(a) Type of circuit: Superheterodyne.

(b) Frequency Range: Believed to cover range from 2,000 to 3,000 KC (not continuously variable.)

(c) Number of Bands: 10 fixed crystal frequencies on switch.

(d) Crystals: Crystal oscillator control at each frequency, 3122 KC. OSC. crystal is 4 KC off receiver oscillator frequency required for proper operation at 2670 KC.

(e) Crystal mounting: Common holder with transmitter crystal for each frequency. Each crystal frequency marked and identified on the holder by T for transmitter crystal and R for receiver crystal.

(f) Total No. of Tubes: 10 (including 6F8G oscillator common to transmitter and receiver.)

(g) Tube Types Used: 6K7, 6L7, 6K7, 6SQ7, 6C8-G, 6V6, 6SQ7, 6F8G, 5V4G.

(h) Power Supply Required: 110 V.D.C.

(i) Type of B Supply: Motor-Generator; Transformer-Rectifier.

(j) Antenna Required: No information available.

(k) Antenna Input Circuit: Single tuned secondary circuit with antenna primary winding.

(l) Radio-Frequency Amplifier: 1 stage 6K7 with primary winding in plate, and tuned secondary.

(m) Radio-Frequency Tuning: R.F. circuits tuned by capacity trimmers on switch ganged to oscillator switch.

(n) Converter: Pentagrid mixer (6L7)

(o) Oscillator: Simple crystal-controlled triode circuit using one triode section of 6F8G; oscillator frequency above signal frequency.

(p) Intermediate Frequency Amplifier: 1 stage (6K7)

Tuning frequency = 456 KC.
2 Transformers = 4 tuned circuits.

(q) Second Detector: Conventional diode. 1 plate of 6SQ7 diode section.

(r) AVC System: Separate from 2nd detector; other plate of 6SQ7 diode section. Tubes on control = R.F. amplifier, mixer, and I.F. amplifier.

(s) CW oscillator: None.

(t) Noise suppressor: Triode section of 6C8G input from cathode of 6SQ7, output to grid of second triode section of 6C8G.

(u) Audio-Frequency Amplifier: 1st stage - Second triode section of 6C8G resistance coupled to 2nd stage - 6V6 beam power output.

(v) Audio Output Circuit: Output transformer with 15 ohm secondary feeding loud-speaker input transformer, phones, and ringer.

(w) Gain Control: Audio gain, by varying resistance in series with primary of speaker output transformer.

(x) Safety Devices: Air gap lightning arrestor.

(y) Changeover Means: Voice-actuated relay actuating power and antenna transfer relays (see par. 2-16(d)).

(z) Remote Control: Remote control handset, speaker, and ringer sections available.

3-2. Mechanical Inspection: The equipment was given a mechanical inspection and the following information obtained.

(a) Number of units composing equipment: 1 (not including ringer or remote control unit).

(b) Size: Shown in Table TR-1.

(c) Weight: Shown in Table TR-1.

(d) General Type of Construction: Refer to par. 2-11.

(e) Number of Front Panel Controls and Function: Refer to par. 2-5.

(f) Other controls: Reference to handset in par. 2-5(b) applies.

(g) General layout and accessibility of controls: Symmetrical layout, easily accessible.

(h) Ease of control and operations: All controls work easily. Operation of controls is very simple.

(i) Accessibility for Servicing: Easily accessible, cabinet cover is removable, exposing all tubes, crystals, and trimmer adjustments.

(j) Accessibility for Repair: Most resistors and condensers are easily accessible. Tube sockets are not easily accessible, and can be removed only by removal of wiring and several components.

(k) Power Indicator: Pilot lamps on control unit and markings on OFF-ON switch.

(l) Materials Used and Finishes: Anodized non-ferrous chassis. Many unprotected steel screws and lock washers, some of which showed signs of rust after undergoing humidity tests. Plated steel tube caps. Cabinet ferrous with gray wrinkle finish. Gray wrinkle finish on IF and antenna transformers.

(m) General Insulation to Moisture: Fair.

(n) General Protection Against High Temperatures: Good, except for electrolytic and paper tube condensers which have tendency to be adversely affected by high temperatures.

(o) Ability to withstand vibration and shock: Generally good, although a few components such as condensers and resistors seem to be loosely mounted.

(p) General Ruggedness: Generally good.

(q) Tube Mounting, Sockets, etc.: Tubes are horizontal, in moulded bakelite sockets. Sockets are replaceable but will require disturbing of wiring and some components. Mounting is good.

(r) Tube Shields: None used.

(s) Transformers, Chokes, etc.: Potting unkown, good terminal spacing, unprotected bakelite insulation; sturdy and easily accessible.

(t) Crystal Mounting: Each crystal mounted in common plastic holder with transmitter crystal; holder plugs into octal bakelite sockets of the single-hole spring mount type.

(u) R.F. Transformer Structure: Paper bakelite form, good terminal spacing, enamel and silk-covered wire, no protection against moisture; solidly mounted.

(v) I.F. Transformer Structure: Coils on waxed paper form in aluminum cans permeability tuned, not readily adjustable, make unknown.

(w) Variable Condensers: None used.

(x) Fixed Condensers: The fixed condensers found in the receiver were mostly Cornell-Dubilier cardboard-tube paper condensers. The electrolytic condensers used were: One 10 mfd - 200 V, one 10 mfd - 25 V, both in cardboard containers; two 10 mfd - 250 V units in an aluminum can; and two condensers in a paint-covered aluminum can. Various moulded mica condensers, mounted on pigtails, were found, with mostly haphazard mounting.

(y) Switch Construction: The selector switch on the receiver chassis is of bakelite wafer construction, apparently unprotected against moisture, with silver-plated wiper contacts. The selector push-button switch on the remote control unit is of paper bakelite insulation, with silver-plated wiper contacts. The ON-OFF switch is of the rotary type, with bakelite insulation. Its failure to operate properly is described in par. 2-5(e) The SPEAKER-PHONE switch is of the toggle type construction, with laminated bakelite insulation. The voice relay-manual switch is also of toggle type construction.

(z) Resistors: The resistors in use in the receiver portion of the equipment are mostly of the one-half watt IRC composition type. Four wire-wound IRC type AB resistors are also used. Generally, the resistors are well-anchored, with a few mounted haphazardly, and easily accessible. Some resistors are mounted on components. This type of mounting makes replacement of components more difficult.

(aa) Terminal strips: With the exception of one cloth-bakelite mounting strip, the mounting strips in use in the receiver portion of the equipment are made of plain bakelite. None of the strips are protected against creepage in the presence of moisture condensation. The spacings on the terminals vary from about 1/10" to 3/16".

(bb) Mounting of Components: No rivets were found. Steel lock washers are used throughout. Self-tapping screws were found on both relay box and control switch unit. Many condensers and resistors are rigidly connected by pigtails, with a few capable of vibrating bodily. In many instances, tube sockets and components are used for condenser and resistor mountings.

(cc) Wiring: Generally neat with few unsupported leads; socket terminals and components are used for mounting condensers and resistors; the wire is of cotton then rubber-like insulation with an outer layer of cambric insulation questionable from moisture standpoint. Outside fabric on some of the wire seems to be varnished. Soldering is generally solid but not neat.

(dd) Miscellaneous: Antenna terminal on central panel, accessible through a hole in side of cabinet. Lightning arrestor mounted underneath antenna post on underside of panel. Wire at the gap is coated with red lacquer.

3-3. Examination of Instruction Book: The comments in par. 2-44 apply.

3-4. Spare Parts: The comments in par. 2-45 apply.

3-5. Listening Tests: No listening tests were conducted on the Jefferson-Travis 500D Receiver.

3-6. Laboratory Measurements: The receiver section of the Jefferson-Travis 500D equipment was measured in a shielded room as per par. 1-15 with the following results.

(a) Sensitivity Noise Output, Image Ratio, and I.F. Response: These are shown in Table R-1.

(b) Selectivity: The selectivity characteristic of the receiver is shown on Plate R-1. Tabulation R-2 summarizes this characteristic.

(c) Resonant Overload and Carrier Noise: The resonant overload characteristics are shown in graph form on Plates R-2 and R-3. The data for Table R-3 have been derived from Plate R-2. Plate R-3 gives the resonant overload characteristics with variation of "noise gate" control. The graphs on Plates R-2 and R-3 show a relatively poor AVC characteristic.

(d) Effect of Modulation Depth on Output: Plate R-4 shows the effect of varying the signal modulation depth on the audio output from the receiver. The curve shows comparatively large distortion as compared to similar receivers under test.

(e) Gain Control Range: The attenuation of the volume, or gain, control of the receiver is greater than 100DB.

(f) Radiation of Oscillator Frequency: The voltages appearing at the antenna terminal due to the local crystal oscillator of the receiver were measured in terms of the microvolts input from a standard signal generator required to give the same output from a receiver tuned to the oscillator frequency. Both the receiver under test and the standard signal generator were connected in turn to the input terminals of the measuring receiver. The resulting data are shown in Table R-4. It should be noted that as the selector switch rotates all crystals which it connects will cause radiation from the oscillator for the duration of the contact.

3-7. Temperature and Humidity Tests. The equipment was set up in the large Temperature-Humidity chamber and was tested under the conditions described in pars. 1-10, 2-18, 2-19 and 2-20.

(a) Effect of Humidity on Gain and Noise Level of Receiver: The equipment was set up and tests conducted as described in par. 2-19. The output of the receiver was measured at maximum gain. The change in receiver gain with variation of humidity was measured in terms of the carrier input voltage required to maintain an arbitrary standard output of 10 MW (signal and noise), with the standard signal generator modulated 90% at 400 cps.

[redacted]

Noise outputs with modulation off, and with carrier off were also measured. Readings were taken at approximately 15 minute intervals. The results of the test are shown on Plate R-5. Tabulation R-5 was derived from these graphs.

(b) Effect of Temperature on Gain, Noise Level, and Control Operations: The change in receiver gain with variation of temperature was measured in a way similar to that in the previous test as described in par. 2-18. Noise outputs were also checked, as well as signal generator dial settings. The controls were checked at -15° C. for operation and it was found that the power switch, volume control, and the phone ringer-speaker switch were stiff, but workable. The failure of the automatic frequency selector system is discussed in par. 2-18. Plate R-6 shows the results of these tests. Tabulation R-6 was derived from these graphs. There was no noticeable change in optimum output termination during this test.

(c) Effect of Humidity on Cold Start Gain and Noise Characteristics: The input for 10 MW output, with gain control on maximum was measured at 40° C. and 32% humidity. Noise was also measured and signal generator dial readings noted. The receiver was then turned off and the humidity increased to 97% at the same temperature, as described in par. 2-20. The receiver was turned on after 2 hours, 35 minutes, and the input for 10 MW output, and noise, immediately measured. Readings were then made at fifteen minute intervals. These readings are shown in graph form on Plate R-7. The values shown in Table R-7 are derived from the above graphs.

3-8. Effect of Vibration and Inclination. The equipment was subjected to a vibration and inclination test as described in par. 2-23 and 2-24. The receiver was measured for changes in gain, whenever possible, between the intervals of vibration and transmitter operation. Throughout the measurements a large amount of noise of variable magnitude was present. However, it was observed that there was a marked decrease in sensitivity of the receiver switch on position No. 10 after vibration. The audio output was distorted during and after vibration, but returned to normal a half-hour after the vibration test was concluded. Due to the high level of noise, measurements were not taken during the inclination test.

[redacted]

3-9. Summary of Defects: The following defects were found as a result of the examinations and tests listed in par. 3-1 to 3-8.

(a) One of the crystal sets furnished (no. 2-2670R-3122T) has a 4 KC deviation from the frequency which is necessary for proper receiver operation (par. 3-1(d)).

(b) Tube sockets may be removed only by removal of wiring and several components. (par. 3-2(j)).

(c) Many unprotected steel screws and lock washers showed signs of rust. The use of steel for cabinet and tube caps is undesirable, although these parts seem to be adequately protected by corrosion-resisting coatings. (par. 3-2(l)).

(d) The use of electrolytic condensers is not in accord with Naval specifications. (par. 3-2(n)).

(e) Loosely mounted condensers and resistors might be adversely affected by vibration and shock. (par. 3-2(o)).

(f) Plastic tube sockets are used throughout.(par. 3-2(q)).

(g) The insulation on the transformers is unprotected against moisture. (par. 3-2(s)).

(h) Unprotected R.F. transformers are wound on paper bakelite forms. (par. 3-2(u)).

(i) I.F. Transformers are wound on paper forms and are not readily adjustable. (par. 3-2(v)).

(j) Many paper condensers in cardboard tubes are used. Many of them depend on pigtail mounting for mechanical support. (par. 3-2(x)).

(k) The rotary selector switch (bakelite wafer) and the selector push-button switch are unprotected against moisture. (par. 3-2(y)).

(l) Resistors are mounted on components. (par. 3-2(z)).

(m) All terminal strips are unprotected against moisture. (par. 3-2(aa)).

(n) The wire at lightning gap is lacquer-covered. (par. 3-2(dd)).

(o) Sensitivity and image ratio are poor on band 10. (Table R-1).

(p) AVC characteristics are poor. (par. 3-6(c)).

(q) The output of the receiver is not linear with changing depth of modulation. (par. 3-6(d)).

(r) Radiation voltages appear to be excessive. (par. 3-6(f)).

(s) Vibration adversely affects the sensitivity of the receiver, and distorts the output. (par. 3-8).

(t) Receiver controls were stiff at low temperatures. (par. 3-7(b)).

(u) Tubes are mounted horizontally, contrary to practice. (par. 3-2(q)).

(v) The crystal sockets used in this equipment are not replaceable by standard Navy type sockets. (par. 3-2(t)).

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TABLE TR-1

Jefferson-Travis Model 500D Radio Equipment

DIMENSIONS AND WEIGHTS

	Transmitter-Receiver Unit Only, Cover Off, but including Shock Mountings	Transmitter-Receiver Unit with Cover, including Shock Mountings	Remote Control Unit
Height	31"	31"	14-1/2"
Width	20-1/2"	20-1/2"	12"
Depth	11-1/8"	11-7/8"	5-1/2"
Weight	133.0 lbs.	152.5 lbs.	14 lbs.*

Miscellaneous information:

Handset connecting cord, length: 3', 10".
Total weight: 166.5 lbs.
Total volume: 3.94 cu. ft.

*Weight of remote control unit includes twenty-three (23) foot length of connecting cable between transmitter-receiver and remote control unit.

[redacted]

TABLE T-1

Jefferson-Travis Model 500D Radio Equipment

POWER OUTPUT DATA

Selector Button No.	Frequency kcs.	P.A. Cathode I (ma.)	Antenna Current Amps.	Watts out	Turns on Inductance Coil*
1	2738	220	1.86	58.5	10-1/2
2	2670	224	1.80	54.0	11-1/2
10	2350	252	1.79	52.6	12-1/2

*As counted from antenna end of tuning coil. This is the left-hand end of the coil as one faces the transmitter.

Notes:

Antenna: 50-watt, 32-volt incandescent light bulb.

The data shown above indicate the best possible compromise in tuning adjustments which will furnish optimum power output at all three frequencies.

[redacted]

TABLE T-2

Jefferson-Travis Model 500D Radio Equipment

OPERATION INTO REAL ANTENNA

Selector Button No.	Output Frequency kcs.	P.A. Cath. I (ma.)	Antenna Current (amps.)	Turns used in tuning coil *	Antenna Capacity μμf	Antenna Resistance ohms	R.F. Watts Out
(Equipment operated directly into antenna of dimensions indicated below.)							
1	2738	155	2.3	13-1/2	2800	8.3	43.9
2	2670	138	2.3	14-1/2	1470	7.8	41.3
10	2350	140	2.4	19-1/2	760	6.4	36.8
(Equipment operated into antenna of dimensions indicated below, using a series condenser of 1000 μμf.)							
1	2738	170	2.28	16-1/2	738	8.3	43.2
2	2670	190	2.33	17-1/2	595	7.8	42.4
10	2350	140	2.16	23-1/2	432	6.4	29.9
(Equipment operated into antenna of dimensions indicated below, using a series condenser of 300 μμf.)							
1	2738	180	2.13	21-1/2	271	8.3	37.6
2	2670	140	2.2	22-1/2	249	7.8	37.7
10	2350	195	2.26	28-1/2	215	6.4	32.7

*As counted from antenna end of tuning coil. This is the left-hand end of the coil as one faces the transmitter.

Notes:

1. The data shown above indicate performance with the best possible compromise in tuning adjustments to permit optimum power output at all three frequencies.
2. The P.A. Cathode Current should preferably reach 200 or 250 milliamperes in order to realize the full output capabilities of the tubes.
3. The antenna consisted of a flat-top section of four parallel wires; spacing between outer wires was 8 feet, height above ground 21 feet, length of downlead portion, including connection to ground, was 29 feet. Fundamental frequency of antenna, 2900 kcs.

[redacted]

TABLE T-3

Jefferson-Travis Model 500D Radio Equipment

EFFECT OF DISCONNECTING OR SHORT-CIRCUITING ANTENNA

Antenna Condition	P.A. Cathode current (ma.)	Antenna Current (Amps.)	R.F. Watts Out
(Frequency 2350 kcs.; Antenna Constants: Resistance, 6.4 ohms.)		Capacity, 432 $\mu\mu f$;	
Normal	135	2.14	29.3
Open	295	0	-
Shorted	295	0.5	-
(Frequency 2670 kcs.; Antenna Constants: Resistance, 7.8 ohms.)		Capacity, 595 $\mu\mu f$;	
Normal	178	2.26	39.7
Open	270	0	-
Shorted	275	0.6	-
(Frequency 2738 kcs.; Antenna Constants: Resistance, 8.3 ohms.)		Capacity, 738 $\mu\mu f$;	
Normal	162	2.23	41.2
Open	258	0	-
Shorted	260	0.6	-

Notes: Real Antenna used.

The above data were taken with the best possible compromise in tuning adjustments to permit optimum power output at all three frequencies.

[redacted]

TABLE T-4

Jefferson-Travis Model 500D Radio Equipment

VARIATION IN AMBIENT TEMPERATURE
(Output Frequency - 2350 Kcs.)

Time	Ambient Temp., °C.	Relative Humidity, %	*Beat Note Frequency, cycles
8:15	+23	36	560
30	+24	31	555
45	+24	26	545
9:00	+24	26	530
9:15	+50	14	505
30	+50	14	450
45	+49	13	405
10:00	+49.5	14	385
15	+50	14	370
30	+50	14	360
45	+49	13	355
11:00	+49.5	14	350
11:15	+49	14	345
11:30	+39	18	330
45	+12	38	370
12:00	+ 1	-	440
15	- 1	-	510
30	- 7	-	540
45	-11.5	-	620
13:00	-14	-	640
13:15	-15	-	655
30	-16	-	675
45	-17	-	690
14:00	-18	-	700
15	-16	-	705
30	-16.5	-	700
45	-16.5	-	705
15:00	-16.5	-	710
15:15	-15	-	700
15:30	+33	16	700
45	+49	13	580
16:00	+48	27	495
16:15	+49	28	440

*In this column are shown the differences between the transmitter output frequency and that of a standard crystal in the frequency measuring apparatus.

[redacted]

TABLE T-4 (Continued)

SUMMARY

Beat Note Frequency at end of 2-hour period of operation at +50°C..345 cycles

Beat Note Frequency at end of 2-hour period of operation at -15°C..700 cycles

Difference: 355 cycles, or 0.015%

Average Temperature Coefficient of 2350-kc. crystal between limits of +50° and -15°C.: 2.3 parts in a million per degree Centigrade.

Notes: 1. During the above test the equipment was in "receive" condition most of the time. The transmitter circuits were in operation approximately one minute at each of the intervals shown above, in order to check the transmitter performance.

2. No substantial change in power output was noted in the successive readings.

3. An examination of the equipment at the end of the test indicated no damage to component parts.

[redacted]

TABLE T-5

Jefferson-Travis Model 500D Radio Equipment

VARIATION IN HUMIDITY
(Output Frequency 2350 Kcs.)

Time	Ambient Temp., °C.	Relative Humidity, %	***Beat Note Frequency, cy.
9:15	40	32	440
30	40	32	430
45	40	30	415
10:00	40	30	410*
10:15	40	90	400
10:30	43	98	390
45	41	98	380
11:00	41	98	370
15	40	98	370
11:30	40	98	365**
11:45	40	71	365**
12:00	40	50	-

At 12:00 the transmitter circuits failed, although the receiver was functioning satisfactorily just prior thereto. Neither the converter or dynamotor would operate. After considerable study as to cause of difficulty, in some unaccountable manner the two power units began to operate again. The humidity test was then resumed as follows:

13:30	40	29	410
45	40	30	400
14:00	40	30	375
15	40	30	370
14:30	40	30	365**

*Beat Note frequency at end of first portion of test: 410 cycles.

**Maximum departure in frequency thereafter noted: 365 cycles.

Difference: 45 cycles, or 0.0019%

Notes: 1. During the periods that the radio equipment was in operation, the unit was in "receive" condition most of the time. The transmitter circuits were in operation approximately one minute at each of the intervals shown above in order to check transmitter performance.

(Continued)

[redacted]

TABLE T-5 (Continued)

2. No appreciable change in power output was noted at the successive readings.

3. An examination of the equipment at the end of the test indicated no damage, and no other detrimental effects were noted as a consequence of the humidity test.

***In this column are shown the differences between the transmitter output frequency and that of a standard crystal in the frequency measuring apparatus.

TABLE T-6

Jefferson-Travis Model 500D Radio Equipment

EFFECT OF PROLONGED HUMIDITY
(Output Frequency - 2350 kcs.)

Time	Ambient Temp., °C.	Relative Humidity, %	*Beat Note Frequency, Cy.
12:15	39.0	31	530
30	40.0	32	500
12:45	40.0	33	465

Thereafter the temperature was held at approximately 40° and the humidity gradually increased to 97%. This value of humidity was reached at 13:15, and was maintained until 15:15. The radio equipment was not in operation from 12:45 to 15:15. At 15:15 the equipment was again placed in operation, and the following readings were noted:

15:15	41.0	97	475
30	40.0	51	470
45	39.5	40	460
16:00	40.0	33	450
16:15	40.0	30	440

Notes:

1. During the periods that the radio equipment was in operation, the unit was in "receive" condition most of the time. The transmitter circuits were in operation approximately one minute at each of the intervals shown above in order to check transmitter performance.

2. No appreciable change in power output was noted at the successive readings.

3. An examination of the equipment at the end of the test indicated no damage, and no other detrimental effects were noted as a consequence of the prolonged humidity test.

*In this column are shown the differences between the transmitter output frequency and that of a standard crystal in the frequency measuring apparatus.

[redacted]

TABLE T-7

Jefferson-Travis Model 500D Radio Equipment

LOCKED KEY OPERATION FOR ONE HOUR
(Output Frequency 2350 Kcs.)

Time	Ambient Temp., °C.	Relative Humidity, %	***Beat Note Frequency, Cy.
14:55*	40	25	-
15:00**	40	25	400
05	40	23	402
10	39	22	403
15	39	21	400
20	40	20	390
25	39	19	370
30	39	18	368
35	40	16	355
40	40	16	350
45	40	16	345
50	40	16	340
55	39	17	336
16:00	40	16	332

*Filaments energized, handset off hook, but carrier not energized.

**Carrier continuously energized hereafter by opening switch SW-1.

Frequency change during first 5 minutes: 2 cycles, or 0.000085%.

Maximum frequency change thereafter noted: 70 cycles, or 0.003%.

No appreciable change in power output occurred during the test.

An examination of component parts at the end of the test indicated no damage, and no other detrimental effects were noted as a consequence of locked-key operation for one hour.

***In this column are shown the differences between the transmitter output frequency and that of a standard crystal in the frequency measuring apparatus.

[redacted]

TABLE T-8

Jefferson-Travis Model 500D Radio Equipment

POWER REQUIRED FROM SUPPLY LINE & VARIATION OF SUPPLY LINE VOLTAGE
(Output Frequency - 2350 Kcs.)

Line				Converter			Dynamotor			P.A. Cath. I	R.F. watts out
				Input	Output		Input	Output			
Volts	Amps.	Watts	Condition	Amps.	Volts	Amps.	Amps.	Volts	ma.	(ma.)	
			(10% above normal)								
126.5	2.65	346	Receive	2.65	117	1.53	-	-	-	-	-
126.5	5.95	752	Trans.,Car.Off	2.62	117	1.52	3.3	730	390	116	0
126.5	6.71	849	Trans.,Car.on	2.50	117	1.41	4.2	700	515	238	64
			(Normal line voltage)								
115	2.5	288	Receive	2.5	107	1.42	-	-	-	-	-
115	5.7	650	Trans.,Car.Off	2.46	106	1.39	3.2	660	360	110	0
115	6.4	736	Trans.,Car.On	2.38	106	1.30	4.0	640	480	210	54.5
			(10% below normal line voltage)								
103.5	2.3	238	Receive	2.3	98	1.22	-	-	-	-	-
103.5	5.1	527	Trans.,Car.Off	2.25	97	1.27	2.8	590	325	97	0
103.5	5.7	589	Trans.,Car.On	2.20	97	1.20	3.5	575	420	180	41.5
			(23.5% below normal line voltage)								
88	1.9	167	Receive	1.90	82	1.08	-	-	-	-	-
88	4.4	388	Trans.,Car.Off	1.95	82	1.07	2.4	500	280	80	0
88	4.8	422	Trans.,Car.On	1.90	82	1.02	2.8	490	330	115	30.0

Antenna: 50-watt, 32-volt incandescent light bulb.

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[redacted]

TABLE R-1

Sensitivity, Noise Output, Image Ratio and
I.F. Response of Jefferson-Travis 500D
Radio Telephone Receiver

Gain Control at Maximum; input modulated
30% at 400 cps. Output impedance 15 ohms.

Selector Switch Position	1	10
Frequency	2738 Kc.	2350 Kc.
Input through Standard Dummy Antenna	1.75 µV	7.5 µV
A.F. Output in 15	40 MW	40 MW
Noise Output - Modulation Off	2.0 MW	.48 MW
Noise Output - Carrier Off	.15 MW	.08 MW
Image Frequency	3650 Kc.	3262 Kc.
Image Ratio	4500	347
I.F. Response from Antenna for 40 MW Output 456 Kc.		60,000 uV

[redacted]

TABLE R-2

Selectivity of Jefferson-Travis 500D
Radio Telephone Receiver

fo = 2738 Kc.

Gain Control at Maximum; input 30%
modulated at 400 cps.; constant output = 40 MW.

Ratio: Input off max. response / Input at max. response	Ratio in DB	Band-Width Kc.	Band-Width %
1.4	3 DB	2.19 Kc.	.08%
2	6	2.74	.1
5	14	5.75	.21
10	20	8.5	.31
100	40	18.1	.66
1000	60	32.0	1.17
10000	80	55.0	2.0
100000	100	81.7	2.98

[redacted]

TABLE R-3

Resonant Overload Characteristics of Jefferson-Travis 500D Radio Telephone Receiver

Gain Control on Maximum; Noise Gate Control at Minimum; Input 30% modulated 400 cps.

(1) Threshold of AVC action	Input 3 uV Output 125 MW.
(2) Maximum variation of output for +100DB increase of input	125 to 1,500 MW (10.8 DB)
(3) Input for 6 DB change in AVC threshold output:	15,000 uV
(4) Range of linear detection below AVC threshold	Input app. 1.7 to 3 uV Output 35 to 125 MW
(5) Carrier noise output (Modulation off):	Max. - 2 MW Min.- .06 MW Ratio - 15.22 DB
(6) Range of input variation to decrease carrier noise from max. to min. value:	1.7 to 5,000 uV 69.38 DB
(7) Max. power output of receiver	1700 MW.

[redacted]

TABLE R-4

Radiation Voltage Due to Receiver Oscillator Appearing at Antenna Terminals of Jefferson-Travis 500D Radio Telephone Receiver

Gain Control on Max.
Noise Gate at Min.

Frequency Switch Position	1	2	10
Receiver Oscillator Frequency	3194 Kc.	3122 Kc.	2806 Kc.
Radiation Voltage - Fundamental	10500 µV	4050 µV	6300 µV
Radiation Voltage - 2nd Harmonic	29000 µV	21000 µV	6850 µV
Radiation Voltage - 3rd Harmonic	13000 µV	13000 µV	39000 µV
Radiation Voltage - 4th Harmonic	3350 µV	1150 µV	1300 µV
Radiation Voltage - 5th Harmonic	770 µV	800 µV	980 µV
Radiation Voltage - 6th Harmonic	72 µV	100 µV	580 µV

[redacted]

TABLE R-5

Effect of Humidity on Gain and Noise Level of Jefferson-Travis 500D Radio Telephone Equipment

Gain Control at Maximum

Humidity	30% (start)	98%	29% (return)
Time	0	90 mins.	390 mins.
Input for 10 MW output	425 µV	470 µV	490 µV
Gain Ratio	1.0	.905	.87
DB change in Initial Gain	0	-.88 DB	-1.2 DB
Noise Level	No definite conclusions due to high local noise level.		

[redacted]

TABLE R-6

Effect of Temperature on Gain and Noise Level of Jefferson-Travis 500D Radio Telephone Equipment

(See Plate R-6)

Gain Control at Max.

Temperature	50°C (start)	50°C.(end)	0°	After 60 mins. at approx.-17°C.	-15°C(end)
Time	0	120 mins.	180 mins.	315 mins.	400 mins.
Input for 10 MW output	490 μV	410 μV	590 μV	375 μV	450 μV
Gain Ratio	1	1.19	.83	1.3	1.09
DB change in Initial Gain	0	+1.5 DB	-1.6	+2.3 DB	+.74 DB
Carrier Noise Level- Mod.Off	.35 MW	.45 MW	.3 MW	.65 MW	.4 MW
Carrier Noise Ratio	1	1.28	.86	1.85	1.14
DB change in Carrier Noise	0	+1.06 DB	-.65	+2.67 DB	+.58 DB
Noise Output Carrier Off	.04 MW	.08 MW	.03 MW	.1 MW	.05 MW
Noise Ratio Carrier Off	1	2	.75	2.5	1.25
DB Change in Noise Output-Carrier Off	0	+ 3 DB	-1.25	+ 4 DB	+ 1 DB

[redacted]

TABLE R-7

Effect of Humidity on Cold Start Gain and Noise Characteristics of Jefferson-Travis 500D Radio Telephone Receiver

Gain Control at Max.- Noise Gate Control at Minimum. - Equipment turned off from 0 to 154 mins.

Condition	Initial Check (a)	Equipment Turned on (b)	Reading (c)	Reading (d)	Final Reading (e)
Time	0	154	169	184	214
Input for 10 MW output	360 uV	1070 uV	660 uV	410 uV	320 uV
Gain Ratio	1	.337	.545	.88	1.12
DB change in Gain	0	-9.44 DB	-5.26 DB	-1.1 DB	+1 DB
Carrier Noise Level- Mod.Off	1.0 MW	.25 MW	.2 MW	.35 MW	1.8 MW
Carrier Noise Ratio	1	.25	.2	.35	1.8
DB change in Carrier Noise	0	- 6 DB	-7 DB	-4.57 DB	+2.56 DB
Noise Output - Carrier Off	.08 MW	.1 MW	.02 MW	.05 MW	.3 MW
Noise Ratio - Carrier Off	1	1.25	.25	.625	3.75
DB change in Noise-Carrier Off	0	+1 DB	-6 DB	-2.04 DB	+5.74 DB

Plate TR-1

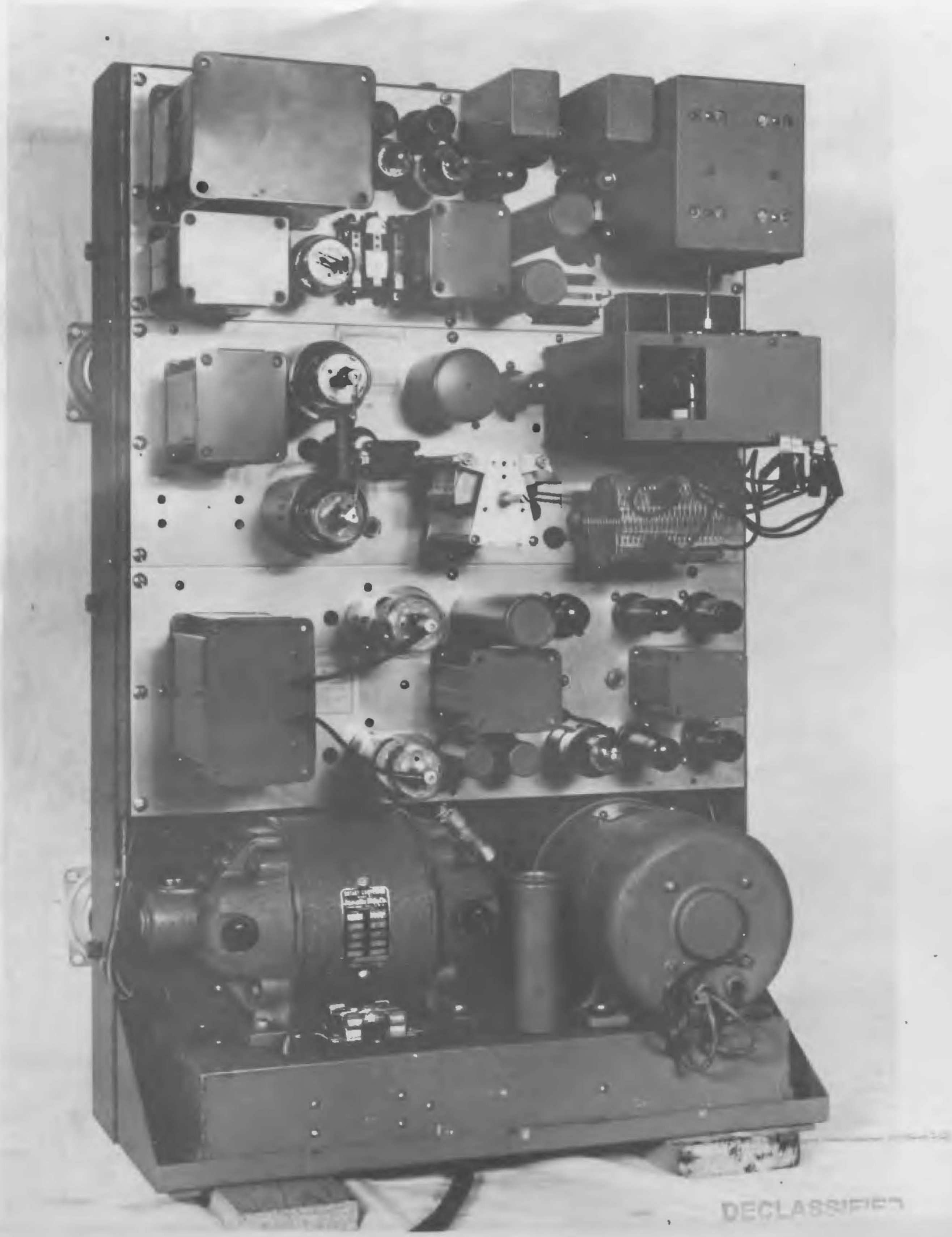

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Plate TR-2

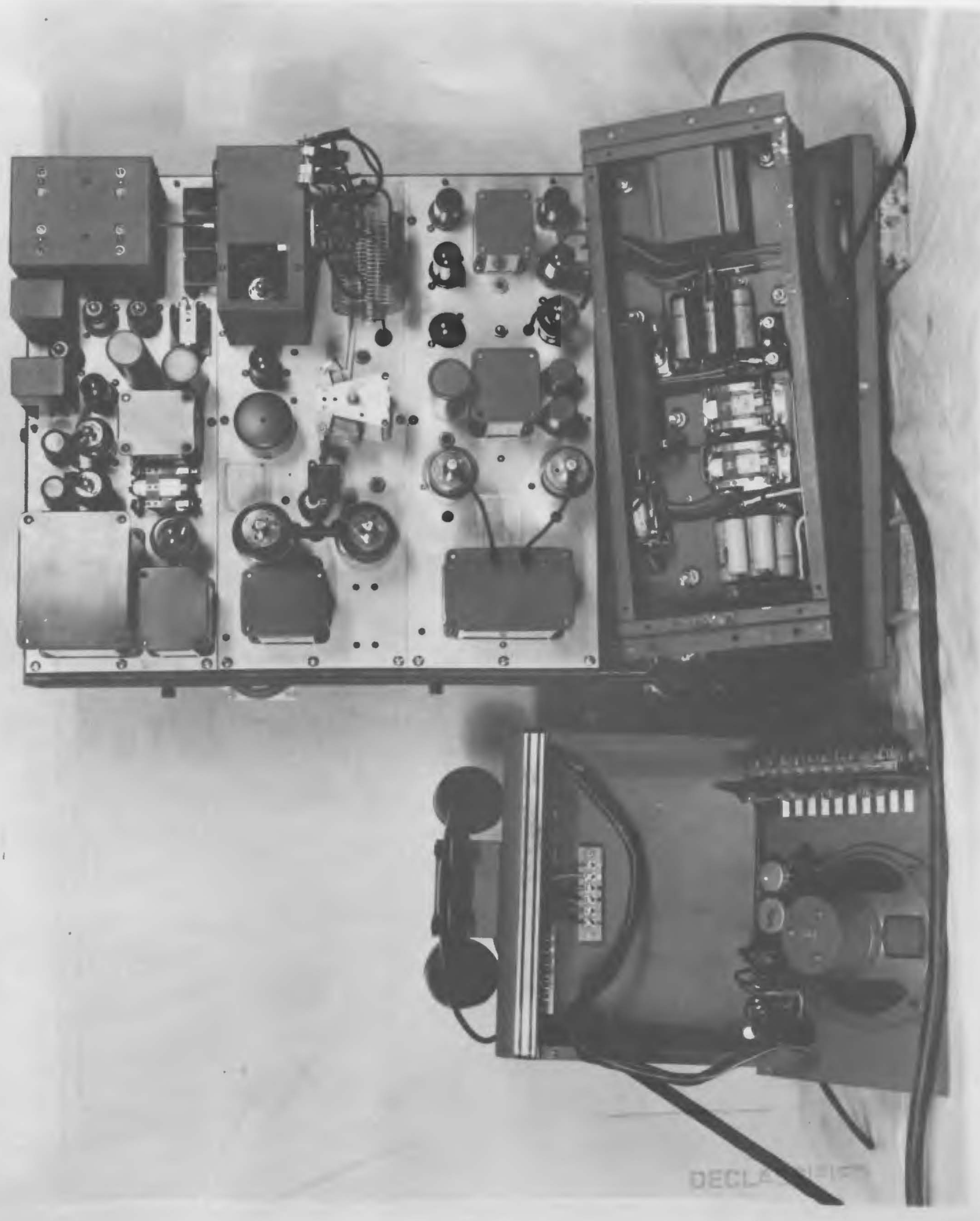


Plate TR-3

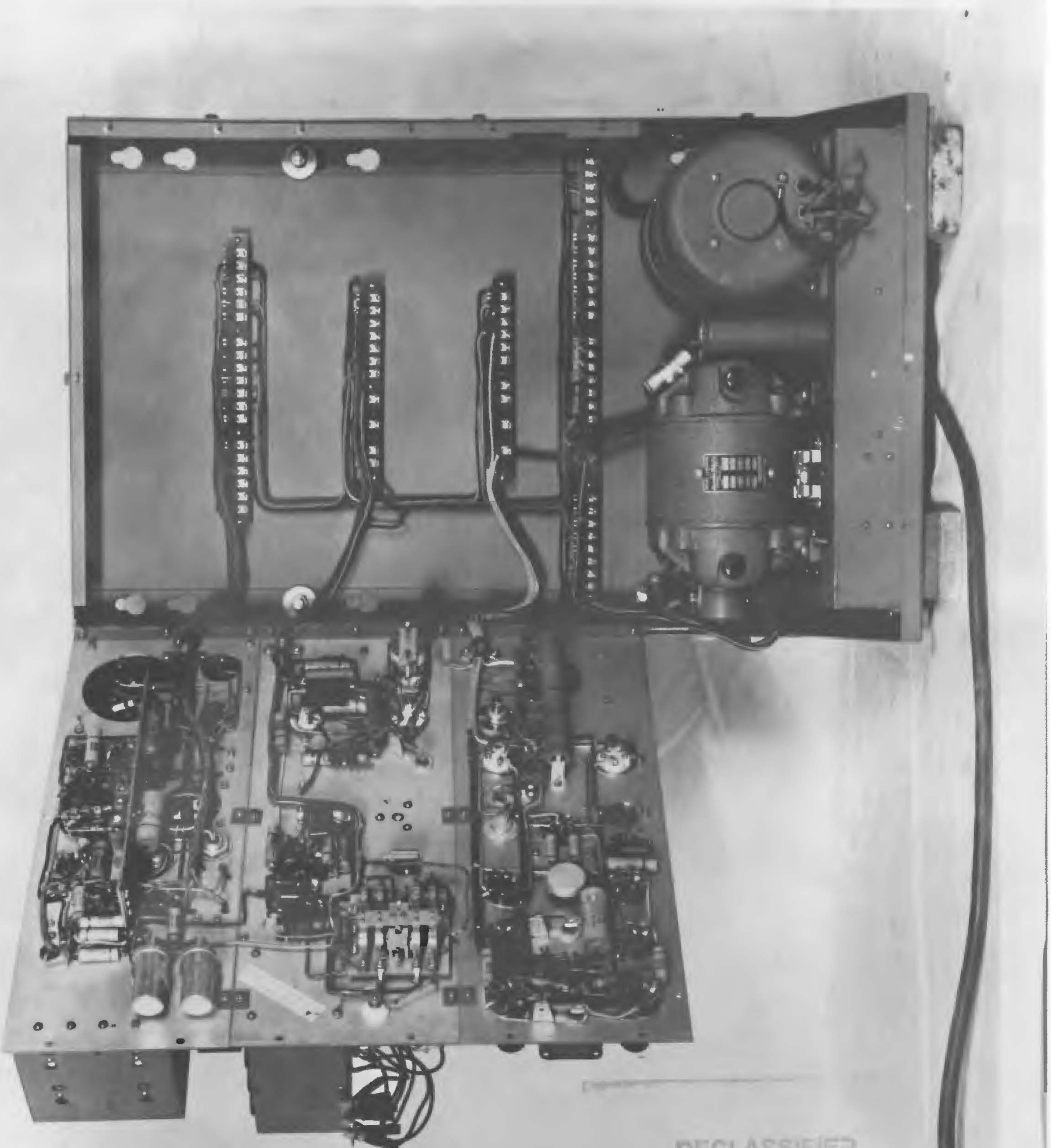
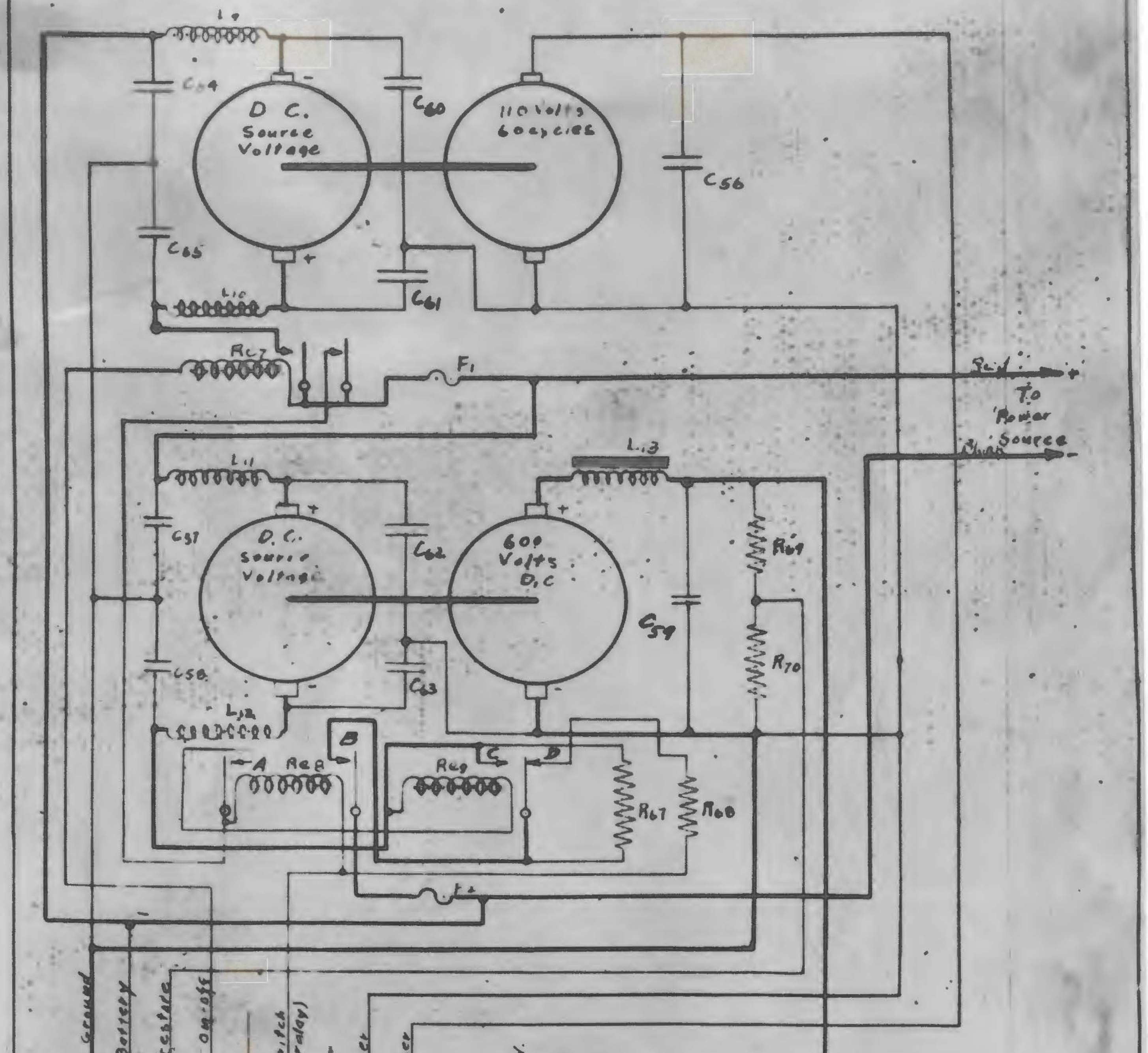


Plate TR-4



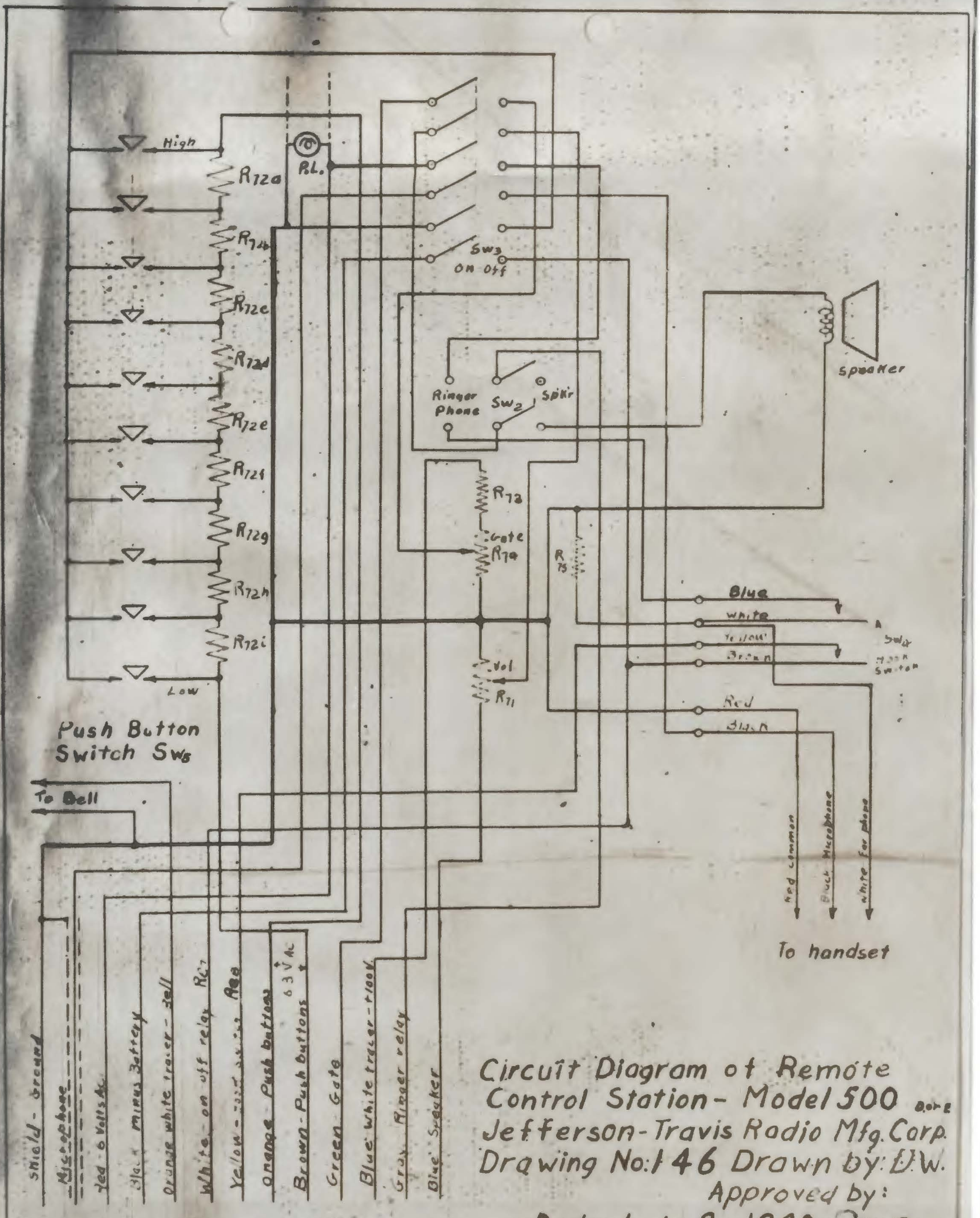
Circuit Diagram of Power Supply Chassis - Model 500

Jefferson-Travis Radio Mfg. Corp.
New York, N.Y.

Drawing No. 145 Drawn by: D.W.

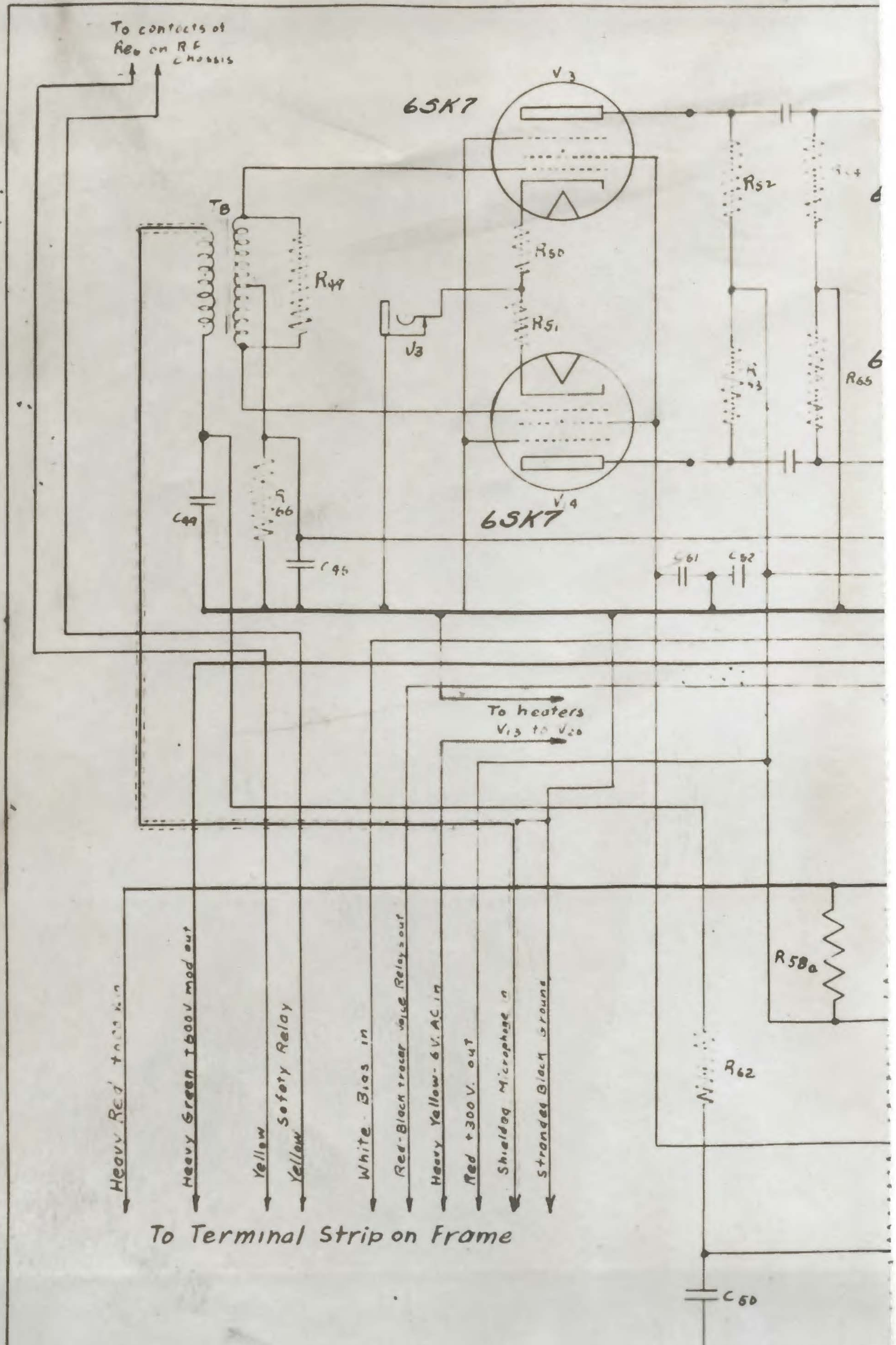
Approved by:
May 27, 1940

PLATE TR-5



Circuit Diagram of Remote Control Station - Model 500
Jefferson-Travis Radio Mfg. Corp.
Drawing No: 146 Drawn by: D.W.
Approved by:
Date: July 8, 1940 M.B.

PLATE TR-6


To contacts of
chassis
V3
6SK7
TB
R47
R50
R51
R52
J3
R65
C44
C45
V4
6SK7
C61
C62
To heaters
Heavy Green T 600V mod out
Yellow
Yellow Safety Relay
White Bias in
Heavy Yellow - 6V. AC in
Red +300 V. out
Shielded Microphone in
Stranded Black ground
R58a
R62
C50
To Terminal Strip on Frame

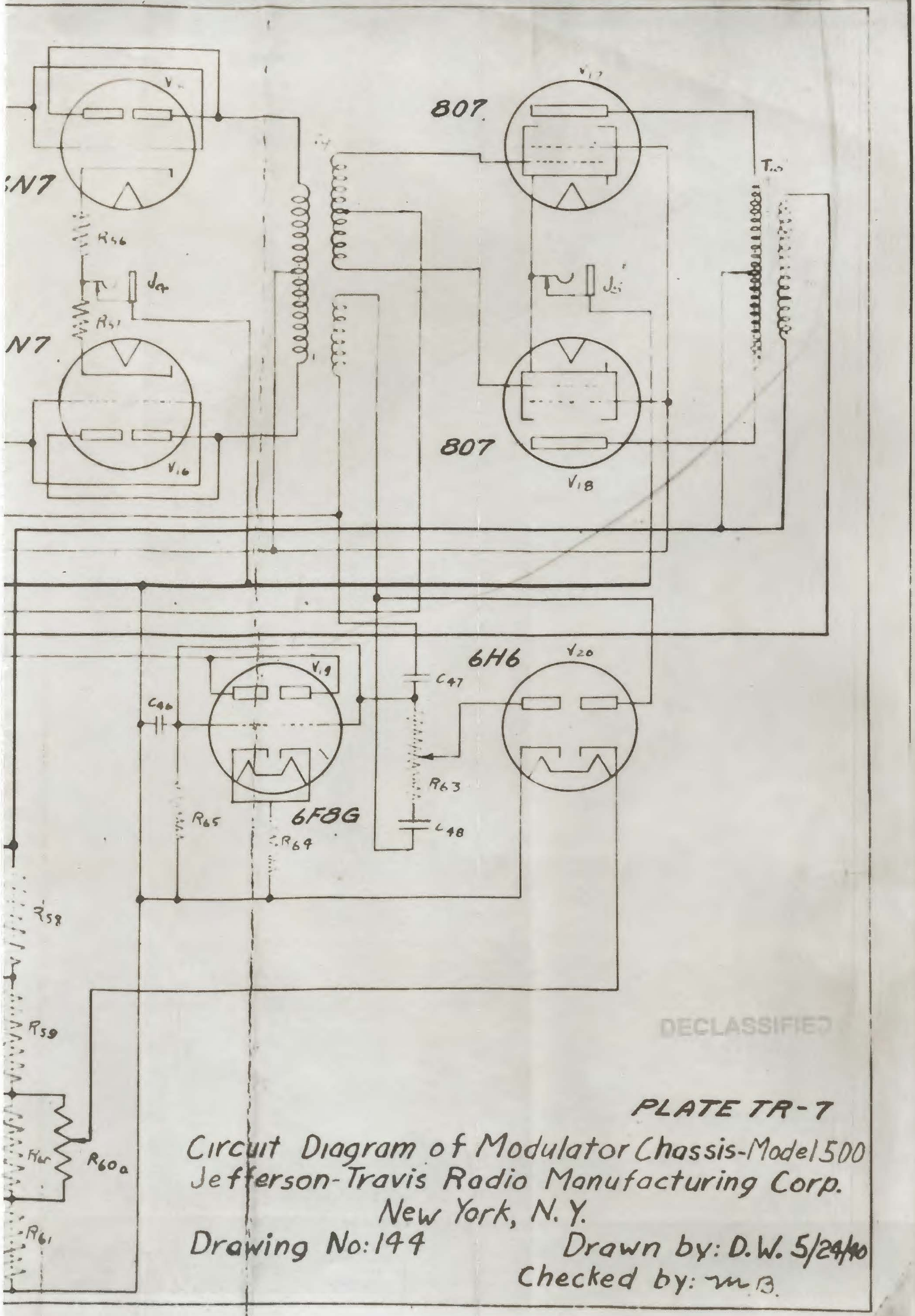
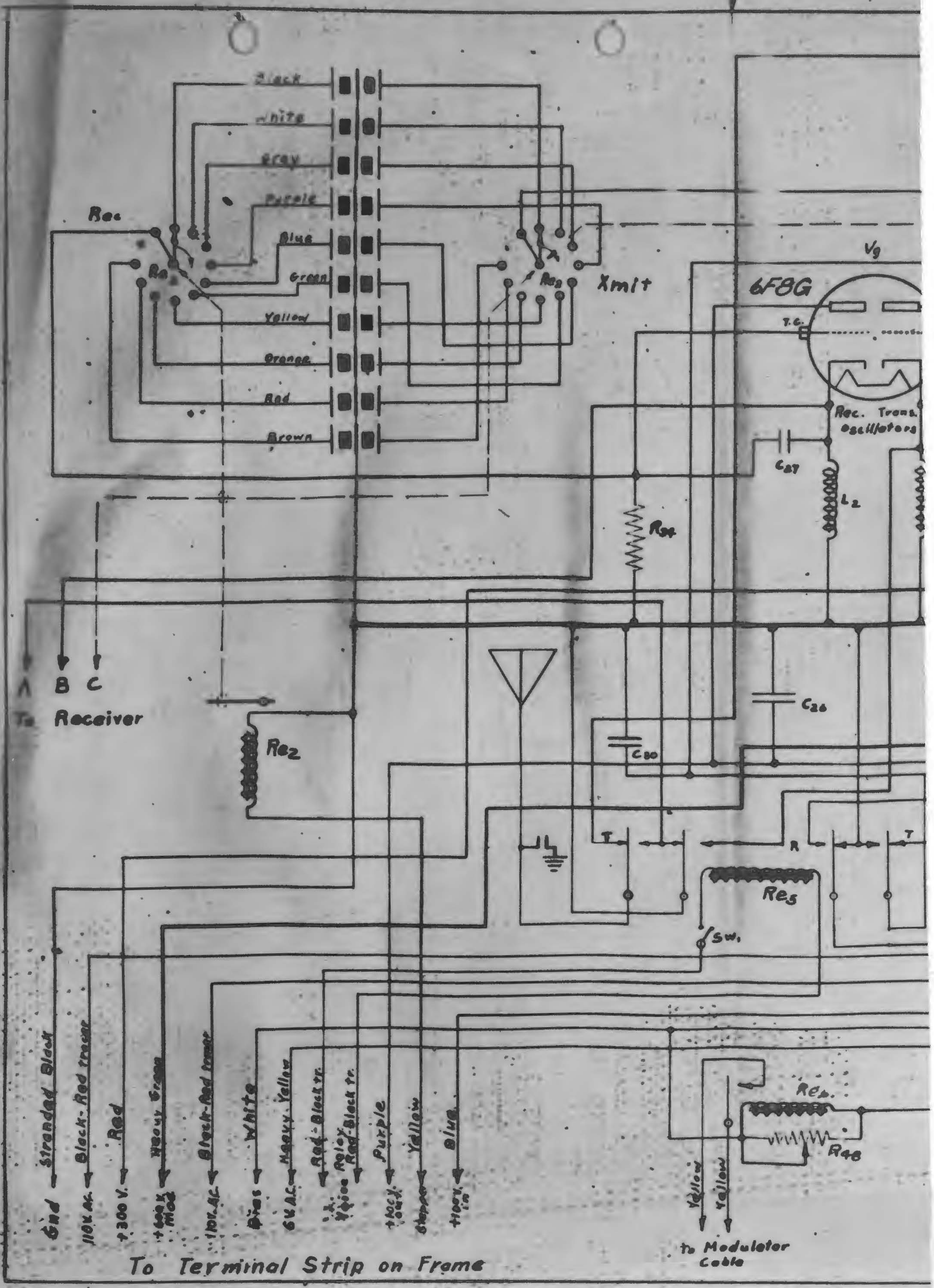


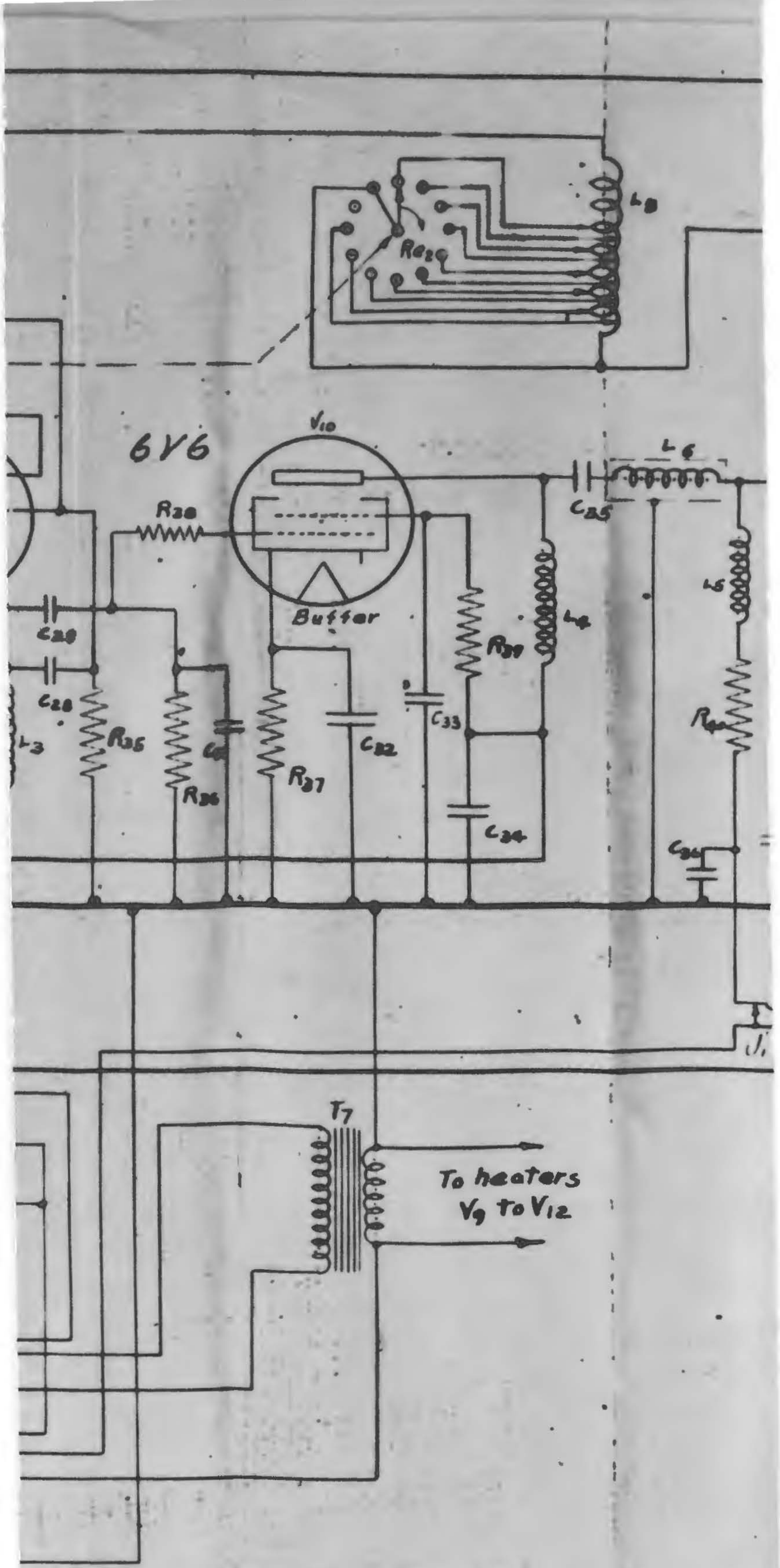
PLATE TR-7

Circuit Diagram of Modulator Chassis-Model 500
Jefferson-Travis Radio Manufacturing Corp.
New York, N.Y.

Drawing No: 144 Drawn by: D.W. 5/24/40
Checked by: M.B.



Black
White
Gray
Purple
Blue
Green
Yellow
Orange
Red
Brown
Rec
Xmit
6F8G
T.C.
Rec. Trans. Oscillators
C27
L2
R34
A B C
To Receiver
Re2
C26
C30
T
R
Re5
Sw1
R48
Stranded Black
Gnd
Black-Red tracer
110V A.C.
Red
+300 V.
Heavy Green
Black-Red tracer
110V A.C.
White
Bias
Heavy Yellow
6V A.C.
Red-Black tr.
Relay
Red-Black tr.
Purple
Yellow
Blue
Yellow
Yellow
To Modulator Cable
To Terminal Strip on Frame



Circuit Diagram
Jefferson-Travi
Ne
Drawing No.143

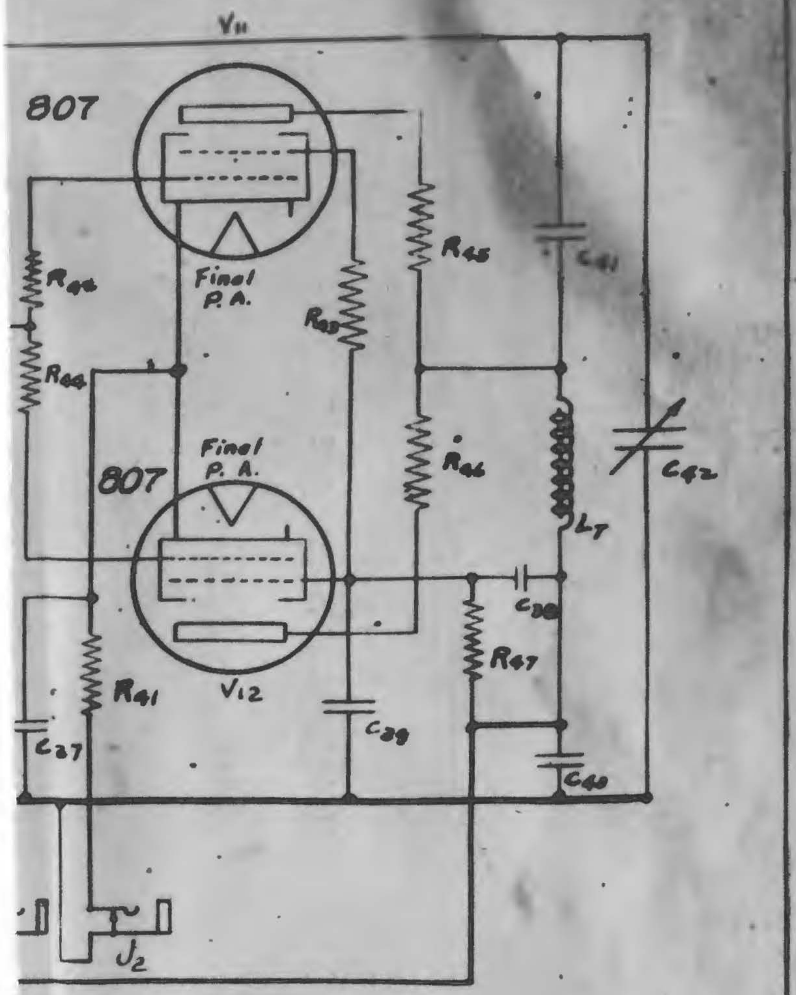
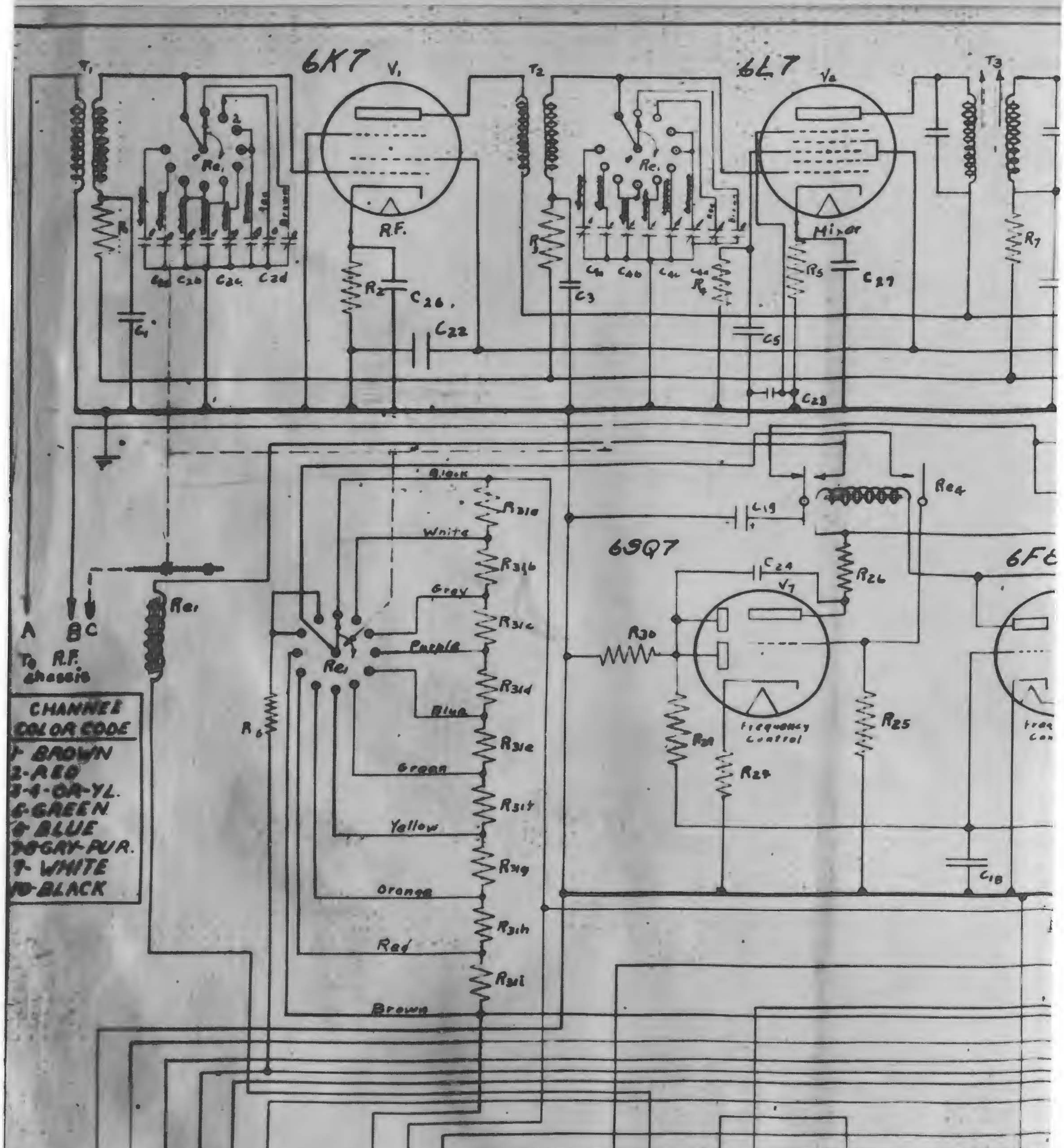
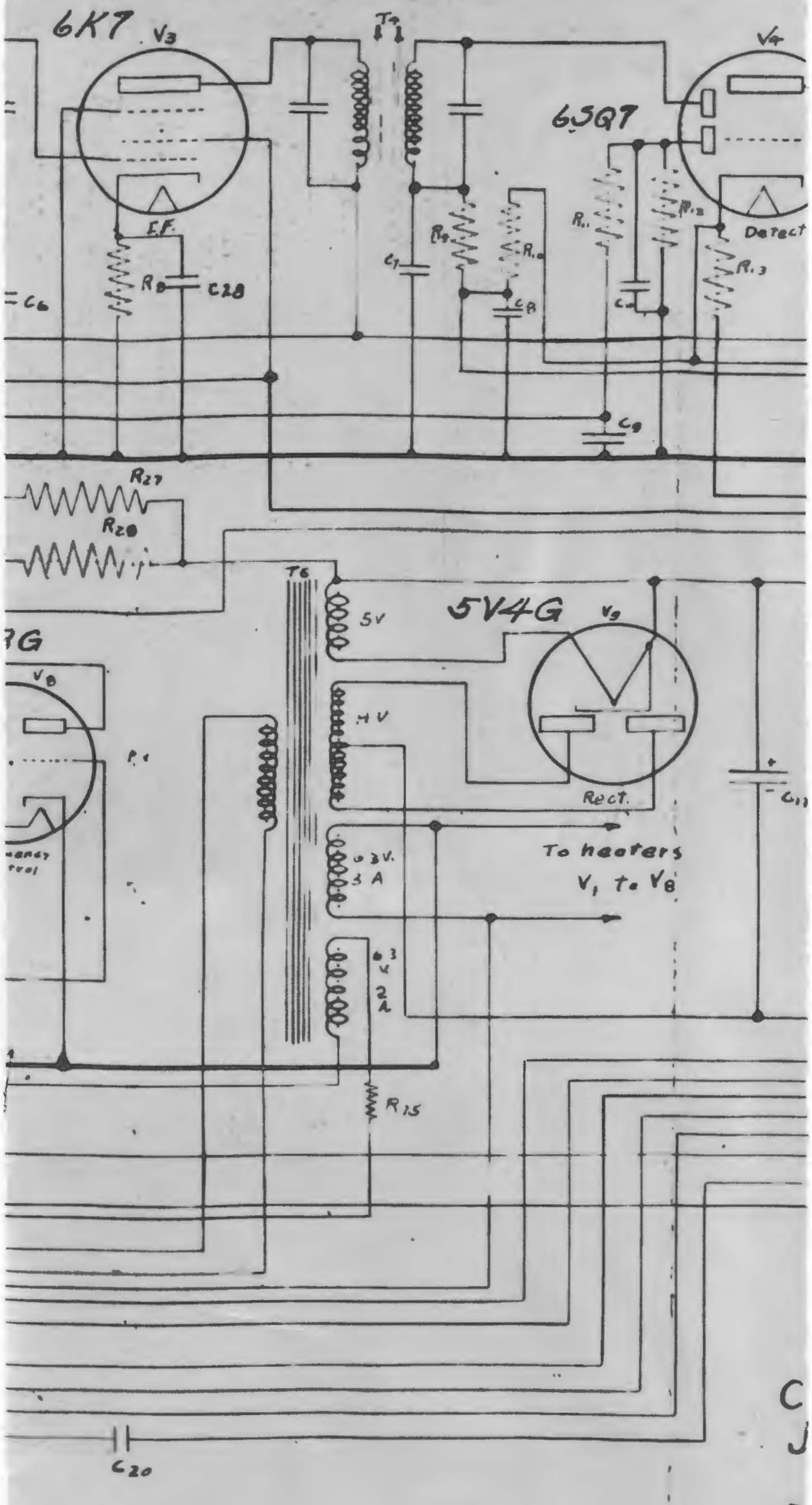
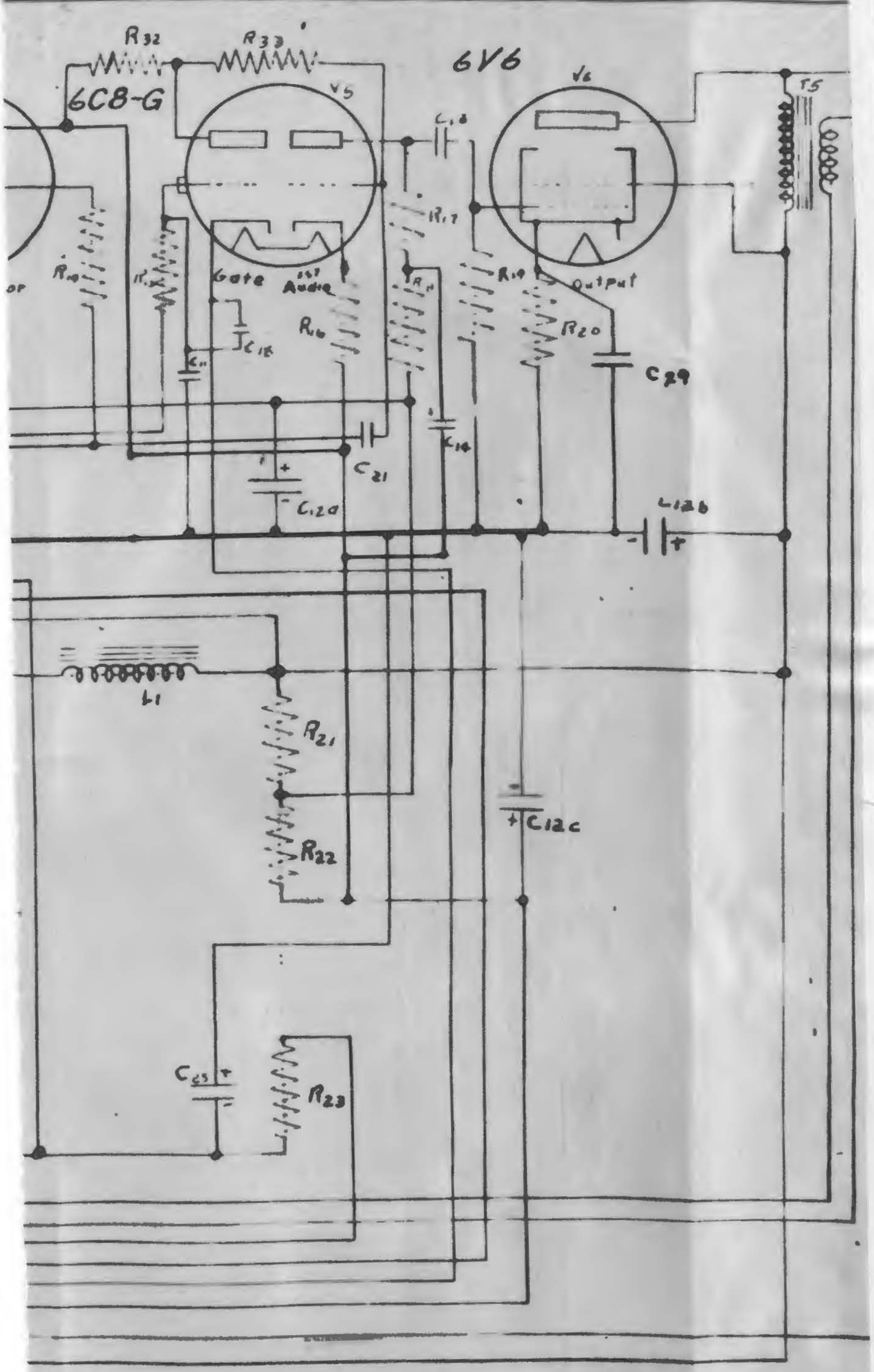


PLATE TR-8

of R.F. Chassis Model 500
's Radio Manufacturing Corp.
w York, N.Y.
3 Drawn by D.W. 5/22/40
Approved by M B


6K7
V1
R.F.
6L7
V2
Mixer
6SQ7
V7
Frequency control
Re1
Re4
Re5
A
B C
To R.F. chassis
CHANNEL COLOR CODE
1- BROWN
2- RED
3-4-OR-YL.
5-GREEN
6-BLUE
7-8 GRY-PUR.
9- WHITE
10-BLACK
Black
White
Gray
Purple
Blue
Green
Yellow
Orange
Red
Brown
Gnd.
Stranded Black
Black
Red tr.
110 VAC
Black
Red tr.
6 VAC
Stranded Red
Black
Spkr
Blue
Gray
Ringer Relay
Brown
6 VAC Freq. ch
Orange
White
Purple
Green
N.C.
Blue
Yellow
Clapper coil
N.C.
Ringer
Glazed Red
Red
+300V
Black tr.
N.C.
To terminal strip on frame


6K7
V3
T4
V4
6SQ7
E.F.
R8
C28
C6
C7
R9
R10
R11
R12
R13
C8
C9
Detect
R27
R28
T6
5V
5V4G
V9
HV
Rect.
C11
6.3V.
3 A
6.3
V
2
A
To heaters
V1 to V8
V8
R15
C20
C
J
D

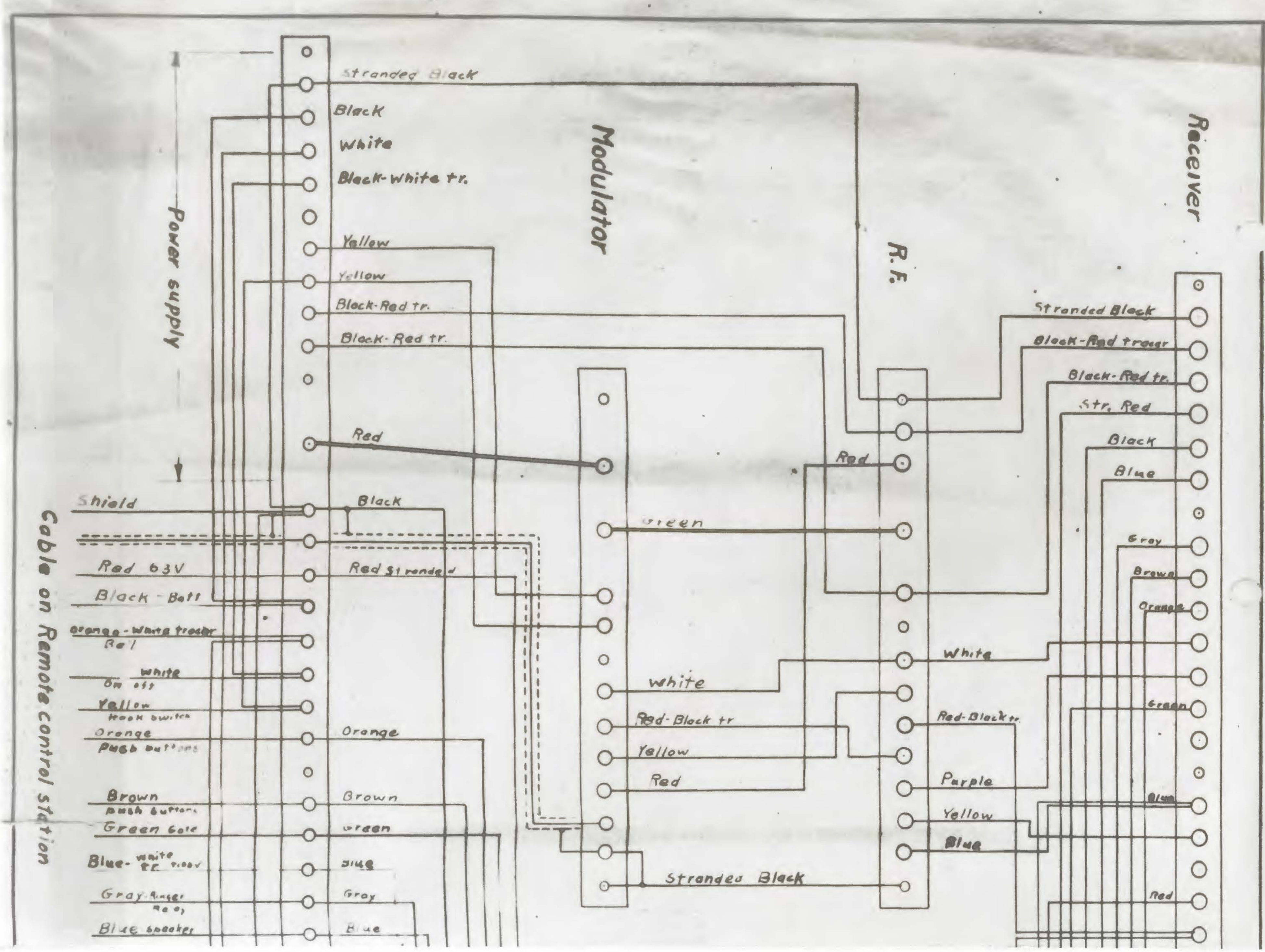


DECLASSIFIED

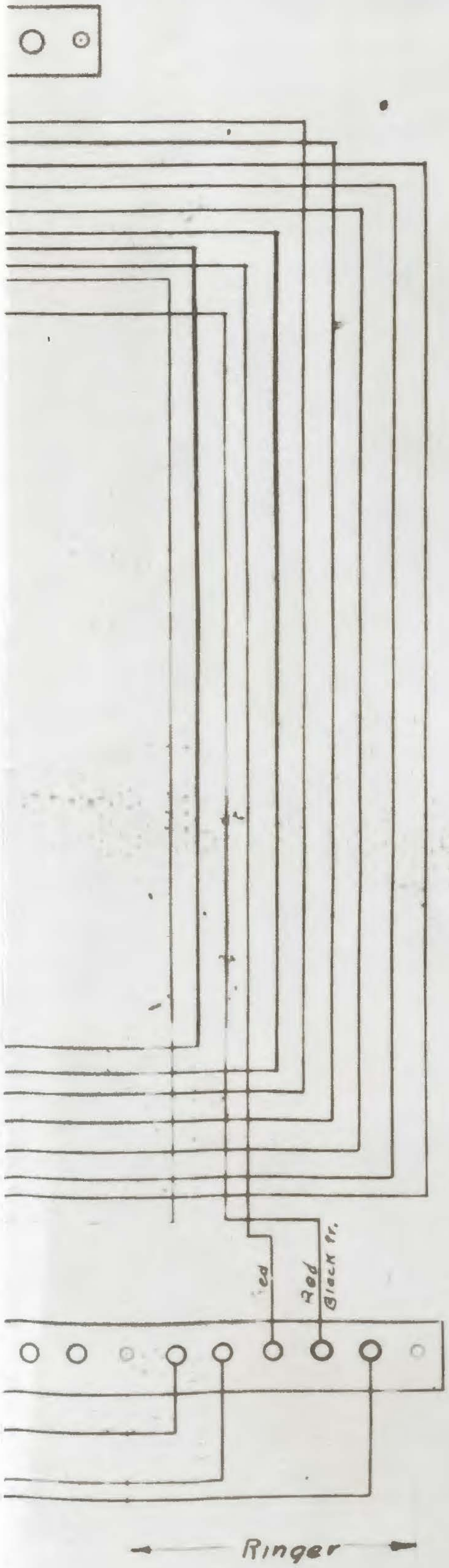
PLATE TR-9

ircuit Diagram of Receiver Chassis-Model 5
Jefferson-Travis Radio Manufacturing Cor
New York, N.Y.

Drawing No. 111 Drawn by: D.W. 7/8/4
Approved by: [handwritten initials]



Power supply
Modulator
R.F.
Receiver
Cable on Remote control station
Stranded Black
Black
White
Black-White tr.
Yellow
Yellow
Black-Red tr.
Black-Red tr.
Red
Shield
Black
Red 63V
Red Stranded
Black - Batt
Orange-White tracer
Bell
White
On off
Yellow
Hook switch
Orange
Push buttons
Orange
Brown
Push buttons
Brown
Green Gate
Green
Blue
Gray
Blue speaker
Blue
Green
White
Red-Black tr
Yellow
Red
Stranded Black
Red
White
Red-Black tr.
Purple
Yellow
Blue
Stranded Black
Black-Red tracer
Black-Red tr.
Str. Red
Black
Blue
Gray
Brown
Orange
Green
Blue
Red



Co

20 gauge Black
Black
White
White
Red
Red
Blue
Blue
Purple
Orange
Brown
Yellow
Yellow
Yellow
Gray
Green
Black-R
Red-Blac
Red-Blac
Red-Blac
Black Wh

Stranded Black
Red

Heavy Yellow
Red
Green

Shielded

Terminal strip conne
Jefferson-Travis
Ne

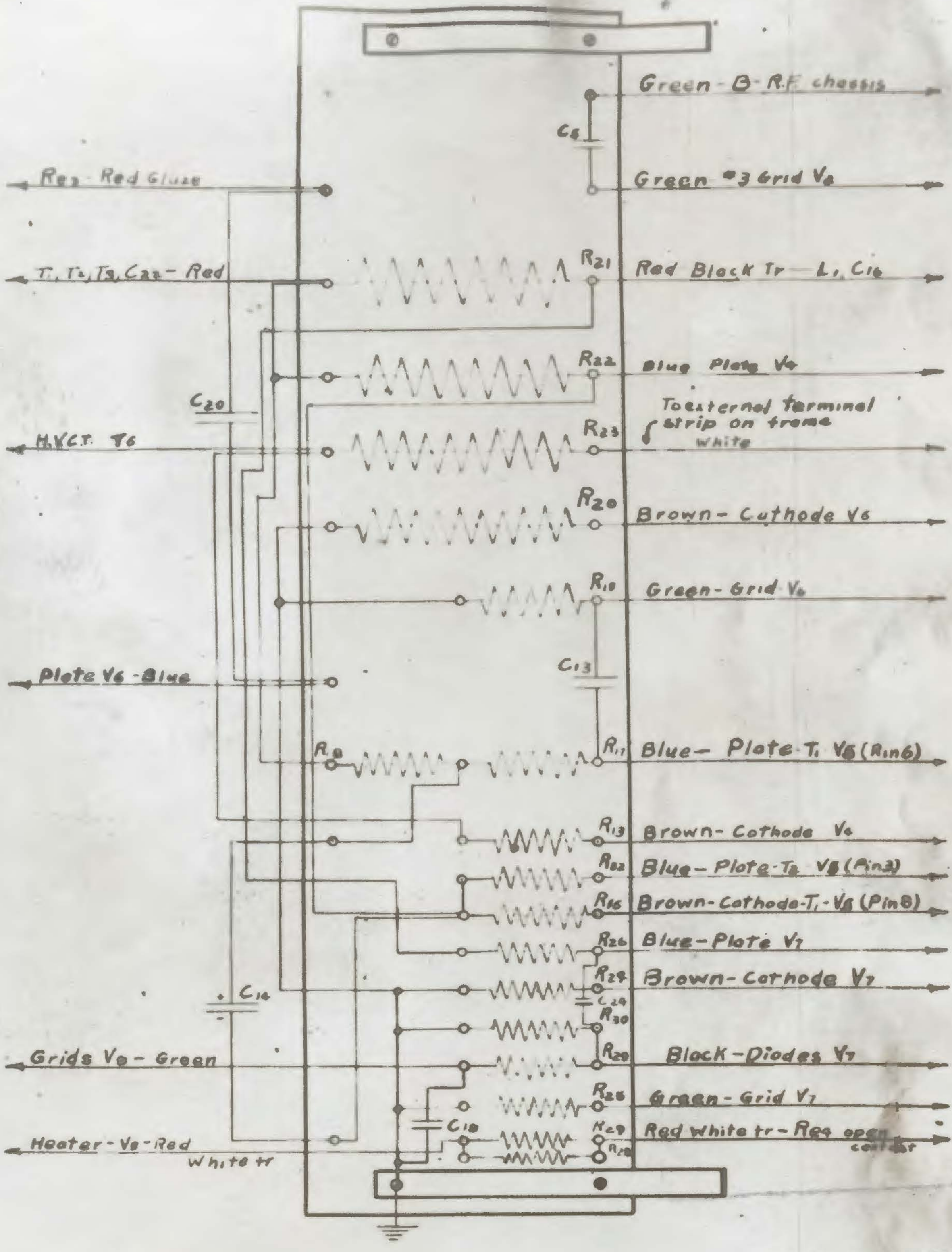
Drawing No: 142

lor Code

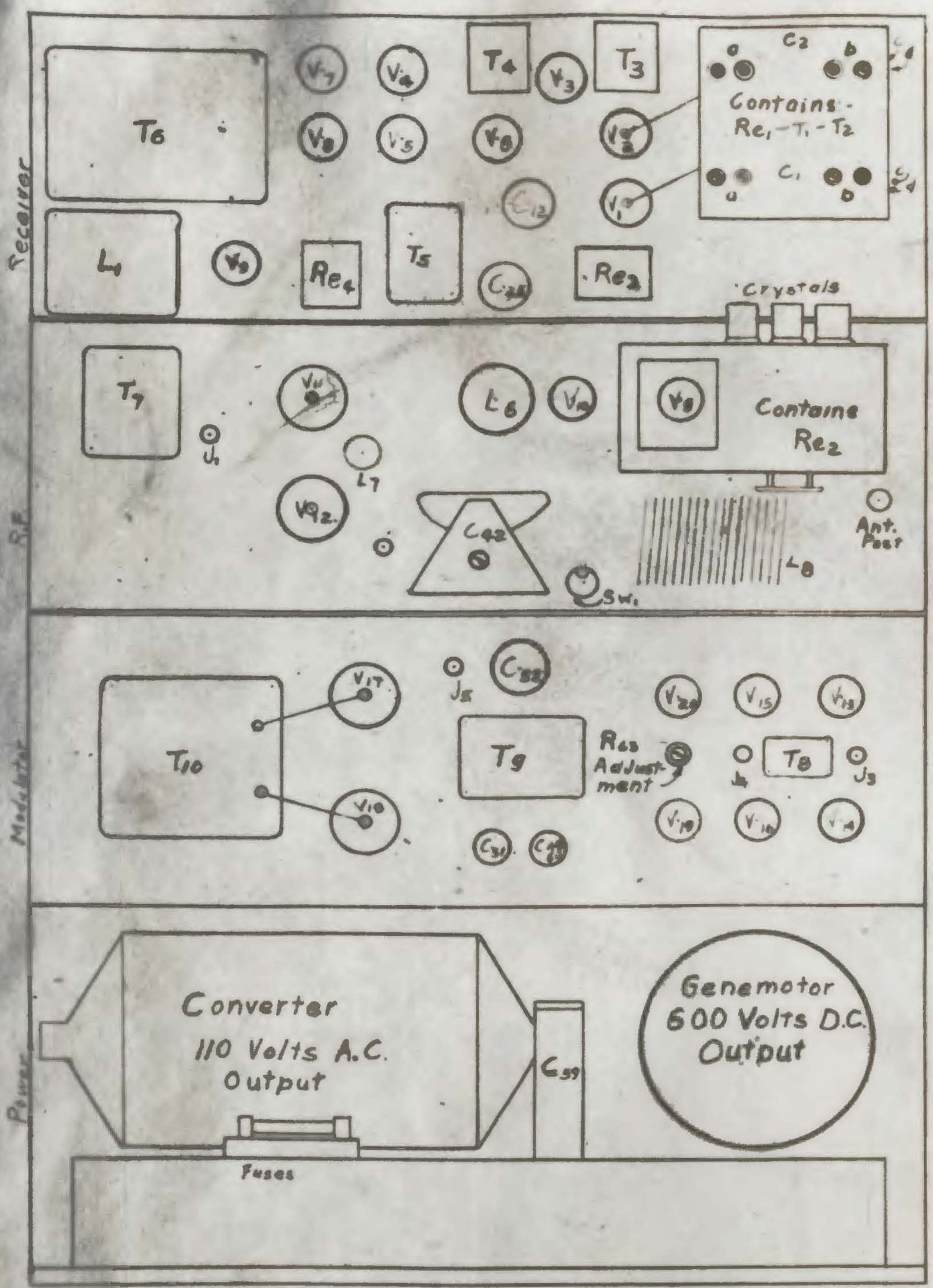
	Battery minus	Power to Remote
	Speaker	Rec. to Remote
	Bias -50V.	Rec. to R.F. to Mod.
	Ringer restore	Power to Ringer
	+300 Volts	R.F. to Mod.
	Ringer output	Rec. to Ringer
	Speaker	Rec. to Remote
	+100 Volts	Rec. to R.F. & Remote
	+100 Volts	R.F. to Rec.
	6V. A.C. push but.	Rec. to Remote
	" " " "	" " "
	Stepper coil	Rec. to R.F.
	Hook switch	Power to Remote
	Safety Relay (2 leads)	Power to Mod.
	Ringer relay	Remote to Rec.
	Gate control	Rec. to Remote
ed tr	110 V. A.C. (2 leads)	Power to R.F. to Rec.
k tr.	+300 V.	Rec. to Ringer
k tr.	+300V. Voice relay	Rec. to. R.F.
k tr.	Voice Relay	R.F. to Mod.
te tr	On-off	Power to Remote
	Ground	All
	6 V. A.C.	Rec. to Remote
	6V. A.C.	R.F. to Mod.
	+600 V.	Power to Mod.
	+600 V. mod.	Mod to R.F.
	Microphone	Remote to Mod.

PLATE TR-12

ctions on Frame Model 500
Radio Manufacturing Corp.
w York, N.Y.
Drawn by: D. W. 5/21/40
Approved by: m 3

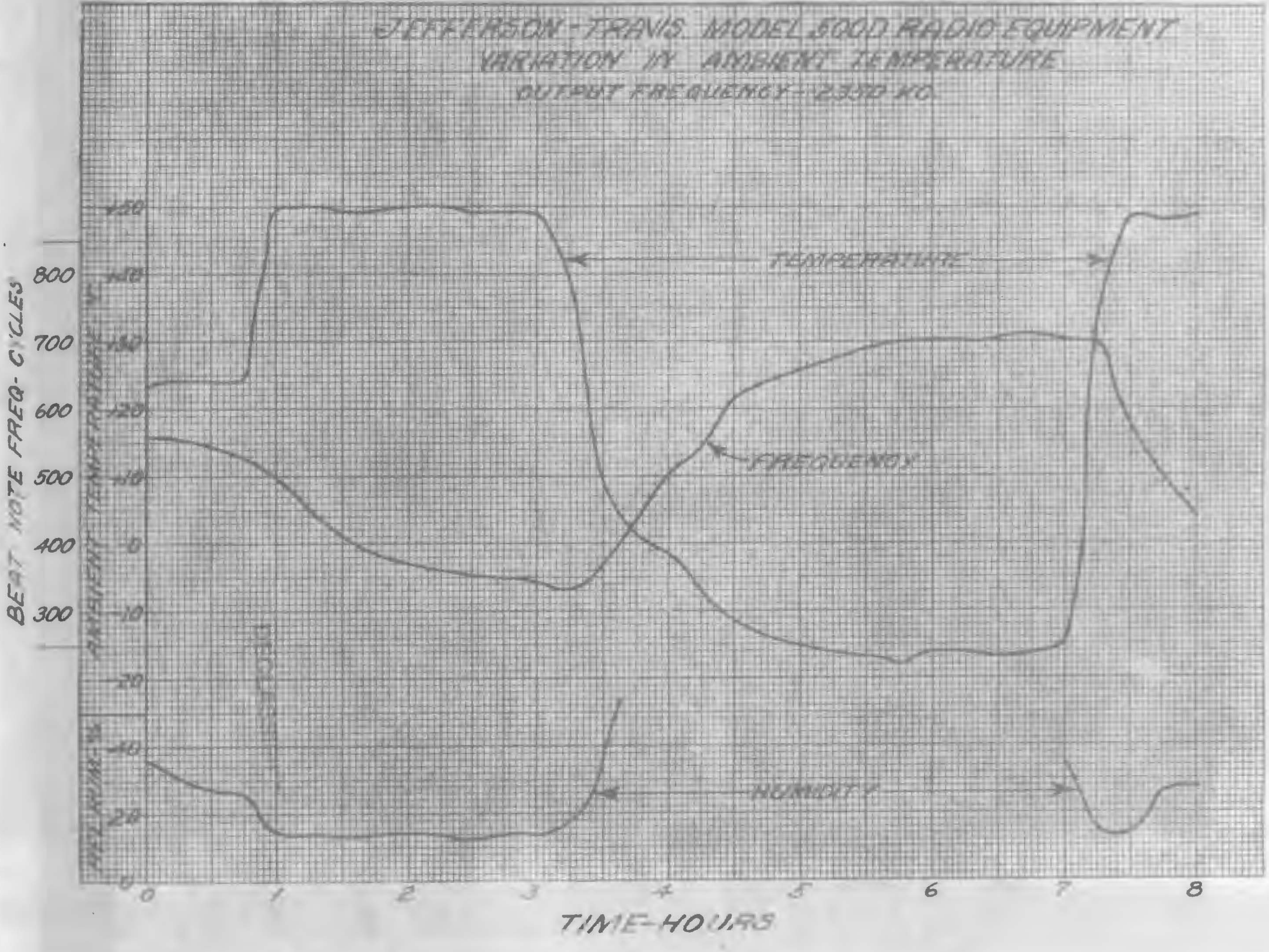


Terminal Board Layout - Receiver Chassis - Model: 500
Jefferson-Travis Radio Manufacturing Corp.
New York, N. Y.
Drawing No: 141 Drawn by: D.W. 5/16/40
Checked by: M.B.



Chasses Layout - Model 500
Jefferson-Travis Radio Mfg. Corp.
New York, N. Y.
Drawing No: 147 Drawn by: D.W.
Approved by: M.B.
May 30, 1940

PLATE TR-11


JEFFERSON-TRAVIS MODEL 500D RADIO EQUIPMENT
VARIATION IN AMBIENT TEMPERATURE
OUTPUT FREQUENCY - 2330 KC.
TEMPERATURE
FREQUENCY
HUMIDITY
BEAT NOTE FREQ- CYCLES
800
700
600
500
400
300
TIME-HOURS
0
1
2
3
4
5
6
7
8

PLATE

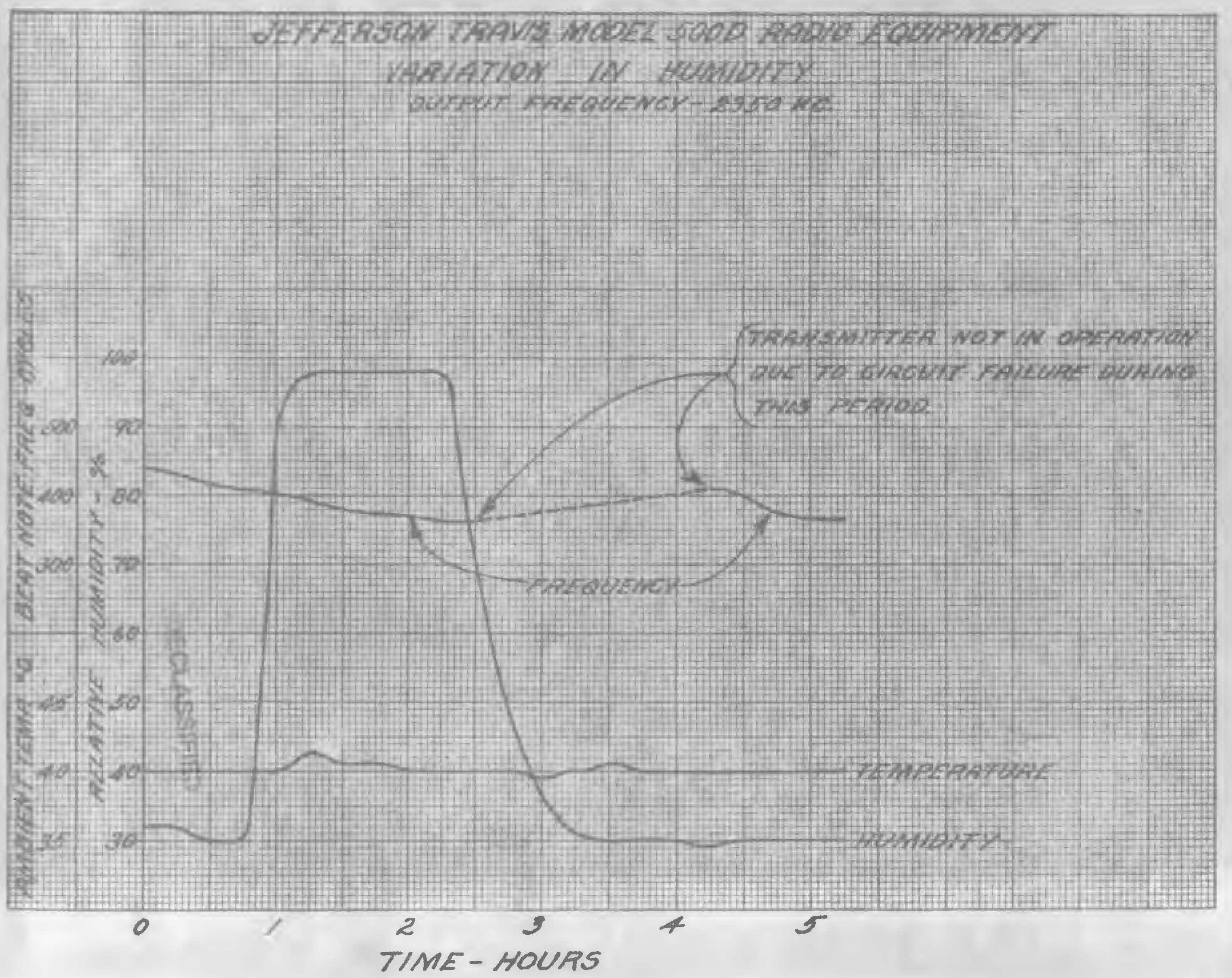

JEFFERSON TRAVIS MODEL 500D RADIO EQUIPMENT
VARIATION IN HUMIDITY
OUTPUT FREQUENCY
TRANSMITTER NOT IN OPERATION DUE TO CIRCUIT FAILURE DURING THIS PERIOD.
FREQUENCY
TEMPERATURE
HUMIDITY
AMBIENT TEMP. °C
BEAT NOTE FREQ.-CYCLES
RELATIVE HUMIDITY - %
100
90
80
70
60
50
40
30
500
400
300
45
40
35
0
1
2
3
4
5
TIME - HOURS

PLATE T-2

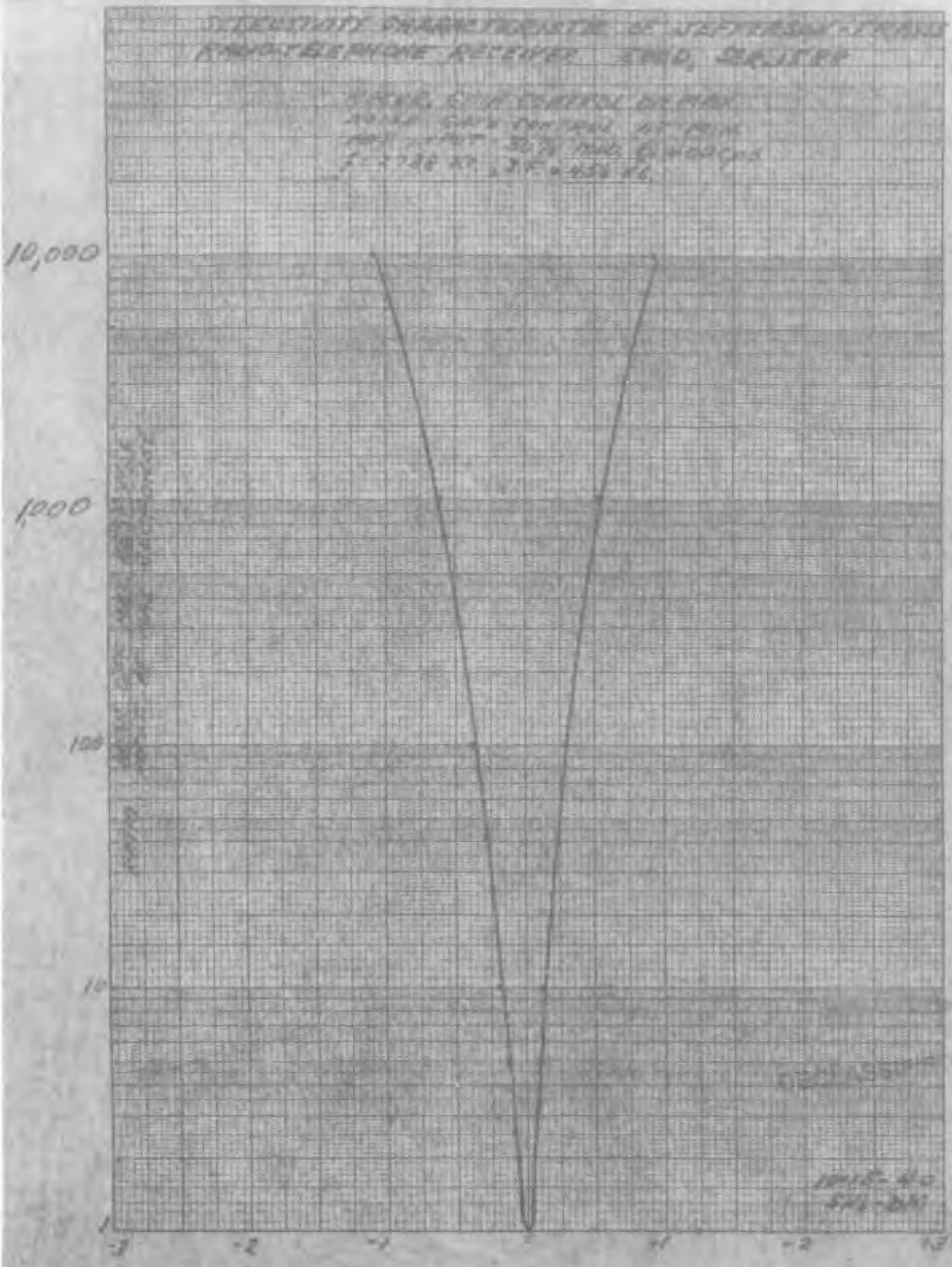
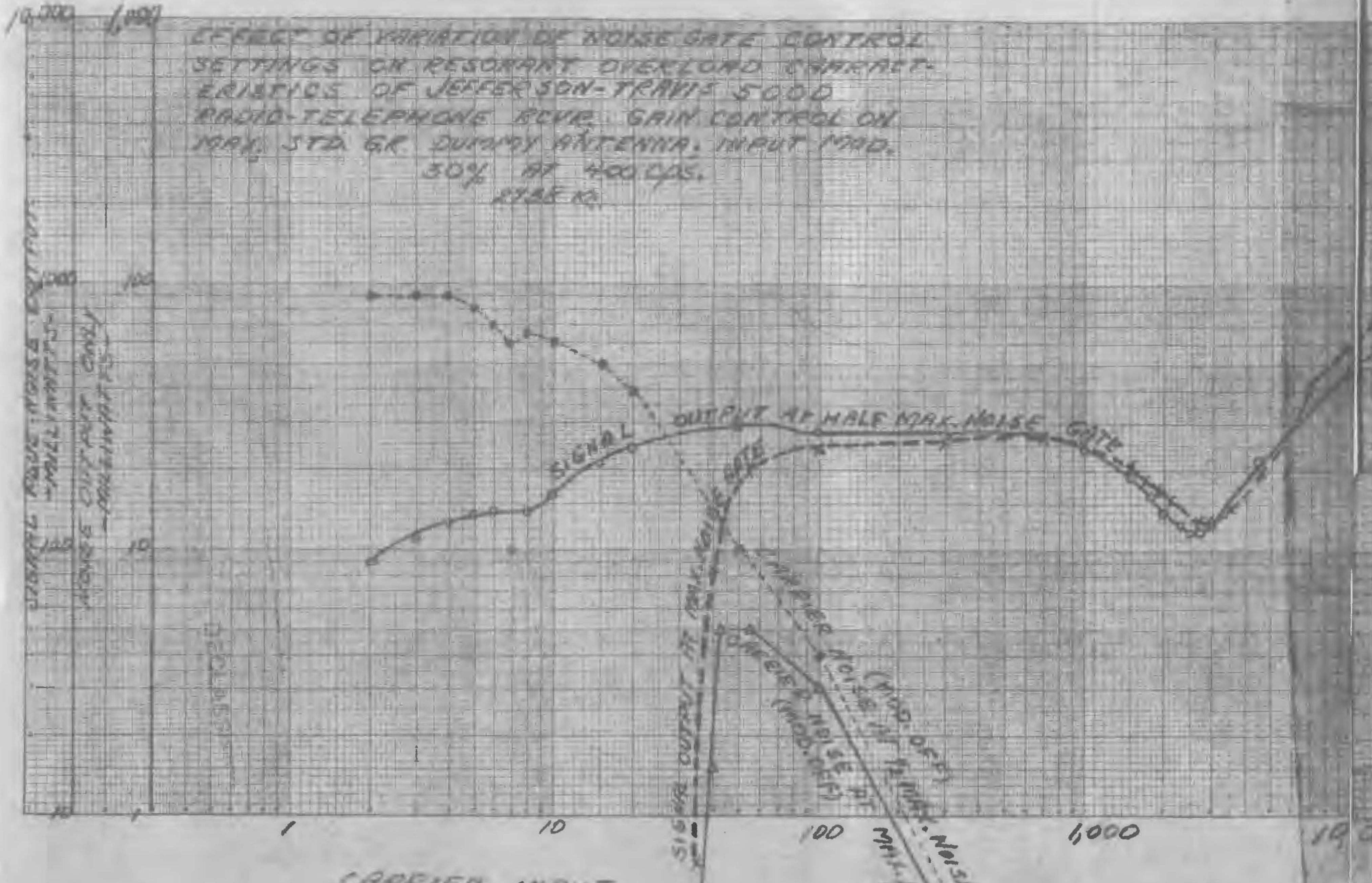

10,000
1,000
100
10
1
-3
-2
-1
+1
+2
+3
PERCENT OFF FREQUENCY OF MAX. RESPONSE

PLATE B-1


EFFECT OF VARIATION OF NOISE GATE CONTROL SETTINGS ON RESONANT OVERLOAD CHARACTERISTICS OF JEFFERSON-TRAVIS 5000 RADIO-TELEPHONE RCVR. GAIN CONTROL ON MAX. STD. G.R. DUMMY ANTENNA. INPUT MOD. 30% AT 400 CPS.
2735 KC.
SIGNAL OUTPUT AT HALF MAX. NOISE GATE
SIGNAL OUTPUT AT MAX. NOISE GATE
CARRIER NOISE AT ½ MAX. NOISE GATE (MOD. OFF)
CARRIER NOISE AT MAX. NOISE GATE (MOD. OFF)
SIGNAL PLUS NOISE OUTPUT -MILLIWATTS-
NOISE OUTPUT ONLY -MILLIWATTS-
CARRIER INPUT -MICROVOLTS-
10,000
1,000
1000
100
100
10
1
1
10
100
1,000
10

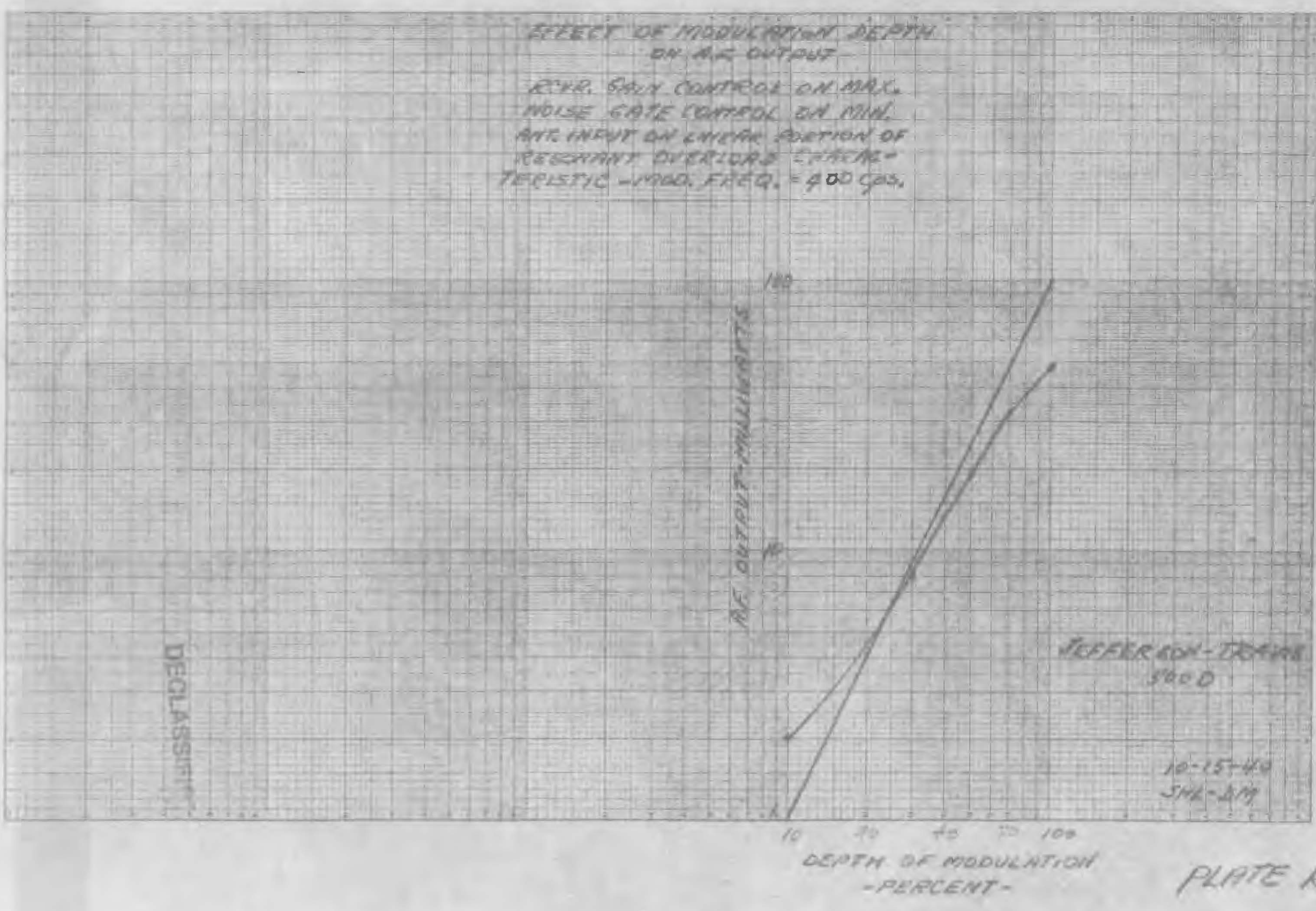
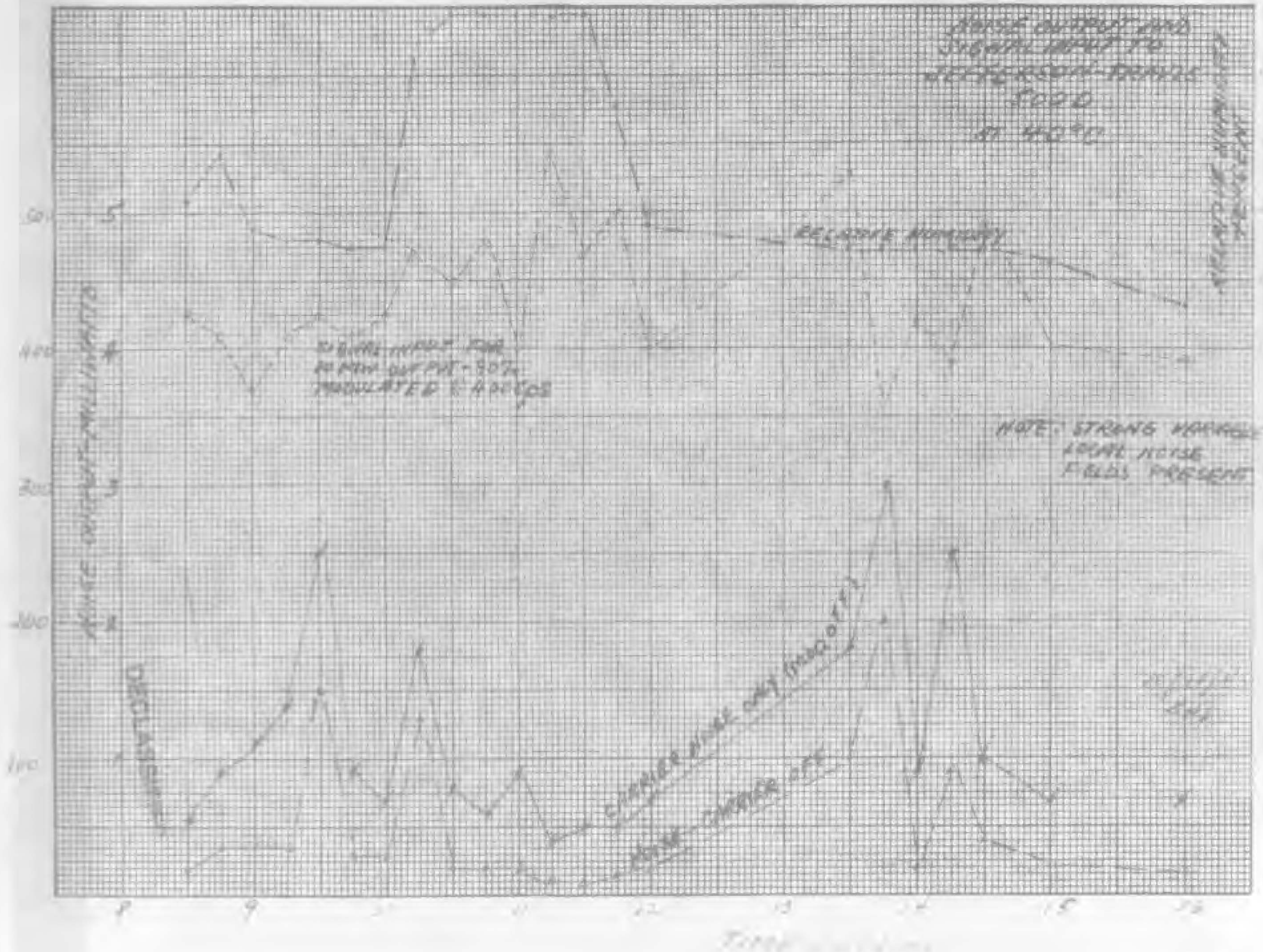
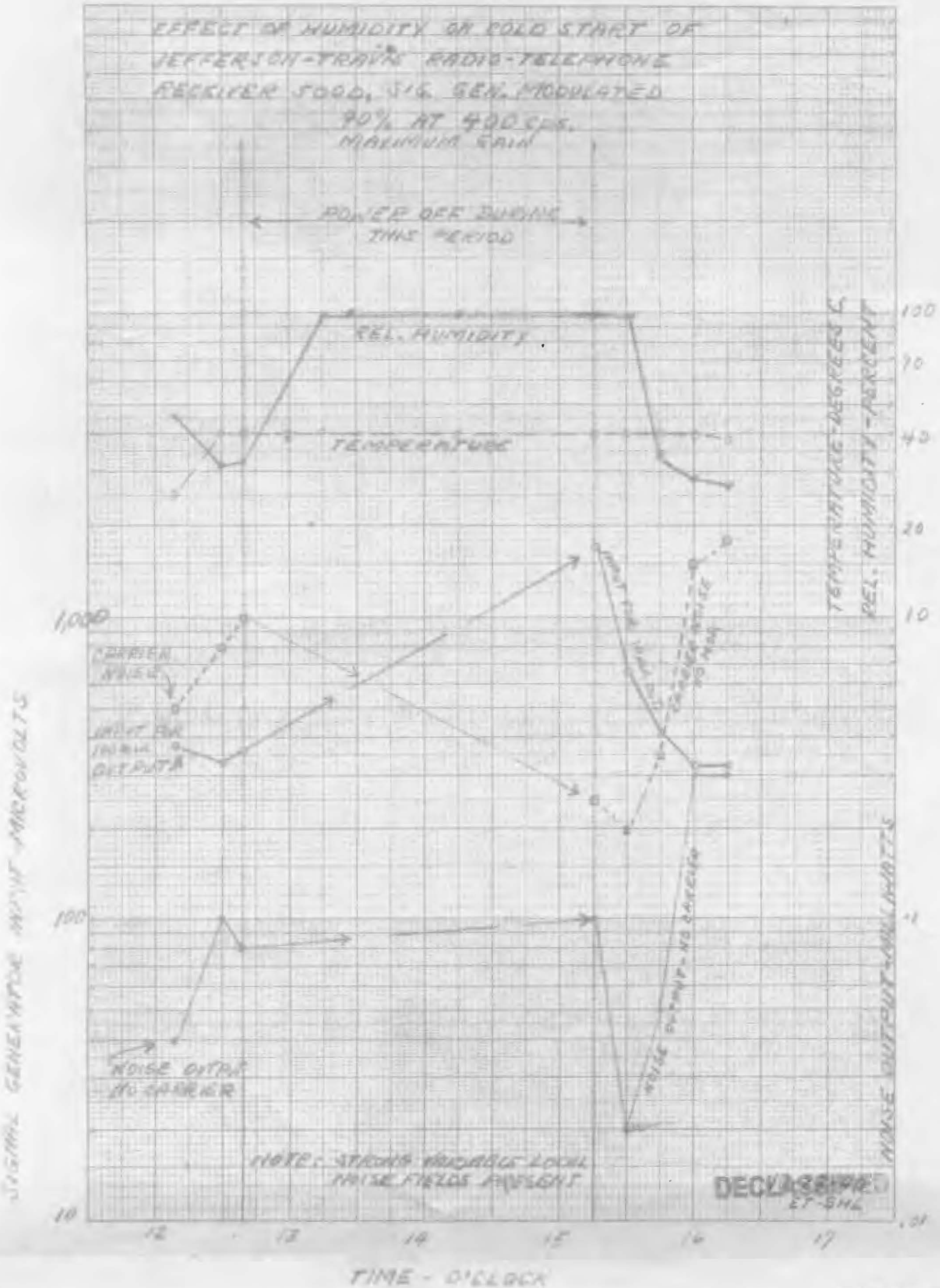

EFFECT OF MODULATION DEPTH
ON A.F. OUTPUT
RCVR. GAIN CONTROL ON MAX.
NOISE GATE CONTROL ON MIN.
ANT. INPUT ON LINEAR PORTION OF
RESONANT OVERLOAD CHARAC-
TERISTIC - MOD. FREQ. = 400 CPS.
A.F. OUTPUT-MILLIWATTS
100
10
1
10
20
40
70
100
DEPTH OF MODULATION
-PERCENT-
JEFFERSON-TRAVIS
500 D
10-25-40
SHL-AM

PLATE R4


NOISE OUTPUT AND SIGNAL INPUT TO JEFFERSON-TRAVIS 500 D AT 40°C
RELATIVE HUMIDITY
SIGNAL INPUT FOR 10 MW OUTPUT - 30% MODULATED @ 400 CPS
NOTE: STRONG HARMONIC LOCAL NOISE FIELDS PRESENT
CARRIER NOISE ONLY (MOD OFF)
NOISE - CARRIER OFF
NOISE OUTPUT - MILLIWATTS
500
400
300
200
100
5
4
3
2
1
8
9
10
11
12
13
14
15
16
DECLASSIFIED



EFFECT OF HUMIDITY ON COLD START OF
JEFFERSON-TRAVIS RADIO-TELEPHONE
RECEIVER 5000, S/G. GEN. MODULATED
30% AT 400 cps.
MAXIMUM GAIN
POWER OFF DURING
THIS PERIOD
REL. HUMIDITY
TEMPERATURE
CARRIER NOISE
INPUT FOR 100 MW OUTPUT
NOISE OUTPUT NO CARRIER
NOTE: STRONG VARIABLE LOCAL NOISE FIELDS PRESENT
SIGNAL GENERATOR INPUT MICROVOLTS
TEMPERATURE-DEGREES C.
REL. HUMIDITY-PERCENT
NOISE OUTPUT-MILLIWATTS
TIME - O'CLOCK
1,000
100
10
12
13
14
15
16
17
100
70
40
20
10
1
.01

PLATE K-7

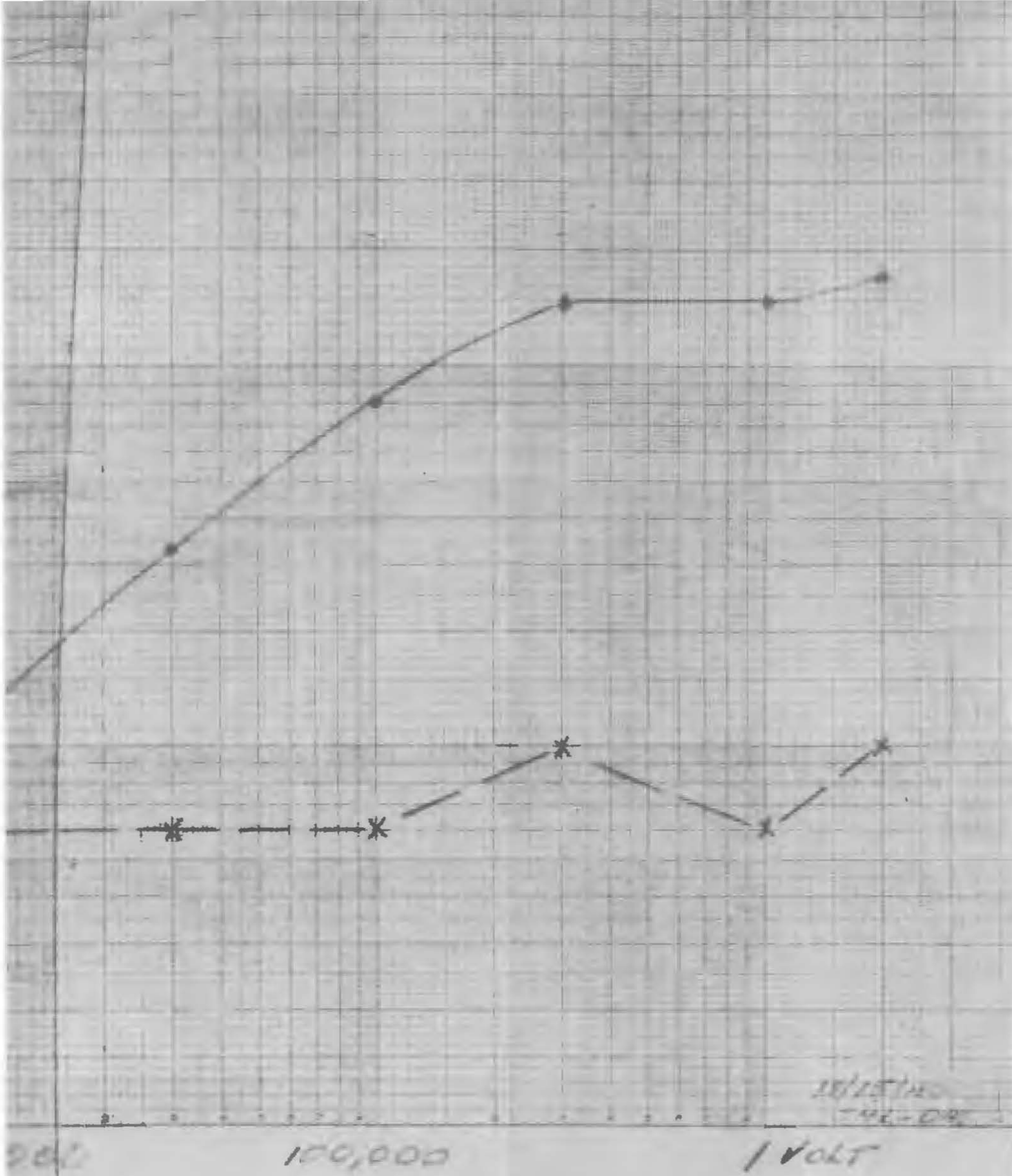


PLATE R-2

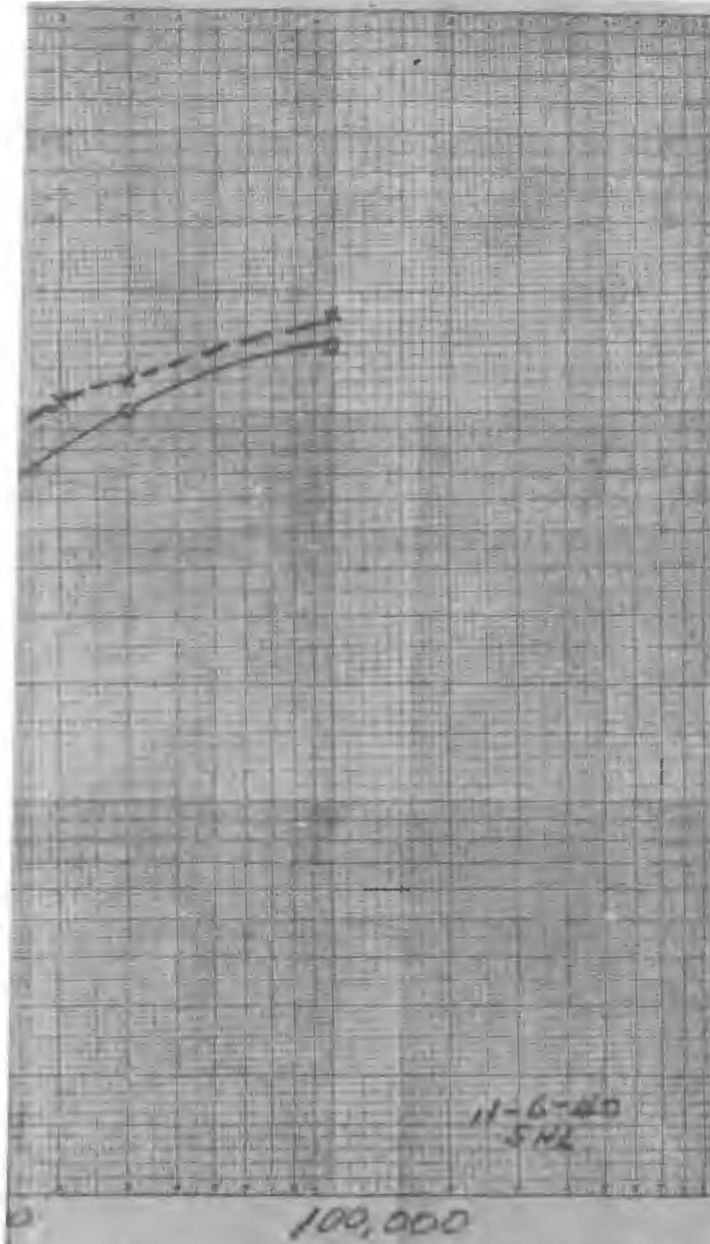
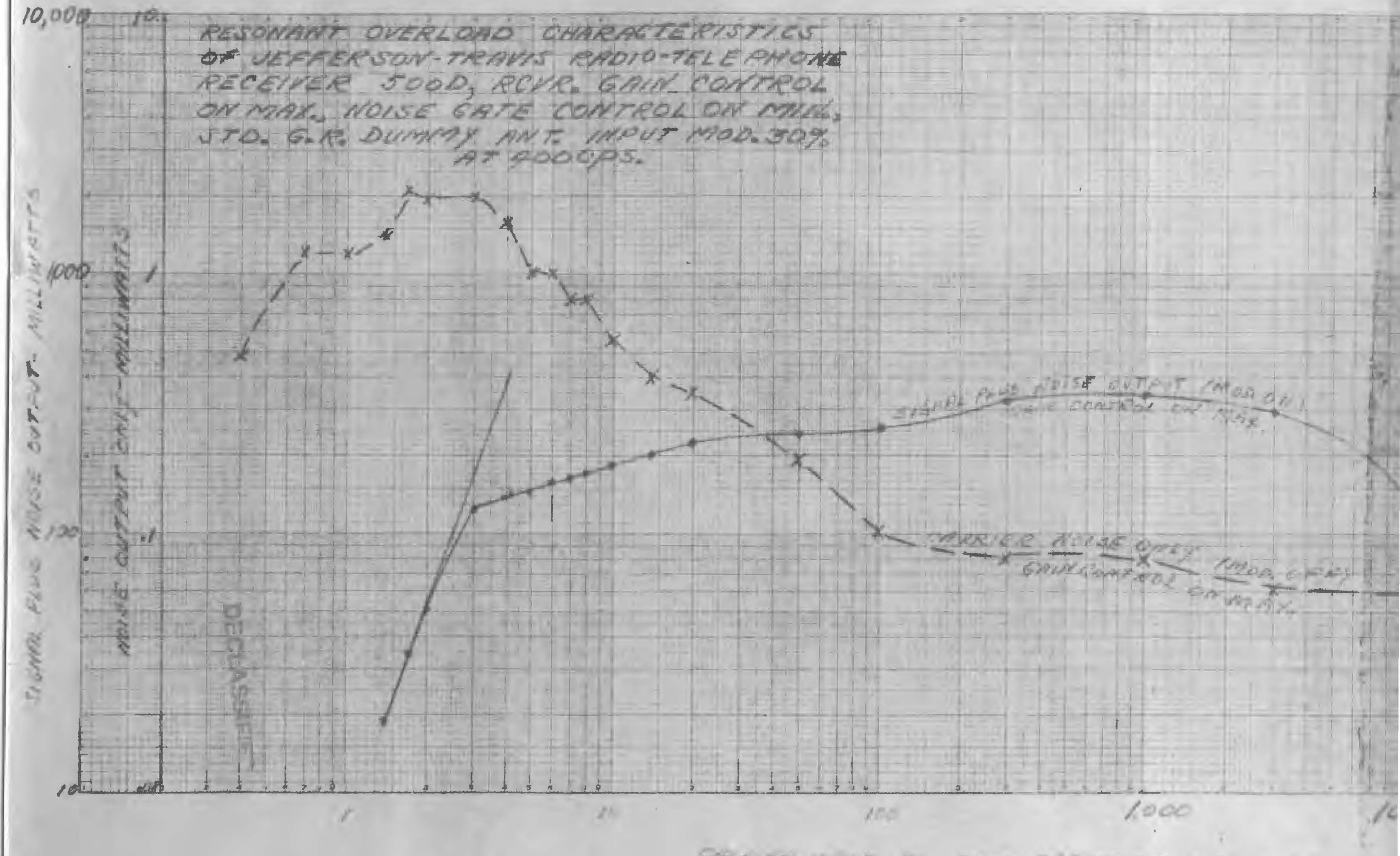


PLATE R-3



RESONANT OVERLOAD CHARACTERISTICS
OF JEFFERSON-TRAVIS RADIO-TELEPHONE
RECEIVER 500D, RCVR. GAIN CONTROL
ON MAX., NOISE GATE CONTROL ON MIN.,
STD. G.R. DUMMY ANT. INPUT MOD. 30%
AT 400CPS.
SIGNAL PLUS NOISE OUTPUT (MOD. ON)
GAIN CONTROL ON MAX.
CARRIER NOISE ONLY (MOD. OFF)
GAIN CONTROL ON MAX.
SIGNAL PLUS NOISE OUTPUT - MILLIWATTS
NOISE OUTPUT ONLY - MILLIWATTS
10,000
1000
100
10
1
.1
1
10
100
1,000
DECLASSIFIED