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WADC TECHNICAL REPORT 55-107

"PROJECT BIG EVA"

Accelerated Service Test of Radio Sets AN/ARC-21

GEORGE H. SCHEER

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WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

Carpenter Litho & Prtg. Co., Springfield, O.
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FOREWORD

Project BIG EVA was initiated through letter directives from HqUSAF to Commander, Strategic Air Command and Commander, Air Research and Development Command in July 1954. In addition, meetings were held at Hq Air Materiel Command, attended by the Director of Communications, Commander Wright Air Development Center, Commander Air Materiel Command, and representatives of Hq Strategic Air Command, Hq Tactical Air Command and Hq Air Research and Development Command.

Acknowledgements are contained in Section VIII, page 15, of this report.

ABSTRACT

Radio Set AN/ARC-21 was designed to provide the Air Force with an improved, long-range, air-to-ground, communications capability. Its features include pressurization to permit operation at high altitudes, and pilot or copilot operation through simplified remote control features. The logistic problem normally associated with changing crystals in the field has been avoided by providing multi-channel operation with a minimum of self-contained crystal units. This latter feature provides a greater potential capability against Electronic Countermeasures. The above characteristics are requirements for jet bomber aircraft equipment where space is at a premium and the crew is limited.

The early production equipments met the performance specifications prior to delivery acceptance. However, field reports early in 1954 indicated that a reliability problem existed. Investigation disclosed the failures were caused by individual components and subminiature vacuum tubes. As a result of these findings the manufacturer was directed to tighten up on quality control and over-all inspection procedures. This action produced results, as later sets coming off the production line had fewer failures.

In order to prove the reliability and maintainability of the later production equipment, an accelerated operational test program, known as BIG EVA, was established, using 12 B-36 aircraft at Carswell AFB and 15 B-47 aircraft at MacDill AFB. The Air Proving Ground Command at Eglin AFB was directed to participate in and monitor the results of the tests at the two Strategic Air Command bases and to perform Operational Suitability Tests using 7 equipments. The plan called for 100 hours of flight per installation. A total of 3853.25 hours of AN/ARC-21 operation was obtained during the tests.

The results of the test program demonstrated that the improvements made by the contractor have resulted in an equipment which is sufficiently reliable for service use. The tests further prove that communications performance of the AN/ARC-21 is excellent, and that Air Force technicians can maintain it.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

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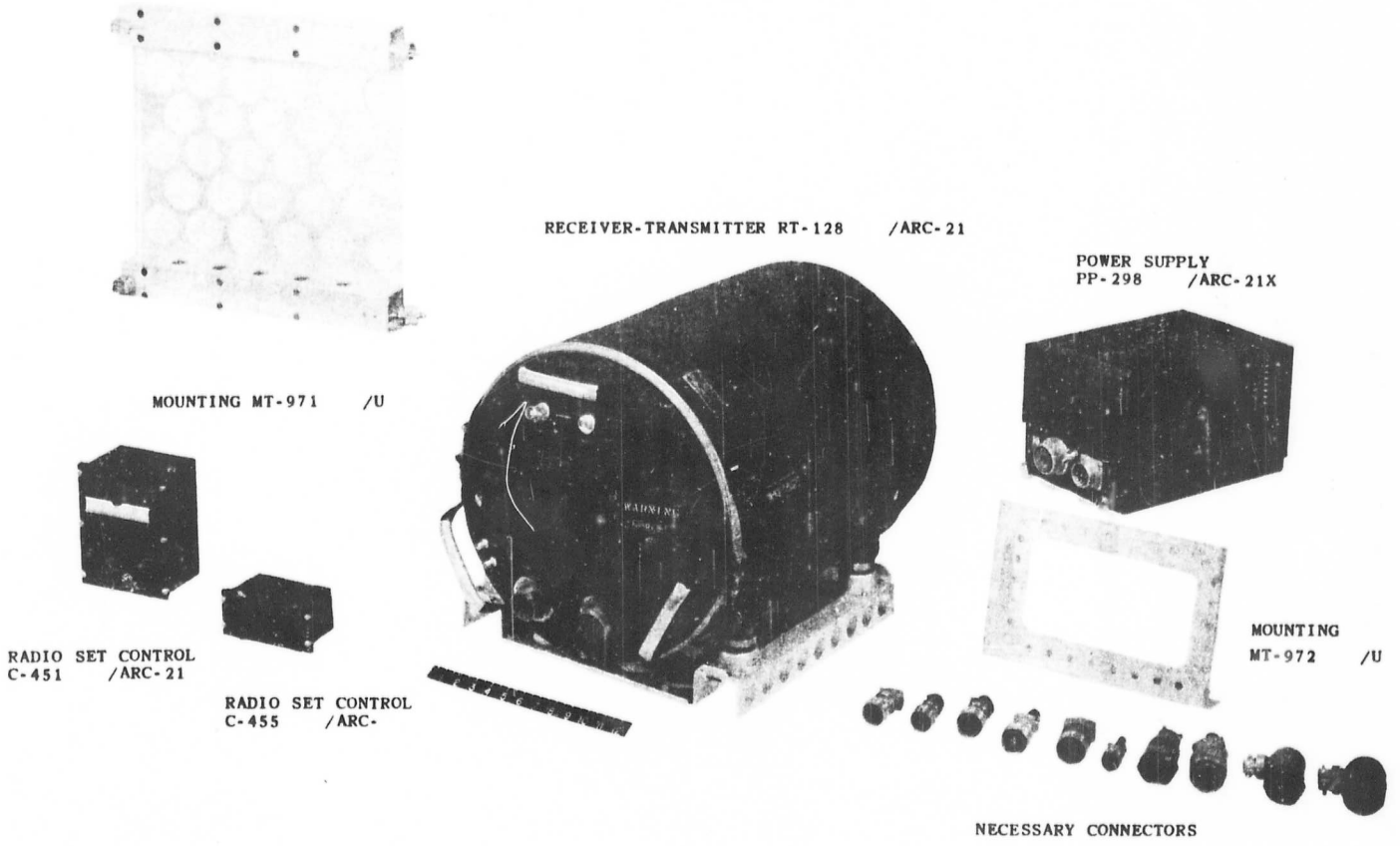

FIGURE 1

COMPONENTS OF RADIO SET AN/ARC-21X

INTRODUCTION

OBJECTIVES: The objectives of the test program described in this report (identified as Project BIG EVA) were to: (1) determine if the improvements effected in the AN/ARC-21 equipment had resulted in an article sufficiently reliable for service use; (2) determine any additional improvements considered necessary or desirable; (3) determine maintainability using simulated normal logistic support; (4) determine the practicability of the radio set from the standpoint of operational performance.

BACKGROUND: Radio Set AN/ARC-21 was developed to meet Military Characteristics to provide the Air Force with an improved H-F Communication System for modern long-range bombardment aircraft. Principal design objectives were: (1) remote control to provide complete automatic tuning and operation from a single control box position; (2) modulation features to provide voice, radioteletype and facsimile transmissions, the latter two by frequency-shift keying; (3) precise, highly-flexible frequency control without the necessity of plug-in crystal units; (4) operation at full transmitter power output up to altitudes of at least 50,000 feet. See Appendix IX for detailed performance characteristics.

This equipment consists of three principal items: A Radio-Transmitter Unit; Power Supply; Control Panels. See Figure 1, Page vii.

Development of the equipment was first carried out under a contract with the Radio Corporation of America and first production deliveries were made during March 1953 under a production contract with the same company.

Field reports received during the early part of calendar year 1954 indicated that the equipment was not sufficiently reliable. Concentrated Air Force and directed contractor action was taken to correct this condition. Production of an improved and more reliable product was effected by the use of higher quality component parts, improved inspection and quality-control procedures, and a 200-hour factory test applied to every production item. Factory and engineering tests of the improved product showed a substantial increase in reliability.

ACCELERATED FIELD TEST PROGRAM. To demonstrate and prove the increase in equipment reliability which had been achieved by the contractor's use of improved components, testing and quality-control procedures, an accelerated field-service test of the new production AN/ARC-21 equipments was instituted by an Air Force directive issued in July 1954.

The test program was joint between Air Research and Development Command, Air Materiel Command, Air Proving Ground Command, and Strategic Air Command. Test sites were: MacDill Air Force Base, Carswell Air Force Base, and Eglin Air Force Base. The over-all program was closely monitored by an AMC-WADC team.

IMPLEMENTATION OF THE TEST PROGRAM

SECTION I

The test program was initiated by assigning test vehicles and equipments to the three test sites. A single point of coordination at each of these sites was established. Representatives of AMC (Air Materiel Command) and WADC (Wright Air Development Center) were assigned to Carswell AFB and MacDill AFB. APGC (Air Proving Ground Command) was advised that aid would be given on an "on call" basis when needed. RCA Technical Representatives were stationed to aid in the test program and to act as direct contacts with RCA, Camden. Through them, the defective portions of AN/ARC-21 were returned to the contractor, the faults analyzed, corrective actions taken, and repairs made. Engineering Research Associates (E.R.A.) Technical Representatives performed similar functions in connection with the antenna couplers. Similarly, airplane contractors' Technical Representatives were present to act in cases where aircraft installation problems were involved.

Reporting on the OST (Operational Suitability Test) was to be done by APGC in the normal manner. In addition, hours of operation and failure reports were to be furnished periodically to the Team. Carswell AFB and MacDill AFB were to prepare reports to be submitted to Hq SAC (Strategic Air Command) at the completion of the tests.

Reporting forms were prepared by WADC in coordination with AMC and supplies of these forms were hand carried to each test site. AMC was made responsible for insuring that the forms would be filled out and furnished to Dayton AFD (Dayton Air Force Depot) on an expedited basis every week. These reports would be furnished to WADC on an expedited basis for technical analysis.

The AMC-WADC Team met weekly for presentations of the previous week's data and for a cumulative summary. In addition, every problem area was discussed and offices designated to take immediate corrective action.

At Carswell AFB the test vehicles assigned were 10 B-36H and 2 B-36J type aircraft. 18 AN/ARC-21's were assigned. At MacDill AFB the test vehicles assigned were 15 B-47E type aircraft. 19 AN/ARC-21's were assigned. At Eglin AFB the test vehicles assigned were a B-47, a B-50, and a KC-97 aircraft. A total of 7 AN/ARC-21's were allocated to take care of the environmental and flight test program at Eglin AFB. For maintenance support, complete sets of subassemblies and special purpose test equipment were allocated to all three test sites. Shipments began in July and were completed in September 1954.

An appreciable number of problems encountered in implementing Big Eva were directly attributed to installation of the equipment in the B-36 aircraft at Carswell AFB and the B-47 aircraft at MacDill AFB. This

condition can be attributed to the lack of experience with the new High Frequency Communications system, comprised of Radio Set AN/ARC-21, antenna, antenna coupler and cabling.

The details of these problems and their solutions have been provided in Section V of this report. It should be noted that a considerable percentage of these problems was solved prior to the beginning of flight test operations.

Details of equipment installation at Carswell Air Force Base and MacDill Air Force Base are shown in Figures 17 through 27, pages 52-62. Implementation at the various sites is detailed in Appendix XVI.

MAINTENANCE ASPECTS

SECTION II

The design of the AN/ARC-21 is unique in USAF airborne long distance radio equipments in so far as maintenance is concerned. Circuitry is grouped in separate subassemblies, each of which may be independently removed. If a failure occurs, it may be isolated to a single such subassembly in a minimum of time through the use of a simple "go, no-go" test meter. The radio set may be made operable by the replacement of the faulty subassembly with a good subassembly. Repair of the faulty subassembly may be effected at a later date and at a different geographical location. In order to best utilize this design feature to maximum advantage and to put the radio set back into the airplane in minimum time, the lowest maintenance echelon would replace defective equipment only on a complete item basis; i.e., R-T Unit, Power Supply and Control Panel. The second echelon generally would make most of the advantage of complete subassembly construction by replacing only complete subassemblies. Final detailed repairs would be done at the third echelon, the depot. This permits use of lower skill levels and a minimum of training for the two lowest maintenance echelons. Project BIG EVA offered the opportunity to determine the validity of the advantages to be gained by this new concept.

The maintenance concept to be employed in connection with the AN/ARC-21 was announced by Dayton AFD on 10 August 1954 in record type Technical Order 16-30ARC21-107, subject: "Maintenance Concept for Initial Support of Radio Set AN/ARC-21." The purpose of this Technical Order was to deviate from established maintenance procedures as outlined in Technical Order 16-1-60 which permits each echelon of maintenance to perform maximum repair within its capability. Under the new maintenance concept, spare components, except vacuum tubes, are stocked only at depot level. Tubes are at Depot and Field level. Subassemblies at Field level. No tubes or subassemblies are stocked at organizational level. In summary, the supply problem is not only reduced by the concept, but also fewer items need be procured. Under the former concept, spare components and tubes would need to be supplied at all maintenance levels. Furthermore the new concept reduces the test equipment required, all echelons considered.

In order that a maximum of data on subassembly failures could be obtained, faulty units were forwarded directly to RCA for fault analysis and repair. The resulting data was provided to Dayton AFD where it was analyzed for the effect on maintenance procedures.

LOGISTICS AND SUPPLY ASPECTS

SECTION III

At the inception of Project "BIG EVA," to assure timely and coordinated accomplishment in obtaining expeditious and effective results, Project Monitors were appointed by RCA, AMC and Air Force Bases involved. These Project Monitors were charged with the responsibility for the logistical support during the test period.

All requisitions for the AN/ARC-21 components and spare parts were submitted directly to the AMC Monitor by the Base Monitor, by telephone or teletype communication. The AMC Monitor was responsible for expeditious release of all materiel.

OPERATIONAL DATA

SECTION IV

Operational statistics are detailed in Appendices I through V. Following are summaries of the data obtained from the two test sites and from the OST performed by APGC.

Carswell AFB. Of the 18 Radio Sets AN/ARC-21 available at Carswell AFB, 16 were flown in 12 B-36 type aircraft. The total number of flights was 128. Minimum number of flights for any one R-T Unit was one, and maximum number of flights for any one R-T Unit was 13. Average number of flights per R-T Unit was 8. Maximum number of flying hours accumulated on any one radio set was 157, with an average of 77.3 flying hours per set. Seven of the 16 radio sets flew more than 100 hours. See Appendix I for complete tabulated data.

In addition, 17 of the radio sets were operated on the ground. The maximum number of ground hours accumulated on any one set was 34 with an average of 12.56. Eight of the 17 sets were operated 10 hours or more. See Appendix II for complete tabulated data.

The total operating time was 1450.5 hours. Ground and air hours on the 16 sets which were flown totalled 1427, with an operating average of 89.2 hours. The average hours of operation per set was calculated using only the sets which were flown. This closely approaches the desired goal of 100 operational hours per radio set.

MacDill AFB. Nineteen Radio Sets AN/ARC-21 were available at MacDill AFB, 17 were flown in 15 B-47 type aircraft. The total number of flights was 285. Minimum number of flights for any one R-T Unit was 8, and the maximum number of flights for any one R-T Unit was 24. Average number of flights per R-T Unit was 17. Maximum number of flying hours accumulated on any one radio set was 131-1/4, with an average of 90.7 flying hours per set. See Appendix III for complete tabulated data.

All 19 sets available at MacDill AFB were operated on the ground. The maximum number of ground hours accumulated on any one radio set was 89.25 with an average of 17.54. Sixteen of the 19 sets were operated 10 hours or more. See Appendix IV for complete, tabulated data.

The total operating time was 1875.75 hours at MacDill AFB. Ground and air hours on the 17 sets which were flown totaled 1785.5 with an operating average of 105 hours. The average hours of operation per set was calculated using only the sets which were flown. This exceeds the desired goal of 100 operational hours per radio set.

Eglin AFB. While not a part of Project BIG EVA and obtained under entirely different and special test conditions, the following summary is made of data obtained in Operational Suitability Tests by Air Proving Ground Command.

Of the seven Radio Sets AN/ARC-21 available at APGC, three were flown, one each in B-47, B-50, and KC-97 type aircraft. The total number of flights was 25. Minimum number of flights for any one R-T Unit was 5, and the maximum number of flights for any one R-T Unit was 13. Average number of flights per R-T Unit was 8.33. Maximum number of flying hours accumulated on any one radio set was 89, with an average of 59.33 flying hours per set. See Appendix V for complete tabulated data.

All seven sets available to APGC were operated on the ground. The maximum number of ground hours accumulated on any one radio set was 188, with an average of 49.86. Five of the seven sets were operated for more than ten hours. Total operating time at APGC was 527 hours, air and ground.

Summarizing, all of the operating time, ground and air, at Carswell AFB, MacDill AFB and APGC, the total hours were 3853.25.

Failure Statistics. Following is a discussion of the failures experienced at Carswell AFB and MacDill AFB. Failure statistics reported as a result of tests at APGC are detailed in Appendix V and are discussed in the separate Operational Suitability Test Report submitted by APGC.

Carswell AFB. Considering the R-T Unit alone, there were seven R-T Unit failures reported in 1236.75 flying hours, giving an average of 176.7 hours per airborne failure. Considering the three items, R-T Unit, Power Supply, and Control Panel which comprise the AN/ARC-21, there were 12 failures reported in 1236.75 flying hours, giving an average of 103.1 hours per airborne failure. See Appendix I for complete, tabulated data.

MacDill AFB. Considering the R-T Unit alone, there were 13 R-T Unit failures reported in 1542.5 flying hours, giving an average of 118.7 hours per airborne failure. Considering the three items, R-T Unit, Power Supply, and Control Panel which comprise the AN/ARC-21, there were 18 failures reported in the 1542.5 flying hours, giving an average of 85.7 hours per airborne failure. See Appendix III for complete tabulated data.

It should be noted that 16 of the 33 R-T Units flown at Carswell AFB and MacDill AFB experienced no failures whatsoever in a total of 1265.5 flying hours. Maximum for any one of these R-T Units was 131.25 flying hours, with six of them having more than 100 air operational hours without failure. In comparison, reports on the early, unmodified sets indicated only a few hours between failures.

Over-all Failure Experience. The distribution of all failures, ground and air, at Carswell AFB, MacDill AFB, and APGC is shown in Appendix VI. It is noted that 39% of the failures occurred in items other than Radio Set AN/ARC-21.

AN/ARC-21. In the R-T Unit there were 35 vacuum tube failures representing 50.73% of the total. Thus tubes were by far the largest cause of failure in the R-T Unit, and since the bulk of these tubes were of the subminiature type, special action was taken as outlined in Section V. There were eight failures due to workmanship, representing 11.60% of the total. Remedial action has been taken by the contractor. Failures in relays, capacitors and switches decrease in frequency of failure in that order. However, each is sufficiently important to warrant further corrective action by the contractor and such action is being taken. While the remaining items are relatively low in failure rate, the goal is the complete elimination of all failures. Each individual failure is being analyzed by the contractor and corrective action taken to avoid them in the future. (Appendix VII indicates action being taken in each case)

In the Power Supply there were eight vacuum tube failures representing 53.33% of the total. This was the largest cause of failure in the Power Supply. Special measures were taken to correct this condition. (See Section V) There were 4 relay failures representing 26.67% of the total. As in the case of the R-T Unit, the contractor is continuing efforts to improve this component.

Control Panels have the lowest failure rate of any single item. The reliability and quality of this item is satisfactory.

Antenna Couplers. In the Coupler, reported failures were quite evenly distributed. The major fault is in the adjustment, and the contractor is taking steps to insure that these adjustments are properly made before shipment from the factory. The remaining failures are not significant as such; however action has been taken to effect improvement.

Aircraft Installation. Most of the installation failures reported concerned the B-47 aircraft at MacDill AFB. The majority of the failures were due to antennas and/or antenna connections. Other aspects of Installation failures are discussed in SECTION VI. One cause of installation failure was the loosening of coaxial and other cable connectors because of vibration. Failures occurred due to eventual loss of electrical contact as the connector worked loose. Preventive maintenance, consisting of periodic checks of all connectors, completely eliminates this cause of failure.

Failure Summary. Summation of all failures without regard to equipment or item shows that 144 separate failures were reported collectively by Carswell AFB, MacDill AFB and APGC. However, this numerical figure is reduced by those failures which were contingent on the failure of other components. For example, if a 4-65A vacuum tube failed by becoming gassy, it would cause the grid suppressing resistor to fail through no fault of its own. On this basis the actual number of equipment failures is reduced to 141. (See Appendices VI, VII for complete, tabulated data). Vacuum tubes had the highest number of failures, 45, or 31.91% of the total. Of

about the same order of magnitude are the Installation failures with 37 items, representing 26.21%. As stated in Section V of this report, action has been taken to reduce these latter faults. The next highest two items are Relays and Workmanship which have been previously discussed. The remaining items will also receive attention and correction in order to improve the over-all reliability of the system. (See Section VI for complete tabulated data).

Results. Following is a summary of Operational Data detailed in this Section.

a. Thirty-three Radio Sets AN/ARC-21 were flown a total of 413 flights for 2779.25 airborne hours at MacDill AFB and Carswell AFB. Sixteen, or 48.5%, of the R-T Units experience no airborne failures whatsoever. Of all airborne failures reported, the AN/ARC-21 items were only 41% of the total.

b. The 33 sets flown at MacDill AFB and Carswell AFB had 20 R-T Unit failures in 2779 hours for an average of 139 hours between failures. On the same basis there were 30 failures for all AN/ARC-21 items in 2779.25 hours for an average of 93 hours between failures. A complex equipment with an average between failures approaching 100 airborne hours is considered acceptable for service use. It is noted that the R-T Unit, Power Supply and control panels individually exceed this figure. Combined, as Radio Set AN/ARC-21, they approach it satisfactorily.

c. Operation was satisfactory with either an external wire antenna (B-47, B-50, KC-97) or a flush-mounted antenna (B-36).

d. While operational profiles did not include operation at altitudes as high as 50,000 feet, flights were successful at 45,000 feet. In addition, APGC reported satisfactory operation at a simulated altitude of 55,000 feet which is in excess of the actual requirement.

e. It has been determined that the AN/ARC-21 is adequately maintained under the concept of maintenance employed during Big Eva tests. The new concept allowed maximum utilization of equipment while requiring only minimum skilled personnel at Organizational and Field maintenance levels. The Strategic Air Command has accepted this maintenance concept.

CHANGES EFFECTED

SECTION V

Since the Radio Sets AN/ARC-21 employed in Project BIG EVA were produced, there has been a continuous increase in reliability of production equipments. Sets now being produced should show a substantial increase in operating hours between failures. It is expected that there will be a further marked increase in reliability in the very near future when improved subminiature vacuum tubes are available in the field.

The following paragraphs indicate problem areas acted upon during the BIG EVA test period. These include not only AN/ARC-21 items but also ancillary items such as the Coupler and Aircraft Installation which comprise the HF Communication System.

Radio Set AN/ARC-21

Power Supply PP-298/ARC-21X. Rectifier tube type 3B22 showed an abnormal failure rate. Investigation disclosed that the filament might not be up to operating temperature before application of high plate voltage under the unusual condition where the radio set was turned off and turned on again prior to the normal thermal delay reset. Correction consisted of modification to time delay circuitry.

ACTION COMPLETED.

Control Panel C-451A/ARC-21. On Control Panel C-451A/ARC-21, it was found that the channel detent mechanism was not always positive enough and that it was possible to stop between channels. This condition was corrected in an improved design and the nomenclature changed by the addition of an "A." This control panel is in production.

ACTION COMPLETED.

AN/ARC-21 Rework Program. A rework program was expedited to modify all sets delivered prior to the reliability improvement program which resulted in improved components. 762 old sets and 35 sets of spare subassemblies were involved. As old sets are modified they are returned to the field and are used interchangeably with sets produced since June 1954. It was determined that the prime equipment contractor should modify the old sets since he could do it most expeditiously. Contractual action was taken and reworked sets are reaching the field.

ACTION COMPLETED.

High Temperature Cutout. APGC reported that one R-T Unit became inoperative because the protective thermal cutout was actuated. It was estimated that the compartment in the KC-97 in which the equipment was

installed reached a temperature of 76°C. However, installation of another radio set showed no further trouble. The radio set is designed to operate continuously at 55°C and for 15 minute intervals at 71°C. Steps have been taken to make actual compartment temperature measurements. The reported incidnt may not be significant on the basis that only one such thermal cutout has ever been reported.

ACTION INITIATED.

Antenna Coupler

E.R.A. Coupler. At one frequency it was found that the transmitter and coupler would not come to a stable tuning point, due to the fact that a pure resistive load was presented to the coupler. The fix consisted in a small modification to the coupler itself of changing wiring and adding resistors.

ACTION INITIATED.

Aircraft Installation

Antenna Mast, B-47. There were several failures of the connection to the antenna coupler lead-in wire. The Boeing Airplane Company corrected this fault by improving the mechanical design involved in the connection.

ACTION COMPLETED.

Circuit Breakers, B-47. In several instances, the circuit breaker in the primary power line to the AN/ARC-21 would open when no fault existed in the equipment. The breaker in question was rated at 20 amperes which was determined to be too near the maximum current requirements under normal operation. This breaker was replaced with one of 25 amperes capacity, and no further trouble was experienced in this area.

ACTION COMPLETED.

Short Cables, B-47. The original mockup of AN/ARC-21 in the B-47 was satisfactory. However, radio sets were not available to the airplane contractor for installation due to short supply, and variations in airplane cable lengths occurred during manufacture. As a result, aircraft at MacDill required some rework to correct short cables. This unsatisfactory condition was corrected by furnishing Radio Sets AN/ARC-21 to the airplane contractor for installation and check during final acceptance tests. After acceptance, the sets were removed and used in succeeding aircraft. This procedure insured that proper installation of Group B parts could be made later in the field. Group B parts are now being installed in B-47 aircraft, and the aircraft are delivered complete. In addition, the airplane contractor has incorporated the following corrections: connectors properly "clocked"; coaxial cables lengthened where necessary to provide slack; auxiliary control panel refitted properly; antenna lead-in properly positioned.

ACTION COMPLETED.

Wire Antenna Breakaway, B-47. Failures of the wire antenna breakaway actually occurred as early as the ferrying flights of B-47's to MacDill AFB. The breakaway released so easily that it was actuated prematurely due to variations in wire tension during flight. The airplane contractor was immediately notified of the fault and undertook a redesign of the breakaway unit. In the meantime for a quick fix WADC designed a breakaway on an expedited basis and manufactured 25 units, which were supplied to MacDill AFB. Procurement information on the latter is available and nomenclature has been requested. It is not known at this time whether the WADC design will be adopted or if Boeing will furnish the final fix.

ACTION INITIATED.

Relay RE-132/ARC. Some difficulty was experienced at MacDill AFB due to transients caused by operation of the antenna shorting relay affecting the proper operation of the ERA Coupler. The fix consisted of an addition of a filter in the Coupler.

ACTION INITIATED.

Special Purpose Test Equipment

Multimeter ME-75/ARC-21. Use of the "go, no-go" meter at Scott AFB in training operations resulted in the discovery of a potential personnel shock hazard. Wearing of insulation within the instrument could connect the metallic case to the potential of the high-voltage lead (1000 v) from the radio set. The contractor determined a fix which prevented such an occurrence. The fix was accomplished by grounding the case of the instrument to the frame of the R-T Unit through a separate lead, after which the instrument case cannot be above ground potential.

ACTION COMPLETED.

Subminiature Vacuum Tubes

Since subminiature vacuum tubes, as a component, had the highest failure rate, special action was taken by the Directorate of Research, WADC, in collaboration with the WADC-AMC Team, prime equipment and vacuum tube manufacturers. The following changes in tube specifications were effected on an expedited basis: narrowing of limits on characteristics such as heater current, transconductance and plate dissipation; increased life test requirements which automatically require a burn-in period; higher level of quality control. In addition, there have been mechanical production improvements occasioned by catastrophic failures such as open cathode tabs, etc. The so-called "A" tube types have not as yet reached the field. It is expected that there will be a marked improvement in tube reliability as a result. See Appendix XVII for tube types and applicable Military Specifications.

ACTION COMPLETED.

FAILURE ANALYSES

SECTION VI

Appendix VII gives a detailed description of each failure, the cause where known, and any corrective action taken to prevent a recurrence in subsequently produced equipments. In some instances the corrective measures are still under study. In other instances, it was determined that no action would be required due to the fact that the failure appeared to be an isolated case. Analyses of failures occurring after BIG EVA will continue and corrective actions will be taken as required.

Section IV of this report discusses failures which occurred during operational testing and comments on the number as related to different types of components.

Appendix VIII gives a summary of component failures. It is referenced to specific items of Appendix VII. Vacuum tubes exhibit the greatest failure rate of any component. Improved tubes are now being installed in production sets and are expected to show a marked improvement in radio set reliability.

Relay types showing unreliability are undergoing individual engineering investigation as to causes, after which corrective actions will be taken. For one type of relay it was determined that defective relays could be culled out by more rigid vendor tests and this is being applied. For another type of relay it was determined that application of environmental tests to each relay would cull out defective units and this is being applied.

Tantalum capacitors showed the greatest unreliability of all capacitors used. Although they have been redesigned, it appears that the further insurance of 100% pretest prior to installation in equipment is required to decrease this source of unreliability. This is being applied.

Most of the switches showing unreliability have been redesigned or are in the process of redesign to improve reliability.

Other component failures are detailed in Appendix VII, but do not warrant individual discussion here because the failure rate is relatively low.

CONCLUSIONS

SECTION VII

1. The reliability of the AN/ARC-21 equipment as established by the BIG EVA tests is considered adequate.

2. All improvements found necessary or desirable as a result of the tests have been effected or initiated. In order to evaluate the increase in reliability to be afforded by the improved subminiature vacuum tubes, the Military Electron Tube Surveillance Program (AIRINC) will include an evaluation at such bases as Carswell AFB and MacDill AFB when the improved tubes are in service use.

3. The AN/ARC-21 equipment is maintainable under field conditions. The basic design of using subassembly construction provides ease of maintenance and leads to simplified maintenance procedures. As the reliability continues to increase, maintenance requirements will decrease.

4. The AN/ARC-21 is practicable for operational service use and its characteristics are operationally acceptable. Communications performance provided is excellent and superior to that provided by any airborne equipment previously available to the USAF.

ACKNOWLEDGEMENTS

SECTION VIII

The success of Project BIG EVA in obtaining a significant amount of carefully collected data on a new equipment in a short period of elapsed time was due, for the most part, to the initiative, cooperation, perseverance, and personal interest of the participants at the test sites.

At MacDill AFB, special credit is due Colonel P. S. Emerick, Comdr 306th Bomb Wing, Med., Lt Col Agan, Comdr 306th Armament and Electronic Squadron, Major E. Purdy, B-47 Operational Engineering Section and official project contact, Major M. B. Gibson, Communications Officer, pilots, co-pilots and B-47 crew members, and the personnel who performed the maintenance.

At Carswell AFB, special credit is due Lt Col David Liebman, Deputy Comdr 11th Bomb Wing, Heavy, Major C. J. Flynn, Comdr 11th Armament and Electronic Squadron and official project contact, his deputy, Captain H. C. Huettig, Major W. B. Cofield, Maintenance Controller, pilots, co-pilots and B-36 crew members, and enlisted personnel of the 11th A & E Squadron and Electronic Branch 8th Air Force, who performed maintenance.

At Eglin AFB, Air Proving Ground Command, credit is due Major J. C. Price, 3242nd Test Squadron and official project contact, and Mr. Ray Atkinson for special reports on the OST.

At Offutt AFB, Hq SAC, special credit is due in particular to Colonel C. L. Derey and Squadron Leader Moulton.

Colonel John E. Frizen on special assignment from Hq USAF, ACO, was particularly helpful through his personal contacts with Hq SAC and the test sites, and through his consultation with the Joint AMC-WADC Team.

Special mention is made of the work performed by the teams of Electrical Installers from San Antonio Air Materiel Area and Warner-Robbins Air Materiel Area, who aided in readying the test aircraft at Carswell AFB and MacDill AFB respectively. In the case of the WRAMA team, the personnel were unfamiliar with airborne installations but did a splendid job nevertheless.

The Technical Representatives of the Radio Corporation of America, Boeing Airplane Company and Electronic Research Associates played a major role in depot-level repair of equipment.

The C & N Communications & Navigation Aids Phasing Group, under sponsorship of Hq AMC, and including representation from AMC and WADC, was active throughout the entire test period.

APPENDIX I

Carswell AFB Airborne Statistics

	R-T Serial	No. Flights	Total Airborne Hours	Reported Failures				
				R-T Unit#	Power Supply#	Coupler	Control Panel#	Aircraft Installation
	575	1	0	1	0	0	0	0
	576	11	103.75	0	0	1	0	0
	577	4	23.25	1	0	0	0	2
	578	7	84.75	1	0	0	0	1
	579	10	106	0	0	0	0	0
	580	11	123.5	0	0	1	0	0
	583	1	20.75	0	0	0	0	0
	584*	0	0	0	0	0	0	0
	585	2	31	0	0	1	0	0
	586*	0	0	0	0	0	0	0
	601	13	120.5	1	0	0	0	1
	602	13	142	1	1	1	0	1
	603	8	41.25	0	1	0	0	2
	605	12	129	1	0	0	0	2
	606	7	47	0	0	0	0	1
	607	9	70.5	0	0	0	0	1
	611	11	157	1	0	0	0	0
	612	8	36.5	0	2	0	1	1
Totals	16	128	1236.75	7	4	4	1	12

*Spare; these sets were not required for airborne replacements. However, No. 586 was operated on the bench. See Appendix II.

#AN/ARC-21 items; total AN/ARC-21 failures 12; other, 16.

APPENDIX II

Carswell AFB Ground Statistics

R-T Serial	Total Ground Hours	Reported Failures				
		R-T Unit#	Power Supply#	Coupler	Control Panel#	Aircraft Installation
575	6	1	0	0	0	0
576	7.75	1	0	0	0	0
577	19.5	0	0	0	0	0
578	8.25	0	0	1	0	0
579	8	1	0	0	0	0
580	9.25	1	1	0	0	0
583	.5	0	0	0	0	0
584*	0	0	0	0	0	0
585	1.5	0	0	0	0	0
586*	23.5	0	0	0	0	0
601	17	5	0	0	0	0
602	12	0	0	0	0	0
603	10	1	0	0	0	0
605	14	0	0	0	0	0
606	9.5	1	0	0	0	0
607	9	0	0	0	0	0
611	24	1	1	0	0	0
612	34	2	0	0	0	0
Totals 17	213.75	14	2	1	0	0

*Spare; this set was not required for either ground or air replacement and was not operated. No. 586 was not installed in an airplane since it was not needed as a replacement. See Appendix I.

#AN/ARC-21 items; total AN/ARC-21 failures 16; other, 1.

APPENDIX III

MacDill AFB Airborne Statistics

R-T Serial	No. Flights	Total Airborne Hours	Reported Failures				
			R-T Unit#	Power Supply#	Coupler	Control Panel#	Aircraft Installation
556	19	109	1	0	0	0	2
557	14	74.5	1	0	0	0	1
558	23	117.5	0	0	0	0	2
559	17	74.5	0	0	0	0	0
560	19	90.25	0	0	0	0	1
561	21	113	0	0	0	0	2
562*	0	0	0	0	0	0	0
563	17	97.75	0	0	1	1	3
564	18	101.75	1	0	0	0	3
565	9	61.5	1	0	0	1	3
566	22	131.25	0	0	0	0	2
567	24	125.25	2	1	1	0	1
568	9	50.5	1	0	1	0	0
569	17	91.25	1	1	0	0	0
570	8	52	2	0	0	0	1
571	20	112	2	1	0	0	2
572	20	99	1	0	0	0	0
608	8	41.5	0	0	0	0	1
613*	0	0	0	0	0	0	0
Totals 17	285	1542.5	13	3	3	2	24

*Spare; these sets were not required for airborne replacements. However, they were operated on the bench. See Appendix IV.

#AN/ARC-21 items; total AN/ARC-21 failures 18; other, 27.

APPENDIX IV

MacDill AFB Ground Statistics

R-T Serial	Total Ground Hours	Reported Failures				
		R-T Unit#	Power Supply#	Coupler	Control Panel#	Aircraft Installation
556	10	2	0	0	0	0
557	15.5	0	0	0	0	0
558	17.25	0	0	0	0	0
559	14.25	1	0	0	0	0
560	12.75	0	0	0	0	0
561	14.5	1	0	0	0	0
562	89.25	10	0	0	0	0
563	13	1	0	1	0	0
564	14.5	0	0	0	0	0
565	8.5	0	0	0	0	0
566	9.75	2	0	1	0	0
567	17.5	1	0	1	0	1
568	19	5	0	1	0	0
569	17.75	0	0	0	0	0
570	20	4	0	0	0	0
571	14.75	0	0	0	0	0
572	13.5	1	2	1	0	0
608	10.5	1	0	0	0	0
613	1	0	0	0	0	0
Totals 19	333.25	29	2	5	0	1

Nos. 562 and 613 were not installed in aircraft since they were not required as replacements.

#AN/ARC-21 items; total AN/ARC-21 failures 31; other, 6.

APPENDIX V

Eglin AFB Statistics

R-T Serial	Total Ground Hours	Reported Failures				
		R-T Unit#	Power Supply#	Coupler	Control Panel#	Aircraft Installation
555	14	1	0	0	0	0
573	188	1	1	2	0	0
574	3	0	0	0	0	0
582	7	0	0	0	0	0
618	15	0	0	0	0	0
619	12	0	0	0	0	0
620	110	2**	1	0	0	0
Totals 7	349	2	2	2	0	0

R-T Serial	No. Flights	Total Air Hours	Reported Failures				
			R-T Unit#	Power Supply#	Coupler	Control Panel#	Aircraft Installation
555'	13	57	0	0	0	0	0
573*	0	0	0	0	0	0	0
574*	0	0	0	0	0	0	0
582"	5	32	0	0	1	0	2
618*	0	0	0	0	0	0	0
619*	0	0	0	0	0	0	0
620##	7	89	2	0	0	0	0
Totals 3	25	178	2	0	1	0	2

*These sets were not installed in aircraft.
**Neither failure chargeable to equipment: one over voltage on primary power causing damage to equipment; one equipment dropped from table to concrete floor causing damage to equipment.
'Installed in B-50 airplane.
"Installed in B-47 airplane.
##Installed in KC-97 airplane.
#AN/ARC-21 items; total AN/ARC-21 air and ground failures 6; other, 5.

APPENDIX VI

Ground and Air Failure Summary

Receiver-Transmitter Unit***

Vacuum Tubes*	35	50.73%
Workmanship	8	11.60%
Undetermined to date	5	7.24%
Relays	5	7.24%
Capacitors	5	7.24%
Switches	3	4.35%
Filter Networks	2	2.90%
Resistors#	1	1.45%
Burned Wiring	1	1.45%
Broken Wiring	1	1.45%
Solenoids	1	1.45%
Clutches	1	1.45%
Plugs	1	1.45%
Transformers#		

R.R.A. Coupler

Adjustments	3	16.67%
Relays	3	16.67%
Plugs	2	11.11%
Switches	2	11.11%
Broken Wiring	2	11.11%
Workmanship	2	11.11%
Vacuum Tubes	2	11.11%
Gear Trains	1	5.56%
Capacitors	1	5.56%

Control Panels***

Dials	1	50.00%
Adjustments	1	50.00%
Solenoids*		

Power Supply***

Vacuum Tubes"	8	53.33%
Relays	4	26.67%
Wiring	1	6.67%
Capacitors	1	6.67%
Undetermined to date	1	6.67%

Aircraft Installation

Antennas	30	81.08%
Circuit Breakers**	3	8.11%
Inverters	3	8.11%
Interphones	1	2.70%

There were 141 failures:

Vacuum Tubes	45	31.91%
Installation	37	26.24%
Relays	12	8.51%
Workmanship	10	7.10%
Capacitors	7	4.97%
Undetermined	6	4.26%
Switches	5	3.55%
Wiring	5	3.55%
Adjustments	4	2.84%
Plugs	3	2.13%
Filters	2	1.42%
Solenoids	1	.71%
Resistors	1	.71%
Gears	1	.71%
Dials	1	.71%
Clutches	1	.71%

Failures by Components:

Vacuum tubes	45	56.96%
Relays	12	15.19%
Capacitors	7	8.86%
Switches	5	6.33%
Plugs	3	3.80%
Filters	2	2.53%
Solenoids	1	1.27%
Resistors	1	1.27%
Gears	1	1.27%
Dials	1	1.27%
Clutches	1	1.27%

*One failure not charged to components; equipment misused.

**Circuit breakers changed from 20 to 25 amperes rating to prevent premature opening with no equipment malfunction.

One failure not charged to components; caused by failure of another component which was charged.

" See 3B22, Appendix X

***Part of Radio Set AN/ARC-21

NOTE: Detailed Failure Analyses are given in Appendix VII.

APPENDIX VII

Detailed Failure Analyses

Reference No.	Unit	Item	Identification	Failure	No. of Failures	Cause	Corrective Action
1	R-T Unit	Relay	K-305	Inop.	4	Contact Clearance	More rigid tests by vendor; further investigation.
2	R-T Unit	Relay	K-301	Intermit.	1	Open contacts	100% Environmental Tests.
3	Coupler	Relay	K-3	Opens	1	Details unknown	Isolated case.
4	Coupler	Relay	K-9	Keying	1	Burned contacts	Further investigation.
5	Coupler	Relay	K-11	Inop.	1	Details unknown	Further investigation.
6	Power Sup.	Relay	K-1702	Inop.	1	Open heater	Isolated case.
7	Power Sup.	Relay	K-1705	Inop.	1	Burned contacts	Further investigation.
8	Power Sup.	Relay	K-1701	Inop.	1	Contacts stick	Isolated case
9	Power Sup.	Relay	--	Inop.	1	Dirty contacts	Isolated case
10	R-T Unit	Cap.	C-303	Intermit.	1	Leaking	Pretest 100% in future before installation.
11	R-T Unit	Cap.	C-1204	Inop.	1 1	Shorted, wrong value Leaking	Factory error. Pretest 100% in future before installation.
12	R-T Unit	Cap.	C-1207	Low	1	Partially shorted	Pretest 100% in future before installation

APPENDIX VII (continued)

Reference No.	Unit	Item	Identification	Failure	No. of Failures	Cause	Corrective Action
13	R-T Unit	Cap.	C-924	Inop.	1	Shorted	Pretest 100% in future before installation.
14	Coupler	Cap.	C-18	Inop.	1	Glass seal broken	Improve parts inspection.
15	Power Sup.	Cap.	C-1703	Inop.	1	Shorted	Pretest 100% in future before installation.
16	R-T Unit	Switch	S-406	Intermit.	1	Arcing contact	Vendor redesigning.
17	R-T Unit	Switch	S-805	Intermit.	1	Contacts bridging	Drive coupling being redesigned.
18	R-T Unit	Switch	S-1202	Inop.	1	Contacts closed	New type replacement.
19	Coupler	Switch	Stepper	Binds	1	Loose bolts	Quality control.
20	R-T Unit	Resistor	R-138	Open	*	Gassy 4-65A tube	Quality control on tube.
21	R-T Unit	Resistor	R-620	Inop.	1	Broken spring	New design adopted.
22	R-T Unit	Filter	Z-1105	Intermit.	2	Burned open	Vendor has taken action.
23	R-T Unit	Wiring		Inop.	1	Cover on microswitch	Redesign to eliminate microswitch.
24	Coupler	Wiring		Inop.	2	R-F lead broken	Undetermined
25	Power Sup.	Wiring		Inop.	1	Ground lead broken	Quality Control.
26	R-T Unit	Wiring		Inop.	1	Broken wire O-180	Quality Control.
27	R-T Unit	Solenoid	O-406	Inop.	1	Plunger binds	Isolated case.
28	C. Panel	Solenoid	K-1401	Inop.	1	Open winding	Operational misuse.

APPENDIX VII (continued)

Reference No.	Unit	Item	Identification	Failure	No. of Failures	Cause	Corrective Action
29	R-T Unit	Transf.	T-701	Inop.	*	Spring on J-1216	See No. 52
30	Power Sup.	Transf.	T-1703	Inop.	*	Shorted 3B22	See Appendix XIV, 3B22
31	R-T Unit	Clutch	C-405	Shorted	1	Insulation breakdown	Improved quality of insulation
32	Coupler	Gears	XD-61942	Inop.	1	Cracked gear	Manufacturing process changed
33	C. Panel	Dial		Slipping	1	Collar not tight	Isolated case
34	C. Panel	Adjust.	S-1301	Erratic	1	Spring tension adj.	Corrected in redesign, C-451A
35	Coupler	Adjust.	XG-61943-3	Hunting	3	Spring adjustment	Corrected through ECP
36	Coupler	Workm.	XR-73615-3	Won't home	1	Bad assembly	Quality Control
37	Coupler	Workm.	XD-62059-1	Broken	1	Rough handling on bench	Quality Control
38	R-T Unit	Workm.	CY-1279	Air leak	2	Nuts not tightened	Increased inspection
39	R-T Unit	Workm.	8835870-1	Slipped off	1	Poor weld	Vendor Quality Control
40	R-T Unit	Workm.	S-606, K602	Intermit.	1	Dirty contacts	Quality Control
41	R-T Unit	Workm.	C-180	Intermit.	1	Bad solder joint	Quality Control
42	R-T Unit	Workm.	V-401 Conn.	Inop.	1	Screw missing from lead	Quality Control
43	R-T Unit	Workm.	R-107	Overmod.	1	Wrong setting	Quality Control
44	R-T Unit	Unknown	Unknown	Inop.	1	Undetermined	

APPENDIX VII (continued)

Reference No.	Unit	Item	Identification	Failure	No. of Failures	Cause	Corrective Action
45	R-T Unit	Unknown	Unknown	Hi alt.	1	Undetermined	
46	R-T Unit	Unknown	MX-1425	Inop.	1	Undetermined	
47	R-T Unit	Unknown	MX-1425	Inop.	1	Undetermined	
48	R-T Unit	Unknown	O-180	Intermit.	1	Undetermined	
49	Power Sup.	Unknown	Unknown	No Power	1	Undetermined	
50	Coupler	Plug	J-11	No contact	2	Defective plug	Corrected in production
51	Coupler	Switch	-	Inop.	1	Mechanical link loose	Quality Control
52	R-T Unit	Plug	J-1216	Inop.	1	Loose pin	Clearance hole enlarged to prevent bending spring
53	Coaxial	Line	RG-58/U	Intermit.	2	Pulled loose from UG-88	UG-88 being redesigned
54	Coaxial	Conn.	UG-59/U	Inop.	3	Loose Pin	Connector being redesigned
55	Mast		Dale	Arcing	3	Loose lead-in	Has been redesigned
56	Antenna	Breakaway		Lost	6	Lost in flight	Contractor studying design deficiencies
57	Antenna	Conn.		Broken	5	Broken connector	Being redesigned by contractor
58	Coaxial	Conn.	UG-59, 60	Broken	11	Connection pulled loose	Connectors being redesigned

NOTE: See also Appendices VI and VIII

APPENDIX VIII

Detailed Component Failure Summary

Relays

Sealed.....11 Failures (1,2,4,5,6,7,8,9)
Unsealed..... 1 Failure (3)

Capacitors

Tantalum..... 5 Failures (10,11,12,15)
Paper..... 1 Failure (13)
Vacuum..... 1 Failure (14)

Switches

Wafer..... 1 Failure (17)
Input..... 1 Failure (16)
Aneroid..... 1 Failure (18)
Leedex..... 2 Failures (19, 51)

Resistors

Variable WW..... 1 Failure (21)

Filters

Chokes..... 2 Failures (22)

Miscellaneous

Solenoid..... 1 Failure (27)
Clutches..... 1 Failure (31)
Gears..... 1 Failure (32)
Dials..... 1 Failure (33)
Plugs..... 3 Failures (50,52)

NOTE: The above listings do not include all classes of components or types thereof, used in the equipment. Only classes and types with reported failures are shown. Numbers in parentheses refer to reference number in Appendix VII immediately preceding. Appendix VII gives detailed failure analyses and corrective actions taken.

APPENDIX IX

AN/ARC-21 Operational Characteristics

Pilot Operation - Completely remote controlled

Altitude - at least 50,000 feet without external pressurization

Radioteletype - Frequency Shift Keying

Manual Frequency Control - available in separate control box providing selection of any one of 44,000 frequencies

Antenna Tuning and Loading - fully automatic

Frequency Indication - Direct frequency reading

Interphone - uses AN/AIC-10 directly

Ambient Temperature - -55° C to +71° C

Unitized Construction - interchangeable subassemblies facilitate maintenance

Fault Isolation - rapid fault finding by "go, no-go" meter

Frequency Control - built-in quartz crystals

Frequency Stability - .0015% or better

Preset Channels - 20; may be changed in flight

Primary Power - either 28 v dc only or 400 cps ac plus 28 v dc

Power Output - 100 watts minimum

Reduced Power - 1/10 power output available for close-in contacts

CW Operation - either broad or sharp selectivity; selectable

Modulation - more than 90% for high sideband power

Frequency Coverage - 2 to 24 mc/s

Squelch - adjustable for receiver quieting

Special Features - speech clipping to reduce distortion; audio AVC for constant audio output

Crossband Operation - Radio Receiver AN/ARR-36

APPENDIX X

Detailed Vacuum Tube Failure Summary

Tube Type	Number Used per Installation	Number of Airborne Failures	Number of Ground Failures	Total Number of Failures
0A2	1	0	0	0
0B2	1	0	0	0
2K26	2	0	0	0
3B22**	1	5	2	7
3B28	4	1	0	1
4-65A	4	0	2	2
991	1	0	0	0
5636*	16	3	10#	13#
5643*	1	0	0	0
5670	3	1	1	2
5687	2	0	1	1
5718*	3	2	1	3
5719*	2	0	0	0
5727	4	0	0	0
5840*	14	2	1	3
5896*	8	2	4	6
5899*	5	0	0	0
5902*	3	0	1	1
6021*	15	4	2	6
6201	3	0	0	0
Totals	93	20	25	45

*Subminiature.
**Cause of these specific failures has been eliminated through redesign of circuit in which used.
#One failure not charged; failure occurred due to primary power overvoltage, an abnormal operating condition.

APPENDIX XI

Vacuum Tube Complements

RT-128/ARC-21

Tube Type	Number Used per Equipment
0A2	1
0B2	1
2E26	2
4-65A	4
991	1
5636*	16
5643*	1
5670	1
5687	2
5718*	3
5719*	2
5840*	14
5896*	8
5899*	5
5902*	3
6021*	15
Total	79

ERA Coupler Type 3001

Tube Type	Number Used per Equipment
5670	2
5727	4
6201	3
Total	9

PP-298/ARC-21X

Tube Type	Number Used per Equipment
3B22	1
3B28	4
Total	5

*Subminiature types

APPENDIX XII

Subminiature Vacuum Tube Specifications

Below are listed the Revised Subminiature Vacuum Tube Specifications for improved versions.

Tube Type	Specification
5636*	MIL-E-1/168B
5639	MIL-E-1/169B
5643*	Pending
5718*	MIL-E-1/172A
5719*	MIL-E-1/173B
5840*	MIL-E-1/140A
5896*	MIL-E-1/174B
5899*	MIL-E-1/97B
5902*	MIL-E-1/187B
6021*	MIL-E-1/188B

*Used in AN/ARC-21

APPENDIX XIII

HF Communication System Sizes and Weights

Item	Dimensions in Inches Width	Height	Depth	Weight Pounds
#Receiver-Transmitter Radio, RT-128/ARC-21 on Mounting MT-971/U	18-3/4	19-1/8	26-13/32	131.625
#AC Power Supply PP-298/ARC-21X** on Mounting MT-972/U	8-3/4	9-1/4	13-7/8	26.625
DC Power Supply DY-50/ARC-21** on Mounting MT-972/U	8-3/4	8-7/16	13-7/8	34.00
#Master Control Panel C-451A/ARC-21*	5-3/4	7-1/8	5-1/8	4.75
#Auxiliary Control Panel C-455/ARC-21*	5-3/4	2-5/8	4-11/32	1.50
Coupler, Antenna CU-145/ARC on Mounting MT-1169/U	17-5/8	8	24-3/32	53.00
Coupler, Antenna ERA Type 3001 on Mounting	11-1/2	9-3/8	24-1/2	31.00
Relay, Solenoid RE-132/ARC	3-1/8		8	2.19
Auxiliary Radio Receiver R-224/ARR-36 on Mounting MT-1276/ARR-36	12-3/4	11-23/32	25	58.50
Master Control Panel C-1210/ARC*	5-3/4	7-1/8	5-3/8	3.00

*Either master control panel may be used with either AN/ARR-36 or AN/ARC-21, but the Auxiliary Control C-455 can be used only with C-451.

**AN/ARC-21 denotes dc operation; AN/ARC-21X denotes ac operation. Difference exists only in power supply used.

AN/ARC-21 items employed at Carswell AFB and MacDill AFB.

NOTE: Power Supply PP-297/ARC-21 provides for use of 110 v 60 cps power for bench operation.

See Figures 1, p vii; 2, p 32; 3, p 33; 4, p 34; 12, p 44; 15, p 50; 16, p 51.

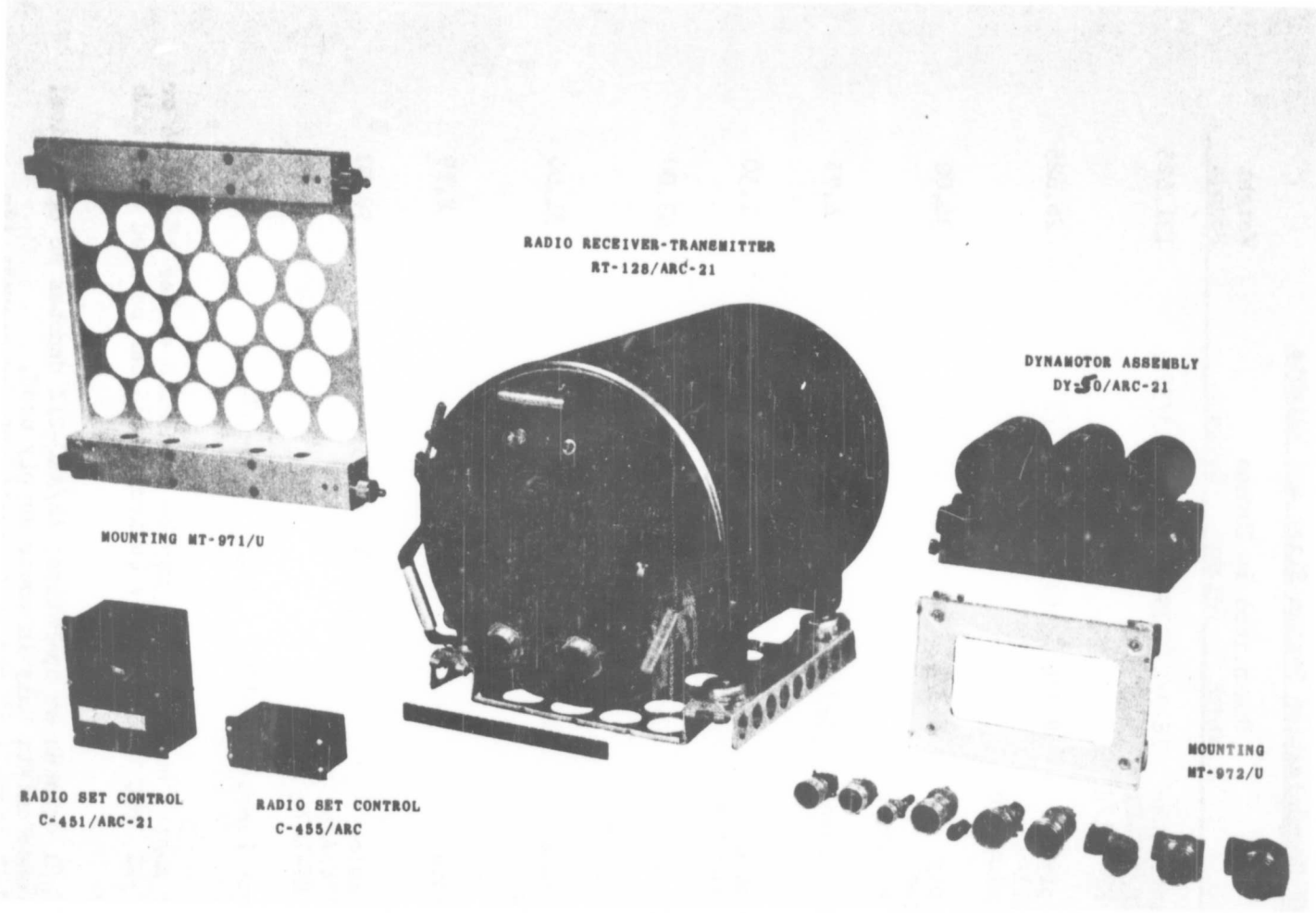

FIGURE 2

COMPONENTS OF RADIO SET AN/ARC-21

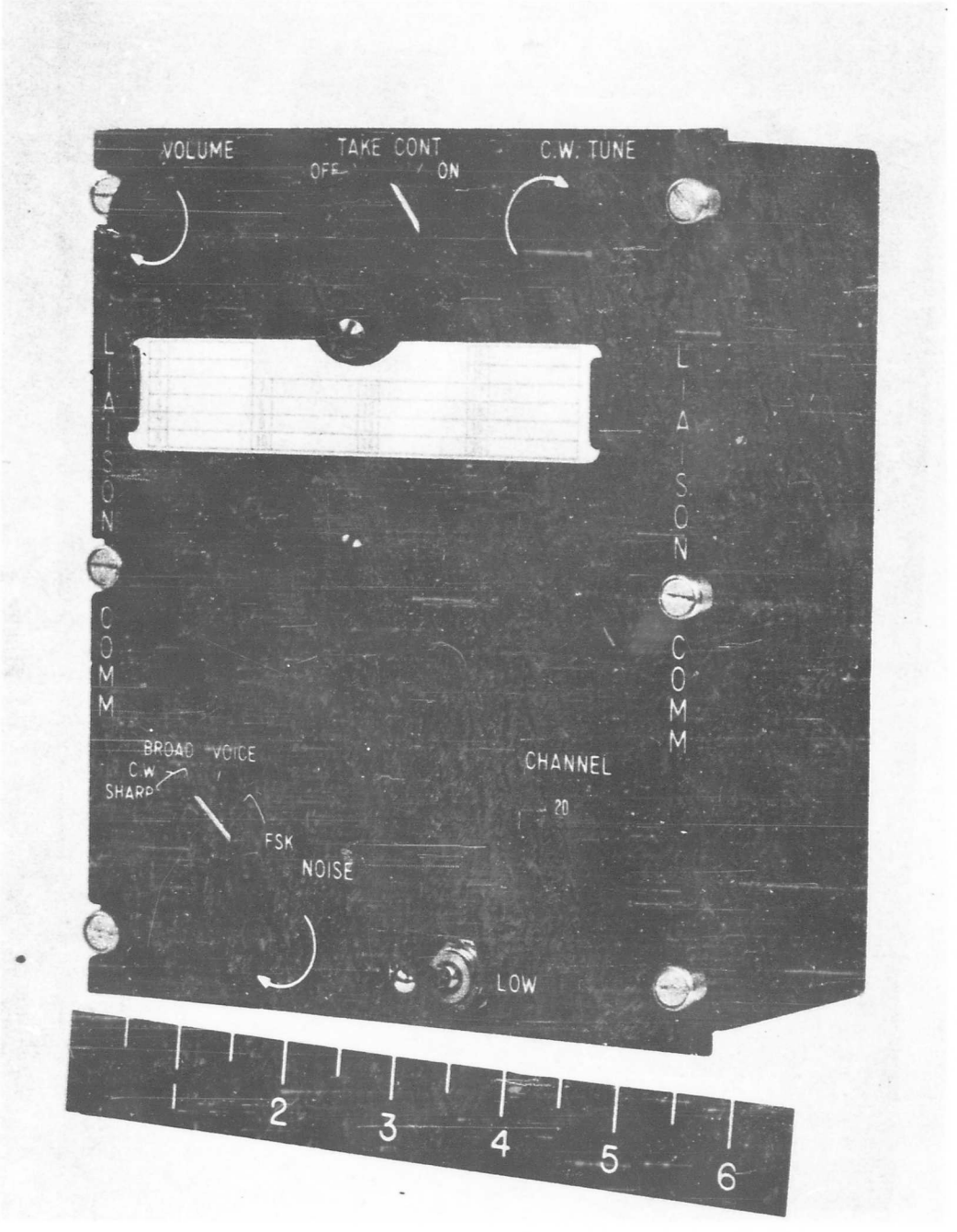

FIGURE 3

RADIO SET CONTROL C-451/ARC-21

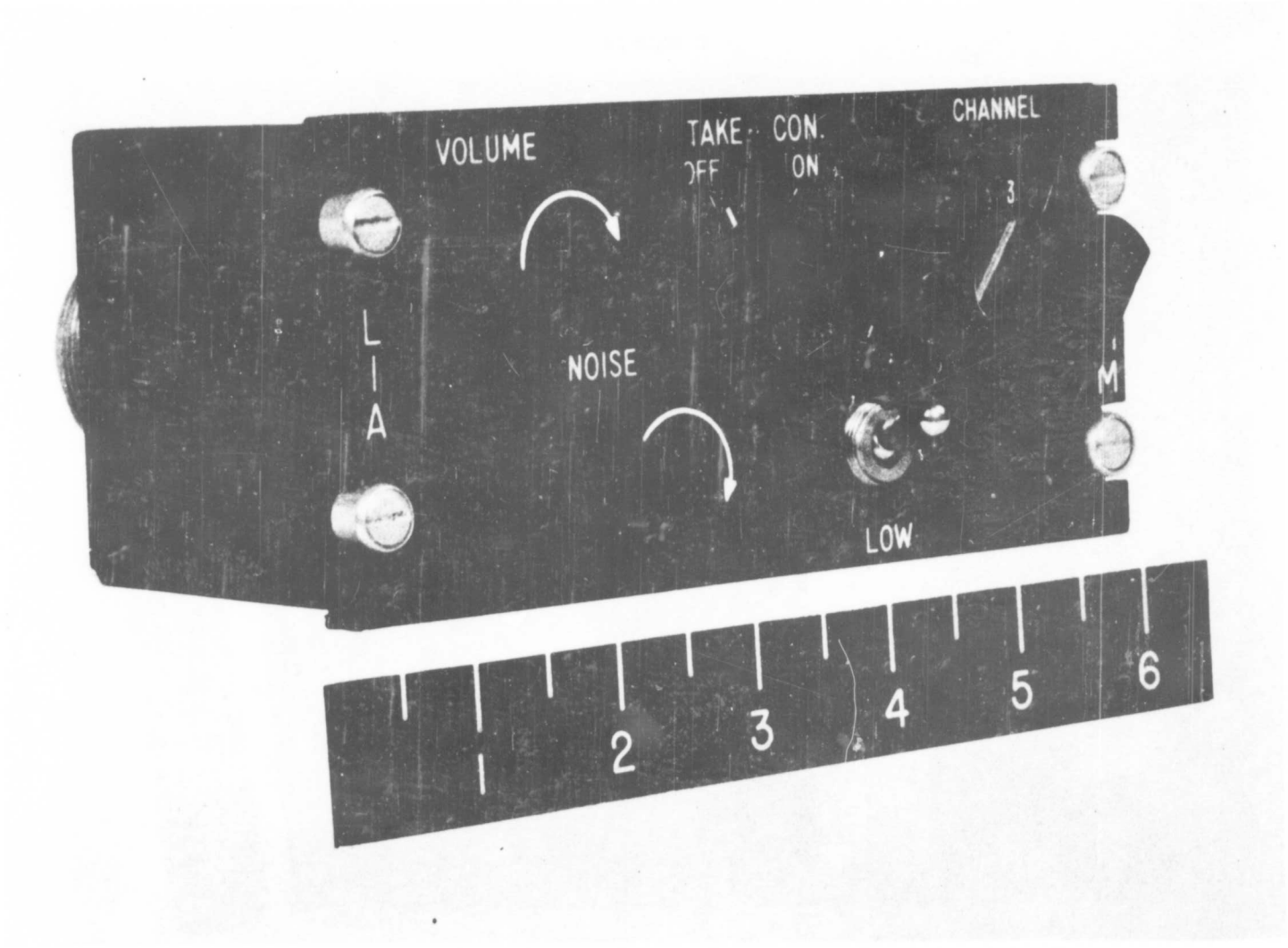

FIGURE 4

RADIO SET CONTROL C-455/ARC

APPENDIX XIV

Subassemblies of Receiver-Transmitter RT-128/ARC-21

Item	Nomenclature	Function
Amplifier, Audio Freq.	AM-773/ARC-21	Modulator-Servo
Amplifier, Radio Freq.	AM-774/ARC-21	Power Amplifier
Amplifier-Filter Assem.	AM-775/ARC-21	Harmonic Generator
Amplifier-Oscillator	AM-776/ARC-21	R-F Tuner-Exciter
Amplifier-Detector	AM-777/ARC-21	I-F, A-F
Relay Assembly	RE-134/ARC-21	Receiver Relay
Relay Assembly	RE-135/ARC-21	Coupler Relay
Relay Assembly	RE-136/ARC-21	Power Ampl. Relay
Oscillator, R-F	O-180/ARC-21	Reference Osc., Divider
Selector Control	MX-1425/ARC-21	Servo Selector
Chassis	MX-1424/ARC-21	Main Frame
Case	CY-1279/ARC-21	Pressure Housing

See Figure 5, p 36.

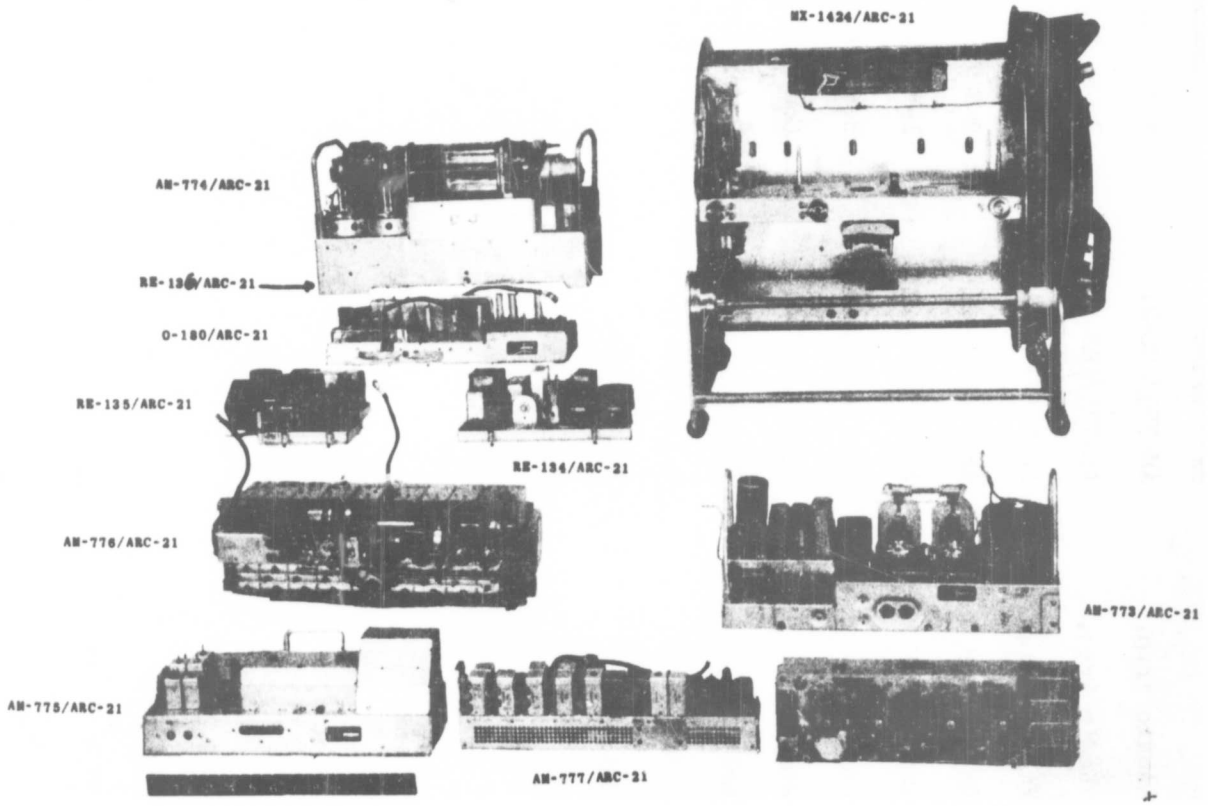

FIGURE 5

SUB ASSEMBLIES OF RT-128/ARC-21

APPENDIX XV

Special Purpose Test Equipment for Radio Set AN/ARC-21

Item	Nomenclature	Function
Multimeter	ME-75/ARC-21	"Go, no-go"
Maintenance Stand	MT-1164/U	Cradle for R-T Unit
Radio Test Set	AN/ARM-6	Handheld Transmitter Tester
Radio Test Set	AN/ARM-7	Bench Transmitter Tester
Test Kit	MK-136/ARC-21	Patching Cables
Interconnecting Box	J-520/U	Junction Box and Breakers

See Figures 6, p 38; 7, p 39; 8, p 40; 9, p 41; 10, p 42;
11, p 43; 13, p 45; 14, p 46.

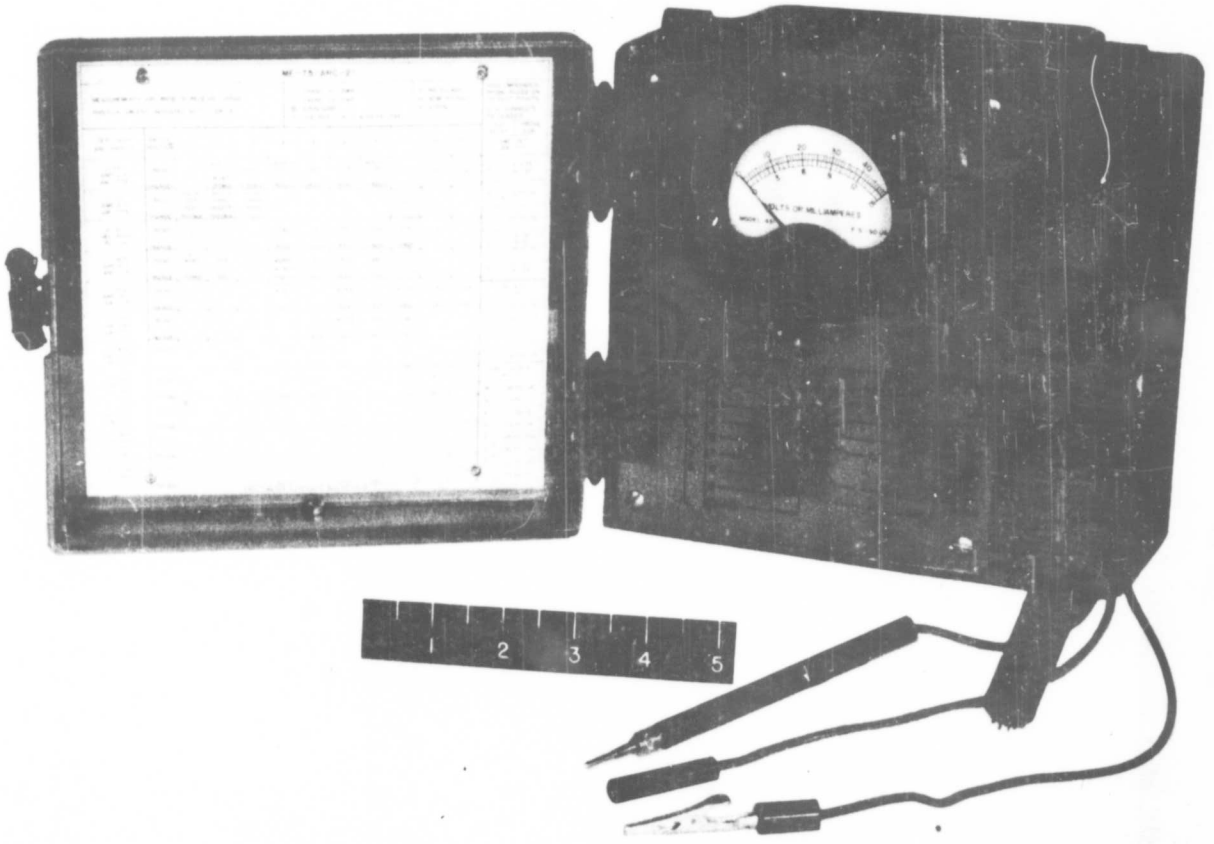

FIGURE 6

TEST METER ME-75/ARC-21

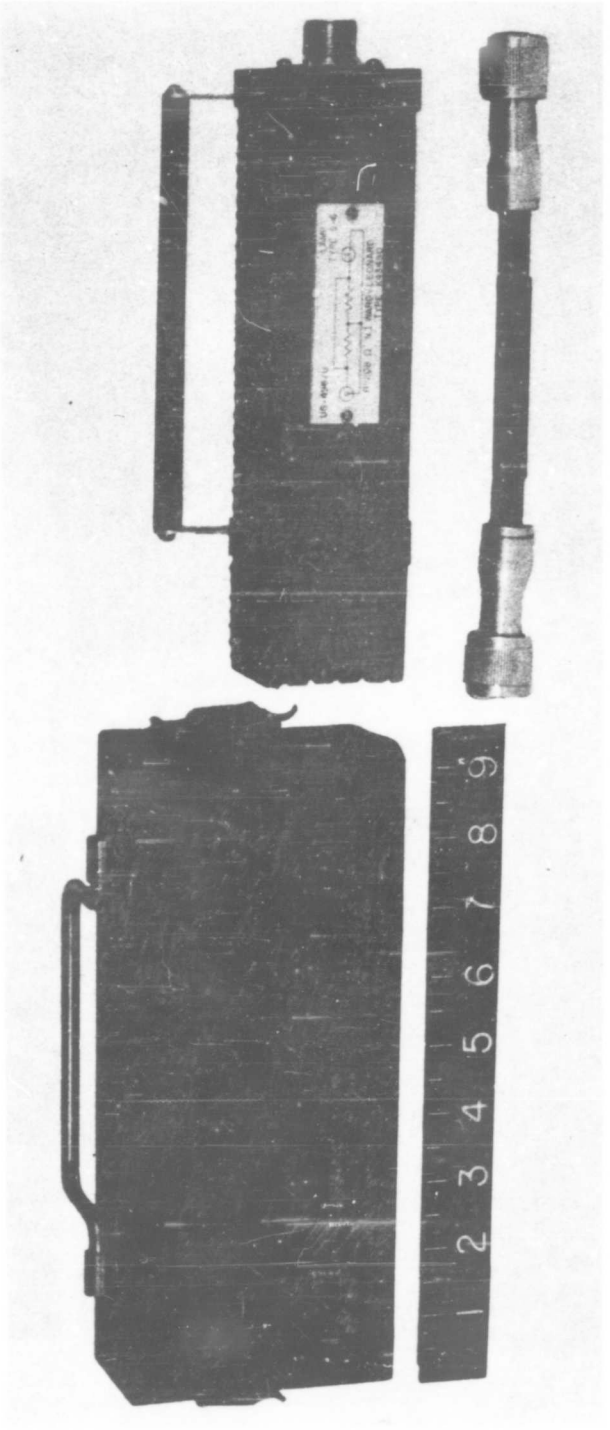

FIGURE 7

TEST SET, RADIO AN/ARM-6

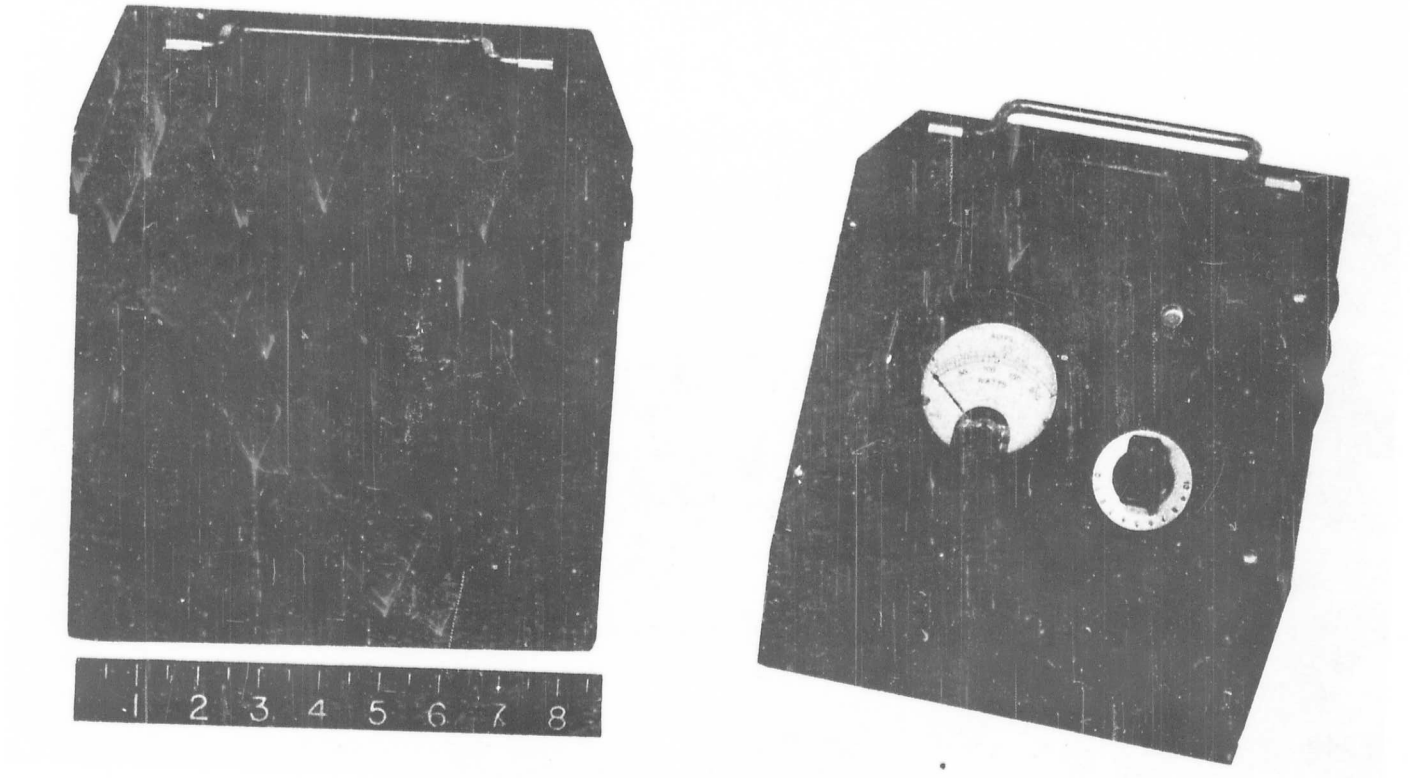

FIGURE 8

TEST SET, RADIO AN/ARM-7

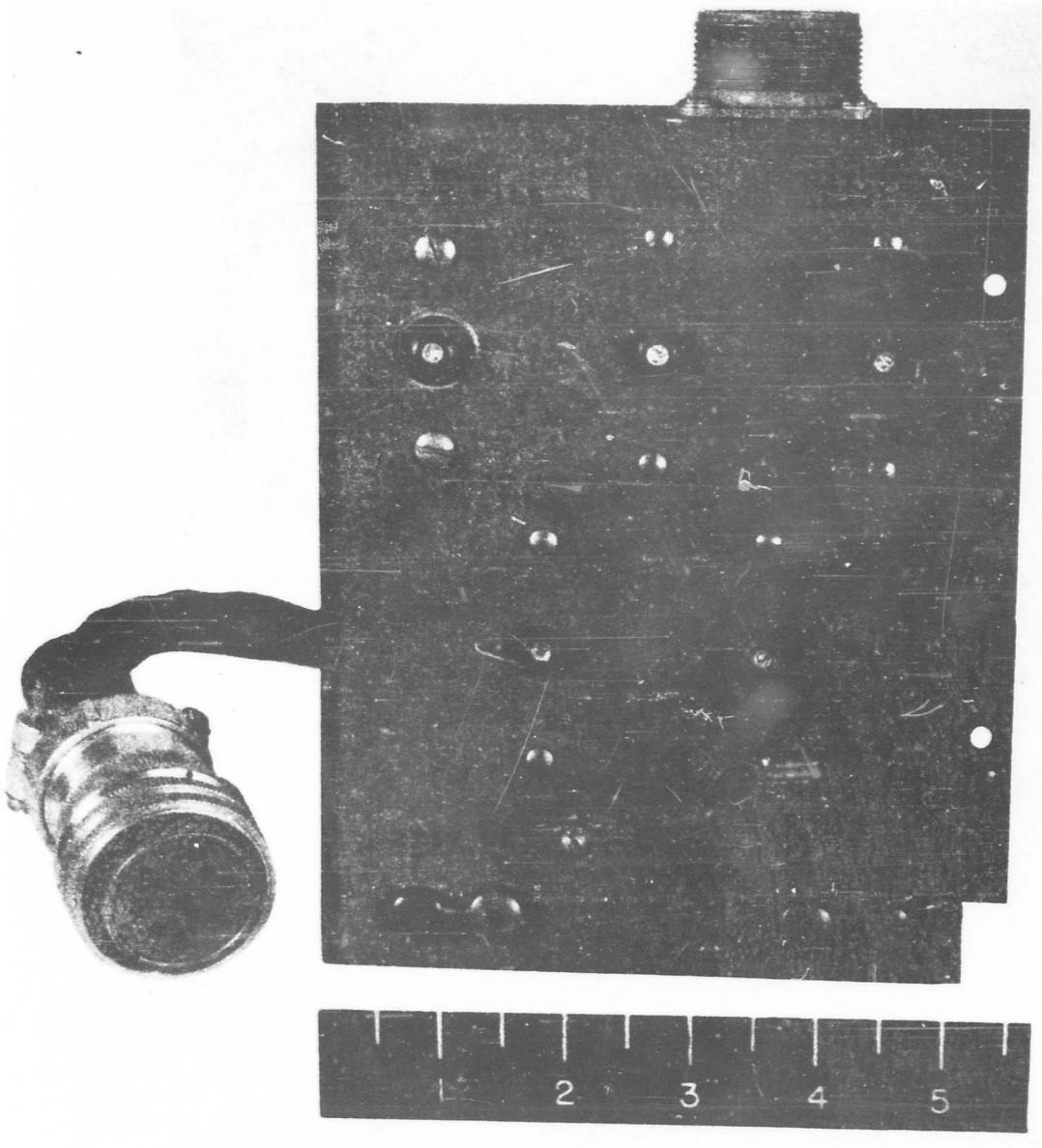

FIGURE 9

INTERCONNECTING BOX J-520/U

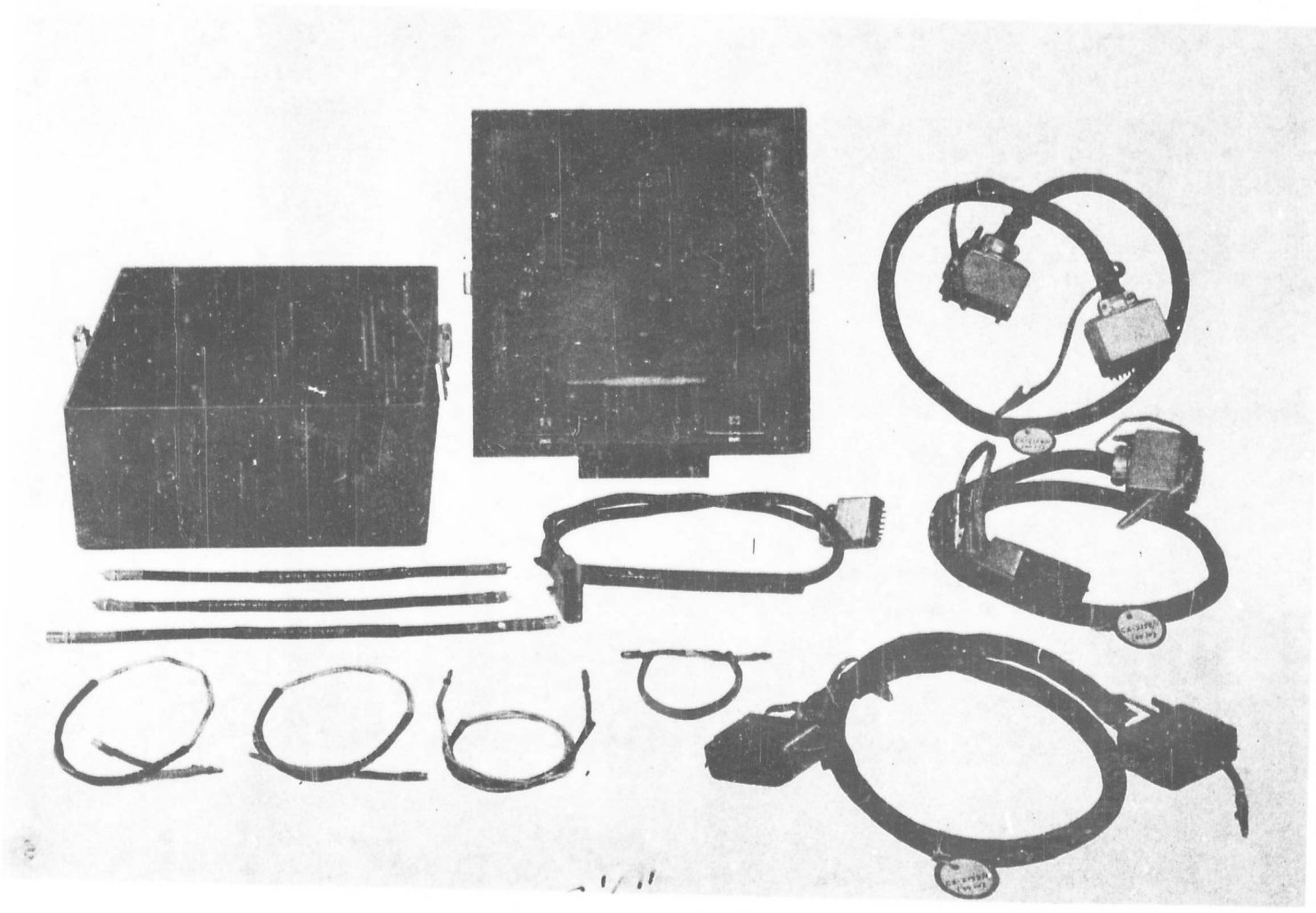

FIGURE 10

TEST KIT, RADIO MK-136/ARC-21

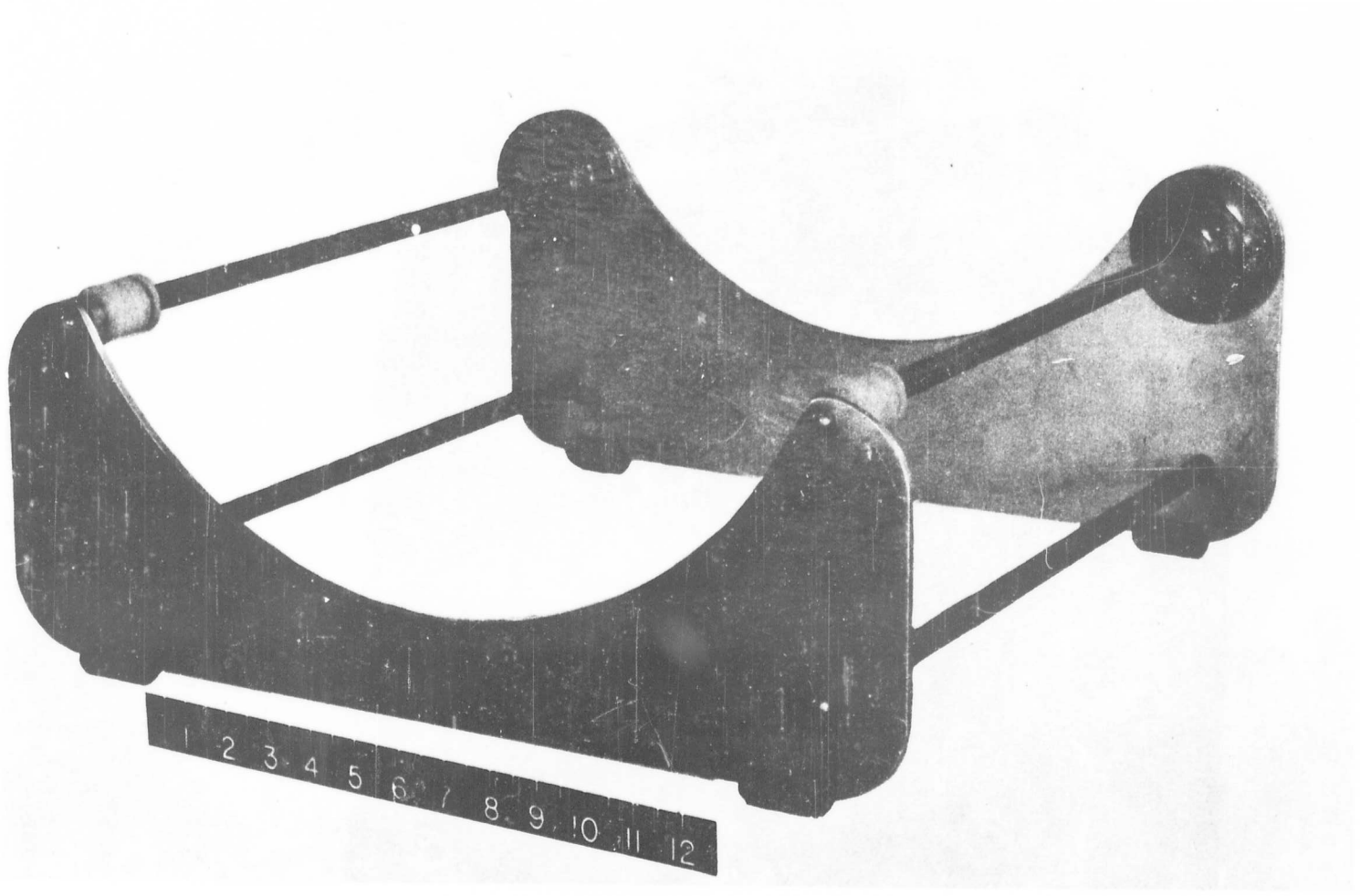

FIGURE 11

STAND, MAINTENANCE, RECEIVER-TRANSMITTER MT-1164/U.

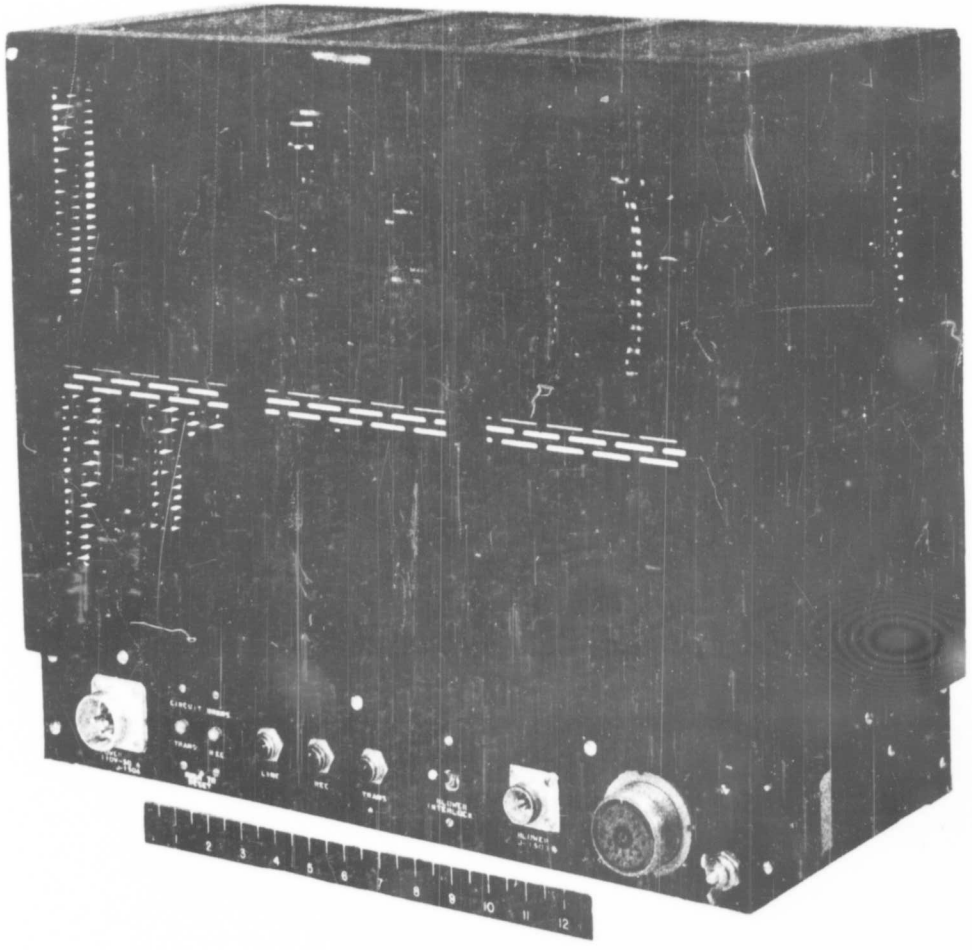

FIGURE 12

POWER SUPPLY PP-297(XA)/ARC-21

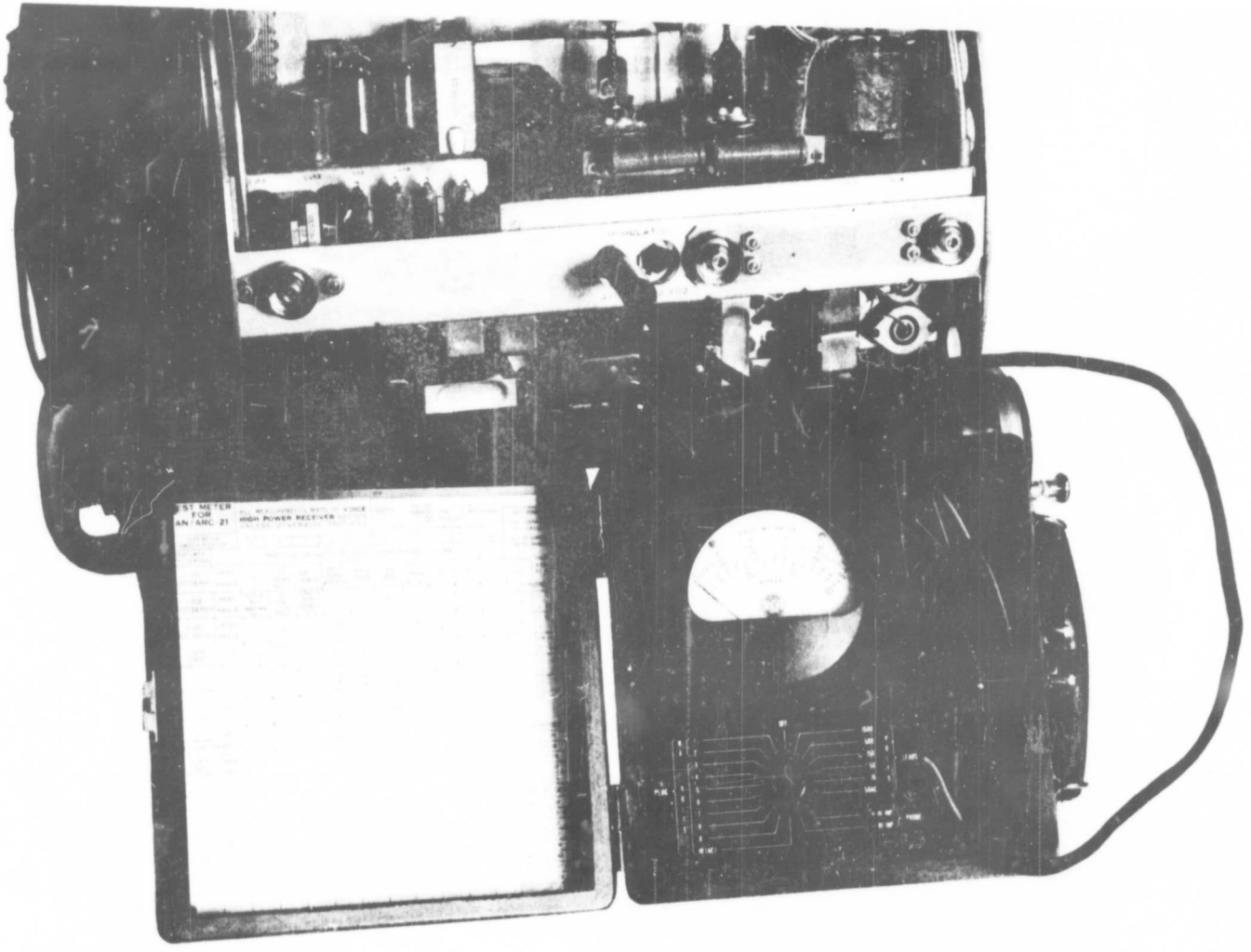

FIGURE 13

MULTIMETER ME-75(XA)/ARC-21 PLUGGED INTO TEST SOCKET

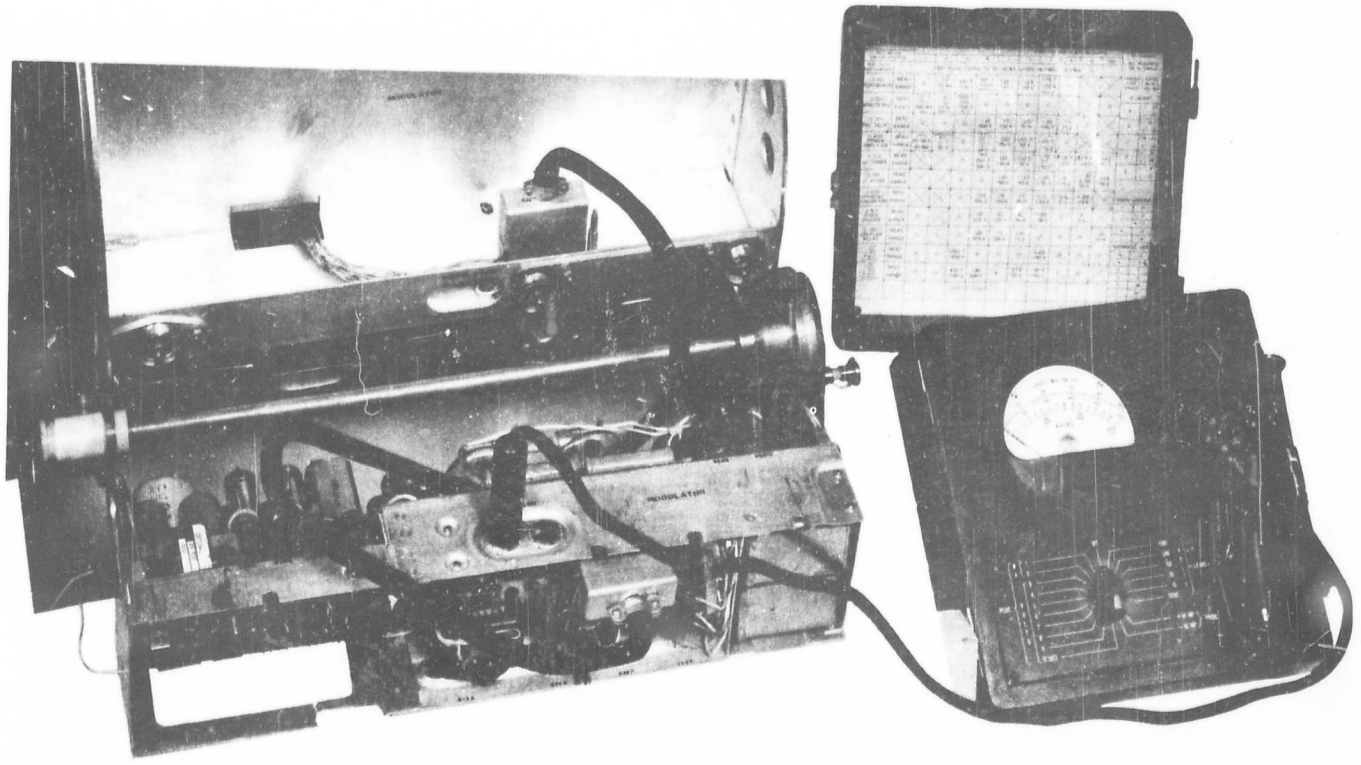

FIGURE 14

MULTIMETER ME-75(XA)/ARC-21 PLUGGED INTO TEST SOCKET OF AMPLIFIER, PATCHED TO RT UNIT

APPENDIX XVI

Implementation Schedule

STATION	EGLIN AFB	CARSWELL AFB	MACDILL AFB
AIRCRAFT TYPE	B-47, B-50, KC-97	B-36 H & J	B-47E
STATION COORDINATOR	Major Price	Major C. J. Flynn	Major E. Purdy
WADC REPRESENTATIVE	On Call	Mr. Michelsen	Major Sheets
AMC REPRESENTATIVE	On Call	Mr. M. Baker	Mr. D. Woolery
RCA TECH REPS	Mr. Bob Coleman Mr. Philip Landis	Mr. Zartman Mr. Spellum	Mr. Worthington Mr. Schectman
ERA TECH REPS	Mr. Marc C. Shoquist	Mr. A. E. Mueller	Mr. M. C. Shoquist
ARC-21 ARRIVE COMPLETE	17 Sep 54	7 Sep 54	14 Aug 54
COUPLERS ARRIVE COMPLETE	10 Sep 54	20 Aug 54	29 Jul 54
SPARE PARTS COMPLETE	14 Oct 54	3 Sep 54	21 Sep 54
TEST EQUIPMENT COMPLETE	24 Aug 54	4 Aug 54	4 Aug 54
BENCH MOCKUP COMPLETE	21 Aug 54	15 Aug 54	21 Sep 54
INSTALLATION COMPLETE	13 Oct 54	1 Sep 54	7 Sep 54
TESTING BEGAN	15 Aug 54	11 Aug 54	3 Sep 54
TESTING ENDED	1 Nov 54	19 Nov 54	4 Feb 55
BASE REPORT SUBMITTED	11 Feb 55	15 Dec 54	4 Mar 55

APPENDIX XVII

THE BIG EVA TEAM

Colonel John R. Knight, WCLN, Senior Project Officer for WADC.
Lt Colonel R. E. Hogan, MCPEC, Senior Project Officer for AMC.
Colonel John E. Frizen, temporarily assigned from AFOAC, Hq USAF.

Air Materiel Command

Mr. A. L. Baker*	Hq AMC	MCMTC
Mr. R. Collins	Hq AMC	MAHPG-35
Captain C. V. Evans*#	Hq AMC	MCPEC-C
Major L. W. Hieatt*#	Hq AMC	MCPEC
Mr. D. C. Jones	Hq AMC	MCPEC-C
Mr. H. Kalbfleisch	Hq AMC	MCPRM-P
Mr. R. R. McKay	Hq AMC	MCQAE
Mr. P. W. Morrell*#	Hq AMC	MCMTC
Mr. G. W. Nesbitt#	Hq AMC	MCSRD
Mr. R. E. Ormerod	Hq AMC	MCPBI-E
Mr. J. C. Stitts*	Hq AMC	MCPEC-C
Mr. N. A. Wilbur	Hq AMC	MCSRD-C
Mr. W. H. Blake*	Dayton AFD	MDSWA
Mr. M. Gold	Dayton AFD	MDMTEO
Mr. F. W. Kyle*	Dayton AFD	MDMTEO
Mr. B. L. Retterer*	Dayton AFD	MDMTEO (RCA)
Mr. M. R. Shafer#	Dayton AFD	MDF
Mr. J. L. Taylor*	Dayton AFD	MDMTEO

Air Research & Development Command

Mr. C. A. Ahalt	WADC	WCLNI
Mr. L. L. Gibbs*	WADC	WCRET
Mr. L. B. Hallman, Jr.*	WADC	WCLN
Mr. H. T. Hart#	WADC	WCLC
Mr. L. A. Hendricks*	WADC	WCLNO
Mr. S. A. Lawson	WADC	WCLNE4
Mr. G. W. Michelsen	WADC	WCLNQ1
Mr. S. W. Munson	WADC	WCLNT5
Major C. R. Osborn	WADC	WCSB(B-47)
Lt Colonel V. E. Redding	WADC	WCLNI
Mr. V. N. Reese*	WADC	WCLNT5
CWO L. H. Sarver	WADC	WCLNE4
Mr. G. H. Scheer*#	WADC	WCLNE
Major S. W. Sheets	WADC	WCLNE4
Lt Colonel E. E. Skinner	WADC	WCLNO
Mr. R. C. Sparks*	WADC	WCLNQ
Mr. J. W. Wilson*	WADC	WCLNI2
Mr. H. F. Yoder*	WADC	WCLNE4

APPENDIX XVII (continued)

Contractor's Representatives

Mr. Tom Finley*	RCA	Dayton
Mr. B. R. Harrigan*	RCA Service Co.	Dayton
Mr. J. M. Hertzberg	RCA	Camden
Mr. R. A. Root	RCA Service Co.	Dayton

NOTE: Other personnel, not listed, participated in some meetings.

*Represent continuity of effort through high meeting attendance.

#Members of the joint AM-WADC C & N Aids Phasing Group.

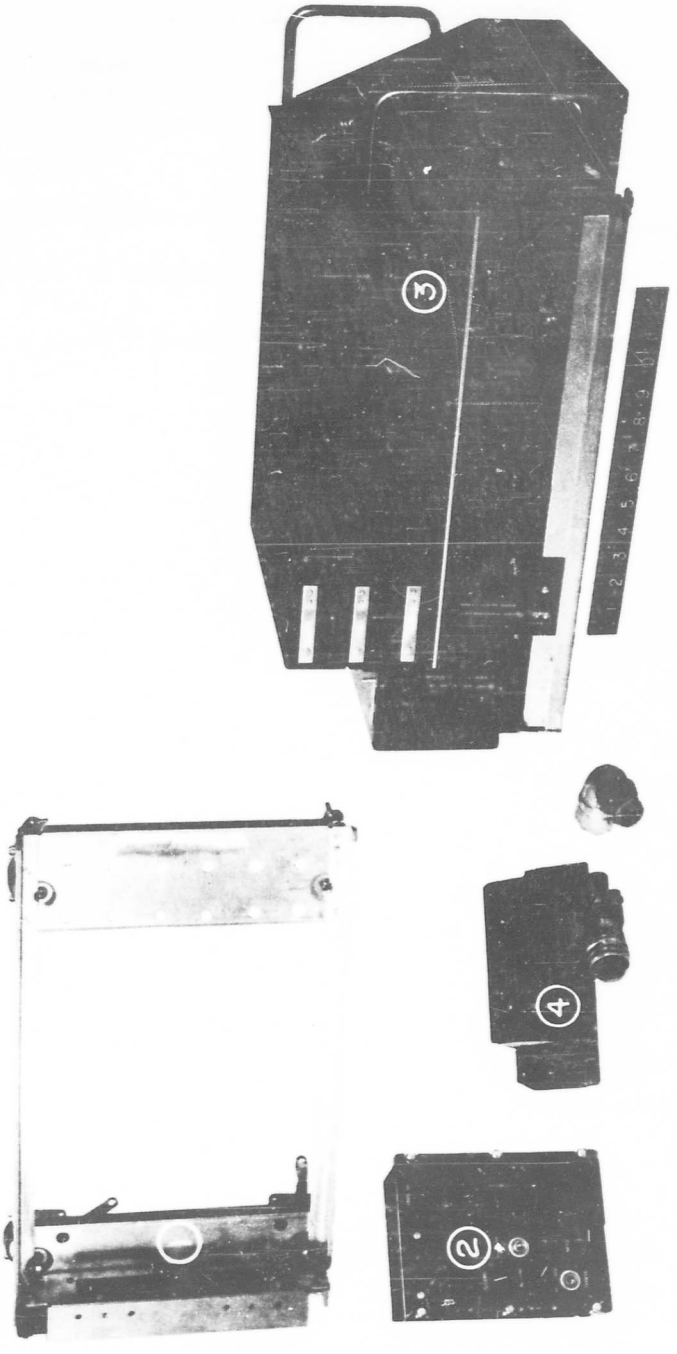

FIGURE 15

RADIO RECEIVING SET AN/ARR-36

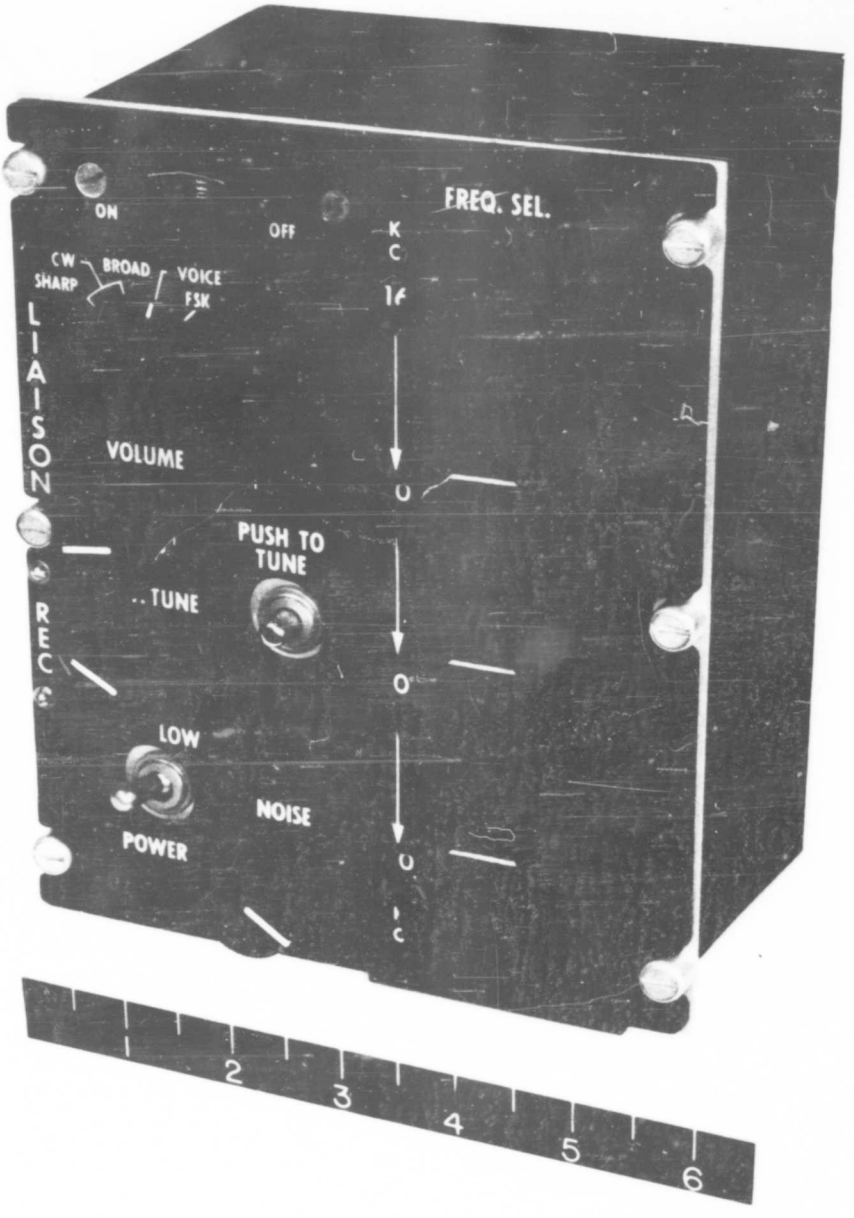

FIGURE 16
RADIO SET CONTROL C-1210/ARC

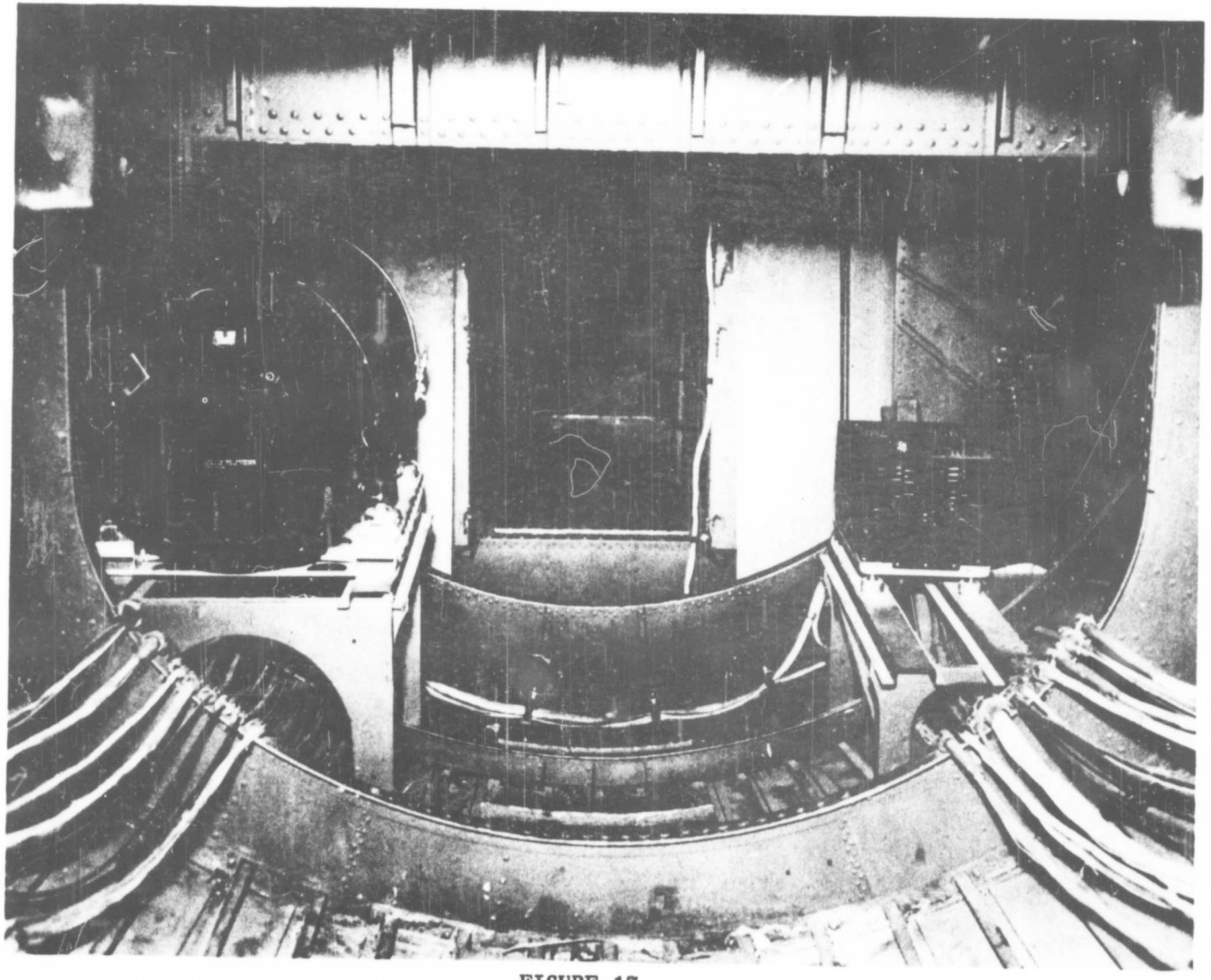

FIGURE 17

B-36 AIRCRAFT INSTALLATION OF R-T UNIT AND POWER SUPPLY

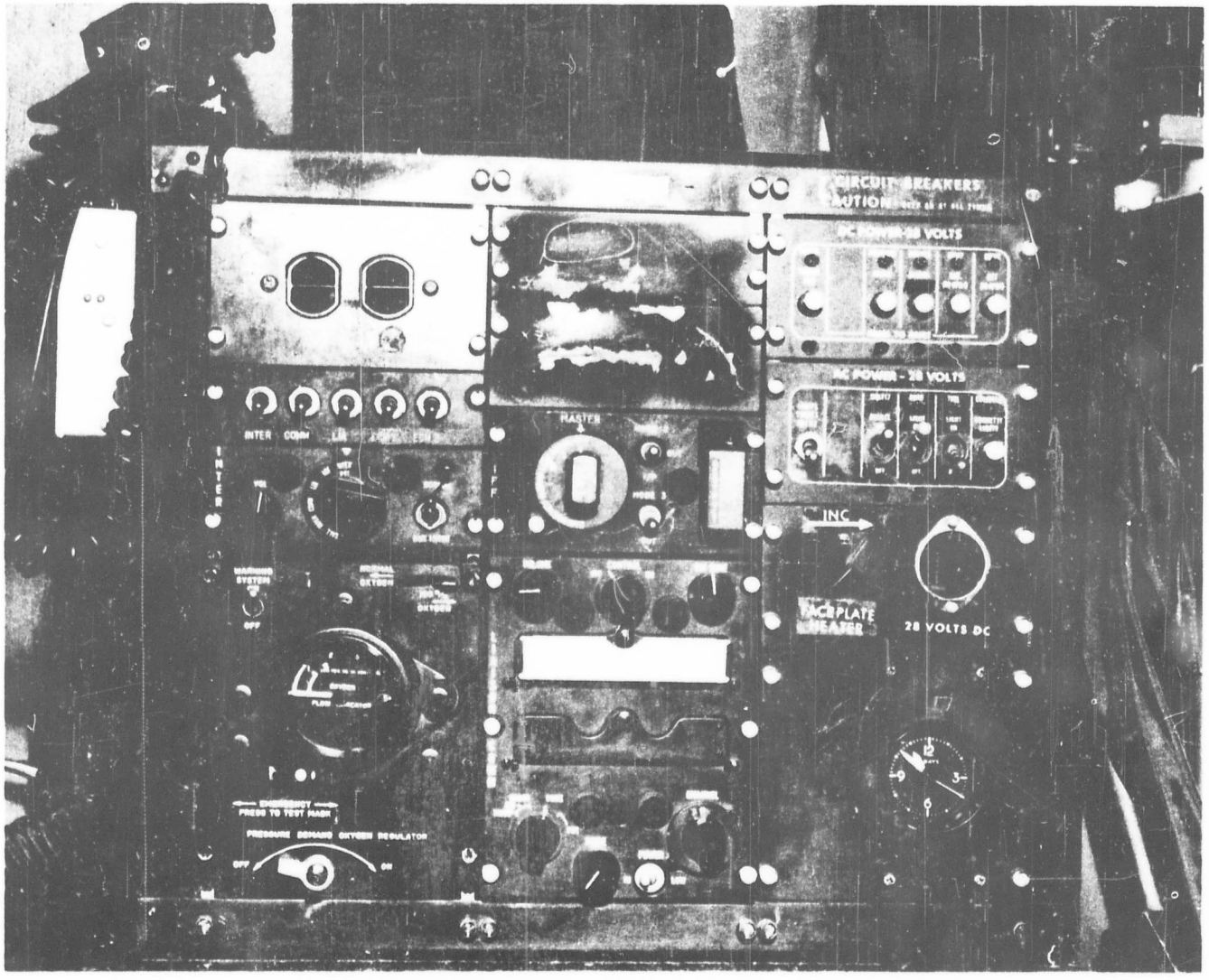

FIGURE 18

B-36 INSTALLATION OF MASTER CONTROL PANEL

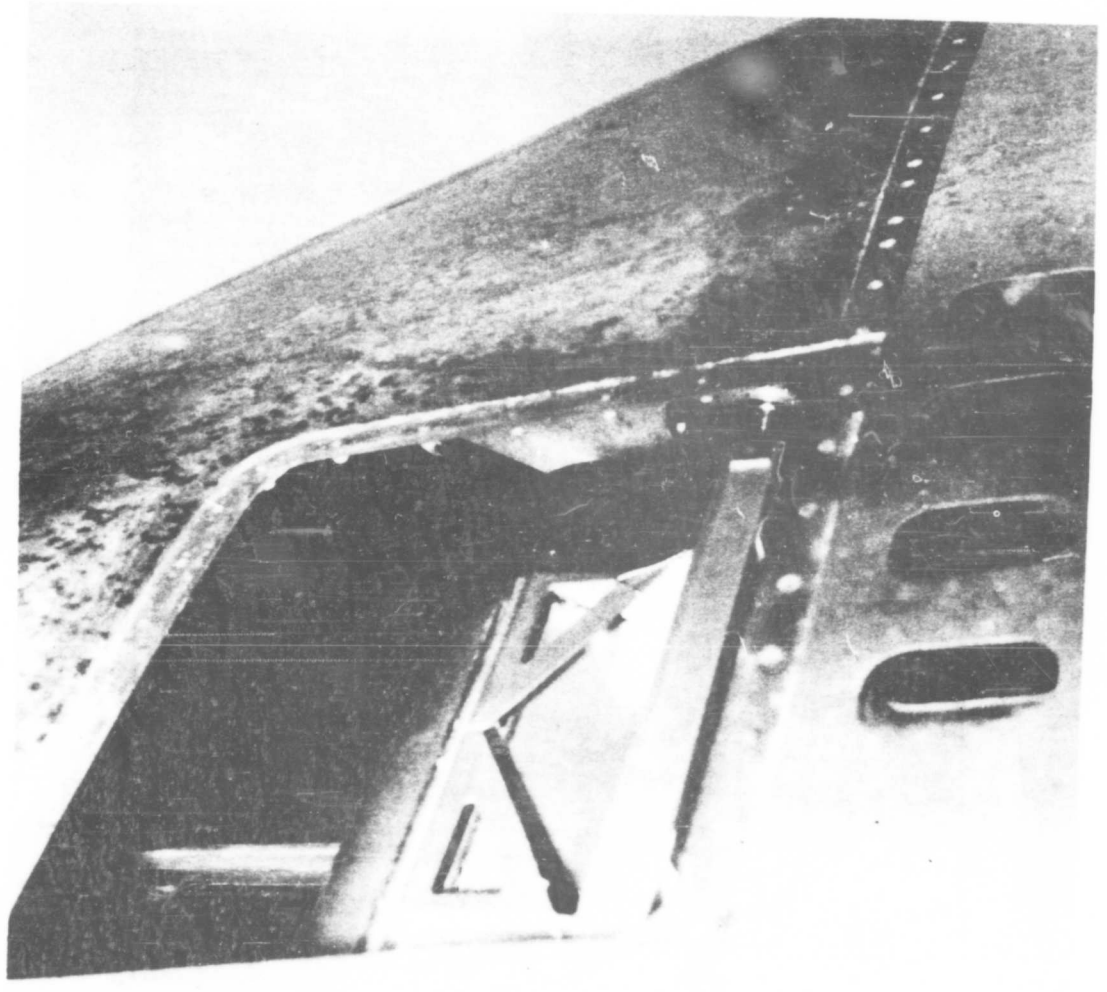

FIGURE 19

B-36 INSTALLATION OF E.R.A. ANTENNA COUPLER

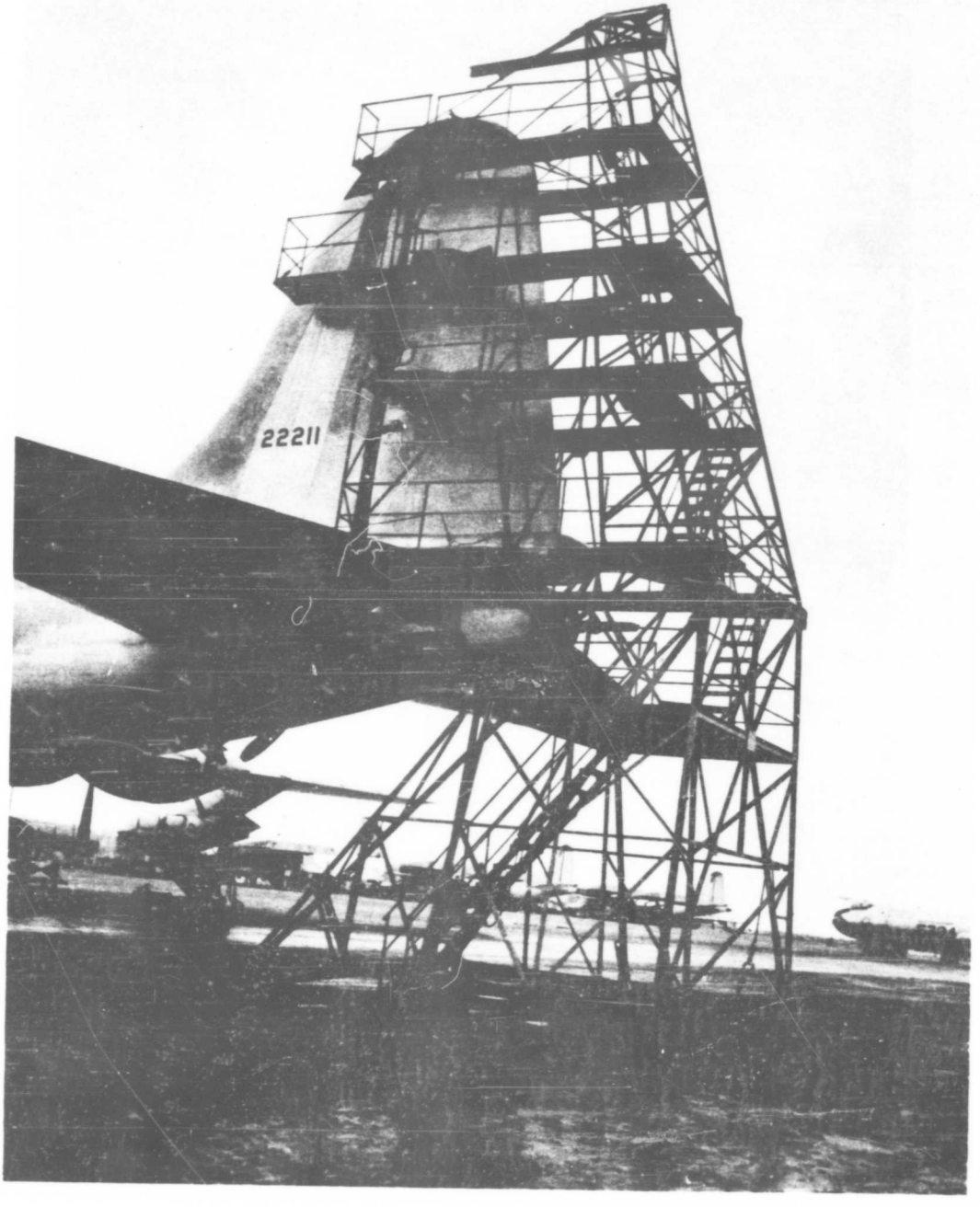

FIGURE 20

B-36 TAIL SECTION SHOWING ISOLATED TAIL CAP ANTENNA

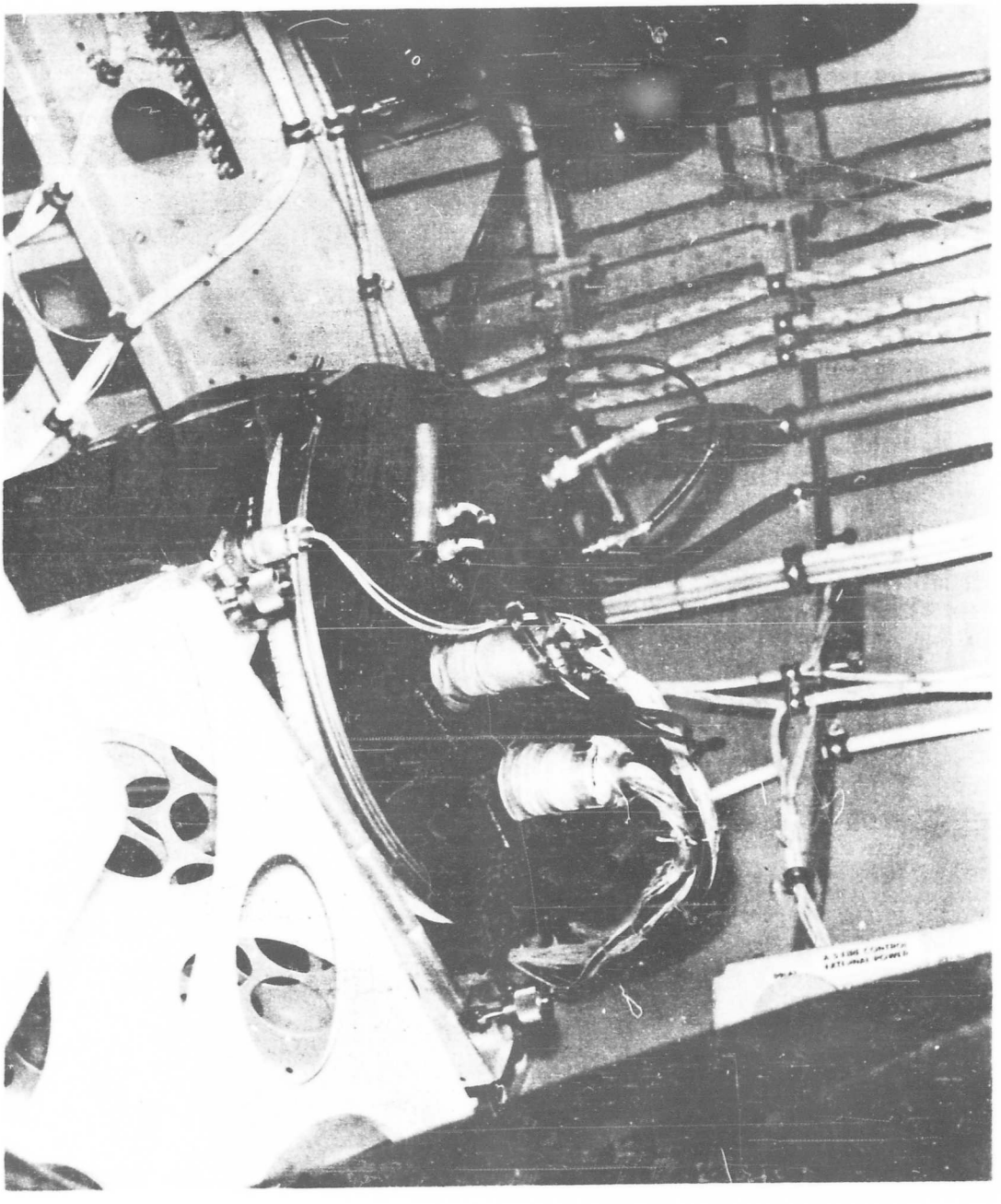

FIGURE 21

B-47 INSTALLATION OF R-T UNIT

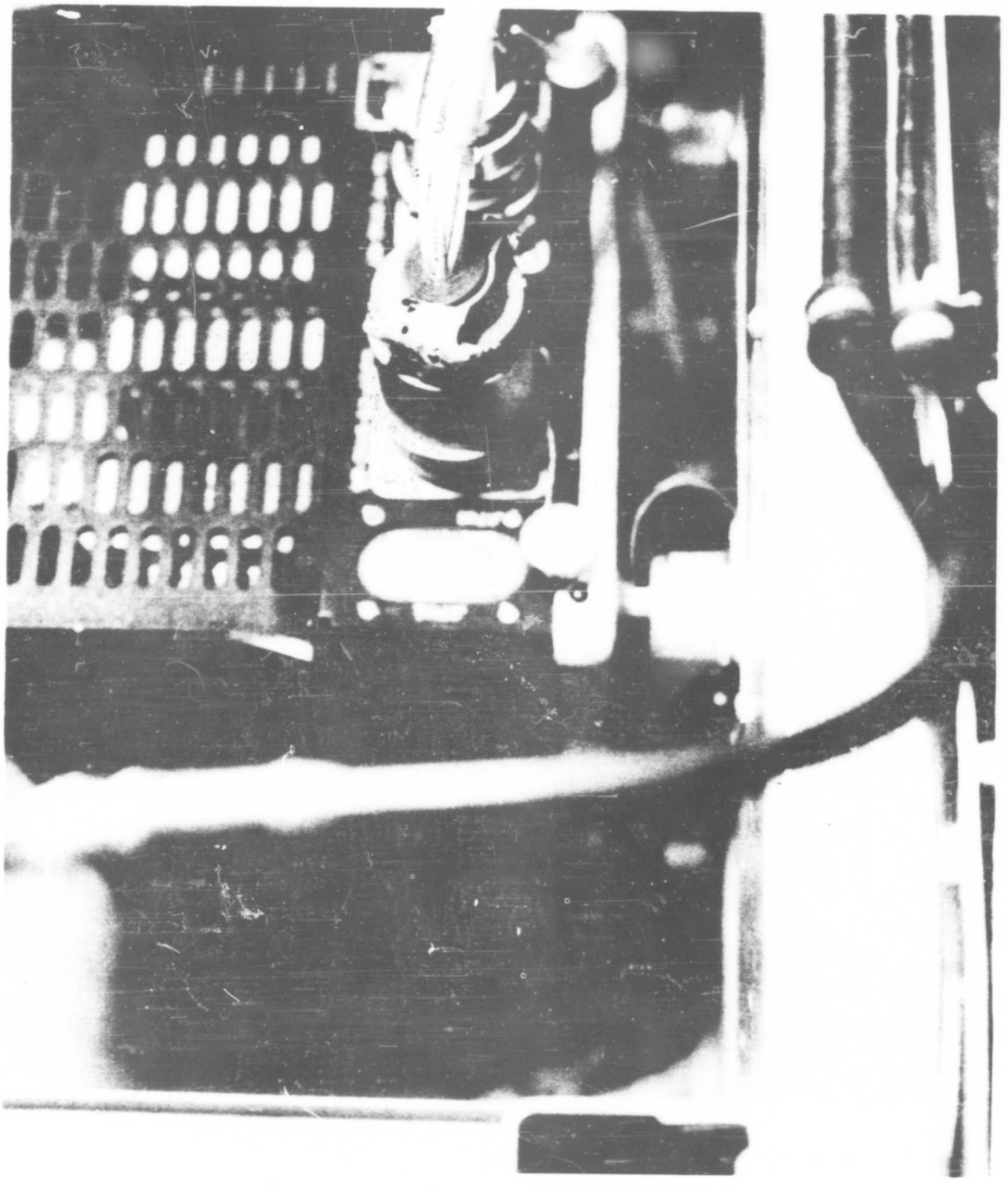

FIGURE 22

B-47 INSTALLATION OF POWER SUPPLY

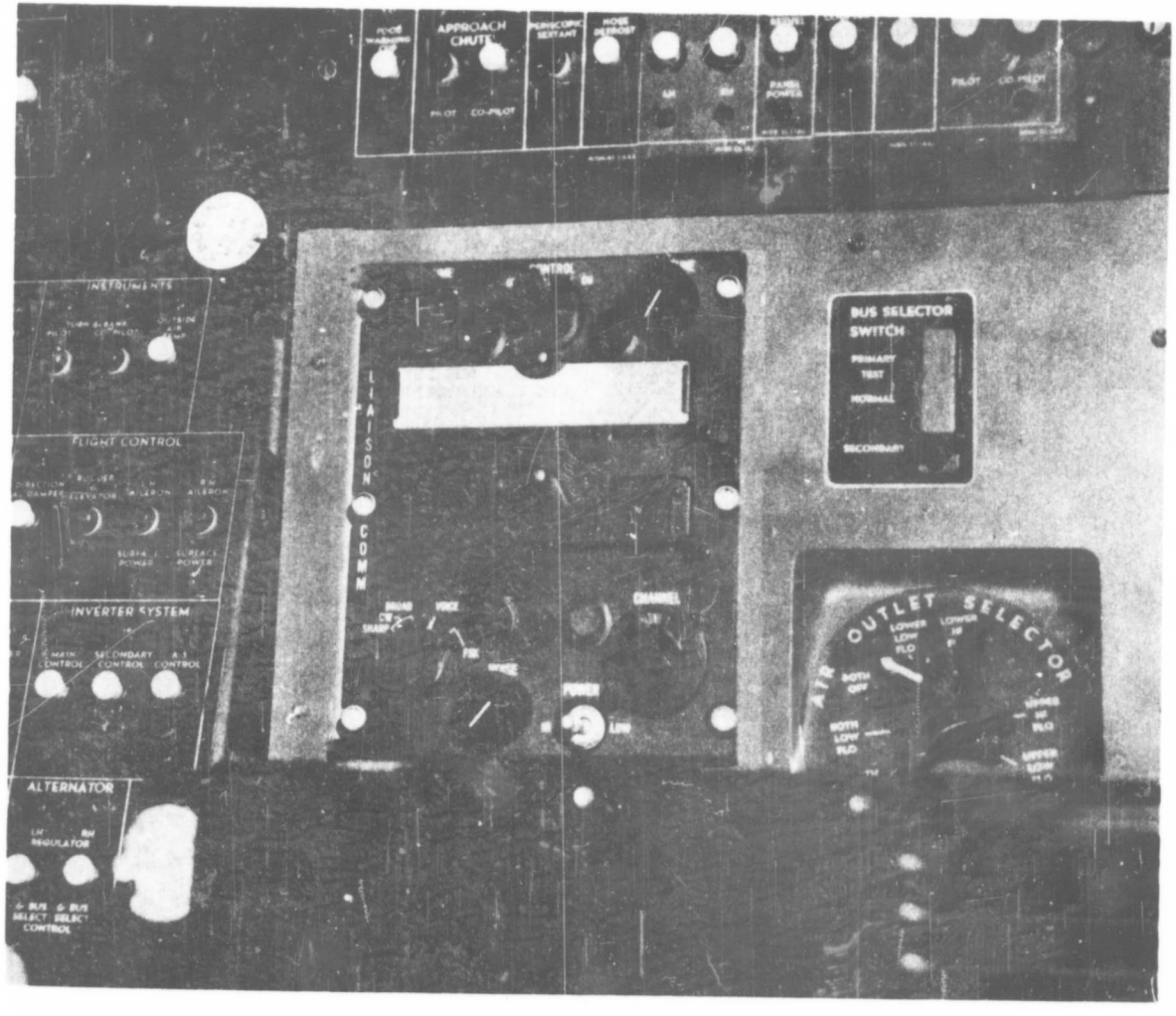

FIGURE 23

B-47 INSTALLATION OF MASTER CONTROL PANEL

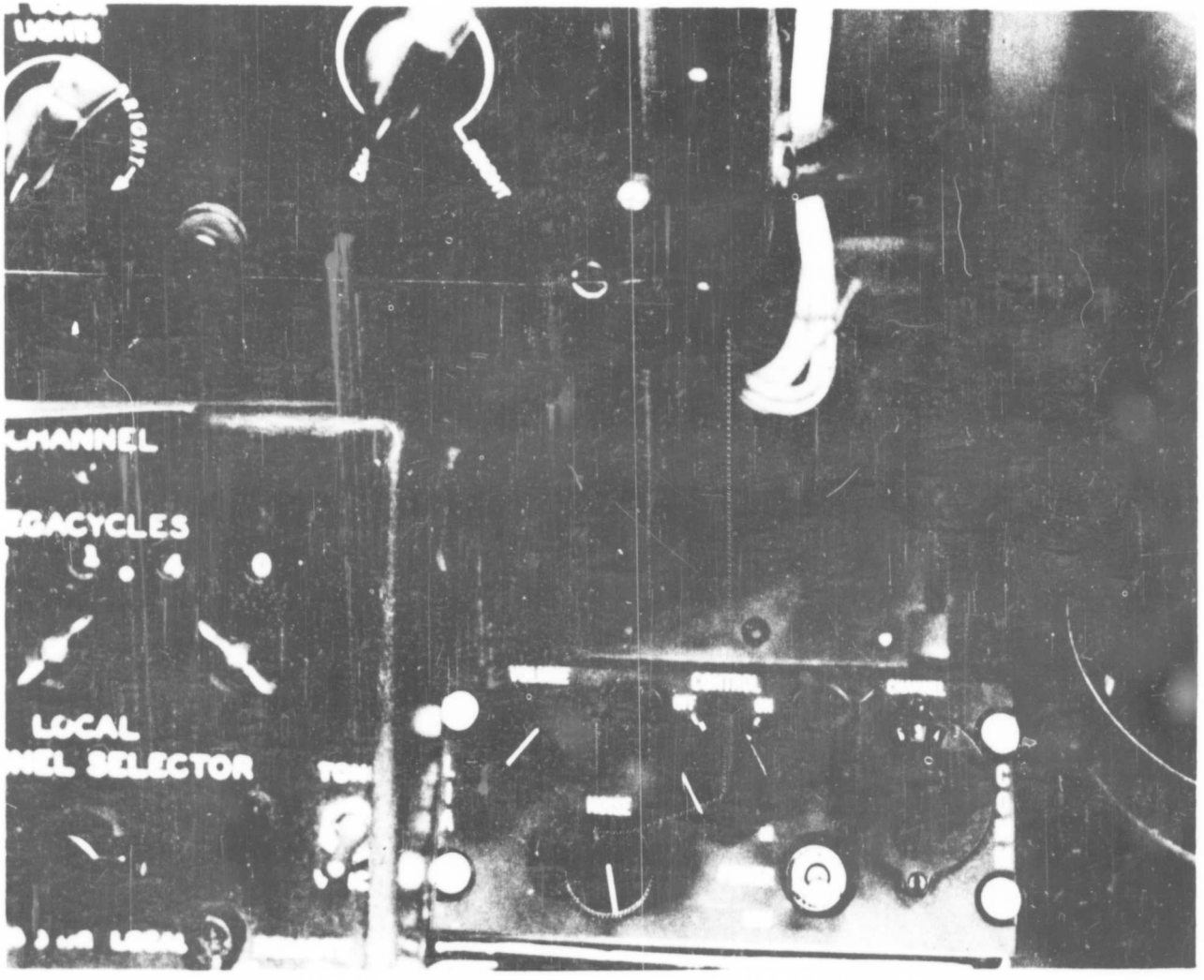

FIGURE 24

B-47 INSTALLATION OF AUXILIARY CONTROL PANEL

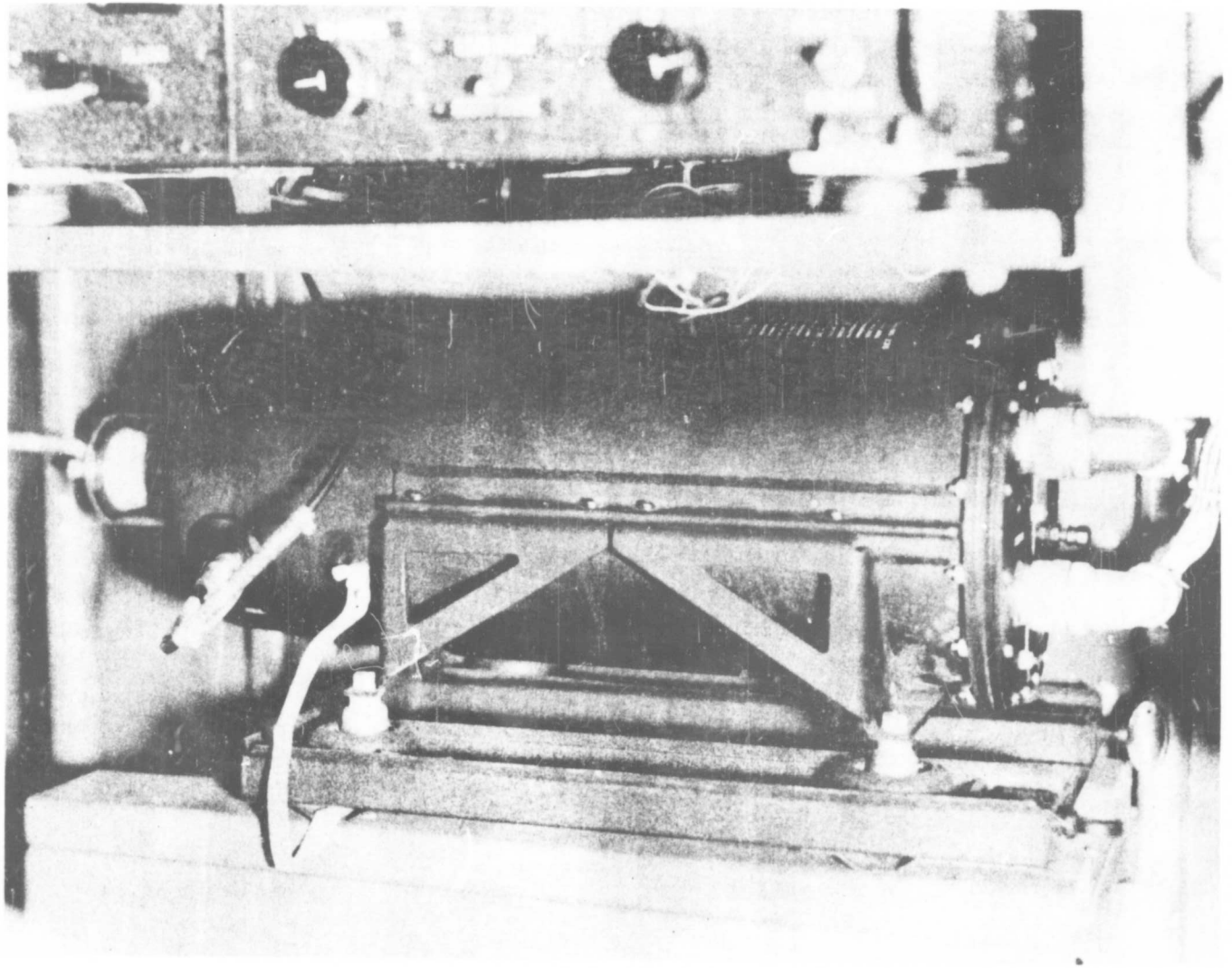

FIGURE 25

B-47 INSTALLATION OF E.R.A. ANTENNA COUPLER

FIGURE 26

B-47 INSTALLATION OF ANTENNA AND MAST

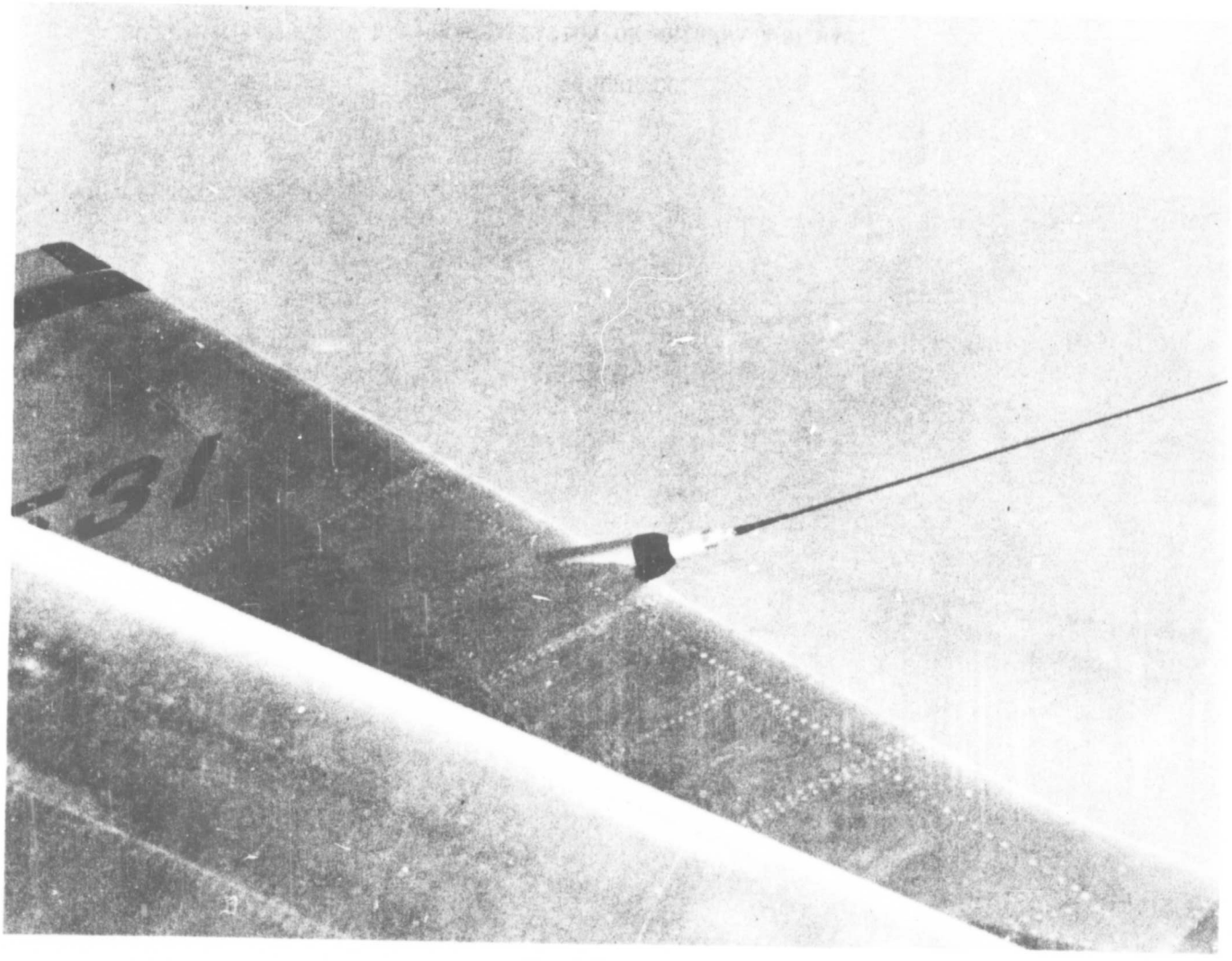

FIGURE 27

B-47 INSTALLATION OF ANTENNA SHORTING RELAY