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SHIP-SHORE RADIO DIVISION - RECEIVER SECTION

19 September 1946

FR-2974

ANALYSIS AND TYPE TESTS OF REMOTE
CONTROL-INDICATOR SYSTEMS FOR MAR,
RDR, AND RDZ RADIO COMMUNICATIONS
EQUIPMENTS

By J. W. Klotz

- Report R-3974 -



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ABSTRACT

Four units of a Remote Control-Indicator System for use with the Model RDZ, Model MAR, and Model RDR radio equipments were type tested and analyzed by the Laboratory to determine their compliance with governing specifications. In addition, the various units of the system were used, as required, to make a system check with the controlled equipments (Models RDZ and MAR).

The performance and design of the four units was, in general, satisfactory, both in mechanical and electrical features, with several exceptions specifically listed below. Elimination of these deficiencies in design should give the performance required by governing specifications and satisfactory operation of the equipments for their application in the Naval service.

The deficiencies in design apparent from the tests were: (a), introduction of hum in the Model RDZ receiver when connected to the CQC-23497 Selector Control Unit; (b), excessive supply voltage from the CQC-23497 Selector Control Unit to the silencer relay of the CRV-491481 Remote Control Adapter; (c), "soft" shock mounts and insufficient cabinet reinforcement on the CQC-23497 Selector Control Unit and the CQC-20409 Power Supply Unit; (d), "soft" contact springs in the K102 relay of the CQC-23497 Selector Control Unit; and (e), improper filter location and design in the CQC-23497 Selector Control Unit.

The Bureau of Ships has been advised by the Laboratory that these deficiencies exist, together with recommendations for their correction. In all instances, with the exception of (e), action has been taken to eliminate these conditions. The deficiency in filter design is discussed in this report, together with a discussion of methods of improving filtering for particular installations that require it.

In addition to recommending the design changes stated above, the Laboratory is submitting in this report a recommendation that the Radio Materiel Schools and technicians of the Fleet be advised of certain operational techniques in connection with the Remote Control-Indicator System, particularly the use of the silencer and antenna controls of the MAR/RDR equipments.

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INTRODUCTION

1. Four preproduction units of a Remote Control-Indicator System, to be used with the Model RDZ and Model MAR/RDR radio equipments, were submitted to the Laboratory for analysis and type tests as required by Bureau of Ships specification 16C11(RE), reference 1, and Bureau of Ships problem assignment, reference 2. Three units of the system, submitted by the Admiral Corporation under Contract N5sr-759, bear etched name plates having the following type nomenclature:

Type CQC-20409 Power Supply Unit
Type CQC-23445 Remote Channel Selector Unit*
Type CQC-23497 Selector Control Unit

* This title is used throughout this report, as it also agrees with the nomenclature of reference 3. It should be noted, however, that the title "Channel Selector-Indicator Unit" is assigned to this unit by reference 1.

The fourth unit of the system, the Type CRV-491481 Remote Control Adapter, was submitted by the RCA Manufacturing Company under Contract N5sr-13646.

2. Reference 2 specifically requested that the Laboratory conduct certain mechanical and electrical tests and that the Laboratory advise the Bureau of Ships on several design features of the equipment. The Laboratory has complied with this request and has reported the results of these tests in conferences, and by written and oral reports to the Bureau. Tests specifically required in paragraph 4-F of reference 1 were also made at the Laboratory, and results have been reported orally to the Bureau. In addition, the Laboratory has made a detailed analysis of the many complex circuits utilized in the various units of the Remote Control-Indicator System, in order to determine their functional and performance characteristics.

3. This report should not be considered as reporting all of the activity of the Laboratory in connection with this problem, but only as a summary of the significant results of the mechanical and electrical tests authorized in references 1 and 2, plus a discussion and analysis of the circuitry of the equipments only in so far as necessary to report any deficiencies found during the type tests.

TESTS AND RESULTS

Type I. System Test - Model RDZ Receiver, CQC-23497 Selector Control Unit, CQC-23445 Remote Channel Selector Unit.

4. A test was made of the Remote Control-Indicator System as used with a Model RDZ radio receiving equipment. This is a Type I System as specified in reference 1, consisting of the controlled receiver, Model RDZ, the CQC-23445 Remote Channel Selector, the CQC-23497 Selector Control Unit, and a Navy Type 23211 Radiophone Unit, connected as outlined in the Systems Instruction Book, reference 3. Reference 3 also contains a detailed description of the function and circuit design of all units of the Remote Control-Indicator System used in the RDZ systems test, and for this reason no description of circuit function or design is given in this report.

5. The various functions of the system were checked including the selection of pre-set channels of the Model RDZ receiver from the remote station, remote indication of channel setting and "Local" operation, remote release of the receiver silencing circuits, and remote "push-to-talk" operation of a composite transmitting-receiving equipment. All of these functions were performed satisfactorily by the equipments; however, it was observed that excessive hum (about six milliwatts with AVC "on") was being introduced into the audio output of the Model RDZ receiver.

6. It was found that the source of this hum interference was in the receiver silencer circuits. When the Model RDZ receiver was used in conjunction with the Remote Control-Indicator System, with the silencer operating, the silencer remote control lines were connected to either side of the cathode biasing resistor (R-250, reference 6) of the silencer amplifier (V-210A, reference 6). The remote silencer lines were connected to the Selector Control Unit through a Type TTHFA-10 cable, together with the remote audio lines and the remote Autotune lines which supply the 115-volt alternating current for the Autotune motor. The inductive coupling between the remote silencer lines and the alternating current supply lines was apparently sufficient to introduce an appreciable 60-cycle voltage to the silencer amplifier (V-210A, reference 5). This voltage was amplified to produce four to six milliwatts of hum output in a 600-ohm load on the remote audio line under conditions of normal operation.

7. Reference 6 records the recommendation of the Laboratory for a circuit modification of the Model RDZ receiver to an arrangement where a single remote silencer line is used at ground potential, eliminating the possibility of inductive hum pick-up in the remote silencer circuits. For operation without the silencer, the remote line is disconnected entirely (by means of the AVC switch) eliminating the possibility of hum pick-up under this condition of operation. In effect, the change is in the arrangement of the cathode biasing resistors of the silencer amplifier (V-210A, reference 6) and the point at which the remote silencer line is connected to these resistors. The Contractors for the Model RDZ and Model RDZ-1 receivers have since incorporated this modification in production; however, early deliveries of the former may require correction in the field.

Test of Filter Networks in CQC-23497 Selector Control Unit.

8. Tests were made to determine the effectiveness of the r-f filter block in the Selector Control Unit (see Plate 6). These filters are inserted in all of the lines connecting the Selector Control Unit and the associated receiving equipment (with the exception of the ground line carried in the interconnecting cable). It was assumed for the tests of these filters that all voltages would be generated external to the Selector Control Unit, either as a result of the interconnection of the associated Model TDZ transmitter through the Radiophone Unit, or as a result of strong r-f fields which would generate voltages on the lines leading to the Selector Control Unit.

9. Tests were made by connecting the Selector Control Unit to a Model RDZ receiver with a ten-foot length of TTHFA-10 cable. The CQC-23445 Remote Channel Selector Unit and the Navy Type 23211 Radiophone Unit were also

connected to the Selector Control Unit by means of shielded cables which were grounded in the equipments at the ends of the cables. Jumpers were placed between pins A and J, and L and K of the jack (J-102) of the Selector Control Unit, as required for audio line interconnection of a Type I System. A coaxial fitting was mounted on the cabinet of the Selector Control Unit in place of one of the shock mounts and the signal generator output was connected to this fitting by means of coaxial cable. The fitting was terminated in a 50-ohm resistive load inside the cabinet. A 0.01 microfarad condenser was placed between the "high-side" of the 50-ohm load and the line under test.

10. R-f voltages were generated on the lines entering the Selector Control Unit from the Remote Channel Selector Unit and the Radiophone Unit. It was found after testing these lines that the remote audio lines (terminals No. 9 and No. 11 of the Selector Control Unit) were the most vulnerable of the remote lines to r-f voltages appearing at the terminal block. This is logical, as the audio lines (and the silencer lines) are the only lines connected directly from the Radiophone Unit to the controlled receiving equipment (in this case, the Model RDZ) through their filters (Z-101, Z-102, Z-103, and Z-104). It should be stated that tests were made to determine that the path of transfer of r-f voltages was through the remote lines, and not by other paths.

11. The total attenuation of the system on the audio lines (this includes Selector Control Unit filter attenuation, line attenuation, RDZ filter attenuation, and the attenuation presented by circuit layout in the RDZ) is given in Plate 18, in terms of the antenna sensitivity, i.e., the amount of signal (in decibels above antenna input) necessary to produce identical audio output to a signal produced by developing voltage at the antenna input. Attenuation in the order of 70 to 90 decibels was observed over a frequency range of 225-390 Mc.

12. In order to determine the effectiveness of the filter block, it was removed entirely from the equipment, and the various lines of the filter were connected. A similar set of measurements were taken, as described above, with the results shown in Plate 18. From this data, it is observed that the filter block in the Selector Control Unit is contributing little to the total attenuation of the system (cable, RDZ filters, RDZ circuits, etc.). The slight additional attenuation obtained for a few frequencies, and the apparent loss of attenuation at other frequencies, would indicate that the location and the design of these filters is inadequate. On the basis of these tests, the Laboratory recommended orally to the Bureau of Ships that the filters as submitted for test be eliminated from the CQC-23497 Selector Control Unit.

13. In view of this recommendation, tests were made to determine if the filtering of the remote lines provided in the Model RDZ equipment was sufficient to filter the audio line alone, if a direct connection were made from the receiver audio output to the receiver monitoring jack provided on the Model TDZ transmitter. Connections were made from receiver to transmitter with a shielded twenty-foot audio line, and the receiver was provided with additional power line filters to reduce interference radiated

to the power line from the Model TDZ antenna. When operating both equipments on the same frequency, it was found that there was only a negligible transfer of the transmitter signal to the receiver through the remote audio lines. As the receiver equipment will present a minimum of 40 or 60 decibels additional attenuation for all signals other than the signal frequency, the filtering provided in the Model RDZ receiver should be adequate for all installations employing audio connections from transmitters to receivers (as in Type I Remote Control-Indicator System). This, of course, would assume that r-f voltages are not being introduced into the system by means other than the direct audio connection between transmitter and receiver equipments (such as a strong r-f field generating voltages in the interconnecting cable, or the Selector Control Unit, or its power source).

14. While the tests and conclusions, described in paragraph 13 above were predicated on the absence of interference generated on the interconnecting leads due to strong r-f fields, it is realized that these conditions will seldom be encountered in a shipboard installation. It is known, for example, that the Model TDZ transmitter has a local r-f field around the cabinet, quite apart from its radiated antenna field. Given a shipboard installation of a Type I Remote Control-Indicator System with a Model TDZ transmitter and a Model RDZ receiver, it is conceivable that the Type TTHFA-10 cable (only partially shielded) connecting the Selector Control Unit and the RDZ receiver, would pick up voltages which would generate interference in the receiver. The methods of eliminating interference will vary, and should be the responsibility of the installation activity, as it is not feasible to provide additional filtering in the receivers or the various units of the Remote Control-Indicator System. In general, it is believed that most cases of interference can be eliminated, where they do exist, by substituting dual-copper-shield inter-connecting cables, or by relocation of the equipments or cables of the system with respect to each other. In very extreme cases of interference, it may be necessary to provide additional filters for the receiver in a suitable junction box next to the equipment (using dual shielded inter-connecting leads), but this should be used only when other methods of eliminating interference have failed. References 8 and 9 contain comments of the Laboratory on the proposed VHF/UHF Remote Control-Indicator Systems installations.

Electrical and Mechanical Tests Required by Specification 16C11(RE), Reference 1.

15. Paragraph E-4 of specification 16C11(RE), (reference 1) specifically requests the Laboratory to test the following electrical and mechanical characteristics of the Remote Control-Indicator System: (a), time of release of minor switch; (b), time required for selecting channels; (c), operation with variations in ambient temperature; (d), operation under high relative humidity; (e), operation under conditions of shock and vibration; (f), ripple present in d-c supply intended for microphone operation; and (g), power consumption of equipment for operation. Results of these tests are described in the following paragraphs of this section, and the report of the Shock and Vibration Division is included with this report as Appendix 1.

16. The time of release of the minor switch is required to be less than 0.10 second as specified by paragraph E-5a(2)a of reference 1. The "stepper" and minor switch assembly used in the Selector Control Unit is a Type 29982 relay unit, which has been given type approval by the Navy. The manufacturer's specification for release of this switch is 0.058 second. As type approval has already been given to the relay, and only a complex electronic or photographic test set-up would determine this interval with accuracy, the Laboratory has assumed that this requirement has been met. The fact that the overall time requirement for dialing channels has been met is also taken as an indication that the time release of the minor switch is within satisfactory limits.

17. The overall time for the selection of channel 10, exclusive of the time required for the operation of the automatic tuning mechanism of the controlled equipment, varied between 1.40 to 1.48 seconds depending upon the speed of rotation of the finger plate of the telephone dial assembly to channel No. 10. The telephone dial assemblies return at a speed of ten impulses (circuit interruptions) per second, and the "stepper" relay follows this as it is designed to operate at a speed of approximately 35 steps per second. The "slow release" relay, K-103, which engages the contacts of the "stepper" switch with the remote controlled equipment, has a time constant of approximately 0.20 seconds. An analysis of the time sequence for dialing channel No. 10 is approximately as follows:

Rotating finger plate to Channel No. 10 (Release of minor switch takes place during this action)	0.30 sec.
Return of finger plate to "normal" position	1.00 sec.
Release of "slow release" relay (K-103)	<u>0.20</u> sec.
Total time to select channel No. 10	1.50 sec.

Selection of channels other than channel No. 10 would require less time, as the time required to rotate the finger plate to the desired position and its return to normal position would be reduced. The intent of paragraph E-5a(4)a of the specification has been met by the manufacturer.

18. Operation of the Remote Control-Indicator System under variations of ambient temperature and under high relative humidity was checked by placing the Remote Channel Selector Unit, the Selector Control Unit, and the Power Supply Unit in a temperature and humidity chamber, and connecting these units by means of suitable cables to a Model RDZ receiver and a standard Navy Radiophone Unit mounted outside the chamber. Operation of the channel selector circuits, the receiver audio output circuits, microphone circuits, and silencer-test circuits was checked periodically during the tests. Suitable current and voltage meters were also placed in the power supply circuits to observe any variations in current drain or voltage output.

19. The equipment was operated for a period of ten hours in an ambient temperature of 50° Centigrade and 95% relative humidity, and for a period of eight hours at 60° Centigrade and 95% relative humidity. No appreciable change in the performance of the equipment was observed during this time.

20. The ambient temperature of the chamber was then changed to -15° Centigrade. After the equipment had been operating for one hour and fifteen minutes, it was observed that the channel selector circuits would not select channel No. 1, when dialed after channel No. 2 had been selected. It was also observed that dialing channel No. 1, when the equipment was operating on channel No. 1, resulted in the selection of channel No. 2. Inspection of the minor switch (K-105) in the Selector Control Unit showed that the roller arm (see Plate 8) on the hub of the contact arm assembly was not engaging the "release" relay control switch, when the "release" mechanism was operated after the Remote Control-Indicator System had been on channel No. 2. Operation of the "release" mechanism when the Remote Control-Indicator System had been on channels No. 3 to 10, however, was satisfactory. This indicated that the inertia in the contact arm of the assembly was sufficient to properly actuate the "release" relay switch on all channels with the exception of channel No. 1 and channel No. 2. Inspection of the roller arm showed that the roller bushing had been lubricated by a heavy oil or grease which had congealed with exposure to low ambient temperature. The roller action of the arm was lost and did not operate properly. Another Selector Control Unit in which the roller arm on the minor switch had not been lubricated was exposed to an ambient temperature of -20° Centigrade for approximately two and one-half hours. The operation of this selector mechanism was satisfactory under these conditions.

21. The Remote Channel Selector Unit dial mechanism, after exposure to an ambient temperature of -20° Centigrade for two hours, became sluggish in its action, and required approximately two seconds to return after channel No. 10 had been dialed. This is in excess of the time interval permitted by paragraph E-5a(3)a of the specification (reference 1), which requires that the dial-return from channel No. 10 be completed in approximately one second. Inspection of the governor mechanism of the dial showed that it had been lubricated with a light machine oil, which evidently congealed at the low ambient temperature. The Remote Control-Indicator System instruction book (reference 3) contains a specific warning (Section 6, paragraph 2) against lubrication of the dial mechanism. If these instructions are followed, it is probable that the mechanism will operate satisfactorily under all temperature conditions.

22. Hum output (ripple) of the direct current microphone supply of the CQC-20409 Power Supply Unit was checked by placing a 75-ohm resistor (to simulate the microphone in the handset) in series with a 180-ohm resistor (R-208 current limiting resistor of Radiophone Unit) across the nominal twelve-volt supply terminal. An auxiliary resistive load of approximately 28 ohms was also placed across the supply, to give a total current drain from the supply of approximately 500 milliamperes. Under these conditions, the RMS value of all the frequency components of the power supply varied between 0.0005 to 0.001 volt across the 75-ohm resistor. This is well within the requirement in paragraph E-5e(2)a of the specifications (reference 1). A variation in the auxiliary resistive load to vary the current drain from a minimum value of 50 milliamperes to a maximum value of 600 milliamperes had little effect on the hum output or ripple of the direct current supply.

23. The power input requirements of the CQC-23497 Selector Control Unit varies between a minimum of approximately fifteen watts for a "stand-by" (or channel) condition, to a maximum of approximately eighty watts for part of the dialing sequence (only a momentary condition). "Local" operation of the equipment requires approximately twenty-two watts. This condition of operation would be for a Type I installation (see reference 1), where one Radiophone Unit and a Remote Channel Selector Unit are used to control a Model RDZ receiver.

24. A Type II installation (see reference 1), where a CQC-20409 Power Supply is used in addition to the above equipment to control a Model MAR equipment, requires approximately twenty-two watts for a "stand-by" (on channel) condition, twenty-seven watts for "Local" operation, and twenty-six watts for "push-to-talk" operation. Line voltage for the 60-cycle, single phase, supply line was 115 volts for all of these measurements. Operation of the equipment was also checked for a $\pm 10\%$ variation in line voltage, and was satisfactory in all respects. Failure of the dialing relays with excessively low line voltages occurred with an input voltage of approximately 65 volts, which is excellent.

MECHANICAL DESIGN OF UNITS SUBMITTED UNDER CONTRACT N5sr-759

25. The mechanical design of the various units submitted by the Admiral Corporation were satisfactory, and met the requirements of the specifications (reference 1) with a few exceptions which were brought to the attention of the Bureau of Ships. Various recommendations were made for minor improvements in layout, wiring, and choice of materials. These recommendations are recorded in conference records of the Laboratory, and will not be recorded here as they do not represent significant design changes. Attention is directed to the appended report of the Shock and Vibration Section of the Laboratory (Appendix 1) for their recommendations on mechanical defects which became apparent during the course of their tests of the Selector Control and Power Supply Units.

DESCRIPTION AND FUNCTION OF MAR/RDR REMOTE CONTROL ADAPTER

26. The CRV-491481 Remote Control Adapter has been designed to provide automatic channel control of the Model MAR and Model RDR equipments when used in conjunction with the CQC-23445 Remote Channel Selector Unit, the CQC-23497 Selector Control Unit, and the CQC-20409 Power Supply Unit. For remote transmission and reception of voice, the system is used with a Type 23211 Radiophone Unit, or equivalent, and will provide control of the silencer-test circuit, and "push-to-talk" operation (of the MAR) in addition to the automatic selection of ten pre-set channels. It should be stated that this system does not include provision for turning the equipment "on" or "off", or for adjusting the silencer level, antenna trimmer, or changing over the "1C-Operate" switch from the remote station (for additional discussion of these features, see paragraphs 41 through 43 below). Suitable hardware and fixtures have been provided with the Remote Control Adapter to make its installation on the MAR/RDR equipment a comparatively simple "field modification", requiring only minor changes in the receiver wiring.

27. The Adapter is designed to be mounted on the front panel of the Model MAR or RDR equipments by removing a special panel, and securing the adapter with twelve machine screws (see Plate 15). Externally, the adapter provides a fitting for connection of seventeen lines (with Type TTHTFA-10 cable) to the CQC-23497 Selector Control Unit, a coaxial fitting for connection of the "Remote Line" of the MAR modulator unit, and a "Remote-Local" switch to select the point of automatic operation of the equipment (see Plates 16 and 17). Connections to the MAR or RDR equipment are made by means of fifteen leads, cabled together, which are connected to terminal blocks provided in the MAR/RDR equipment.

28. Internally the adapter provides filter networks in the remote leads to the MAR/RDR equipment in order to suppress possible interference from strong local fields. In addition a single-pole relay provides for control of the silencer-test circuit of the adapter, and a two-pole switch controls, externally, for "Local-Remote" operation. Operation and circuit function of these components are discussed below.

TYPE II SYSTEM TEST - MODEL MAR EQUIPMENT, CQC-23497 SELECTOR CONTROL UNIT, CQC-23445 REMOTE CHANNEL SELECTOR UNIT, CQC-20409 POWER SUPPLY, AND CRV-491481 REMOTE CONTROL ADAPTER

29. The Laboratory installed and connected the adapter to a Model MAR equipment as specified in drawing M-445109 (furnished by the manufacturer), and connected the adapter through a suitable cable to a CQC-23445 Remote Channel Selector Unit, a CQC-23497 Selector Control Unit, a CQC-20409 Power Supply Unit, and a Type 23211 Radiophone Unit. The six functions of the adapter, (a) remote selector operation, (b) remote silencer-test operation, (c) remote reception of signals, (d) remote "push-to-talk" operation, (e) channel indication on Remote Channel Selector Unit, and (f) shielding integrity, were observed and are discussed below. Conclusions and recommendations are included in each paragraph.

30. Remote selector operation was checked by setting the MAR selector switch (S-601B) and the adapter switch (S-1601) to the "remote" position. The control of channel settings was transferred by this operation to the CQC-23445 Remote Channel Selector Unit. Dialing of any one of the ten channels gave the desired setting on the MAR equipment, after allowing sufficient time (about 30 seconds) for the channel changing sequence to take place. The adapter switch (S-1601) was switched back to the "local" position, and the control of the channel settings was transferred back to the MAR selector switch (S-601B).

31. Remote silencer-test operation was checked by selecting at random one of the ten receiver channels, and adjusting the noise level of the audio output of the receiver to approximately six milliwatts on the remote audio line. This adjustment was made with the silencer level control (R-437) set at zero. The panel silencer switch (S-401) of the MAR was then switched to the "off" position, which is necessary for remote silencer-test. The silencer level control (R-437) was then adjusted to "silence" or reduce the noise output in the audio line by approximately 40 decibels. The silencer control switch (S-207) of the Type 23211 Radiophone Unit was then momentarily depressed, which permitted the noise output in the audio line

to rise to its original level of approximately six milliwatts. Releasing the silencer control switch (S-207) restored the equipment to its "silenced" condition. This sequence of action indicated that the circuit connections and remote operation of the silencer-test were satisfactory.

32. The action taking place during the operation described in paragraph 31 is as follows: The panel silencer switch (S-401) of the MAR is closed for silencer "on" operation, and open for silencer "off" operation. Placing this switch in the "off" position, with the remote control adapter connected, placed the silencer circuit control function on the contacts of relay (K-1601) of the adapter, which are connected in parallel with the silencer switch (S-401) of the MAR. These contacts are normally closed (Radiophone Unit silencer switch not depressed). To open the silencer circuits, or the contacts of the relay, the solenoid of the relay is energized by supplying current (through lines R & V of J-1601) from the power supply of the Type 23497 Selector Control Unit. This is accomplished by depressing the silencer control switch on the Radiophone Unit (S-207), which energizes the silencer relay solenoid (K-107) of the Type 23497 Selector Control Unit; and this, in turn, connects the silencer control lines (R and V of J-1601) of the adapter unit to the 28-volt direct current supply of the Selector Control Unit through the links of the silencer terminal board (E-105) and the relay contacts (K-107).

33. An analysis of this action reveals that two relays, each with single-pole contacts, and a single pole "push-to-close" hand switch are required for remote control of the silencer-test circuits of the MAR/RDR equipments. The relay in the Type 23497 Selector Control Unit is required for multiple remote stations, and the relay in the Type 491481 Adapter is required, as the manufacturer claims (oral reports to BuShips) that long remote lines attached to the silencer control panel switch (S-401) would introduce noise into the audio system of the receiver. With these requirements, it is seen that the action of the silencer control circuits is necessarily complex, and is dependent upon the action of several components, as outlined above.

34. The silencer circuit relay in the Type 491481 Remote Control Adapter is a C.P. Claire Company miniature type relay with a solenoid resistance of 120 ohms. According to the test report of the RCA Manufacturing Company, the current drain of the solenoid is rated nominally at 100 milliamperes for an applied voltage of 12 volts. It should be noted that the voltage developed by the power supply of the Type 23497 Selector Control Unit, when supplying this relay under normal operation, is about 29.5 volts, which produces a current of approximately 290 milliamperes in the solenoid. This supply voltage of the Selector Control Unit was nominally rated at 12 volts for operation of the silencer relay in a Type II System by specifications (reference 1) and was subsequently changed to a nominal 28-volt supply by the Admiral Corporation for reasons not known to the Laboratory.

35. In view of this condition, the Laboratory made additional tests of the relay (K-1601) in the CRV-491481 Remote Control Adapter to determine if sustained operation of the silencer-test circuit for any reason would damage the relay or solenoid. After two hours of continuous operation with the silencer control switch (S-207) on the Radiophone Unit depressed,

the solenoid had become excessively hot (approximately 80° Centigrade), although no visible signs of deterioration of the paper solenoid cover, or of the enamel on the solenoid winding, were observed. While this action will not occur under any normal conditions of operation, and only where a deliberate attempt has been made to use some artificial means of depressing the "push-to-close" silencer-test switch (S-207) on the Radiophone Unit, or if a failure occurred so as to energize the relay, the Laboratory recommends that the relay be replaced with a 28-volt solenoid winding. A solenoid rated for operation at 28 volts will reduce the current drain from the power supply unit.

36. The remote reception of signals was checked by monitoring the telephone receiver of the handset of the Radiophone Unit for the noise output of the MAR receiver. Operation of the MAR "local" gain control (R-432) was checked as was the operation of the "remote" gain control (R-203) of the Radiophone Unit. For reception of signals on the MAR equipment, a 15-volt d-c potential is present on the "Remote Line" of the MAR modulator unit. This potential is isolated from the winding of the audio transformer (T-202) in the CQC-20409 Power Supply Unit by a series electrolytic condenser, C-203, rated at 1500 microfarads and 25 volts d.c.

37. Remote "push-to-talk" operation was checked by depressing the "push-to-talk" switch on the handset unit of the Radiophone Unit. Audio signals were received from the microphone at the MAR modulator unit, indicating that all necessary actions for this function were occurring.

38. Channel indication on the Remote Channel Selector Unit was checked by switching the "Remote-Local" switch on the Remote Control Adapter to "Local" and "Remote" positions. The indicator pointer on the synchro-receiver of the Remote Channel Selector Unit pointed to the associated markings on the dial, showing correct connection of the switch (S-1601), and associated circuits. The theory of operation of the synchro-receiver and transmitter indicator systems is discussed in detail in reference 3.

39. A measurement of the shielding integrity of the Remote Control Adapter installed on the MAR was not specifically requested by the Bureau of Ships; however, a discussion of the design of the adapter and filters is included below, with a summary of tests made by the manufacturer. The adapter is provided with filter networks (see Plate 17) in all of the lines, with the exception of line M of the indicator circuits feeding to the MAR/RDR equipments, from the CQC-23497 Selector Control Unit. The purpose of the filters is to attenuate r-f voltages generated on the lines to the Selector Control Unit, before entering the receiving equipment. Each of these pi section filters makes use of a bushing type of titanium-dioxide-dielectric condenser, together with a bakelite encased choke. Similar components have been used by the Laboratory in developing filters for the frequency range of these equipments, and have provided the optimum filtering action with the present choice of components available commercially. The components are used to good advantage in that the coupling between input and output terminals is reduced by the filter layout. It is believed that the filters in the Remote Control Adapter will be adequate for the majority of permanent installations, where the MAR receiver with the Remote Control-Indicator System will be used in a shielded compartment or radio room aboard ship, and the

antenna will be removed from the receiver and selector control units.

40. The Laboratory recommends that a dual copper-braid shielded connecting cable be used between the Remote Control Adapter and the Selector Control Unit where extremely strong fields are encountered close to the receiving equipment, in place of the Type TTHFA-10 cable which provides only a partial coverage of aluminum painted steel armor and no shield. The Contractor has also advised the Laboratory that additional protection against strong fields may be realized by removing the various rubber gaskets of the adapter, but this will probably not be necessary for most installations. With the gaskets removed, reports of the contractor state that a shielding integrity was realized, with the Remote Control Adapter installed, that was approximately equal to the shielding integrity obtained without the adapter on the MAR equipment.

41. It has been stated above that the Remote Control-Indicator System for the MAR/RDR equipment, including the CRV-491481 Remote Control Adapter, the CQC-23445 Remote Channel Selector Unit, the CQC-23497 Selector Control Unit, and the CQC-20409 Power Supply Unit, does not provide for turning the equipment "on" or "off", changing over the "IC-Operate" switch, or for adjusting the silencer level and antenna trimmer from the remote station. The fact that the "on-off" and the "IC-Operate" cannot be changed from the remote station will probably not effect the operation of the equipment seriously; however, sufficient instruction should be given operating personnel and technicians in the proper use of the silencer level controls (RDZ and MAR/RDR) and the antenna trimmer (MAR/RDR) in order to realize the optimum performance from the equipment when controlled from a remote station.

42. Reference to NRL test and evaluation reports on the Model MAR and Model RDR equipments (references 5 and 7) will reveal that signal sensitivity varies between approximately two and ten microvolts, when the antenna trimmer is adjusted for optimum setting on each channel. It is also reported that a random setting of the antenna trimmer may give sensitivities approximately four orders lower, or between 20,000 and 100,000 microvolts. For ten channels spaced approximately at equal intervals across the 230- to 390-megacycle spectrum, it was found that the antenna trimmer varied in setting by about two points (setting 6 to setting 8, for example) for optimum weak signal sensitivity. If a compromise setting of the antenna trimmer is made for the ten channels (setting 7, for example) the sensitivity varied only one order from optimum sensitivity, that is from approximately five to fifty microvolts for the ten channels across the band. Sensitivities varying in this range would probably give satisfactory reception for the ten channels, without the need of adjusting the antenna trimmer for each individual channel, which is desirable for remote operation of the MAR/RDR equipment.

43. A similar condition exists with the silencer level controls in both the RDZ and MAR/RDR equipments, in that the optimum silencer action (silencing of receiver noise with no signal input, and release of silencer action with weak signals) can be realized for only one channel, due to the inherent design of the silencer circuits. As silencer action is dependent upon signal levels appearing at the second-detector diode, which is a function of gain, sensitivity, and other factors, it is obvious that the optimum setting of the silencer will vary from channel to channel across the 230- to 390-megacycle

band. In order not to penalize the sensitivity on a channel requiring a low-level setting of the silencer control, the silencer control should not be advanced beyond the minimum-level setting on the channel requiring a high-level setting. In view of the conditions described in paragraphs 41 through 43, the Laboratory recommends that the Radio Materiel Schools and radio personnel assigned to the Fleet be advised of these conditions, and that techniques be evolved for optimum setting of the antenna trimmer and the silencer-level controls for ten channel operation, where the RDZ and MAR/RDR equipments are remotely operated.

MECHANICAL DESIGN OF THE CRV-491481 REMOTE CONTROL ADAPTER

44. The mechanical design of the Remote Control Adapter was, in general, satisfactory, and in keeping with the design standards of the Model MAR and Model RDR equipments. Accessibility to the various components has been sacrificed for compactness. Several deficiencies in mechanical design have been brought to the attention of the Bureau of Ships and are summarized below:

- (a) The fifteen cabled leads, which connected the Remote Control Adapter and the MAR/RDR equipment, are subjected to considerable strain and wear due to the position of the adapter on the MAR/RDR cover-plate. The Laboratory has recommended that a rubber or plastic covered fifteen-wire cable be used in place of the cabled leads. In addition, sufficient clamps of a suitable character should be provided to secure the conductors to the cover-plate, adapter, and receiver units.
- (b) After the installation of the Remote Control Adapter on the MAR/RDR equipment, the cover-plate, adapter, and receiver (see Plate 15) become a unit, and the cover-plate can no longer be laid aside while adjusting the Autotune assemblies. After the cover-plate is unfastened, its weight, and the weight of the adapter is supported by the fifteen cabled leads, which produces excessive strain on the cable. It is recommended that the cover-plate be supported with chains, or straps, or by other suitable means, when removed for adjustment of the Autotune assemblies.
- (c) The two brackets or supports (Manufacturer's Part Nos. M-442882-1 and M-442882-2) were approximately one-quarter inch too short, so that spacers had to be inserted between the supports and the MAR front cover before fastening with the two cap screws. This may be due to a variation in dimension on some of the early MAR equipments. The Laboratory has advised the Bureau of Ships of this condition.
- (d) No cable assembly (Manufacturer's Part No. M-439521-504) was furnished with the equipment. This cable connects the audio jack of the Remote Control Adapter with the "line" output of the Modulator-Dynamotor Unit.

CONCLUSIONS

45. It is concluded that:

- (a) The Type I Remote Control-Indicator System for use with the Model RDZ receiving equipment gives satisfactory operation, and performs all functions required by specifications (see paragraphs 4 and 5). Due to the silencer

circuit design of the Model RDZ receiver, excessive hum was developed in the receiver audio system when operated with the Control-Indicator System. This condition was eliminated by a simple change in receiver circuits (see paragraphs 6 and 7).

(b) The Type II Remote Control-Indicator System used with the Model MAR/RDR receiving equipment gives satisfactory operation and performs all functions required by specifications (see paragraphs 29 through 40). Excessive voltage was supplied to the silencer-test-circuit relay of the MAR/RDR Remote Control Adapter from the power supply of the CQC-23497 Selector Control Unit.

(c) The effectiveness of the filter networks in the CQC-23497 Selector Control Unit was negligible in protecting the Model RDZ equipment from r-f voltages entering the receiver along the interconnecting cable from the Selector Control Unit (see paragraphs 8 through 14).

(d) The requirements of paragraph F-4 of specification 16C11(RE) for the mechanical and electrical performance of the units has been satisfactorily complied with by the Contractor (see paragraphs 15 through 24).

(e) The characteristics of the silencer level controls of the RDZ and MAR/RDR receivers, and the antenna trimmer controls of the Model MAR/RDR equipment may give unsatisfactory unattended remote operation of the equipment, if not adjusted properly (see paragraphs 41 through 43).

(f) The connection of the Remote Control-Indicator System to the Model RDR, MAR, and RDZ receivers offers a potential source of interference, in that the interconnecting cables may provide a path for r-f voltages to enter the receiving equipments. The Laboratory believes that the filters in the receivers will provide adequate protection for most installations. Certain additional measures may be necessary where extremely strong r-f fields occur in the vicinity of the equipment (see paragraphs 14 and 41).

(g) Several undesirable items in the mechanical design of the CRV-491481 Remote Control Adapter were found during the tests. The Bureau of Ships has been advised of these deficiencies (see paragraph 44).

(h) Various deficiencies in the mechanical design of the CQC-23497 Selector Control Unit and the CQC-20409 Power Supply Unit were found during shock and vibration tests. Recommendations for their correction are given in the report of the Shock and Vibration Section, which is appended.

RECOMMENDATIONS

46. It is recommended that:

(a) Early Model RDZ receiver silencer circuits be modified in the field as recommended in reference 6 (see paragraph 7). Note: This recommendation has since been complied with by the Contractors for Model RDZ and RDZ-1 receivers.

(b) The silencer-test-circuit relay in the CRV-491481 Remote Control Adapter for the MAR/RDR be changed to a relay having a solenoid rated for 28-volt operation (see paragraph 35).

(c) The r-f filter networks in the CQC-23497 Selector Control Unit as submitted for test be eliminated from the unit (see paragraph 12).

(d) The Radio Materiel Schools and the radio personnel assigned to the Fleet be advised of the characteristics of the silencer level and antenna trimmer controls, and that techniques be evolved for optimum setting of these controls for ten-channel operation, where the RDZ and the MAR/RDR equipments are remotely controlled (see paragraph 43).

(e) The deficiencies in mechanical design of the Selector Control Unit discussed in paragraph 25 and the appended Shock and Vibration Report be eliminated in production equipments.

REFERENCES

1. BuShips Specification 16C11(RE) dated 1 November 1945, superseding 16C11(RE) of 1 February 1945 and Amendment 1 of 1 May 1945: Control-Indicator Systems, Remote, for VHF and UHF Equipment.
2. BuShips ltr. Serial No. 1949(925Ca) of 2 July 1945 to Director NRL: Problem Request S1174, Acceptability Test of a Preliminary Model Remote Control System for Use with the Model RDZ and MAR Equipments.
3. NavShips 900,777: Instruction Book for Remote Control-Indicator Systems.
4. NavShips 900,617: Instruction Book for Model RDZ Radio Receiving Equipment.
5. NRL ltr. C-S67/43(356:LFB) of 17 August 1945 to BuShips: Test Report of Model MAR Equipment.
6. NRL ltr. C-S67/46(353) over C-350-354/45 of 29 December 1945 to BuShips: Conference Report on Model RDZ Receivers (Modification to Eliminate Hum in Silencer Circuits).
7. NRL Report No. R-2960: Evaluation of Model RDR Equipment (in preparation).
8. NRL ltr. S67/84(1225) over 1220-123/46 of 29 August 1946 to BuShips: Test Report of Type 23496 Control-Indicator Unit.
9. NRL ltr. C-S67/46(353) over C-350-38859 of 19 July 1945 to BuShips: Comment on Proposed UHF Communication Systems Plans RE 101F 100.

APPENDIX 1

C-E5-2(2)/S67/46(872)

Report No. M 250
870-277/45

21 November 1945

From: Shock and Vibration Division, Code 870
To: Receiver Section, Code 350
Subj: Contract N5sr 759 - Acceptability Tests of pre-production Remote Control units for RDZ and MAR Equipment - Shock and Vibration Tests of - Report on -
Ref: (a) Problem Number S1174T-C
(b) BuShips Specification RE 9284B dated 1 August 1944
Encl: (HW)
(A) Photograph of equipment mounted on vibration machine.
(B) Photograph of bottom of Power Supply unit showing shock mounts.
(C) Transmissibility Curve of Power Supply CQC 20409
(D) Transmissibility Curves of Selector Control Indicator unit, CQC 23497, Serial #1.

INTRODUCTION

1. As requested by the Receiver Section, Code 350, shock and vibration tests were conducted on the Remote Control units for RDZ and MAR Equipment. This equipment included the following units:

- (1) CQC 20409 Power Supply
- (2) CQC 23497 Selector Control Unit
- (3) CQC 23445 Remote Channel Selector

These equipments were manufactured by the Admiral Corporation and the units submitted were pre-production units. Representatives of the Receiver Section witnessed the tests and were responsible for energizing the equipment and observing the electrical performance of the equipment during the tests. This report presents observations and data on the mechanical performance of the equipment during the shock and vibration tests.

SHOCK TESTS

2. Shock tests were conducted on the Selector Control unit, Serial #1 and the Remote Channel Selector mounted on the shelf of the H.I. Shock Machine at the same time. The Selector Control unit was mounted on 4 Barry L. W. 5210 mountings while the Remote Channel Selector was mounted rigidly.

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870-277/45

3. As required in the specification, reference (b) the equipment mounted as described in paragraph 2 was subjected to a total of nine blows; three side blows of 1 ft., 2 ft. and 3 ft. hammer drops, three back blows of 1 ft., 2 ft. and 3 ft. hammer drops, and three top blows of 2 ft., 3 ft. and 4 ft. hammer drops.

4. There was no mechanical damage to either unit, but the Selector Control unit changed channels during the tests. The changes constitute an electrical failure and are summarized in the following table:

No. of Blow	Direction of Blow	Hammer Drop	Original channel setting	Channel reading after blow
1	Side	1 foot	10	6
2	Side	2 foot	10	2
3	Side	3 foot	10	5
4	Back	1 foot	10	2
5	Back	2 foot	10	1
6	Back	3 foot	10	6
7	Top	1 foot	10	1
8	Top	2 foot	10	6
9	Top	3 foot	10	10

5. The Power Supply unit was next mounted on the shelf of the H. I. Shock Machine on 4 Barry LW 5210 mountings. As required by reference (b) the unit was subjected to a total of nine blows as described in paragraph 3. Except for the pilot indicator bulb failing, no mechanical or electrical damage resulted.

6. Since the Selector Control unit, Serial #1, failed electrically during the shock test (see paragraph 4) a modified unit, Serial #3, was submitted for test. The K103 relay contact in this modified unit was made from heavier gauge metal which increased its stiffness. It was felt that this would correct the reason for the channels changing, and the modified unit was vibrated before again subjecting it to shock. For reasons stated in paragraph 8, it was also necessary to replace the Barry LW 5210 mounts with Barry type LW 5220.

7. The modified Selector Control unit (serial #3) and the Remote Channel Selector were again mounted on the shelf of the H. I. Shock Machine in the same manner as outlined in paragraph 2 and subjected to the same shock tests as outlined in paragraph 3. Except for the pilot indicator bulb failing there was no mechanical or electrical damage.

VIBRATION TESTS

8. Both of the Selector Control unit and the Power Supply unit when submitted for tests were mounted on 4 Barry LW 5210 mountings. During the preliminary vibration tests it was found that the resonant frequencies of both units were below the allowable minimum of 25 cps and the LW 5210 mountings were replaced by LW 5220 mountings. This raised the resonant frequencies of both units above 25 cps (see transmissibility curves, enclosure (c) and enclosure (d)).

9. The modified Selector Control unit, serial #3 and the Remote Control Selector were mounted on the vibration table at the same time. The Selector Control unit was mounted on 4 Barry LW 5220 mountings and the Remote Channel Selector was rigidly mounted to the table. These equipments were subjected to vibration along their three principal axes. The amplitude of vibration was 0.007 inch and the frequency varied from 10 to 33 cps to obtain data for the transmissibility curves, see enclosure (D).

10. The equipments were next vibrated along each of the three principal axes for a period of 2 hours (total of six hours) while the frequency of the table was uniformly varied between 9 and 23 cps and the amplitude of the table vibration was 0.030 inches. Following this the equipments were vibrated for a period of 4 minutes at each integral cycle between 10 and 23 cps along each of the three principal axis. No mechanical or electrical damage resulted.

11. The Power Supply unit, mounted on 4 Barry LW 5220 mountings was vibrated along its three principal axes. The amplitude of table vibration was 0.007 inch and frequency varied from 10 to 33 cps to obtain data for the transmissibility curves, see enclosure (C).

12. The Power Supply unit was then vibrated along each of its three principal axes, the procedure, frequencies, amplitude and time being the same as outlined in paragraph 10. No mechanical or electrical damage resulted.

COMMENTS

13. It is to be noted the Power Supply unit and the Selector Control unit were mounted in racks during the first shock test conducted. A representative of the Receiver Section stated that it had been decided to abandon the use of the racks; the second shock test and vibration tests were therefore conducted with the equipment mounted directly to the mounting plate. Although the functioning of the mountings would not be effected by the elimination of the racks, some means of mounting the units on a raised platform or channels should be provided to give sufficient clearance for opening the units for ease of mounting and servicing.

14. The leaf spring contacts for the K103 relay in the Selector Control unit, serial #1, were not stiff enough and during 8 of the 9 blows of the shock test, there were channel changes. This condition was remedied in the modified unit, serial #3 by making the K103 relay contact from a heavier gauge metal thus imparting to it more stiffness. During the second shock test no channel changes occurred.

15. It is to be noted that the filaments of the pilot indicator bulbs failed during shock in both the Selector Control unit and the Power Supply unit, see paragraphs 5 and 7. This is a typical failure which results under shock when lamps are energized. A satisfactory remedy for this fault is unknown at the present time.

CONCLUSIONS

16. The Selector Control Unit, serial #3, as modified and mounted on Barry LW 5220 mountings, meets all the requirements of shock and vibration of reference (b).

17. The Remote Channel Selector, rigidly mounted, meets all the requirements of shock and vibration of reference (b).

18. The Power Supply unit, mounted on 4 Barry LW 5220 mountings meets all the requirements of shock and vibration of reference (b).

RECOMMENDATIONS

19. The Selector Control units should be modified as per serial #3 unit.

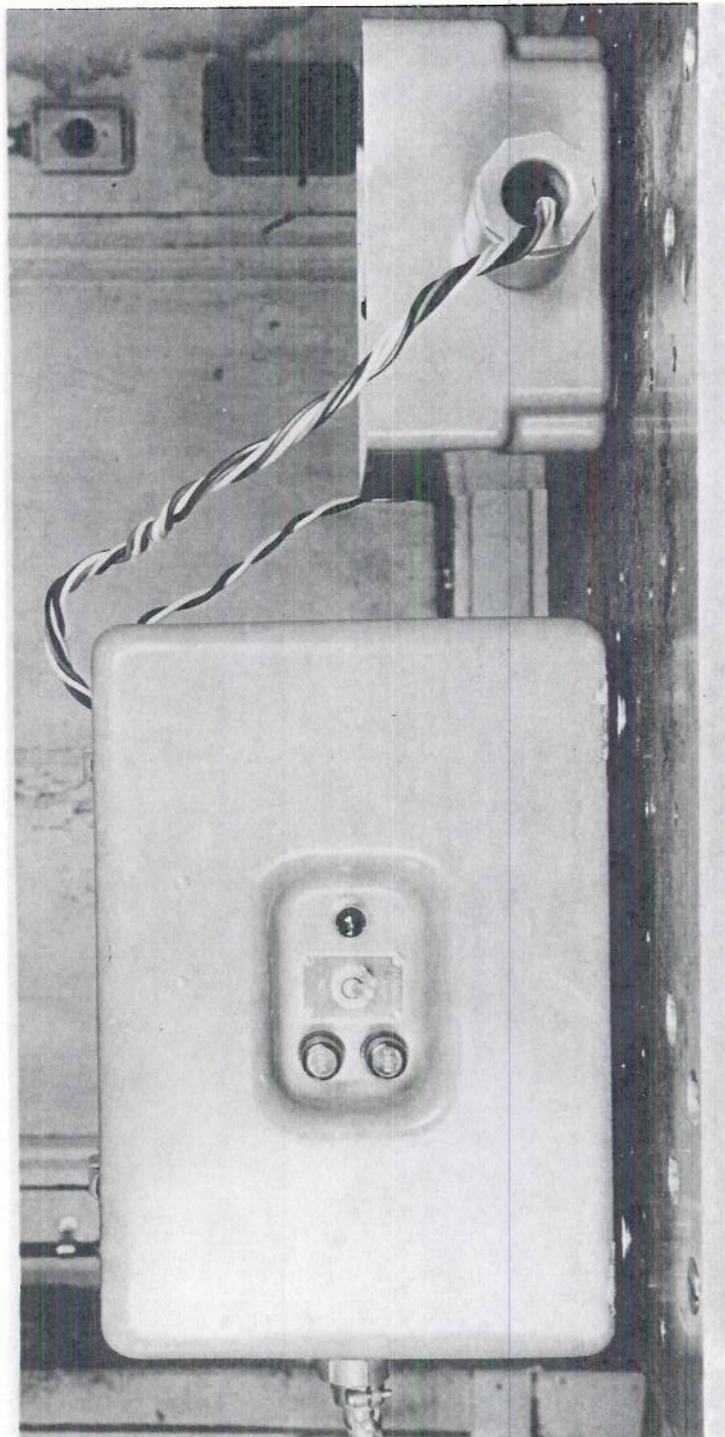
20. The Barry LW 5210 mounts should be replaced with Barry LW 5220 mountings.

21. Both the Selector Control units and the Power Supply unit should be mounted on a raised platform or channels to simulate the racks, for ease of mounting and servicing.

Report prepared by

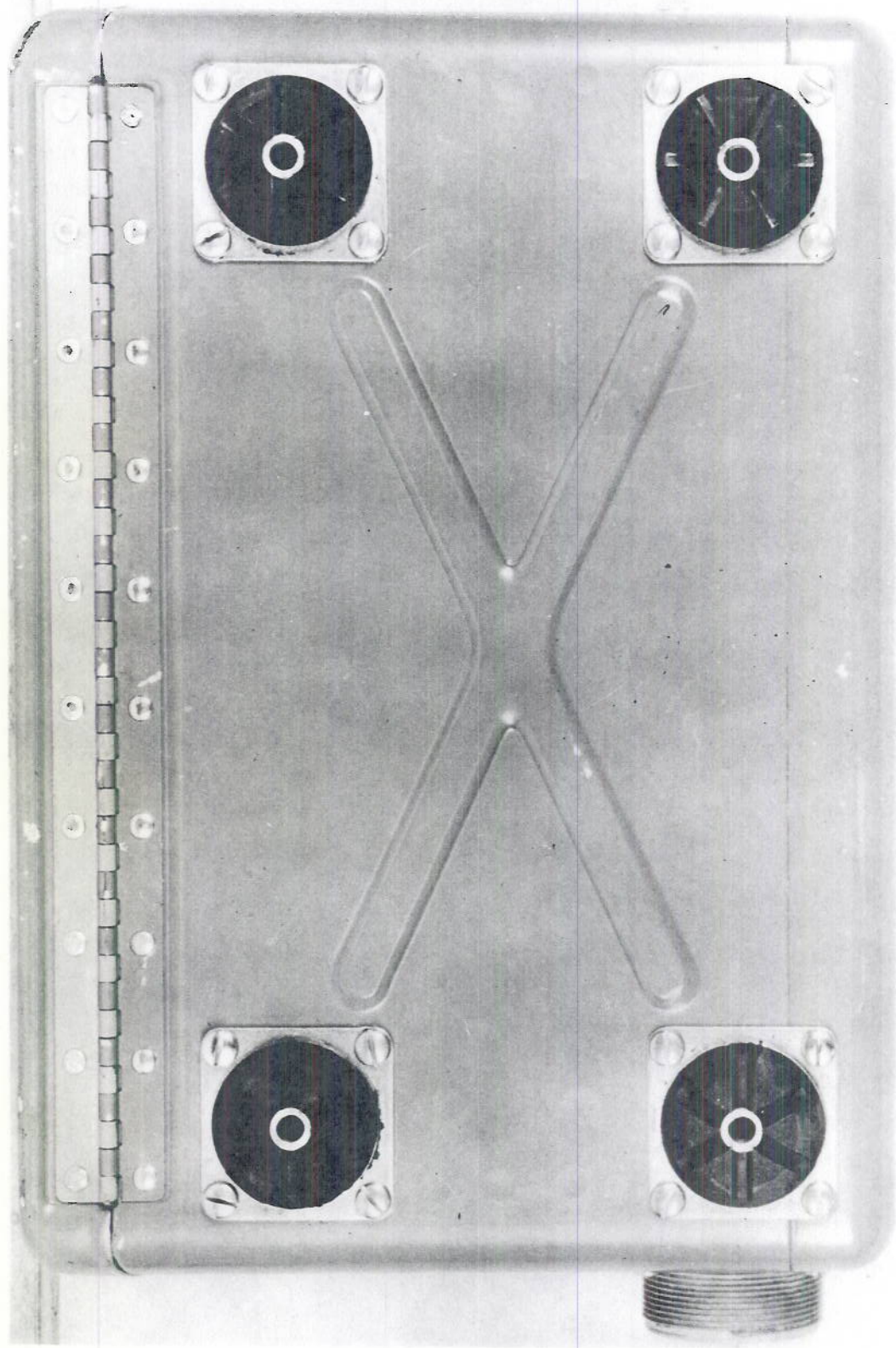
E. J. Birgelaitis

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C-L5-2(2)/S67/46(872)
REPORT NO. M250

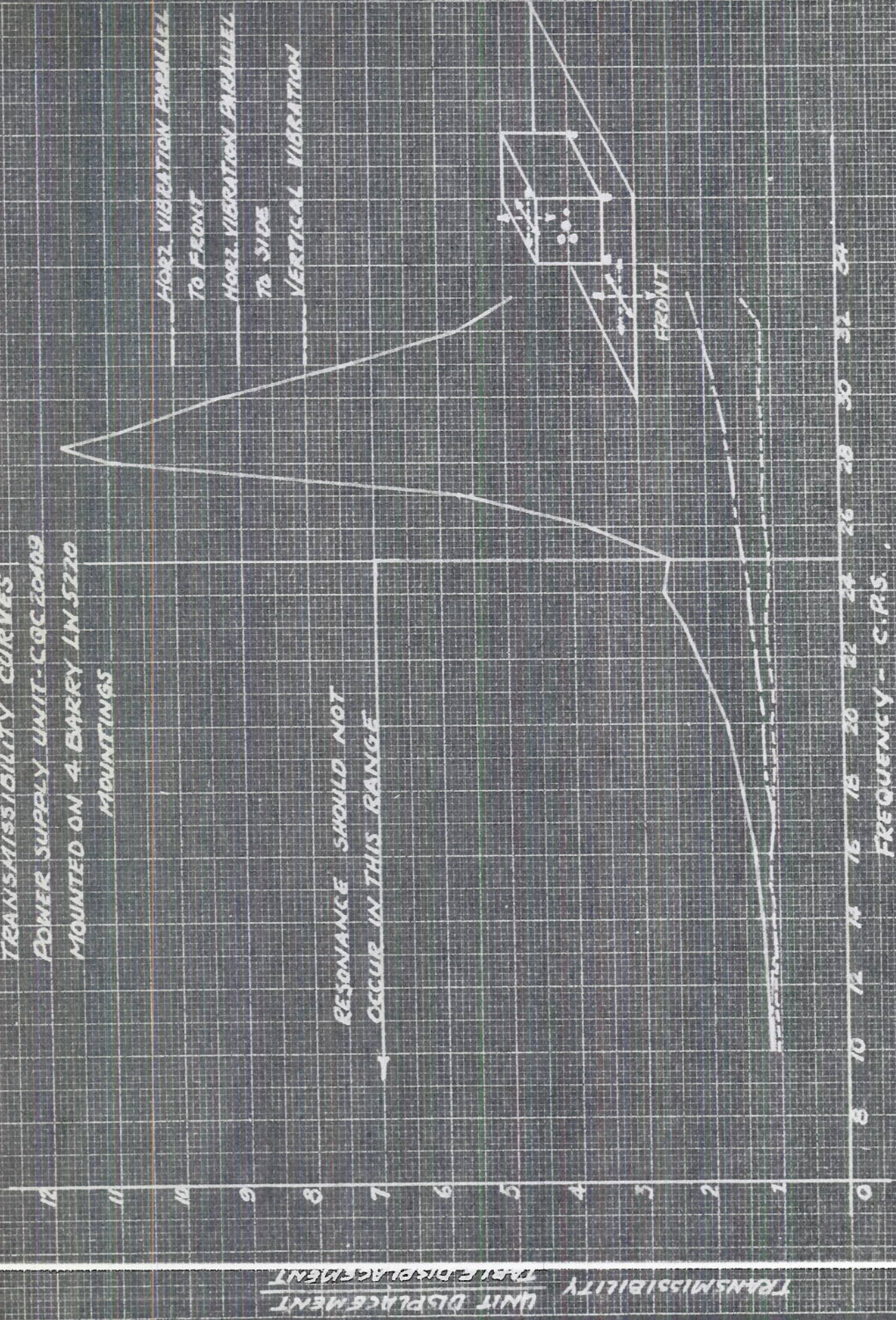
ENCL. A



C-L5-2(2)/S67/46(872)
REPORT NO. M 250

ENCL. B

TRANSMISSIONITY CURVES
 POWER SUPPLY UNIT-CQC20409
 MOUNTED ON 4 BARRY LN 5220
 MOUNTINGS



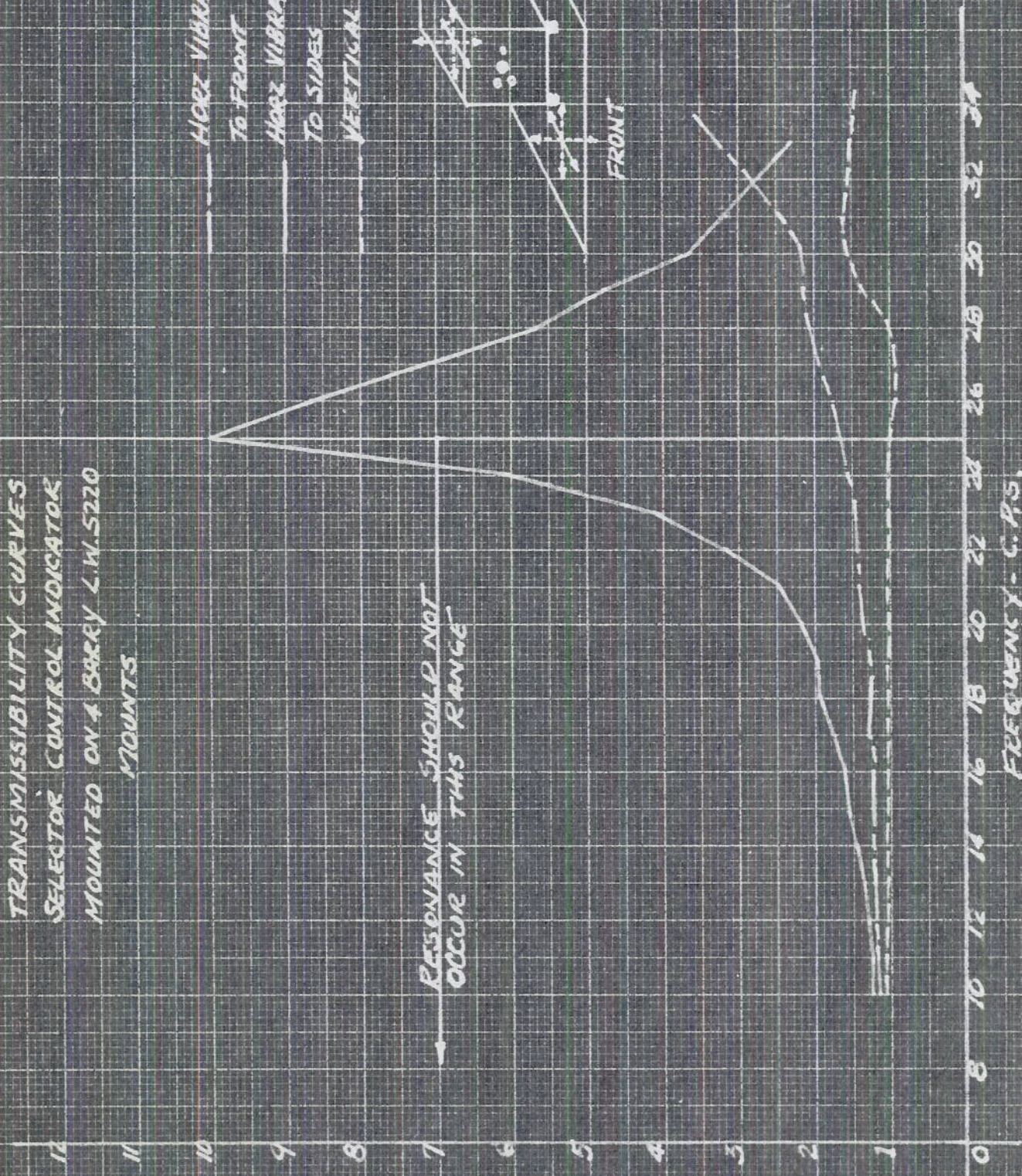
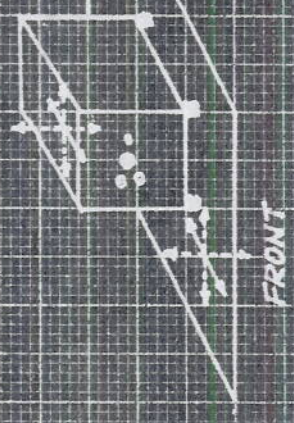
CL5-2(2)/567/46(872) REPORT No. M250 ENCLOSURE (C)

10 X 10 to the 1/2 inch, 5th lines accurate.
 Engraving, 7 X 10 in.
 MADE IN U.S.A.

TRANSMISSIBILITY CURVES
 SELECTOR CONTROL INDICATOR
 MOUNTED ON 4 BARRY L.W. 5220
 MOUNTS

--- HZ VIBRATION PARALLEL
 TO FRONT
 --- HZ VIBRATION PARALLEL
 TO SIDES
 - - - VERTICAL VIBRATION

RESONANCE SHOULD NOT
 OCCUR IN THIS RANGE



CL 5-2(2)/S67/46(872) REPORT No. M250 ENCLOSURE (D)

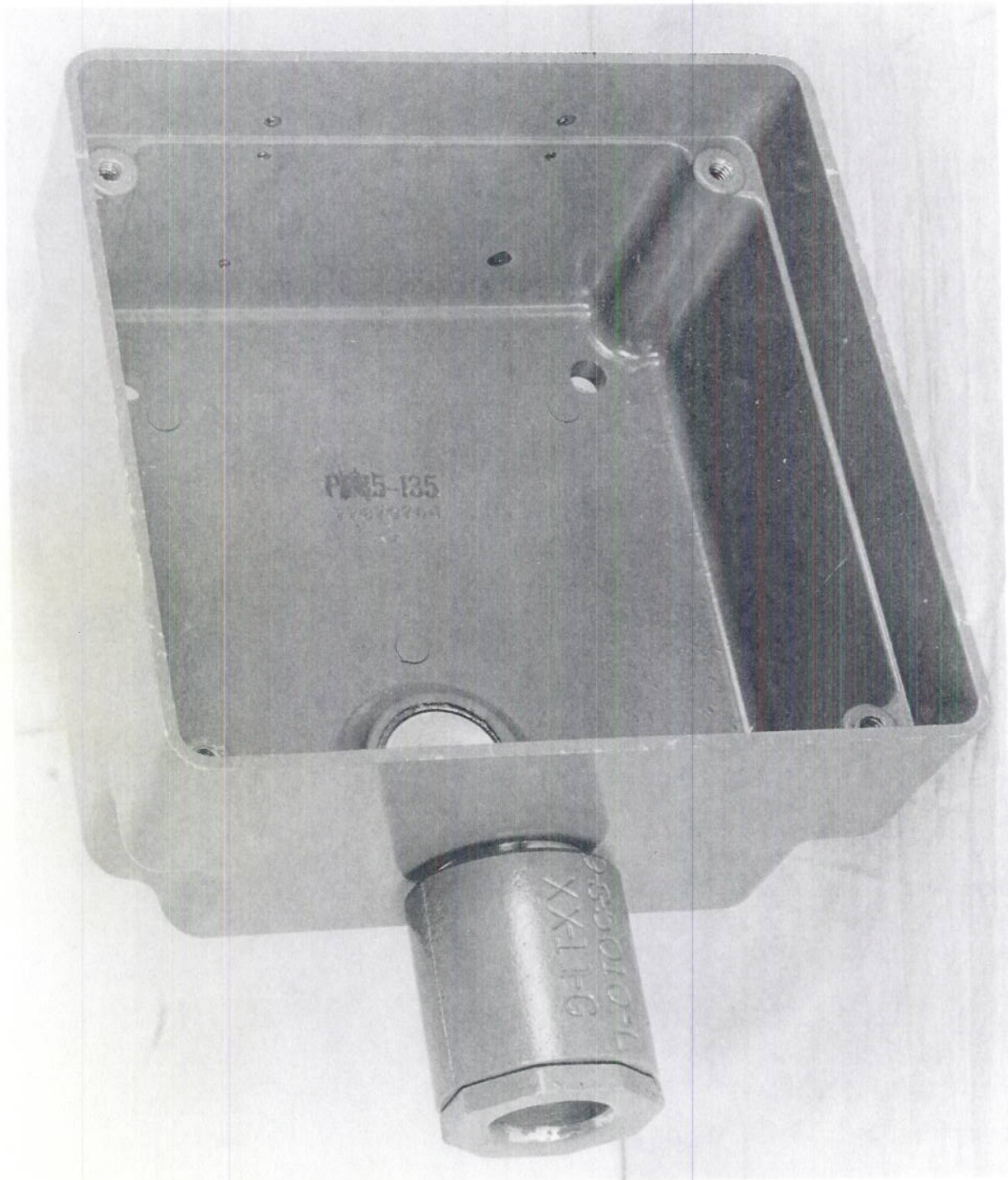


FRONT OBLIQUE VIEW, TYPE CQC-23445 REMOTE CHANNEL SELECTOR UNIT FOR TDZ, RDZ,
RDR OR MAR RADIO EQUIPMENT

~~RESTRICTED~~

DECLASSIFIED

PLATE I

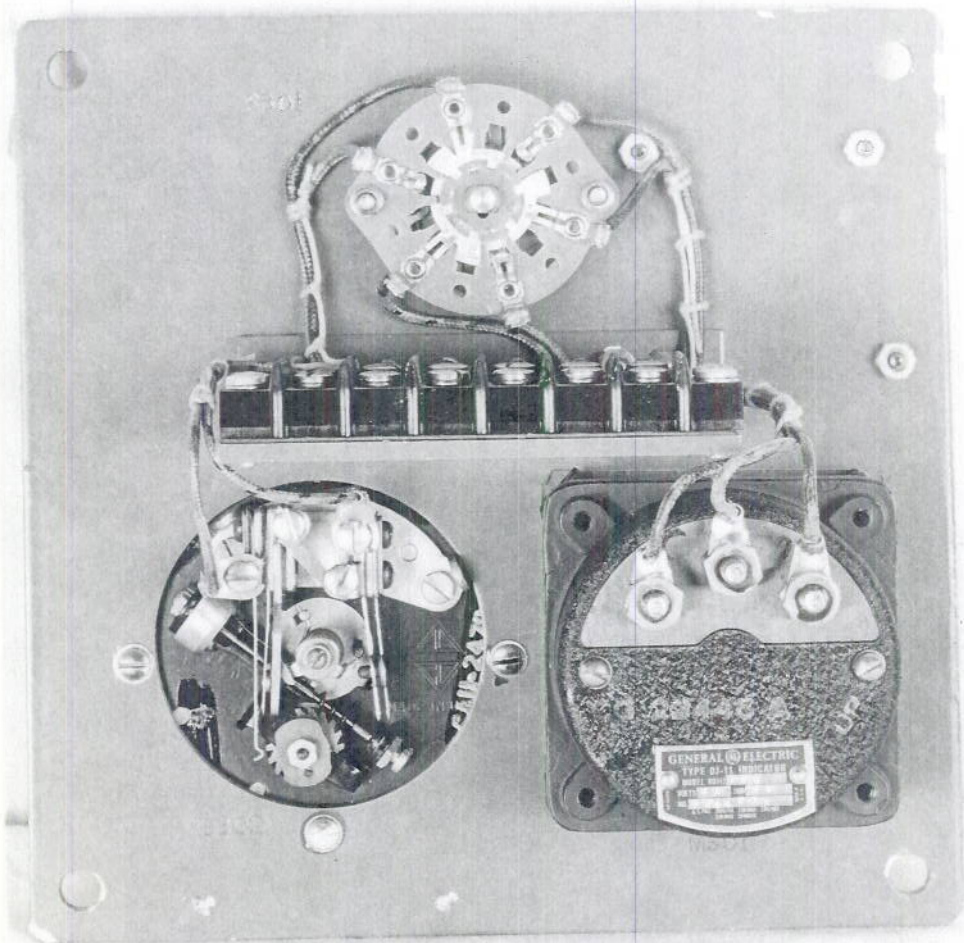


FRONT OBLIQUE VIEW, TYPE CQC-23445 CHANNEL SELECTOR UNIT
HOUSING, SHOWING MOUNTING HOLES AND STUFFING
TUBE FOR MHFA-7 CABLE

~~RESTRICTED~~

DECLASSIFIED

PLATE 2

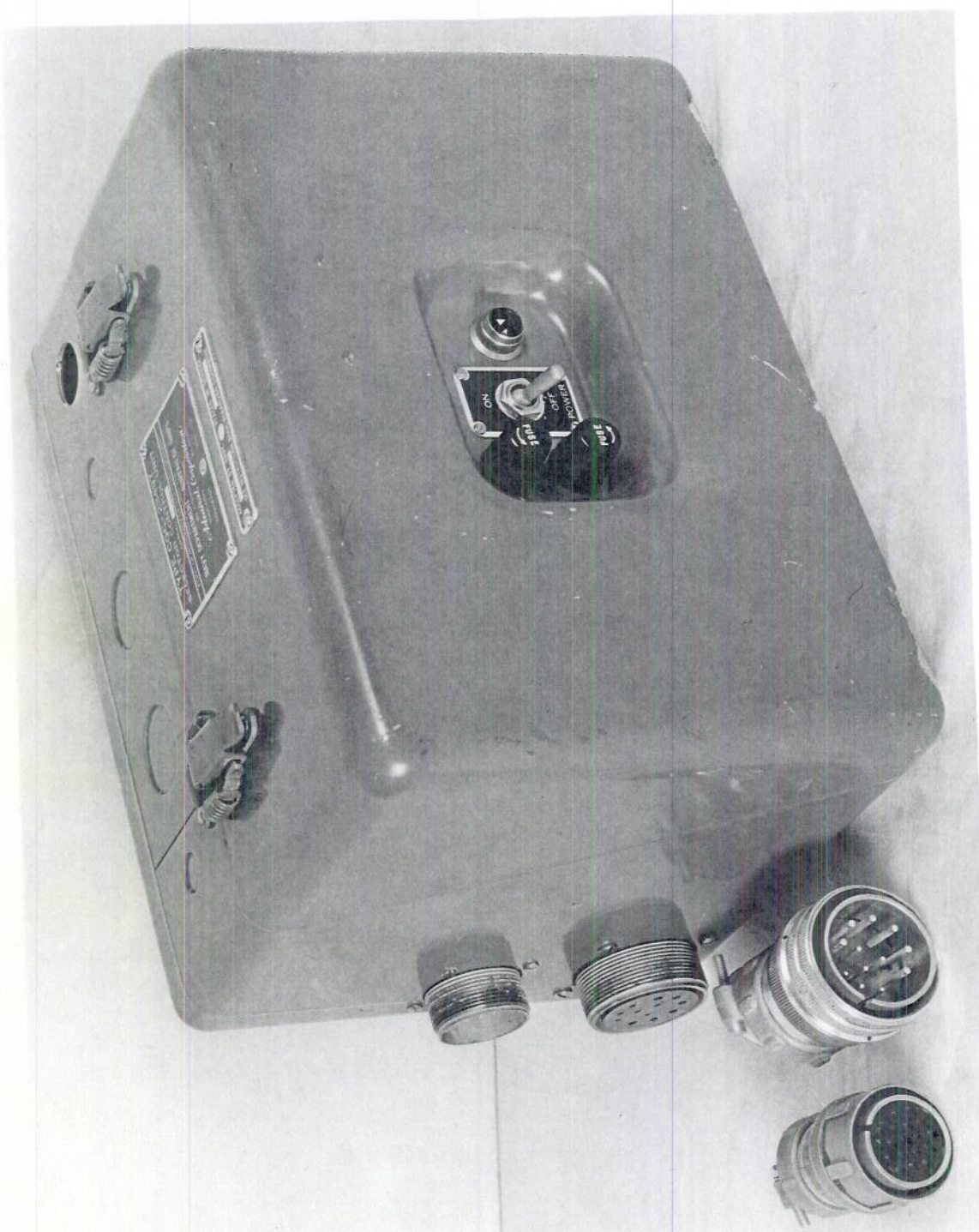


REAR VIEW OF FRONT PANEL, TYPE CQC-23445 CHANNEL SELECTOR UNIT.
DIAL ASSEMBLY (LOWER LEFT), SELSYN INDICATOR (LOWER RIGHT),
ON-OFF SWITCH (UPPER CENTER), TERMINAL
BOARD (CENTER)

RESTRICTED

DECLASSIFIED

PLATE 3

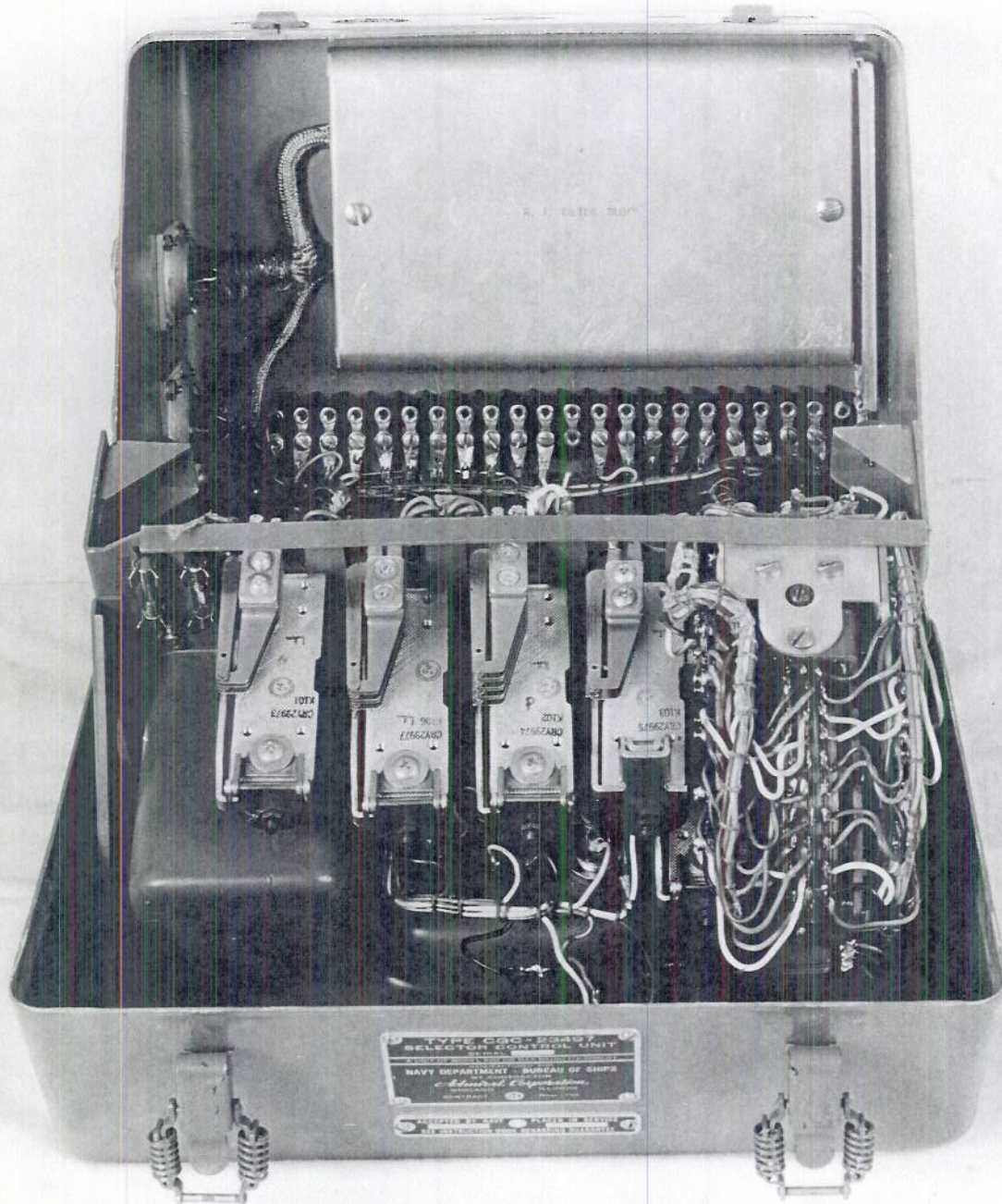


FRONT OBLIQUE VIEW, TYPE CQC-23497 SELECTOR CONTROL UNIT FOR RDZ, RDR OR MAR
RADIO EQUIPMENT

RESTRICTED

DECLASSIFIED

PLATE 4

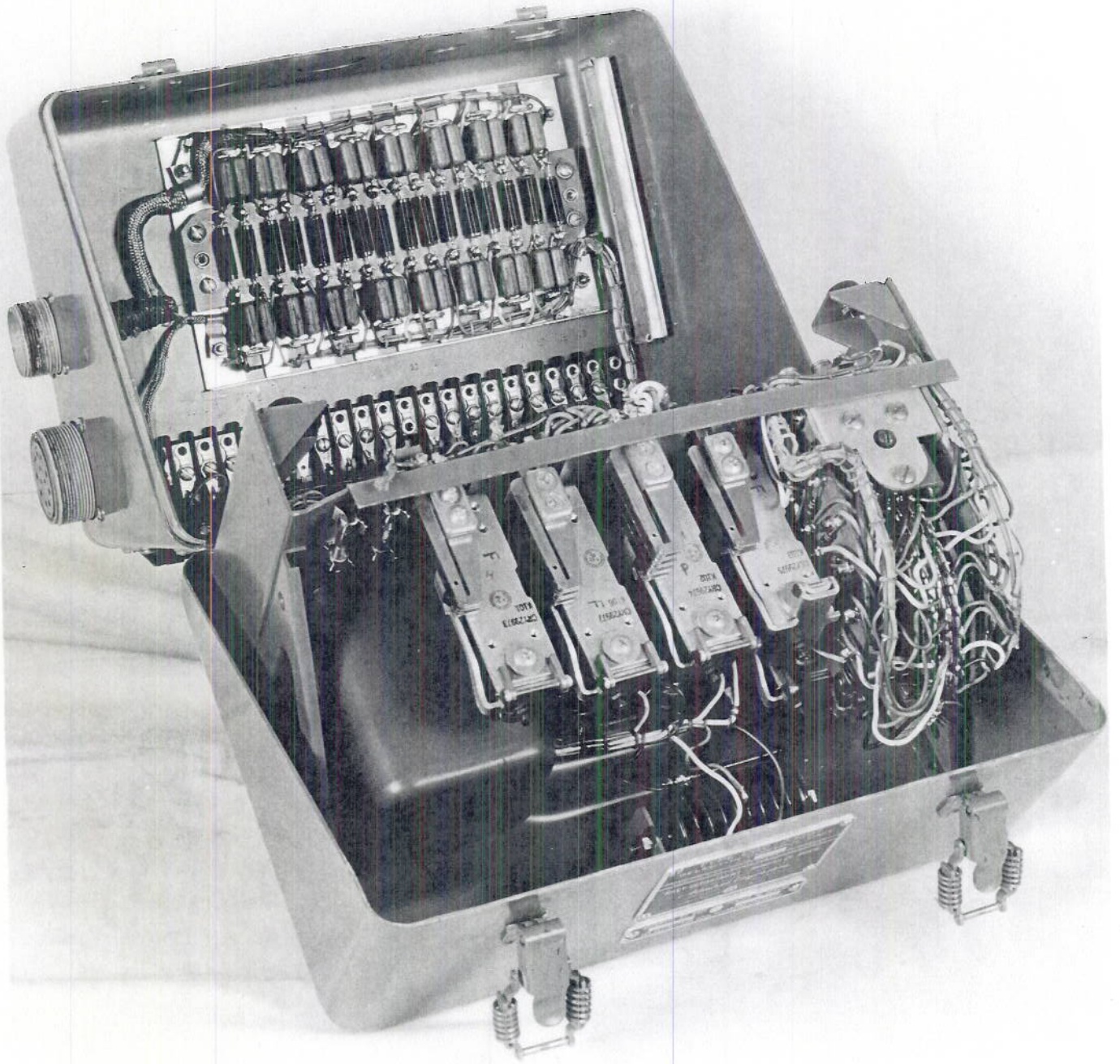


INTERIOR VIEW, TYPE CQC-23497 SELECTOR CONTROL UNIT,
CABINET OPENED APPROXIMATELY 120 DEGREES SHOWING
RELAY DECK, R-F FILTER BLOCK AND TERMINAL
CONNECTION BLOCK

RESTRICTED

DECLASSIFIED

PLATE 5

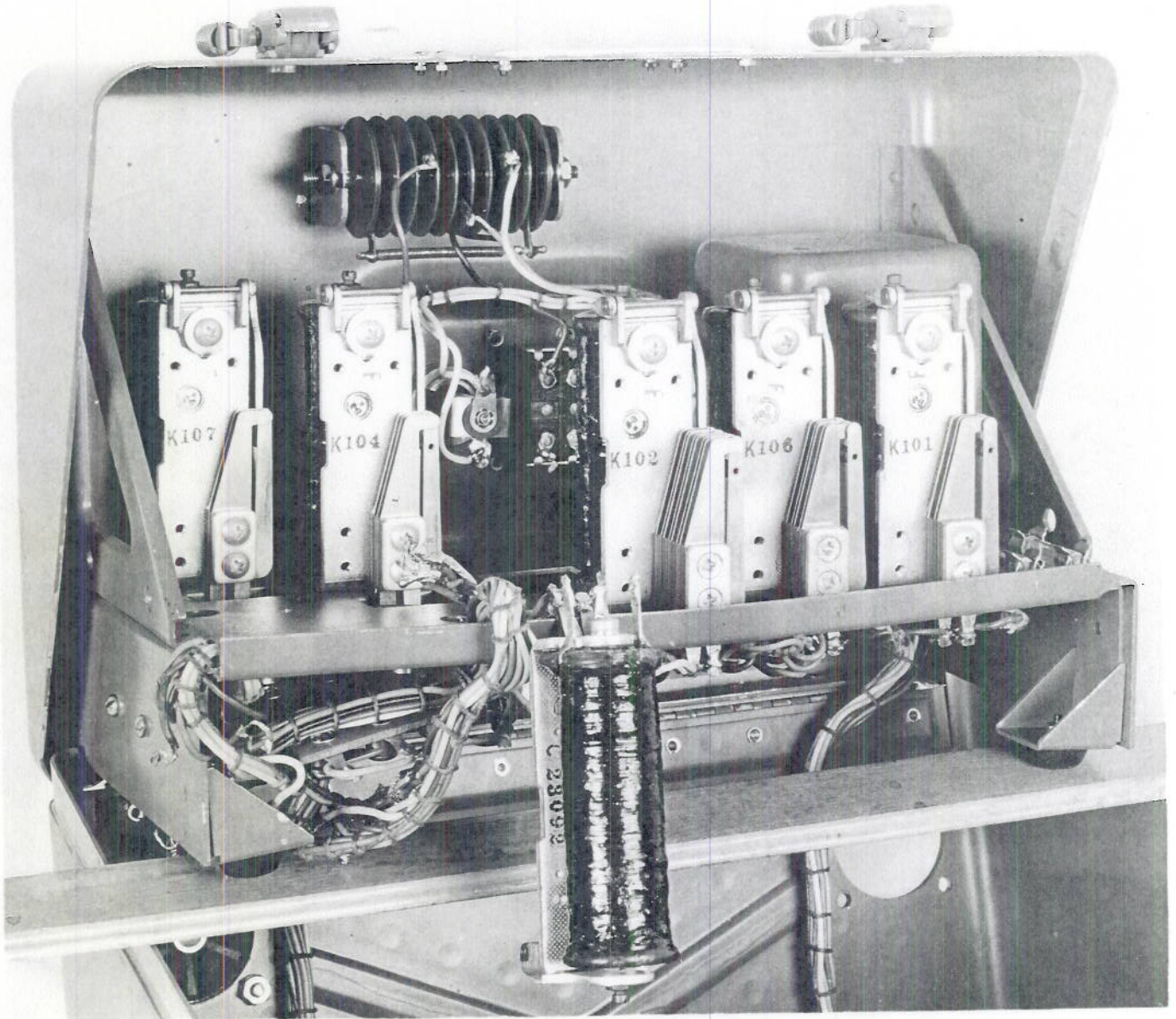


OBLIQUE INTERIOR VIEW, TYPE CQC-23497 SELECTOR CONTROL
UNIT, COVER REMOVED FROM R-F FILTER BLOCK

RESTRICTED

DECLASSIFIED

PLATE 6

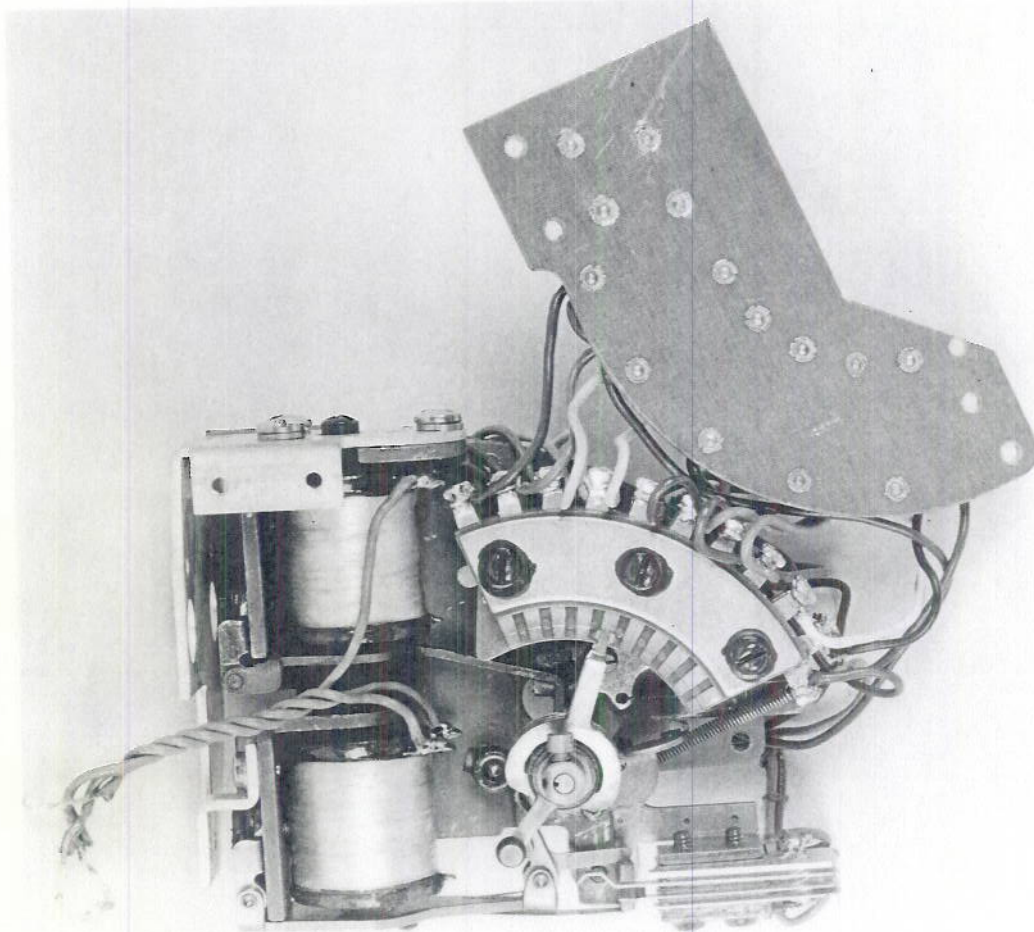


INTERIOR VIEW, TYPE CQC-23497 SELECTOR CONTROL UNIT, MINOR
SWITCH (K-105) AND SLOW RELEASE RELAY (K-103)
REMOVED FROM CHASSIS

DECLASSIFIED

RESTRICTED

PLATE 7

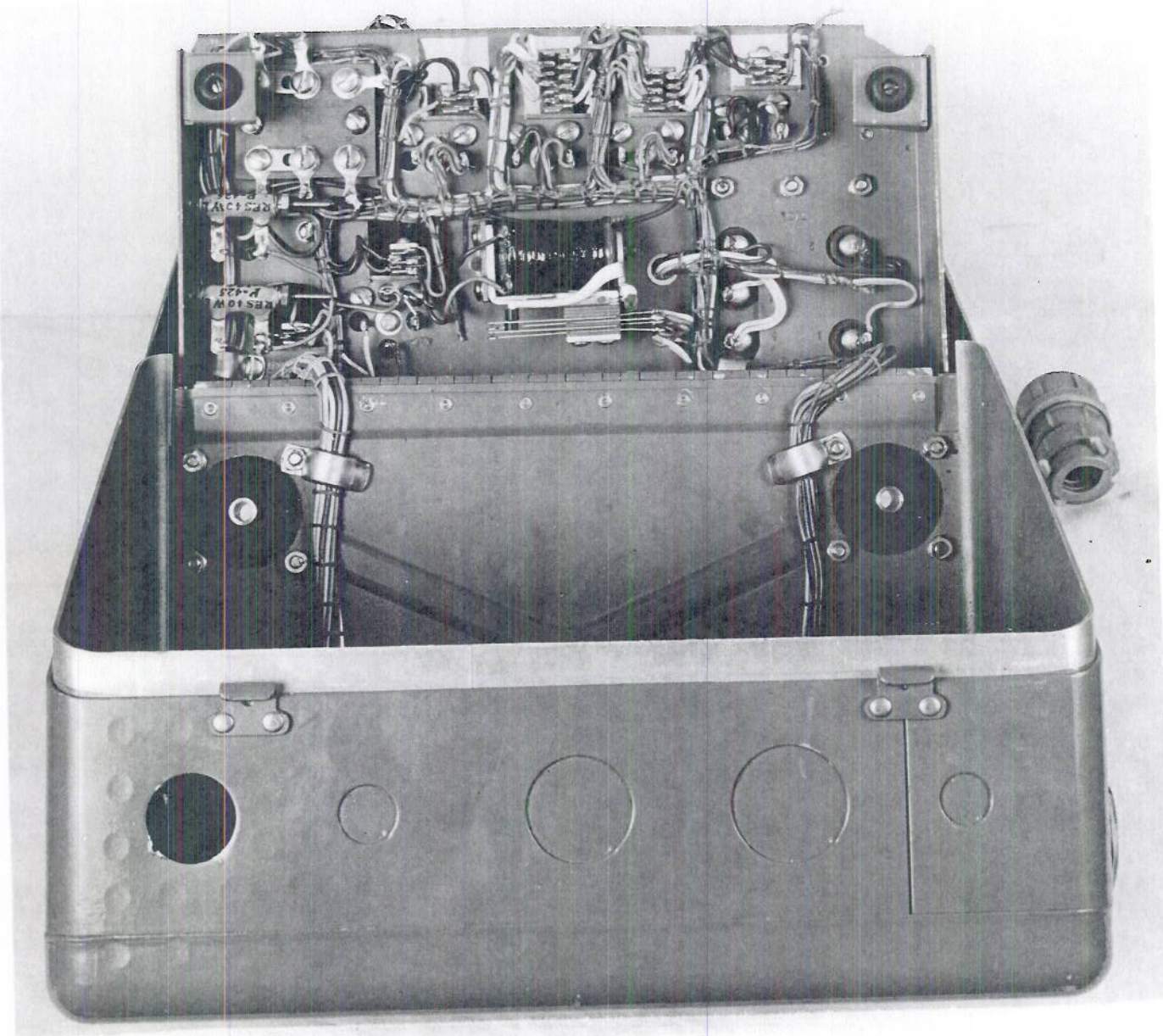


SIDE VIEW, MINOR SWITCH (K-105), SIDE TERMINAL BOARD REMOVED TO SHOW "STEPPER" AND "RELEASE" RELAYS (LEFT), SWITCH CONTACTS AND ARMS (UPPER RIGHT), AND "RELEASE" RELAY CONTROL SWITCH (LOWER RIGHT). "RELEASE" RELAY SWITCH IS OPERATED BY ROLLER ARM ON HUB OF CONTACT ARM ASSEMBLY. (NOT ENGAGED AS SHOWN)

RESTRICTED

DECLASSIFIED

PLATE 8

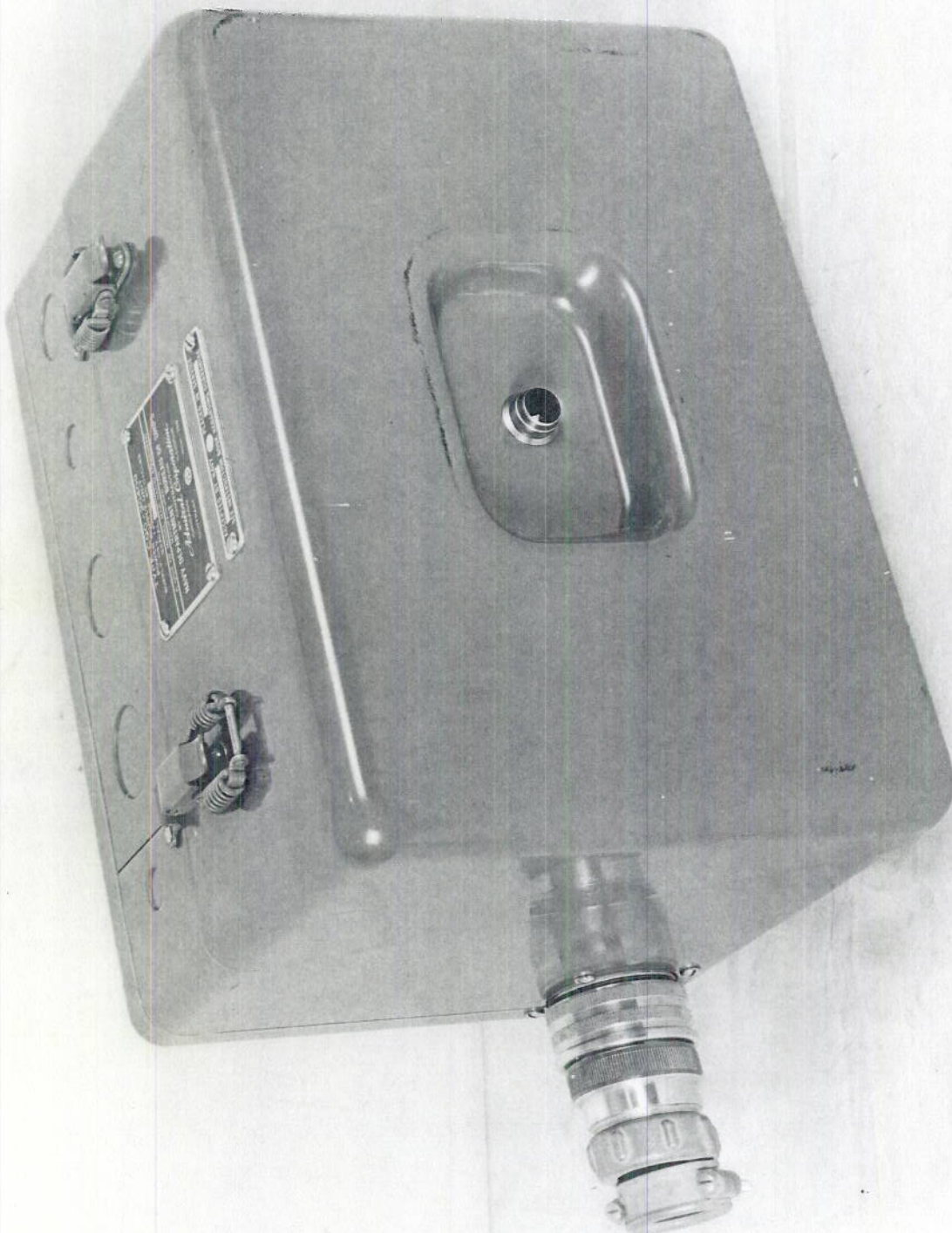


BOTTOM VIEW OF RELAY CHASSIS, TYPE CQC-23497 SELECTOR
CONTROL UNIT. LINK SWITCHES FOR CHANGE OVER FROM
RDZ' TO MAR EQUIPMENTS IN UPPER LEFT
CORNER OF CHASSIS

RESTRICTED

DECLASSIFIED

PLATE 9



FRONT OBLIQUE VIEW, TYPE CQC-20409 POWER SUPPLY UNIT

DECLASSIFIED

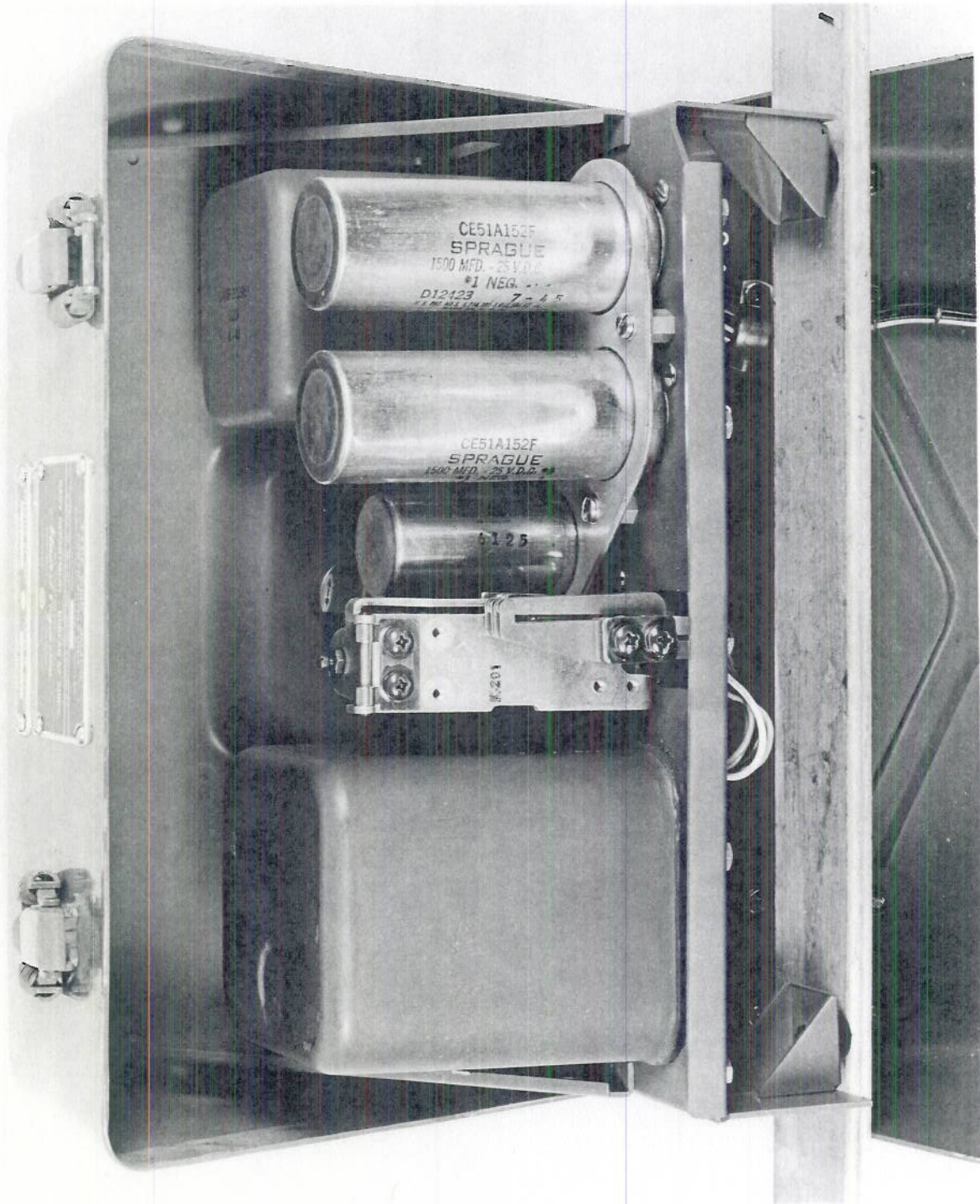
RESTRICTED

PLATE 10

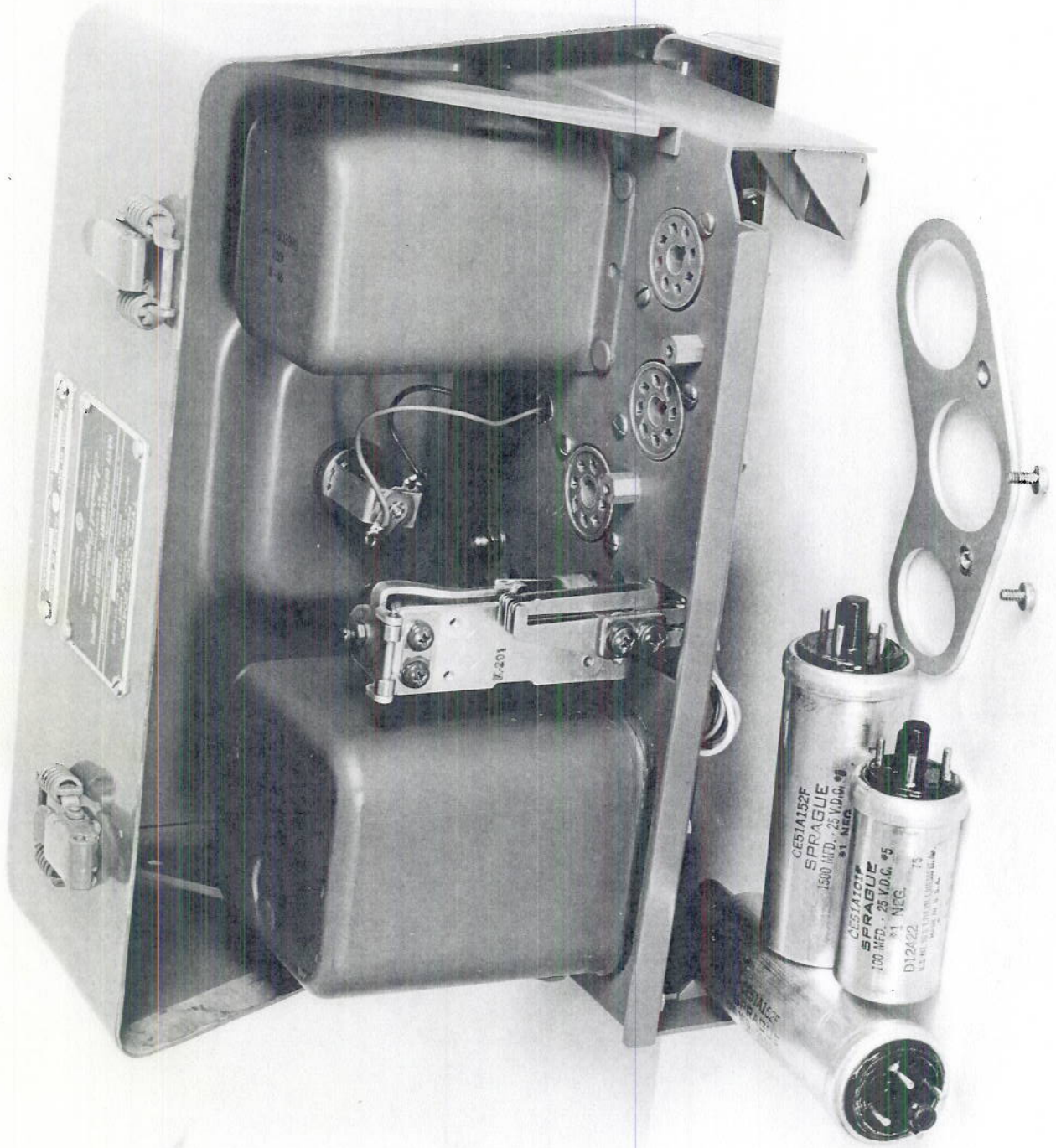
RESTRICTED

DECLASSIFIED

PLATE II



INTERIOR VIEW, TYPE CQC-20409 POWER SUPPLY UNIT

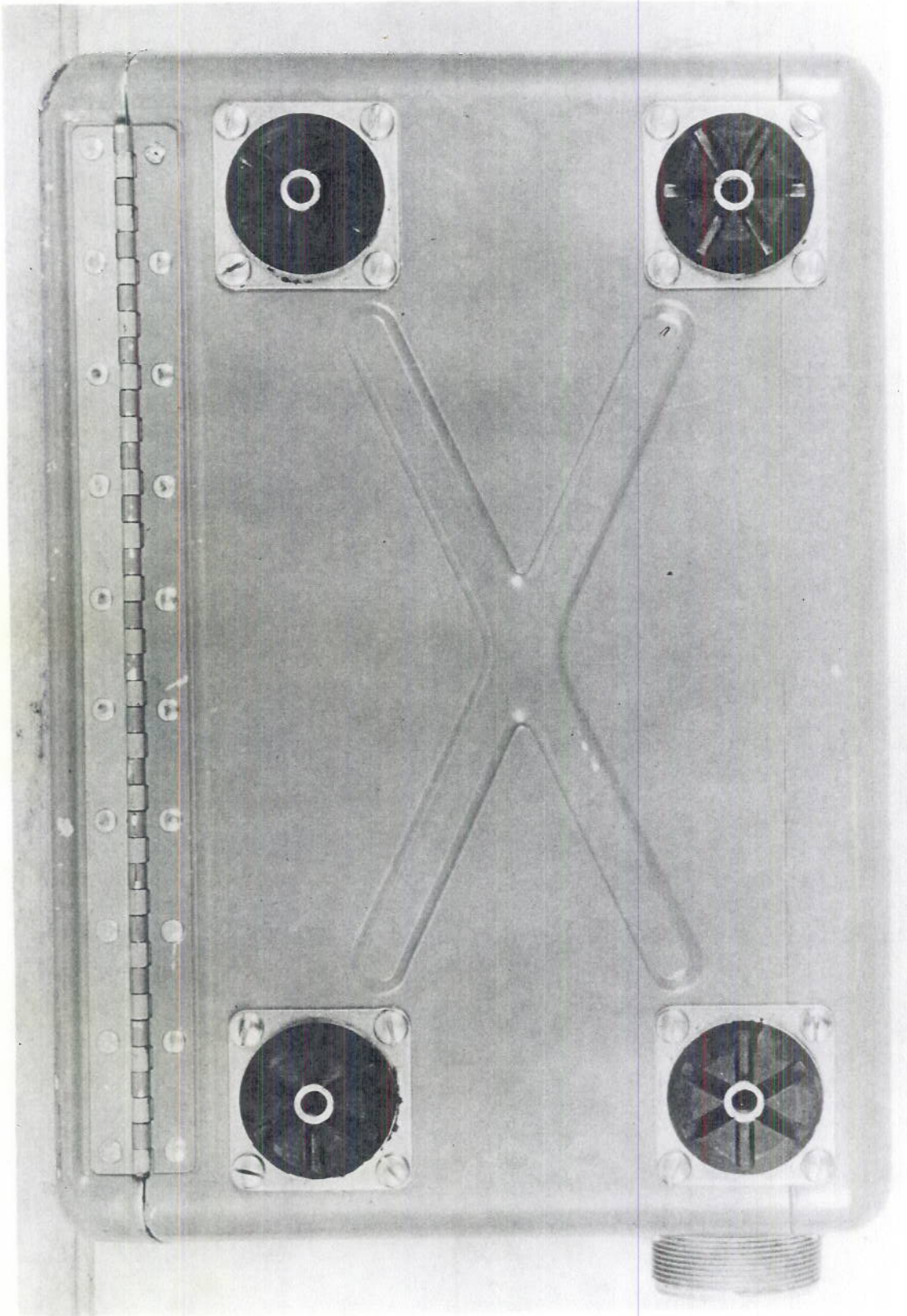


INTERIOR VIEW, TYPE CQC-20409 POWER SUPPLY UNIT. FILTER CONDENSERS AND CLAMP REMOVED

~~RESTRICTED~~

DECLASSIFIED

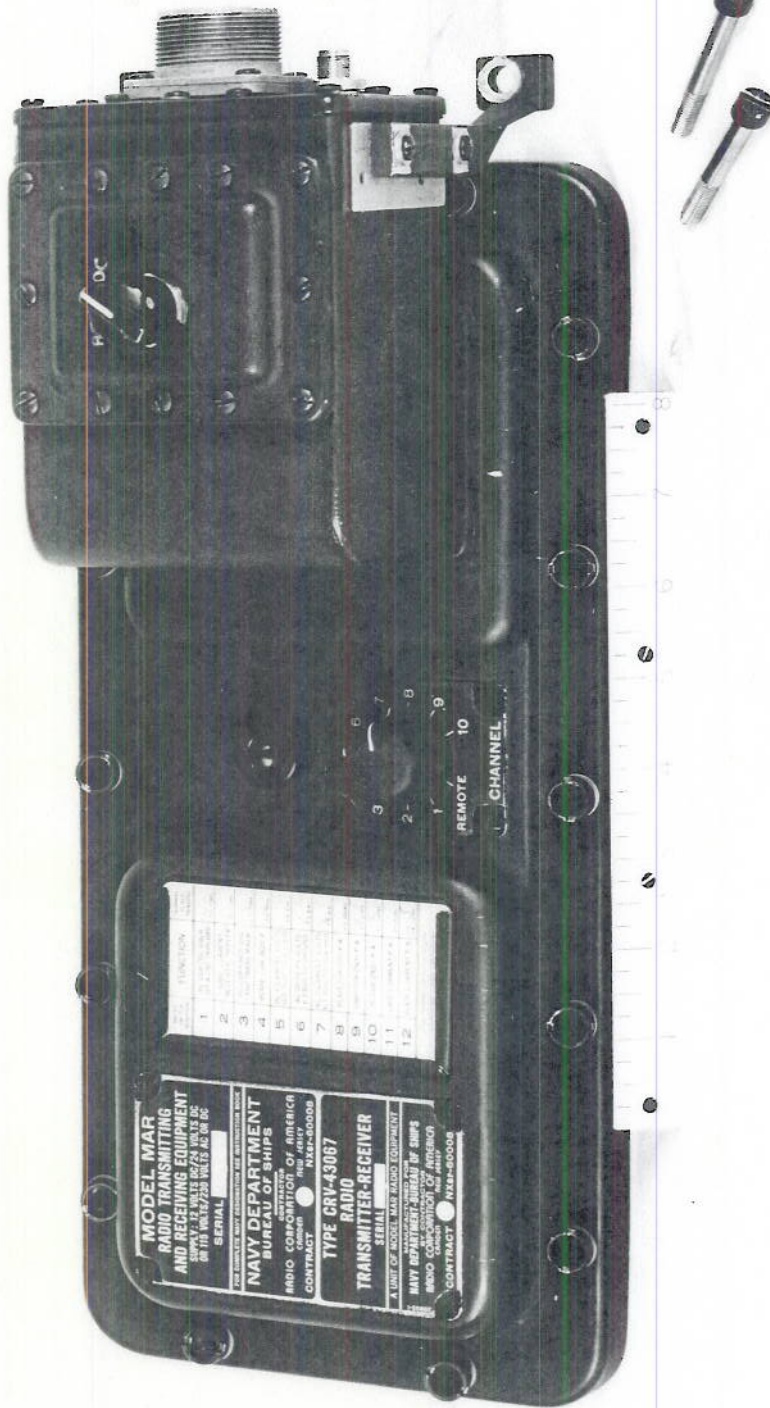
PLATE 12



BOTTOM VIEW FO CABINET, TYPE CQC-20409 POWER SUPPLY UNIT AND TYPE CQC-23497
SELECTOR CONTROL UNIT

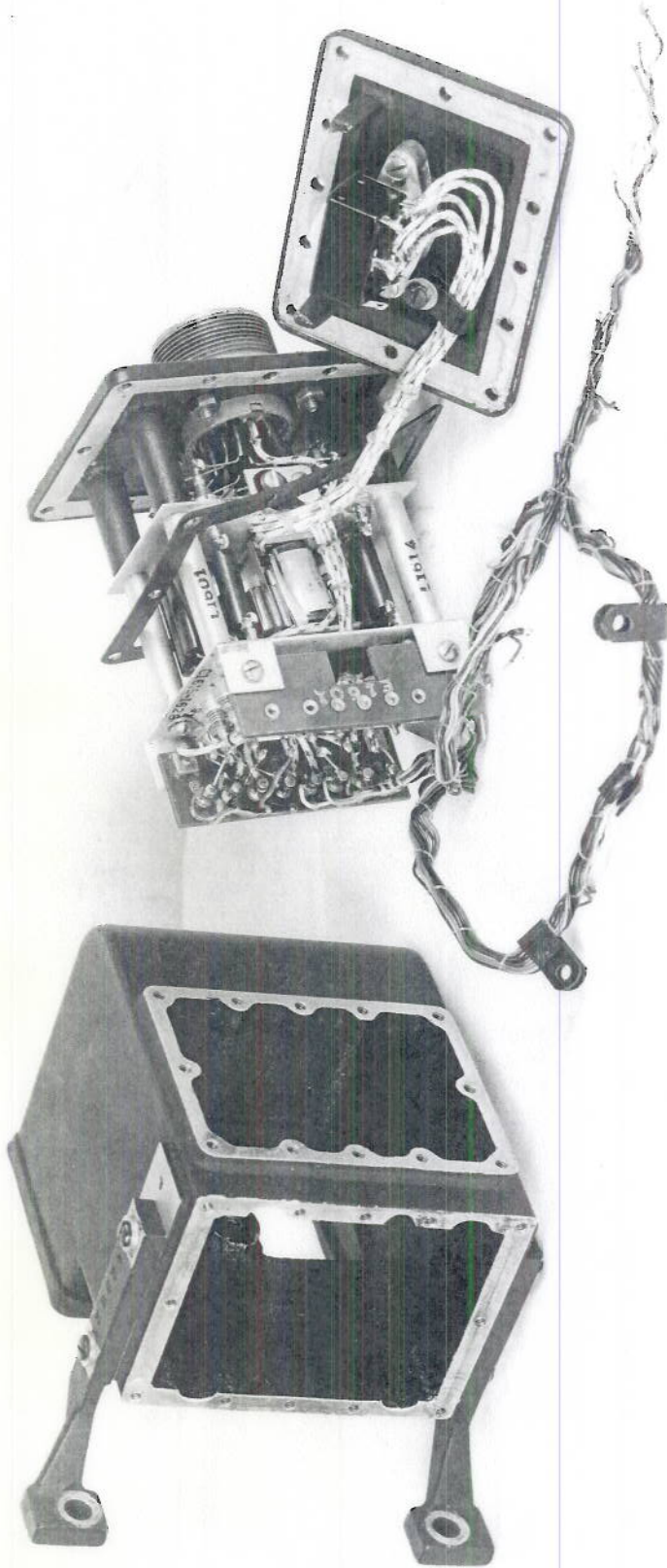
DECLASSIFIED





FRONT VIEW, TYPE CRV-43067 REMOTE CONTROL ADAPTER MOUNTED ON COVER PLATE OF MODEL MAR RADIO EQUIPMENT. CABLE CONNECTORS TO MODULATOR UNIT AND SELECTOR CONTROL UNIT (RIGHT SIDE OF ADAPTER); "LOCAL-REMOTE" SWITCH (FRONT PANEL OF ADAPTER)

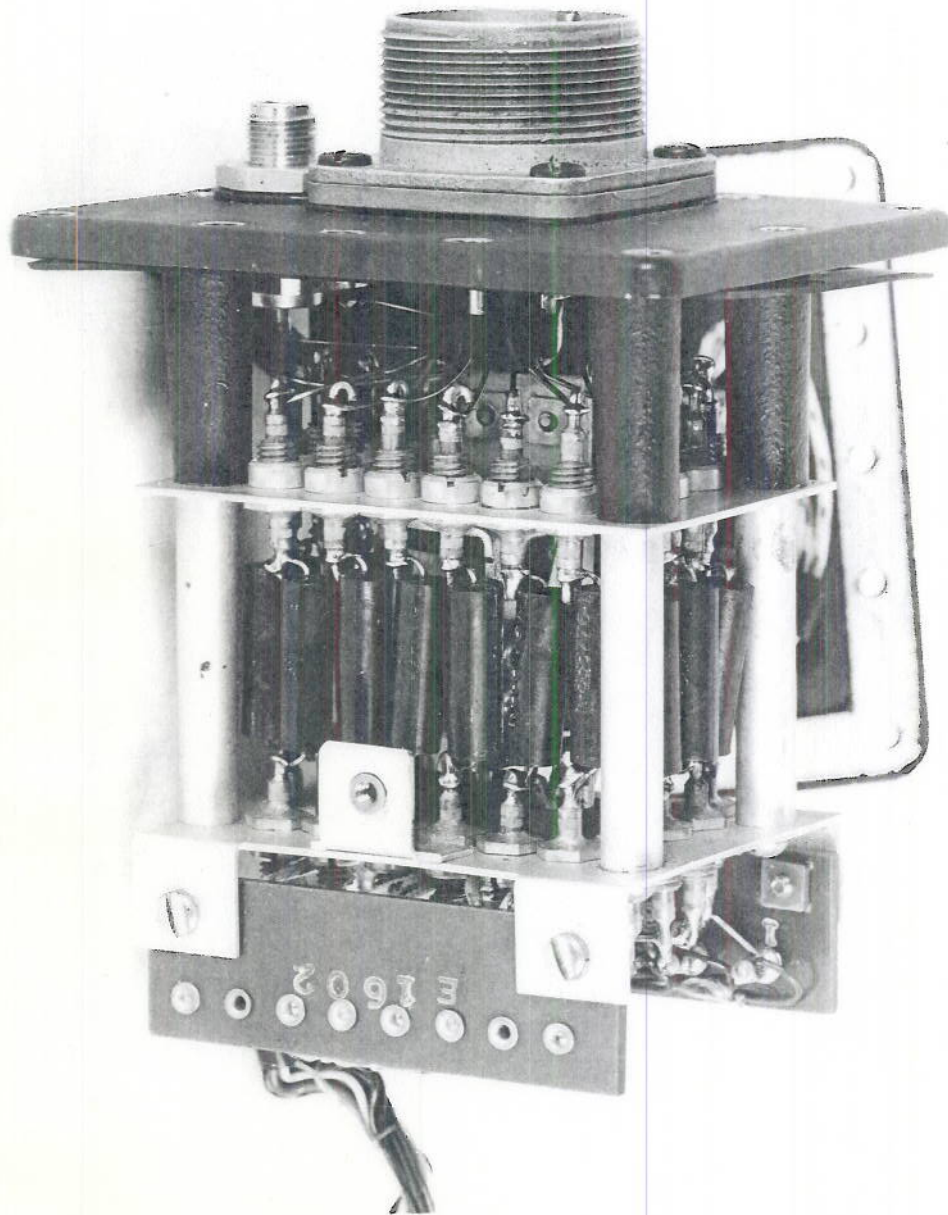
RESTRICTED



TYPE CRV-491481 REMOTE CONTROL ADAPTER DISASSEMBLED SHOWING COMPONENT ASSEMBLIES.
NOTE SILENCER RELAY AND FILTER DETAIL. LACED CABLE IS CONNECTED TO TERMINAL
BOARD E-106 IN RECEIVER CHASSIS OF MAR OR RDR EQUIPMENT

DECLASSIFIED

PLATE 16



TYPE CRV-491481 REMOTE CONTROL ADAPTER DISASSEMBLED SHOWING FILTER
COMPONENTS AND TERMINAL BOARDS

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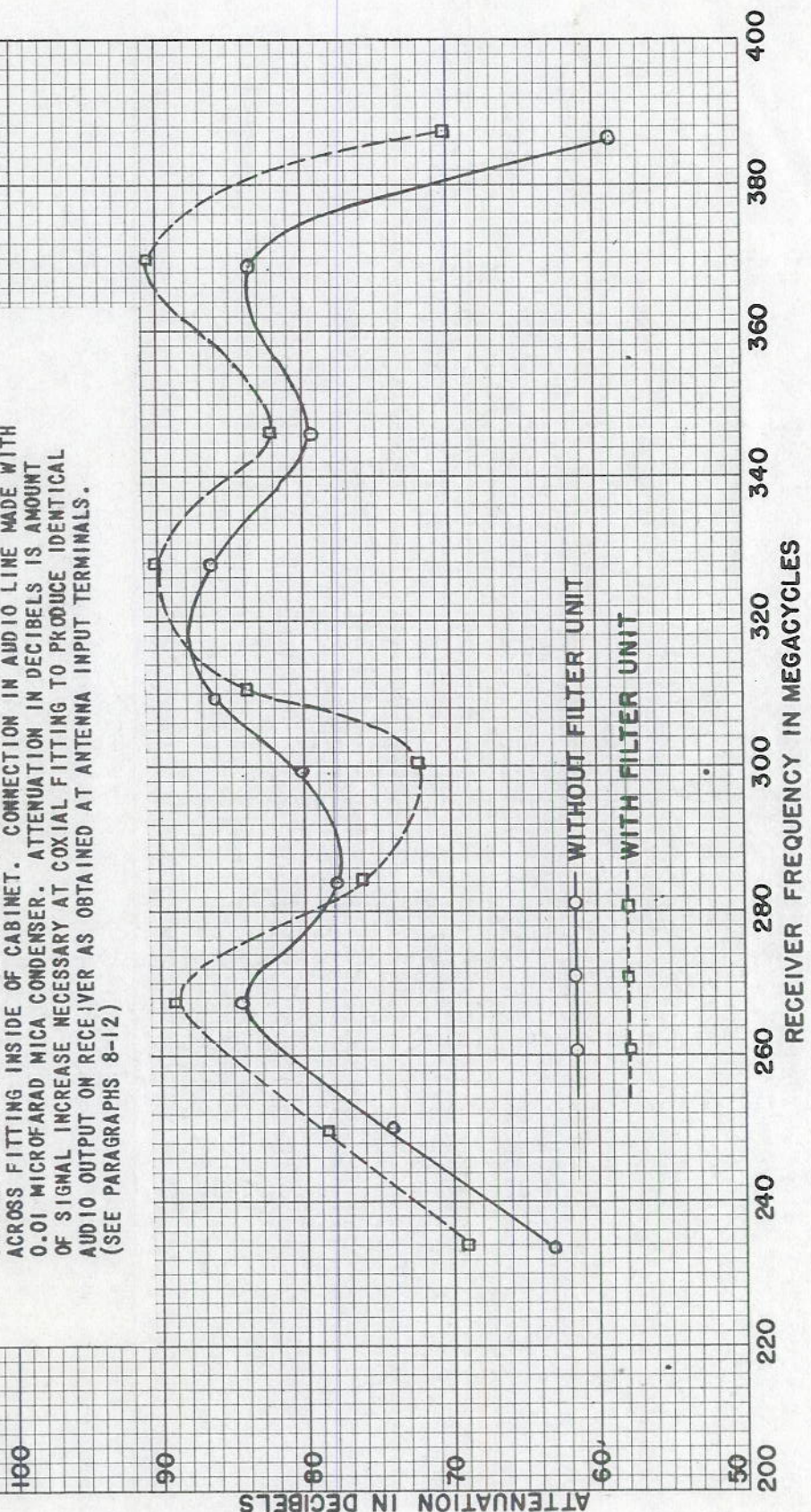
PLATE 17

~~RESTRICTED~~

R-F ISOLATION CHARACTERISTICS OF RDZ RECEIVER AUDIO LINE DUE TO R-F FILTERS IN TYPE 23497 SELECTOR CONTROL UNIT

EQUIPMENT:
 SIGNAL GENERATOR, MEASUREMENTS CO., MODEL 80, SERIAL 334
 TYPE I REMOTE CONTROL-INDICATOR SYSTEM.
 10 FEET OF TTFEA-10 CABLE BETWEEN SELECTOR CONTROL UNIT AND RDZ RECEIVER.

METHOD OF MEASUREMENT:
 COAXIAL FITTING PLACED ON UNIT IN PLACE OF SHOCK MOUNT GENERATOR OUTPUT CONNECTED TO FITTING WITH 50-OHM CABLE. 50-OHM RESISTIVE LOAD PLACED ACROSS FITTING INSIDE OF CABINET. CONNECTION IN AUDIO LINE MADE WITH 0.01 MICROFARAD MICA CONDENSER. ATTENUATION IN DECIBELS IS AMOUNT OF SIGNAL INCREASE NECESSARY AT COAXIAL FITTING TO PRODUCE IDENTICAL AUDIO OUTPUT ON RECEIVER AS OBTAINED AT ANTENNA INPUT TERMINALS.
 (SEE PARAGRAPHS 8-12)



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