SM-65 SERIES D/SAMOS/MIDAS

FLIGHT TERMINATION SUBSYSTEM

Pacific Missile Range

Report No. ~~AE60-0769A~~

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UNCLASSIFIED

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DOWNGRADED AT 3 YEAR INTERVALS; DECLASSIFIED AFTER 12 YEARS. DOD DIR 5200.10

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UNCLASSIFIED

TRC-60-0114

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FOREWORD

This document supersedes Report No. AE60-0263, dated 30 June 1960 and Report AE60-0769, dated 28 September 1960. The primary purpose of this report is to inform the Range Safety Officer, Pacific Missile Range (PMR), of the configuration and operating characteristics of the flight termination subsystem to be used on Samos/Midas flights from Point Arguello Launch Site. The secondary purpose is to inform qualified personnel about the operations involved in the airborne flight termination subsystem, as required for test.

The satellite vehicle and satellite-vehicle systems described in this report are the Samos vehicle, Models 9205 and 4205, and Midas Model 7205.

The Samos/Midas program uses a modified version of the SM-65 Series D/IOC missile as a booster vehicle to launch a satellite from PMR. One of the subsystems which has been modified on the Series D/IOC missile for use in the Samos/Midas program is the flight termination subsystem.

To provide consistency between this report and other literature dealing with the Samos/Midas program, the SM-65 Series D missile will be referred to as the booster vehicle; the combination of booster and satellite vehicles will be referred to as the flight vehicle.

CONCURRENCE

Information contained in this Flight Termination Subsystem Report which pertains to the Samos satellite has been furnished, and consequently agreed to, by Lockheed Aircraft Corporation, Missiles and Space Division.

D. J. Gribbon
Manager, Satellite Systems

[redacted]

ADDENDA

The following information on primers is issued to holders of Report AE60-0769A, "SM-65 Series D/Samos/Midas Flight Termination Subsystem, PMR", revised 20 February 1961. It is to be inserted in the bound copies immediately following the title page.

Primers Used in the Booster Destructor Unit

The primers shown in the 27-04306-3 Destructor Unit in the booster, labled in Figure 1-3 and Figure 1-17 as BW-10004, and shown in Figure 1-18, will be replaced by BW-10081 primers in boosters 27-0006-3, -7 (108D), and on. The primer type designation "BW-10004" should be deleted from Figures 1-3 and 1-17, and the following effectivities should be observed:

Primers	Effectivities
BW-10004	27-0006-1, -2, -4, -5, -6.
BW-10081	27-0006-3, -7 (108D) through -29.

The following electrical characteristics (vendor's data) are identical for both the BW-10004 and BW-10081 primers:

(a)	Bridgewire Resistance:	0.3 ±0.1 ohm at 70° F 0.50 ±0.15 ohm at 350° F
(b)	Minimum Firing Current, (5 min):	0.450 amperes
(c)	Recommended Minimum Firing Current:	1.0 amperes
(d)	Ignition Time, 1-amp Current:	58 ±15 milliseconds
(e)	No-fire current (testing):	0.2 amperes
(f)	Spontaneous Detonation Temperature:	370°F

The two primers differ in the transmission time of the explosive front through the primer. The BW-10004 has no delay, and detonation of the high explosive may be assumed to occur within a few microseconds following initiation. Thus, firing time is equal to the ignition time.

The BW-10081 primer is 5/16-inch longer than the BW-10004 primer in order to accommodate a pyrotechnic delay consisting of a slow-burning powder train. The pyrotechnic delay time is 90 ±30 milliseconds. Thus, the minimum firing time is equal to 60 milliseconds plus the ignition time. The BW-10081 primers will fire the high explosive within 60 to 120 milliseconds following ignition, even though the electrical signal is removed simultaneously with ignition.

[redacted]

ERRATA

The attached pages are furnished for insertion in bound copies of Report AE60-0769A, "SM-65 Series D/Samos/Midas Flight Termination Subsystem," dated 9 December 1960, to correct published information.

Insert this Errata sheet between pages ii and iii of the bound copy. Remove and destroy the following bound pages and insert the corrected pages in their place:

Title Page and ii
Pages iii and iv (Table of Contents)
vii and viii,
1-5 and 1-6,
1-27 and 1-28,
1-33 and 1-34,
1-37 and 1-38,
1-39 and 1-40,
4-7 and 4-8,
4-11 and 4-12,
4-13 and 4-14

Delete section II in entirety (pages 2-1 thru 2-4). Insert dummy sheet for Section II to indicate deletion of material.

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LIST OF TABLES

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INTRODUCTION

The Samos/Midas program is designed to place a satellite reconnaissance vehicle into orbit around the earth. The experimental satellite vehicle is scheduled for launching from Point Arguello Launch Site within the Pacific Missile Range. The SM-65 Series D booster vehicle will go through a normal phase of powered flight. Following vernier cutoff, the satellite will be separated from the booster vehicle and will coast until the satellite engines ignite to propel it into its correct orbit.

To ensure the safety of the range and its environs, the capability of destroying both booster and satellite must exist. This destruct capability is required in case either erratic operation or premature separation takes place. In view of this requirement, Convair has so modified the SM-65 Series D missile flight termination subsystem that it will relay a destruct signal to the satellite vehicle.

The satellite vehicle adapter section contains a destructor which can be actuated by a destruct signal from the booster vehicle flight termination subsystem, or by premature separation circuitry if premature separation of the satellite from the booster vehicle should occur.

Range Safety is the responsibility of the Range Safety Officer. He maintains the capability of destroying both the booster and the satellite throughout the powered phase of booster-vehicle operation, i.e., until the sustainer cutoff (SCO) signal is given to the booster by the guidance-control radio link. The SCO signal "safes" the satellite destruct system; once this command is received, the Range Safety Officer can no longer destroy the satellite vehicle. He can, however, destroy the booster until either extensive range (possibly exceeding 1500 n. mi.) or battery life (possibly as long as 10 minutes) limit this capability.

NOTE

The seeming inconsistency between the satellite and booster destruct initiator terminology is reconciled by the following explanation.

Comparison and Explanation of Booster and Satellite Destruct Initiator Terminology

In general, the term "primer" refers to a physically separate unit containing one or more squibs and a small powder charge. The term "squib" basically refers to a resistive wire, contained within the powder charge, whose temperature increases rapidly with conduction of current; "squib" is here used in the same sense as the term "bridgewire".

The booster destructor utilizes two physically separate primers, each with its own squib or bridgewire and powder charge. Ignition of the powder charge in either primer will result in detonation of the high explosive when the device is armed. Primer current refers to the current passing through the squib or bridgewire within the primer. In the diagrams, the primer bridgewires are shown by symbols normally used to represent fuses.

The satellite destruct initiator is a single primer employing two squibs or bridgewires. Sufficient current through either squib will ignite the powder charge within the primer and will cause detonation of the high-explosive shaped-powder charge. The satellite squibs are shown in the drawings as resistors enclosed in boxes.

The diagrams in this report are functionally correct; ignition of a single primer or squib in either stage will initiate destruction of that stage.

SECTION I

FLIGHT TERMINATION SUBSYSTEM

1.1 INTRODUCTION. The function of the flight termination subsystem (FTS) is to receive frequency-modulated signals from the ground transmitter, decode these signals into a command, and to destroy the flight vehicle upon command. The satellite vehicle is automatically destroyed upon premature separation. The flight termination subsystem has been designed to be compatible with the PMR Range Safety System ground equipment and operational procedures. Figure 1-1 shows a block diagram of the subsystem. The pod configuration of the SM-65 Series D booster vehicle is shown in Figure 1-2.

The basic flight termination subsystem consists of an essentially omnidirectional antenna, two range safety command receiving sets (operated in parallel for reliability) which are compatible with the Pacific Missile Range FRW-2 UHF ground destruct transmitter (GDT), power changeover switches, power sources, arming and safing devices capable of remote-control operation, and two destruct units (one in the Atlas booster and one in the adapter section for destruction of the satellite vehicle). The adapter section also contains two separation switches and two auxiliary batteries which are so connected as to ignite the adapter section destruct unit and destroy the satellite vehicle if separation of the satellite from the booster occurs before commanded separation.

An integrated schematic diagram of the flight termination subsystem is given in Figure 1-3.

1.2 COMMAND FUNCTIONS. The design of FTS equipment is based on the following ground transmitter operation: When the Range Safety Officer wishes to destroy the flight vehicle, he presses first the PRE-ARM button and then the DESTRUCT button on his console. These buttons cause the FM carrier signal being sent by the GDT to be modulated with combinations of designated tone channels. The frequency-modulated signals are received by two independently operated receiver sets. Each set decodes the signals into the PRE-ARM and DESTRUCT commands. The outputs from each set are separated through appropriate circuits to permit either or both sets to perform the required function.

1.2.1 PRE-ARM. When the Range Safety Officer depresses the PRE-ARM button, the ground transmitter signal is modulated by tone channels 1 and 5 for more than 100 milliseconds. The pre-arm command operates relays within the receivers. The logic circuit for the pre-arm function is discussed in Paragraph 1.6.1.

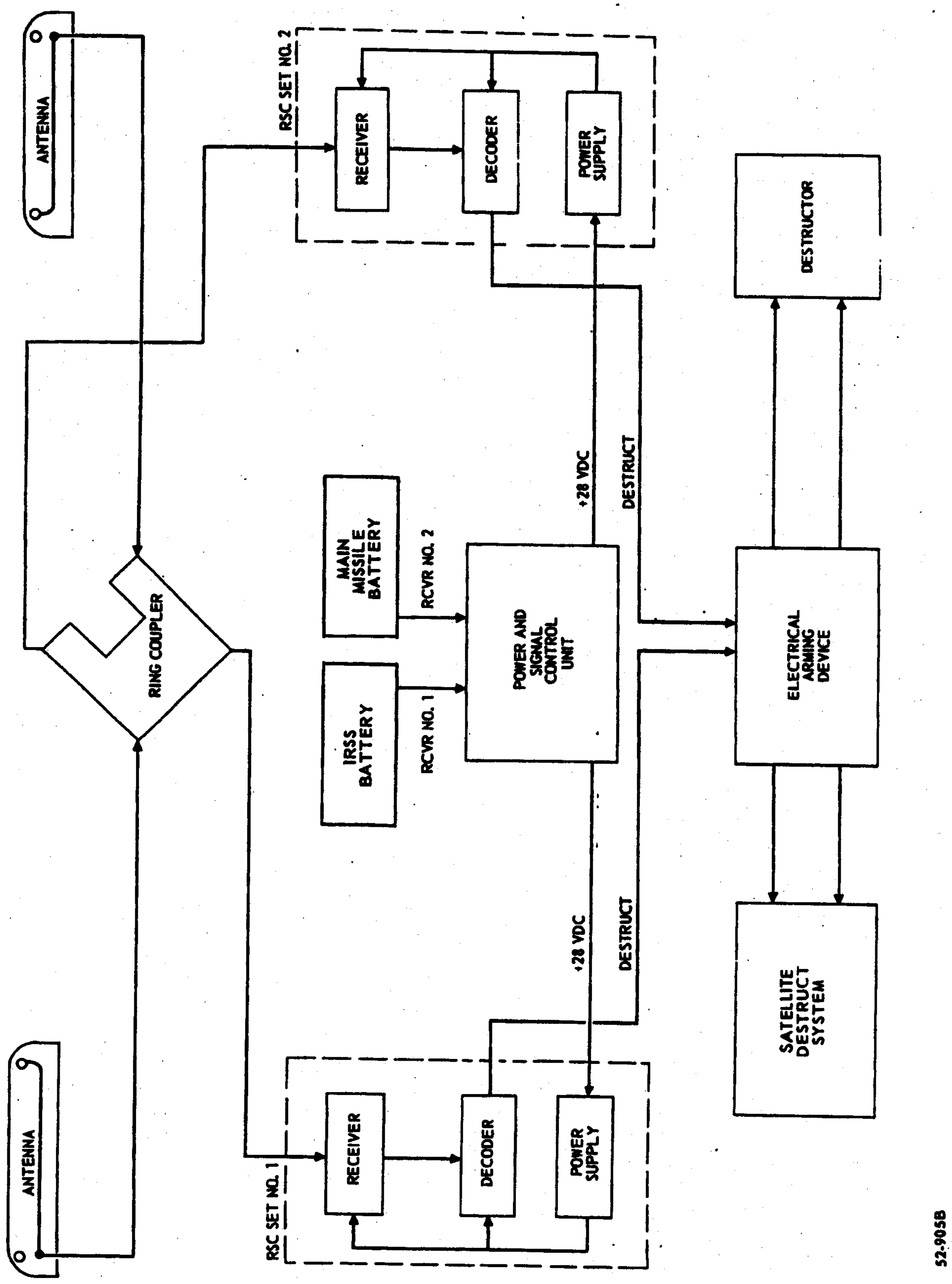

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Figure 1-1. Flight Termination Subsystem in SM-65 Booster Vehicle

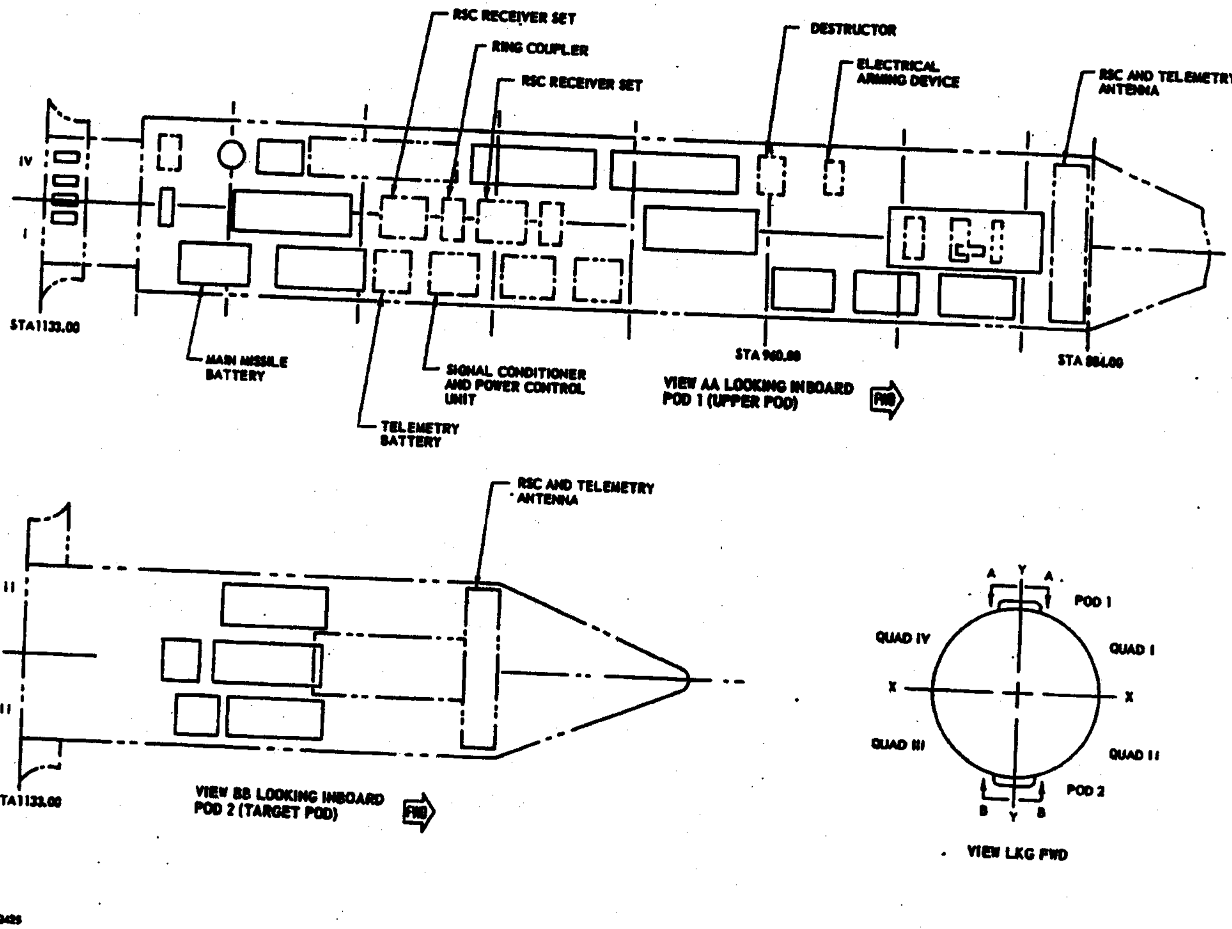


Figure 1-2. Booster Vehicle Pod Configuration

1.2.2 DESTRUCT. The destruct command, generated by modulating the carrier signal with tones 1 and 2, ignites the primers in the destructor units of the booster and satellite vehicles. This command is initiated by the RSO. The destruct logic circuitry is shown in Figure 1-4. Both destructors are so located with respect to the propellant tanks of their respective stages that, when detonated, they will rupture these tanks. The resultant combination of propellants will cause massive explosions that will destroy the flight vehicle.

1.3 PREMATURE SEPARATION. During the booster portion of powered flight, i.e., before sustainer cutoff, premature separation of the satellite vehicle from the booster will actuate separation switches located on the adapter section that cause a destruct signal to be sent to the satellite's destructor unit to destroy the satellite vehicle. However, under the condition of premature separation, the booster is not automatically destroyed but can be destroyed by RSO command. The sustainer cutoff (SCO) signal from the booster autopilot places the premature separation system in the SAFE condition. The vernier cutoff (VCO) signal performs a backup function for this safing operation. After normal separation, all of the receiving equipment and the destruct units remain on the Atlas/adapter stage so that there is then no way to destroy the satellite.

1.4 INPUT SIGNAL CHARACTERISTICS. The flight termination subsystem input signal characteristics are compatible with those of the Range Safety Ground Station. These characteristics are as follows:

a) Carrier frequency tolerance ±0.013%: ±0.010% allotted to the transmitter, and an additional 0.003% for doppler shift.

b) Carrier signal strength provided by the UHF ground transmitter is to be within the range between 950 microvolts per meter and 65 volts per meter.

c) A modulation deviation of 60 kc, ±10% peak deviation for any number of tones.

d) Equality of modulation-tone deviations ±10%.

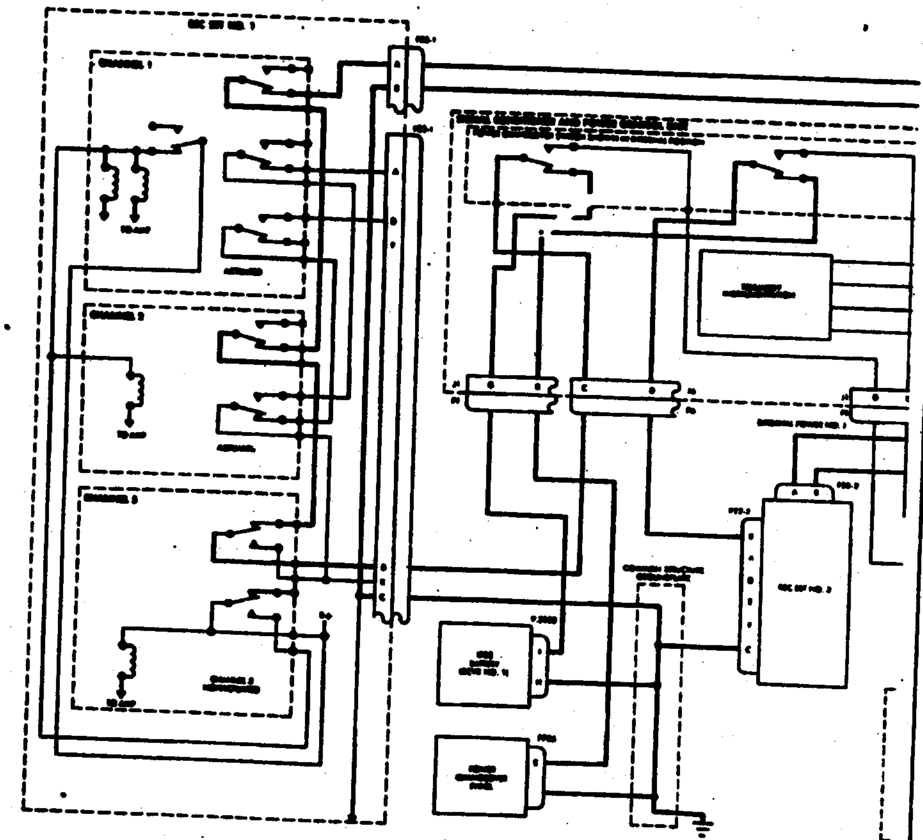
e) Tone frequency tolerances ±1.0%.

1.5 ANTENNA SYSTEM. The Flight Termination subsystem utilizes two single-cavity antennas mounted opposite each other. Each antenna cavity contains two range safety command probes, as shown in Figure 1-5.

The combined telemetry-and-command antenna was designed to require the least amount of space in the SM-65 Series D missile, yet provide the necessary antenna pattern coverage. At the telemetry frequencies, sufficient isolation exists between the telemetering antenna probe and the command antenna output to prevent possible interference with the command subsystem. Figure 1-6 shows a linearized mercator projection of the antenna radiation pattern for the Series D/Samos/Midas missile prior to staging. Figure 1-7 shows the antenna radiation pattern after staging. The method of determining the antenna radiation pattern is indicated in Figure 1-8.

The antenna patterns shown in the mercator plots were taken from a one-tenth-scale model, using a left-hand sense of illumination. The 3-db loss associated with the transition from linear to circular polarization has been accounted for in the plot, so the indicated signal intensities may be taken as actual values.

Figure 1-9 shows the interconnection of the antenna system components. The antennas are coupled to the receivers by a ring coupler, Figure 1-10; this prevents the failure of the RF link to one receiver package from affecting the other set in the dual system. The coupler provides a minimum of 20-db isolation between receivers.



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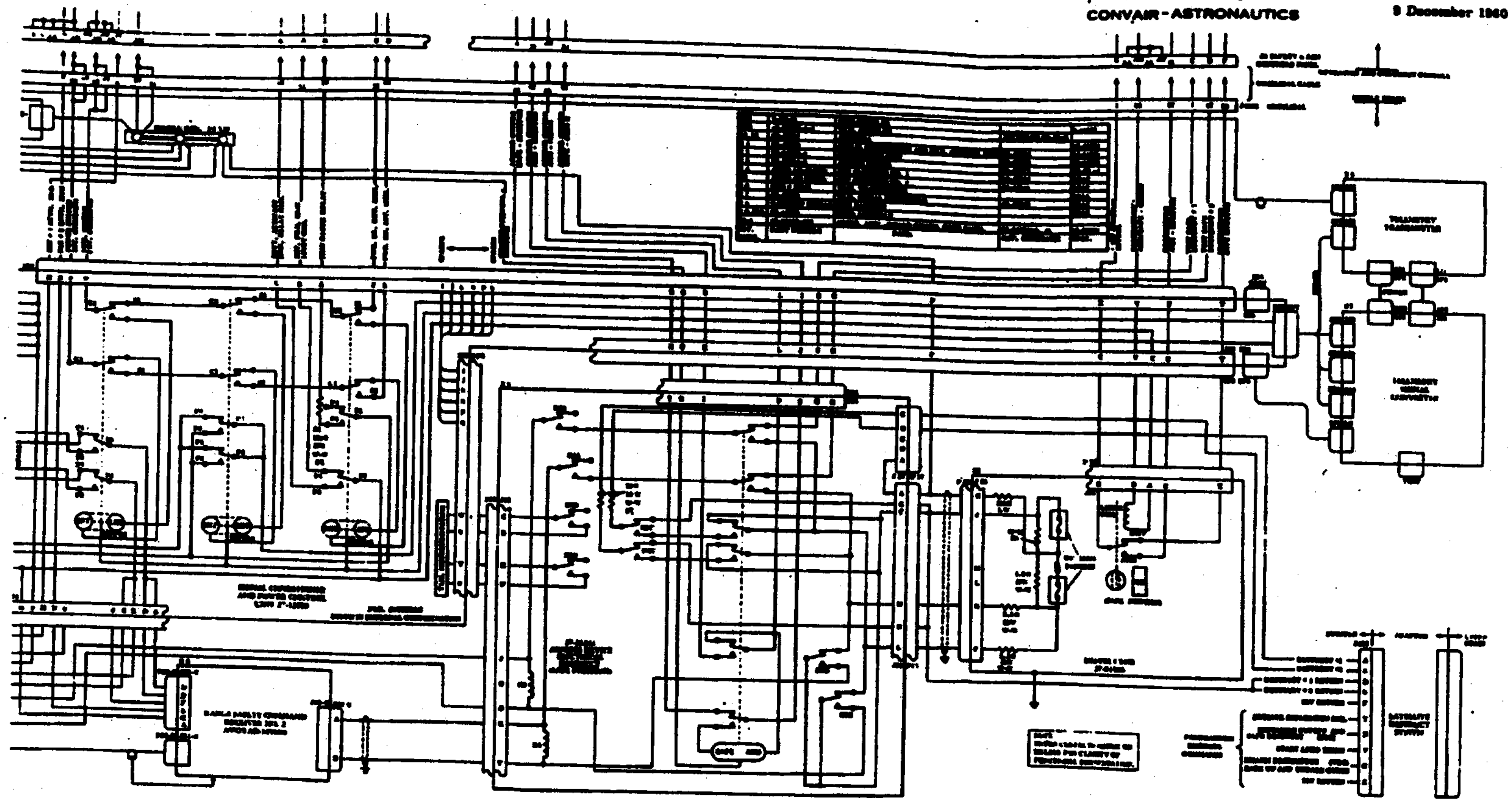

Figure 1-3. Integrated Electrical Schematic of Booster Flight Termination Subsystem

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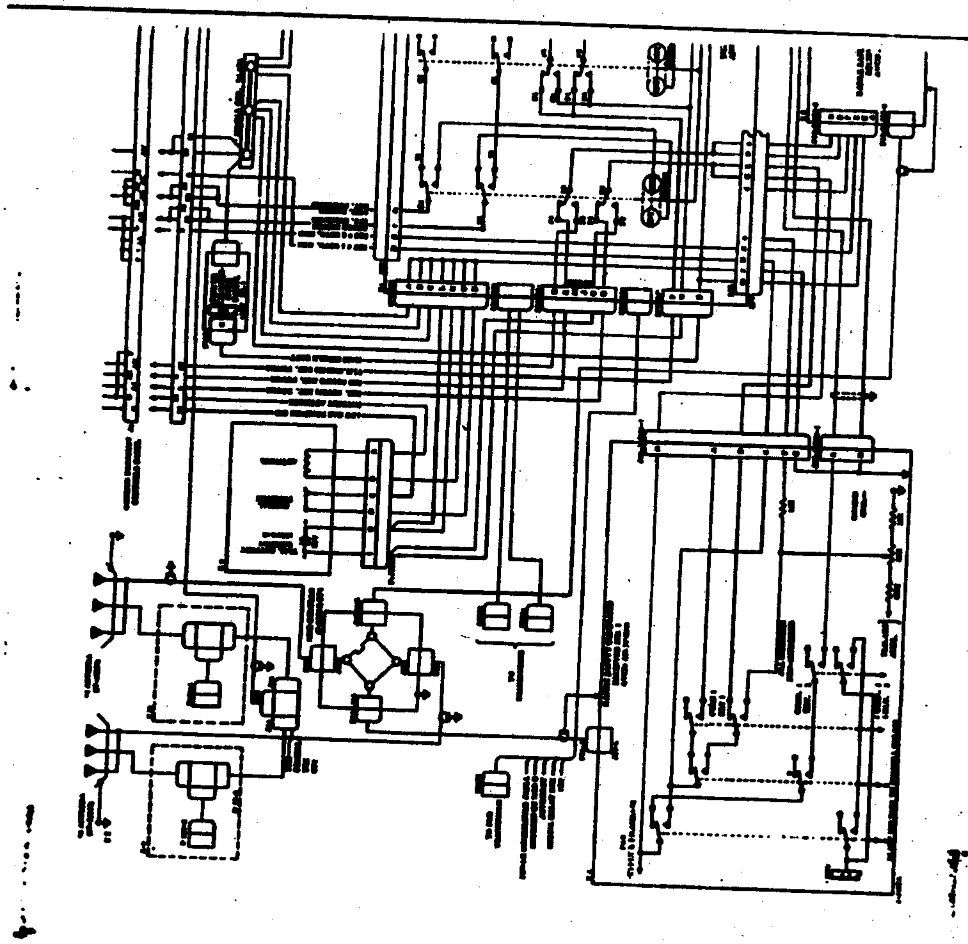

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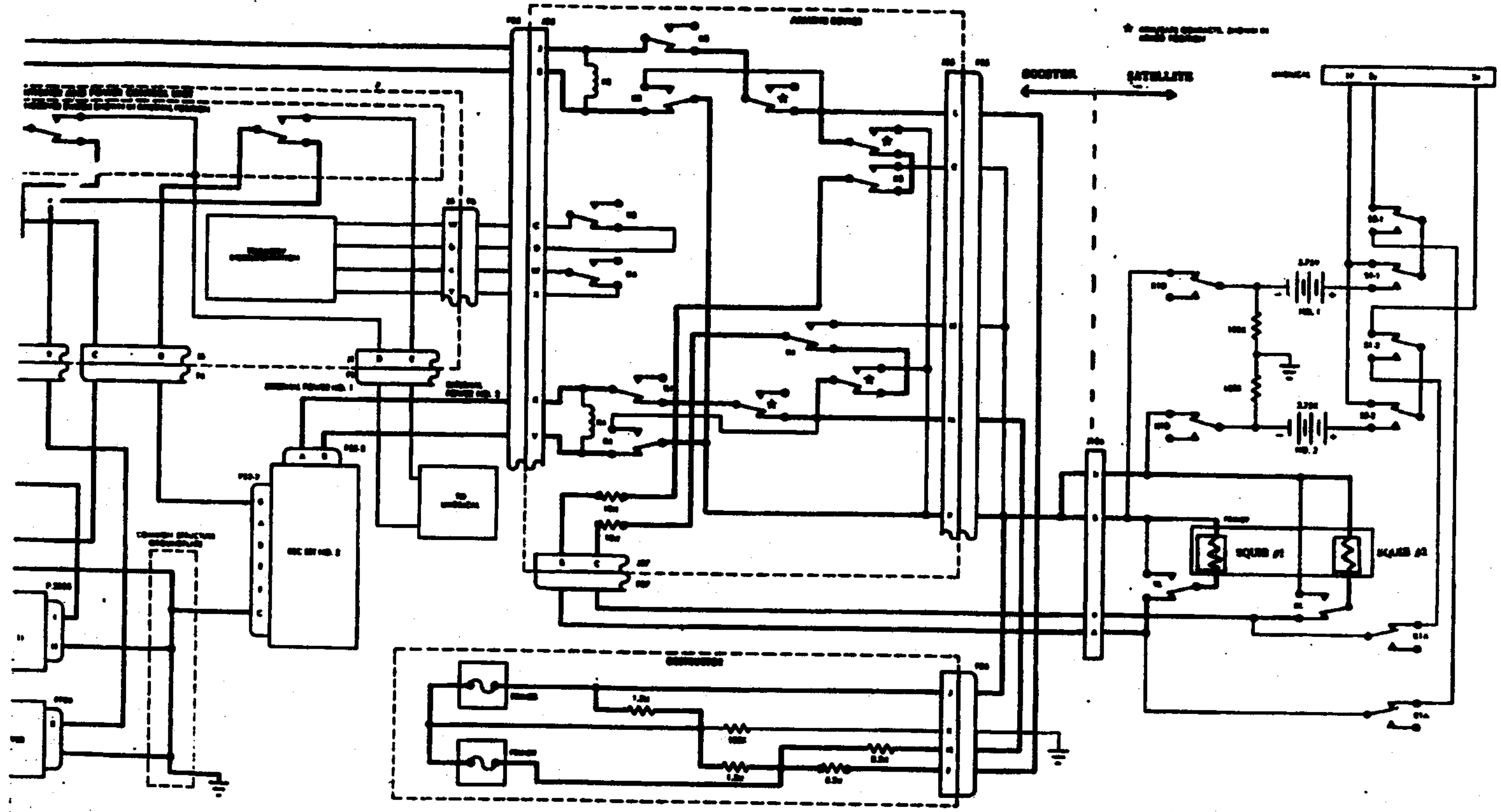

Figure 1-4. Flight Termination Subsystem - Destruct Circuit

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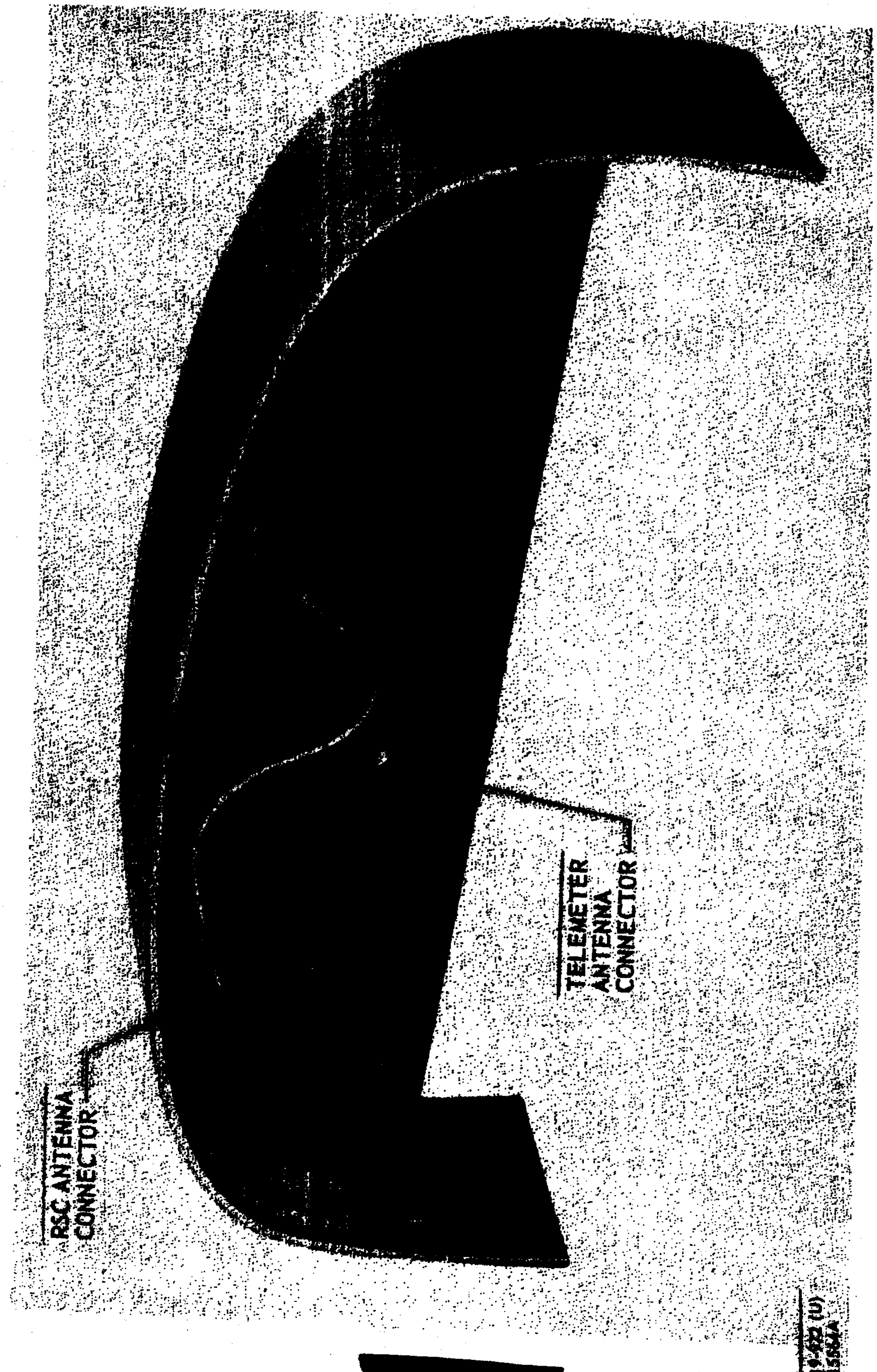

Figure 1-5. Range Safety Command & Telemetry Antenna

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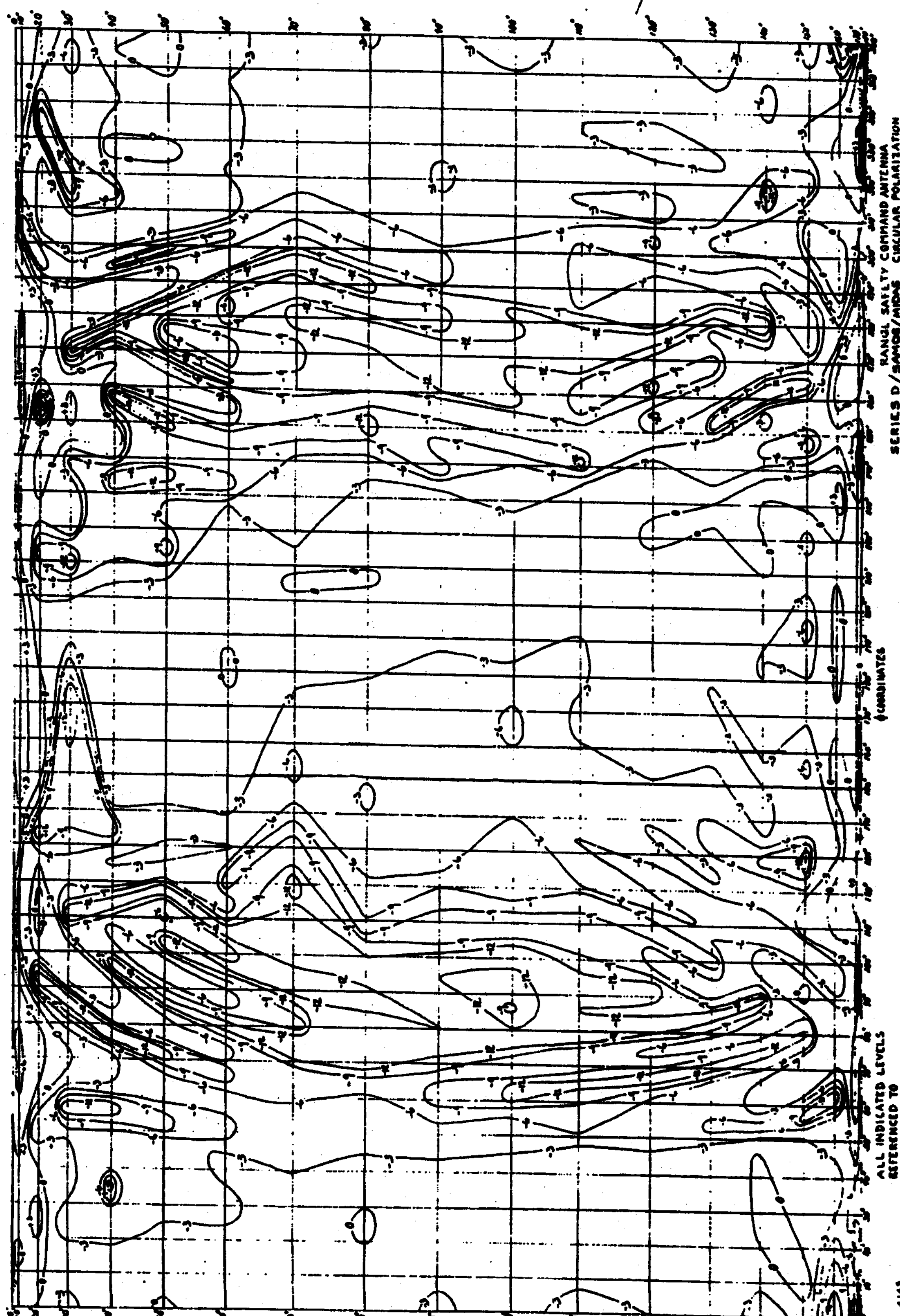

Figure 1-6. Antenna Radiation Pattern, Pre-Stage

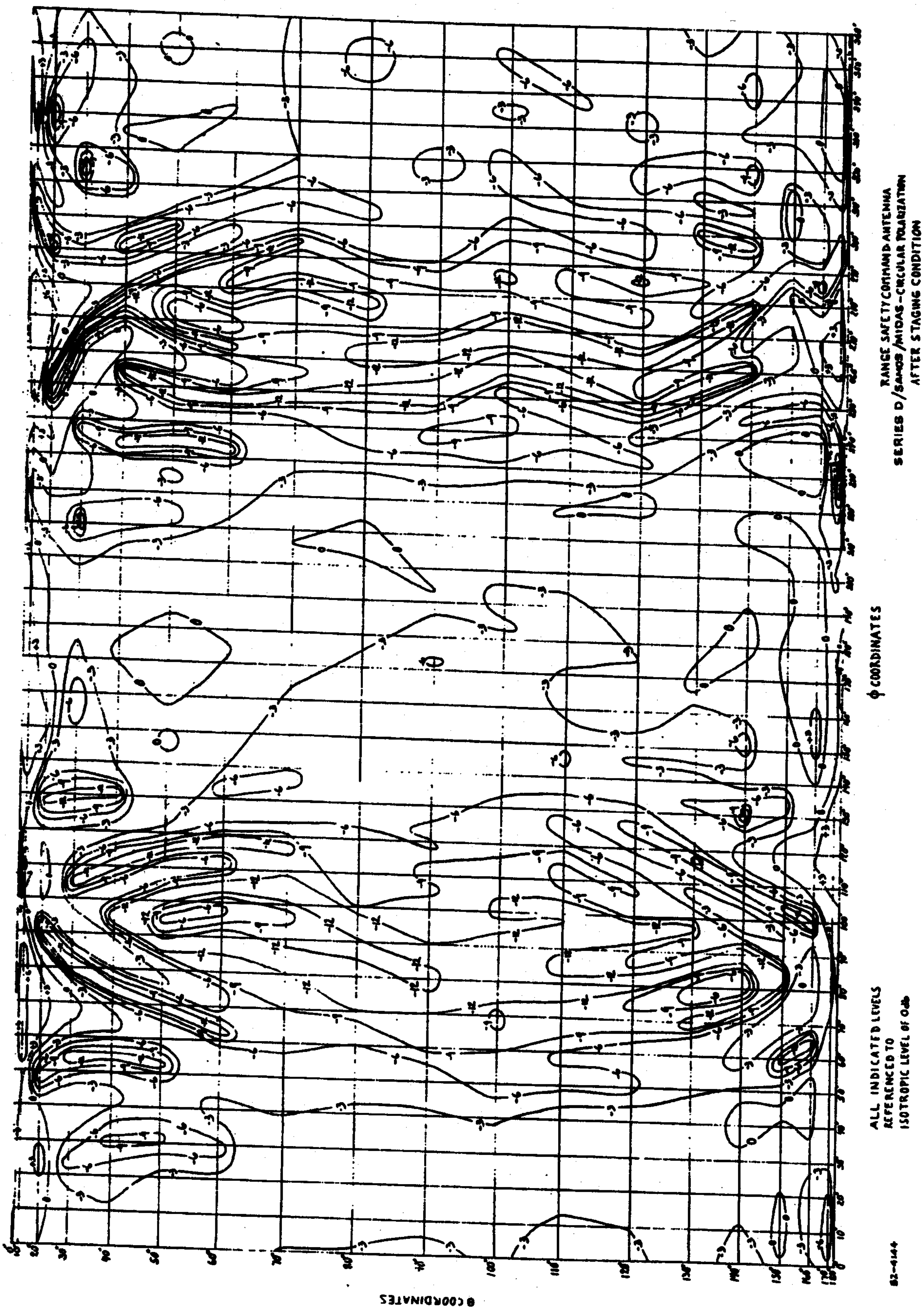

Figure 1-7. Antenna Radiation Pattern, Post-Stage

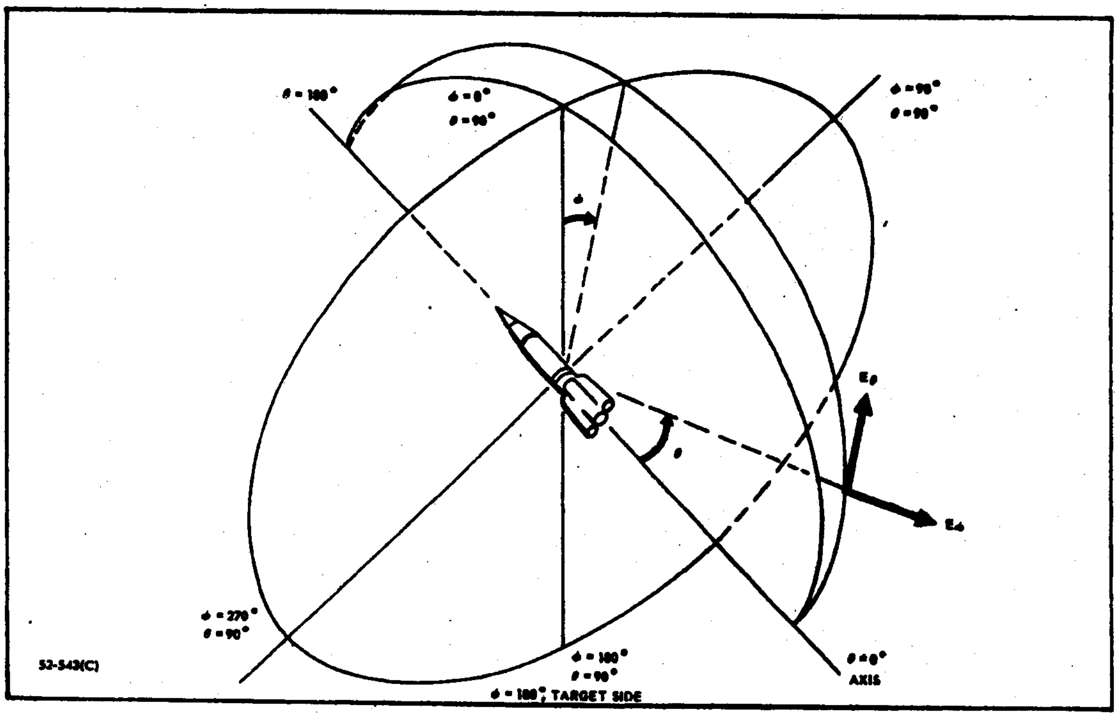

Figure 1-8. Missile Coordinate System

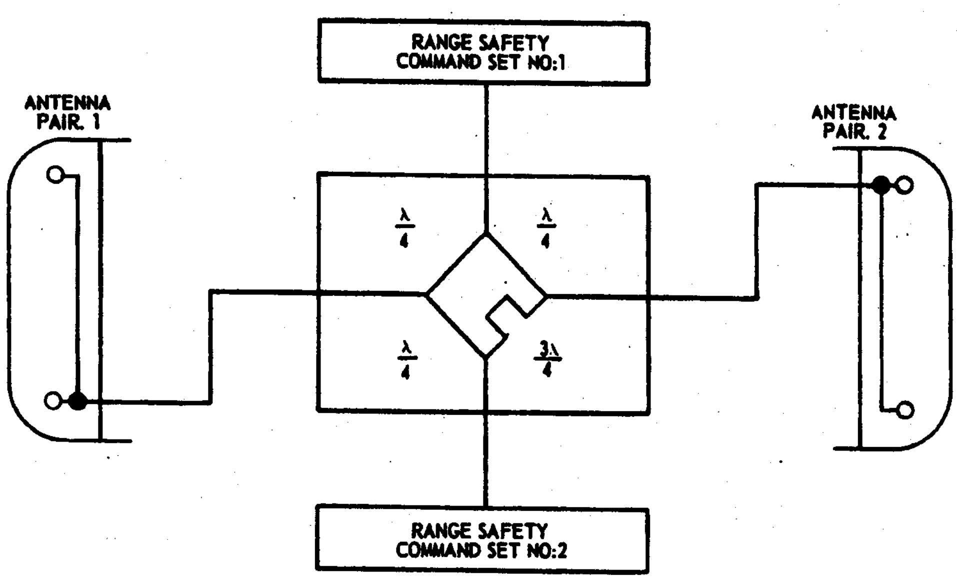

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Figure 1-9. Schematic of Antenna System

Figure 1-10. Ring Coupler, Part No. 7-36044

The interconnection of antennas and receivers is accomplished by parallel junctions (ring coupler) to a re-entrant transmission line 3/2-wavelengths in circumference. Three of the junctions are separated by 1/4-wavelength branch lines, leaving 3/4-wavelength separation between the two remaining junctions. The antennas are connected to one pair of opposite junctions, and the receivers to the other pair.

A signal arriving at Antenna No. 1 will be divided equally between the two branch lines and produce signals of equal amplitude and phase at each of the receiver terminals. At the other antenna terminal, the signals from Antenna No. 1 will be of equal amplitude, but in phase opposition due to the 1/2-wavelength difference in transmission-line length along the two branches of this junction. The result, with no coupling between the junction of Antenna No. 1 and Antenna No. 2, is a voltage node at this point. Minimum isolation between antennas is 20 db. The loss from each antenna junction to each receiver is 6 db or less. There is a 3-db loss in obtaining a power division at the ring coupler. The remaining losses are in the RF cable and connectors.

Besides providing the required isolation between antennas and receivers, the coupler serves to provide isotropic antenna radiation coverage about the missile. With the antennas mounted on opposite sides of the missile, the spacing between them is approximately four wavelengths.

Separation of the antennas produces lobes at the small interference regions where the radiation patterns of the individual antennas overlap.

Figure 1-9 shows that signals from both antennas travel the same distance through the ring coupler to Receiver No. 1. However, signals to Receiver No. 2 must travel 1/2-wavelength further from the target antenna than those from the upper antenna. Consequently, Receiver No. 1 acquires signals from both antennas in like phase, while Receiver No. 2 acquires signals in opposing phase.

This arrangement makes the radiation pattern seen by a given receiver complementary to that seen by the other receiver. When Receiver No. 1 receives a strong signal, Receiver No. 2 receiver a weak signal, and vice versa. For all angles outside the interference region, both receivers get signals of the same amplitude. As long as both receivers are operative, omnidirectional coverage is provided. If one receiver fails, the radiation pattern presented to the other provides coverage for 84.7% of the solid angle before staging the booster engines of the Atlas, and 85.9% of the solid angle after staging, with an antenna gain of greater than 10 db below the gain of an isotropic radiator.

1.6 RECEIVERS. The command receiver sets used in the Samos/Midas program are two government-furnished AVCO AD-319600 units (Figure 1-11). These sets may be tuned, in one-megacycle steps, from 405 to 420 megacycles. Retuning requires only the replacement of one crystal and some minor adjustments. They are pretuned to the Standard PMR frequency.

The specified deviation for these frequency-modulated receivers is ±60 kc for any number of tones. The GFAE specified sensitivity for the receivers is 3 microvolts, although it should be noted that the subsystem specification of 950 microvolts per meter was calculated on the basis of receiver sensitivity of 10 microvolts and a -10 db gain (with respect to an isotropic radiator) in the antenna system; thus, there is an inherent margin of safety of approximately 13 db between the subsystem's maximum sensitivity and the specified sensitivity.

1.6.1 OPERATION. Radio command signals are received as a combination of audio tones. A specific sequence of tones must be received before the receiver can generate the destruct command. When the Range Safety Officer depresses the PRE-ARM button on his console, the ground destruct transmitter sends a signal that is modulated by tone channels 1 and 5; when he presses the DESTRUCT button (the PRE-ARM button remaining in the "pressed" state) tone 5 is deleted and tone 2 is substituted. The desired result is for tones 1 and 2 to be transmitted and for tone 1 not to be deleted during the transition from PRE-ARM to DESTRUCT.

Once these audio tones reach the receivers, they are separated by tuned electrical filters located in the decoder portion (Figure 1-12) of each receiver. The filter output is rectified, smoothed and applied as a d-c voltage to the grids of the corresponding channel relay amplifiers. Each Channel Relay Unit contains two Type 5906 pentodes operating as d-c channel relay amplifiers, the common plate load of which is a channel relay coil. The amplifiers are

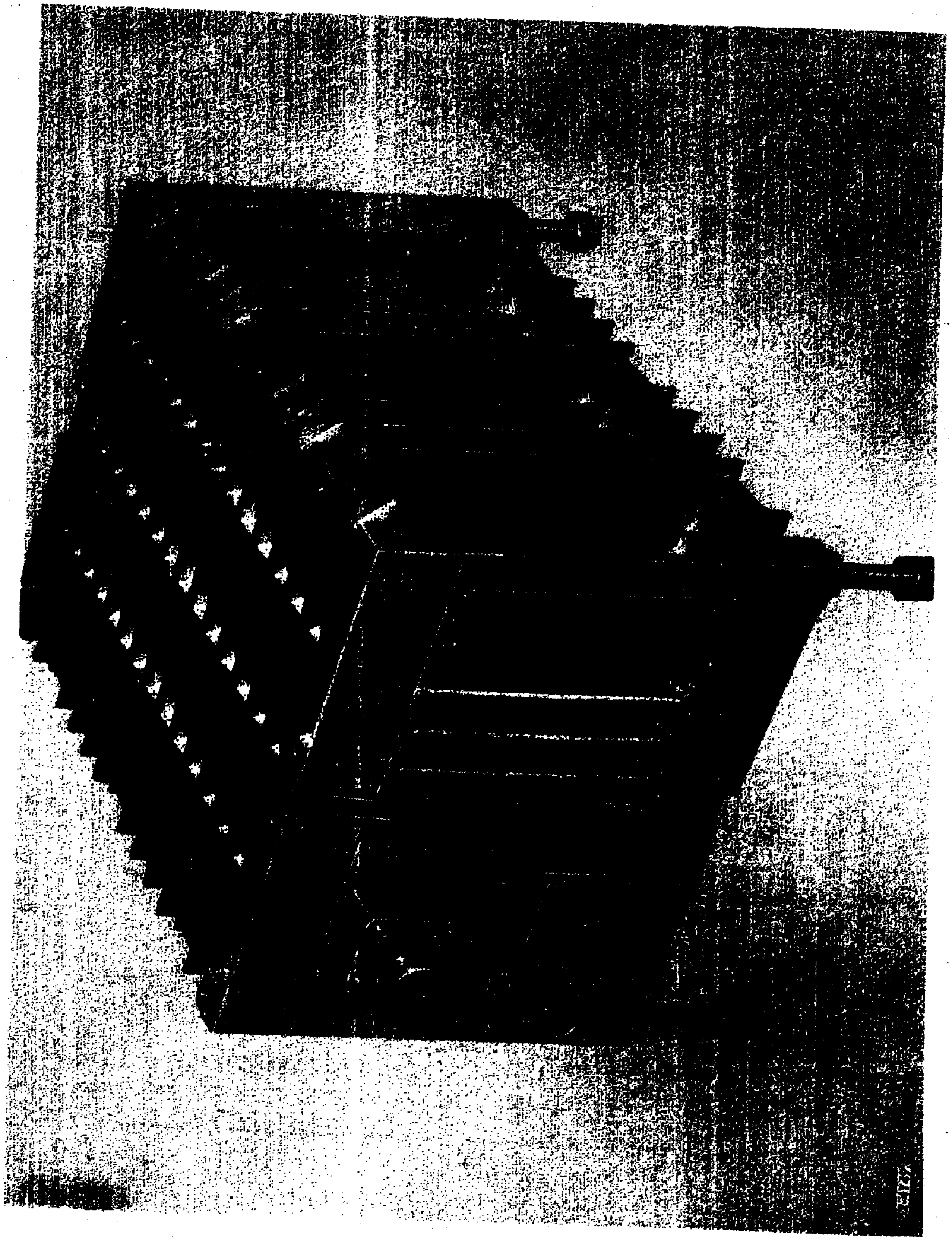

Figure 1-11. AVCO AD-319600 Range Safety Command Receiver

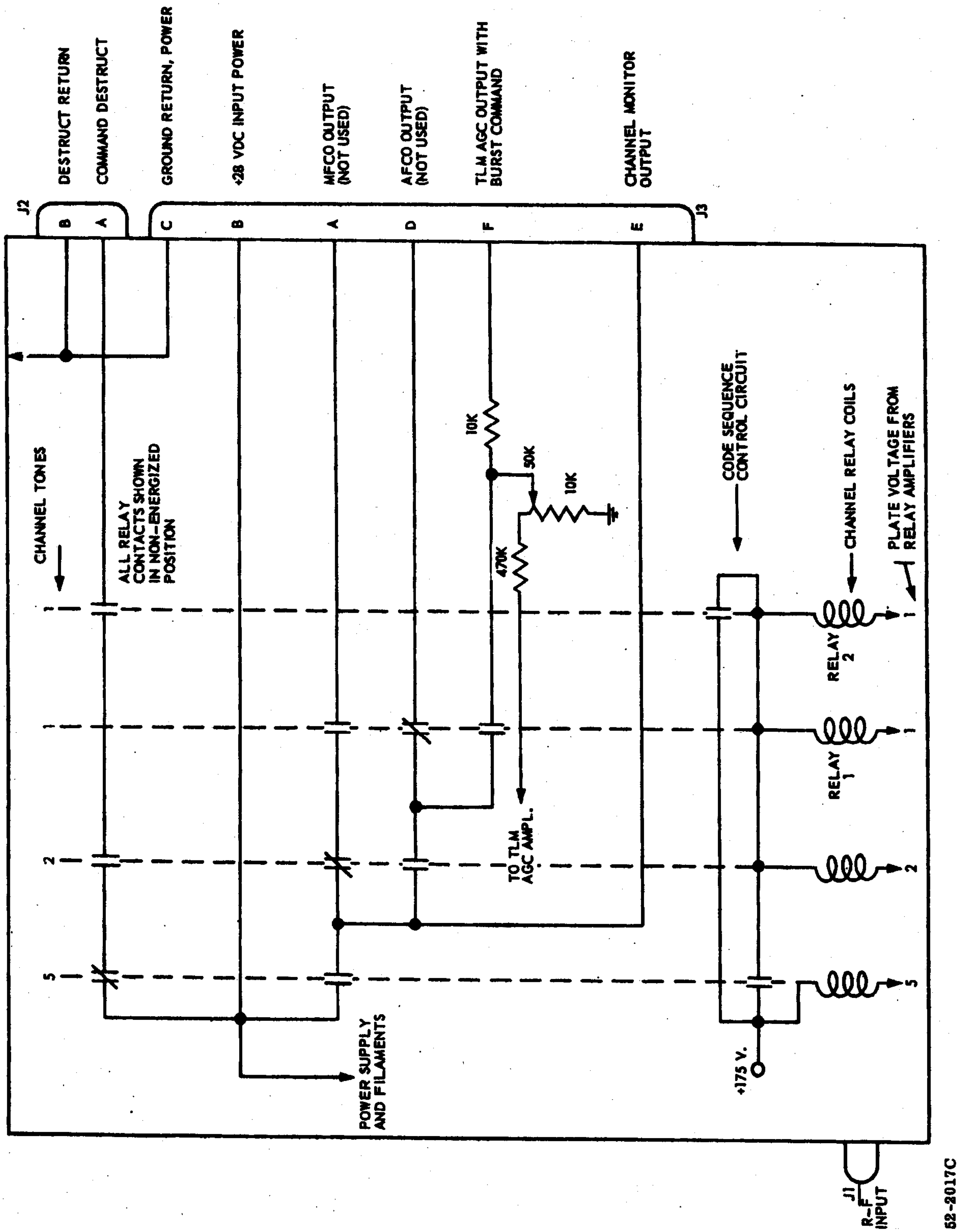

Figure 1-12. Schematic Diagram of Decoder Relay Circuit

held in cutoff state in the absence of grid voltage. When a filter output is received, the amplifier is driven into saturation, and this results in plate current energizing the channel relays. The relays complete the logic circuit required to provide a destruct command.

As a safety factor, the tone 5 relay has been designed with a dropout time of 100 to 250 milliseconds, in case tone 1 is briefly removed in the transition from tones 1 and 5 to tones 1 and 2. Since the receiver procurement specification (GFAE) does not stipulate this dropout time, the dropout time of channel 5 may vary from 5 to 250 milliseconds. Therefore, the maximum elapsed time between the depression of the DESTRUCT button and the actual destruction of the missile is 350 milliseconds: 250 milliseconds (maximum) for channel 5 dropout, and 100 milliseconds (maximum) for ignition of the primers.

A dimensional outline of the AD-319600 receiver is shown in Figure 1-13.

1.7 BOOSTER SIGNAL CONDITIONER AND POWER CONTROL UNIT. This unit, shown in Figure 1-14, primarily serves the telemetry subsystem. However, it performs two functions for the flight termination subsystem. It changes the FTS to and from internal and external power sources by means of a power changeover switch (Convair-Astronautics Part No. 27-01206-1), and it serves as a junction box for electrical connections in the subsystem.

1.8 BOOSTER ELECTRICAL ARMING DEVICE. The purpose of the electrical arming device (Figure 1-15) is to provide a means for placing the flight termination subsystem in either SAFE or ARM condition. Two destruct-signal paths, one from each receiver set, lead into this device. In the SAFE condition both satellite and booster vehicle destructors are electrically isolated from the command-destruct signal; additionally, a short circuit is placed across the booster vehicle destructor primers.

The hazard of premature operation of the primers due to stray currents is considerably reduced by arranging the arming-device circuit to provide isolation of both sides of the destructor primers from the ground return and from the energizing voltage until a destruct command is received. This isolation from structural ground and power sources is provided even when the FTS is in the ARM condition. A high-resistance leakage path to structural ground is provided, within the destructor unit, for safe drainage of static charges from the destructor circuit. The common return lines from the satellite destruct circuit are isolated from ground by the same leakage resistor (in the booster destructor unit); the two destruct signal lines to the satellite are each shorted to the common return lines through separate current-limiting resistors until the destruct command is given. Direct shorts are also placed across the input to the booster destructor unit until the destruct command is received; current-limiting resistors are provided within the booster destructor unit.

Contacts within the electrical arming device provide an electrical indication of SAFE or ARM on the Operation and Checkout Console in the blockhouse.

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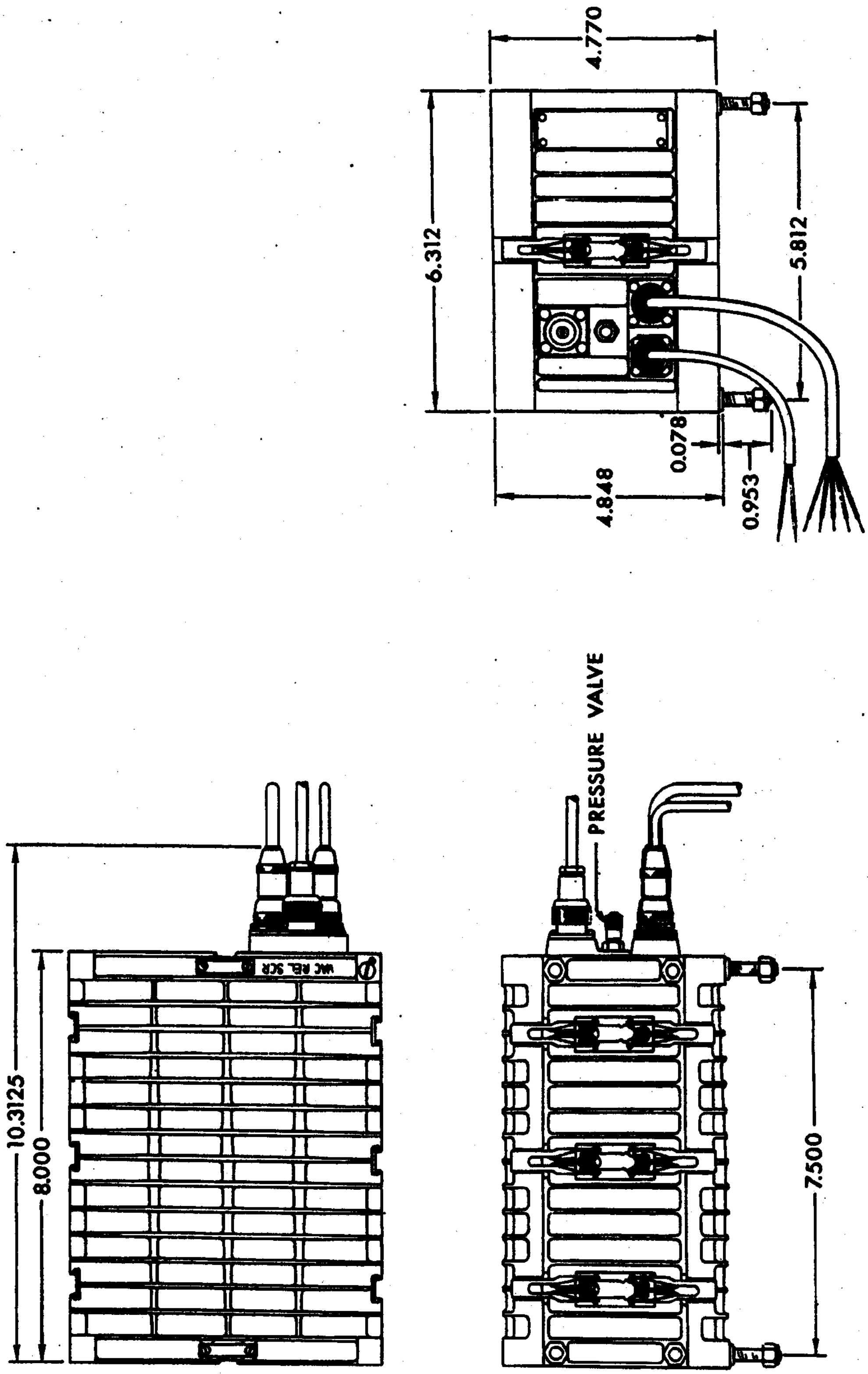

Figure 1-13. Dimensional Outline of AVCO AD-319600 Receiver

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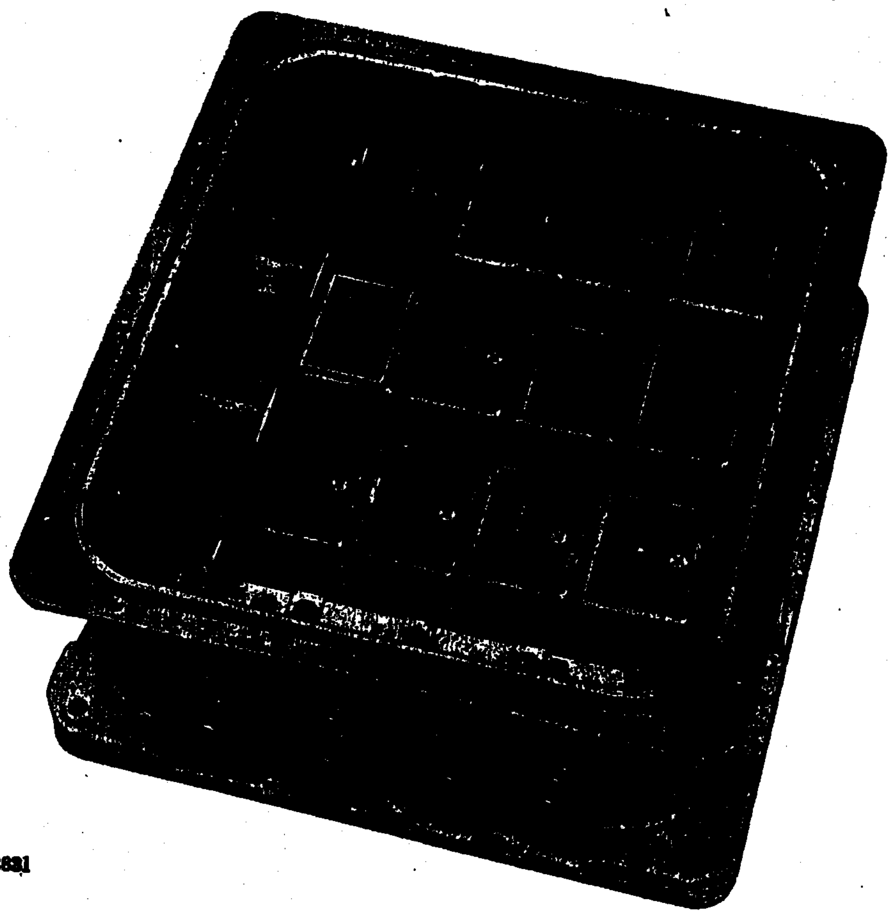

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Figure 1-14. Signal Conditioner and Power Control Unit, Part No. 27-12590

1.9 BOOSTER DESTRUCTOR. The reliability of the destructor has been demonstrated through qualification tests and actual flights; therefore, only one is used. The destructor (Figure 1-16 and 1-17) is enclosed in a red-anodized aluminum box which measures 5.0 x 5.5 x 5.5 inches. Glass wool insulation protects the switch and explosive charge from abnormal temperature and moisture conditions. The destructor is capable of operating at temperatures up to 160° F for a soak period of four hours, and at temperatures as low as -65° F for a soak period of eight hours. The destructor complies generally with Specification MIL-E-5272A for environmental testing.

1.9.1 PRIMER CIRCUIT. The primer circuit assures the firing of either or both primers within the destructor. The circuit has the primers in series; each primer is shunted by a resistance that requires only one-quarter of the current taken by the primer. This increases the reliability of igniting one primer, should a broken wire or a short circuit occur in the other primer.

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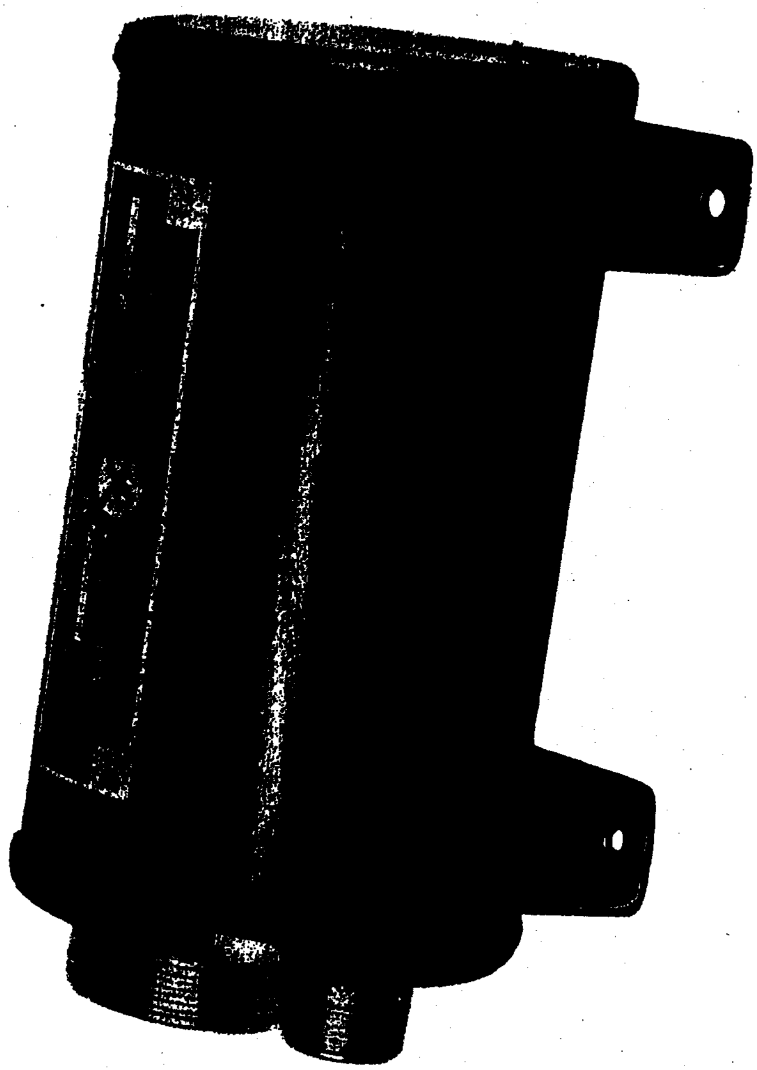

Figure 1-15. Electrical Arming Device, Part No. 27-36244

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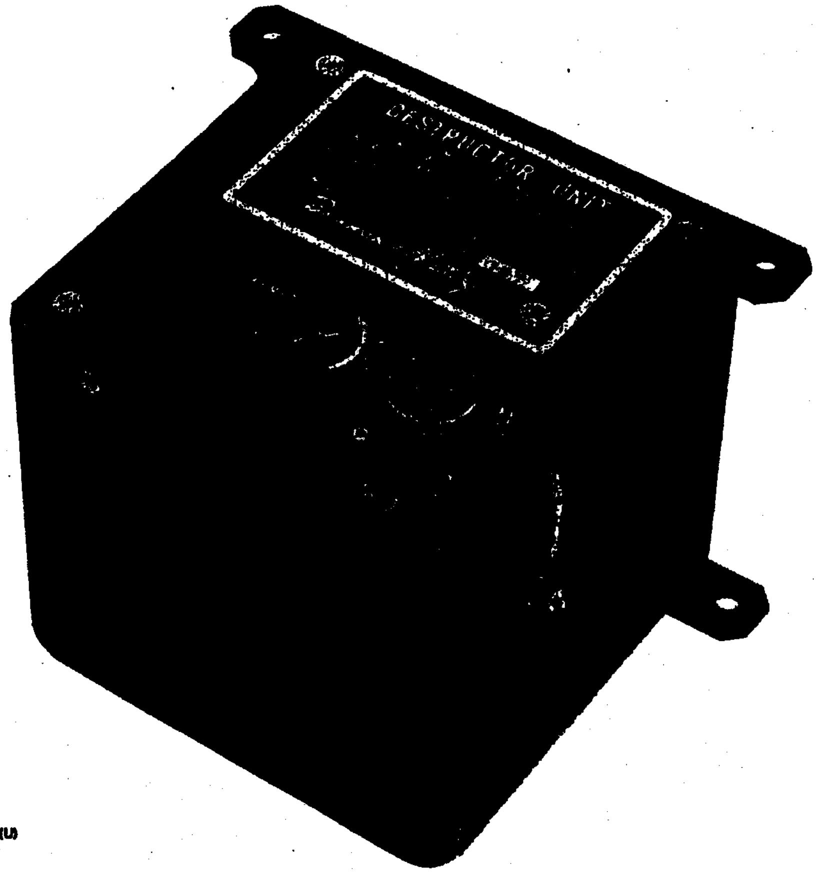

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Figure 1-16. Booster Vehicle Destructor Unit PN 27-04306

A high-resistance leakage path to ground is provided for safe drainage of static charges from the destructor circuit.

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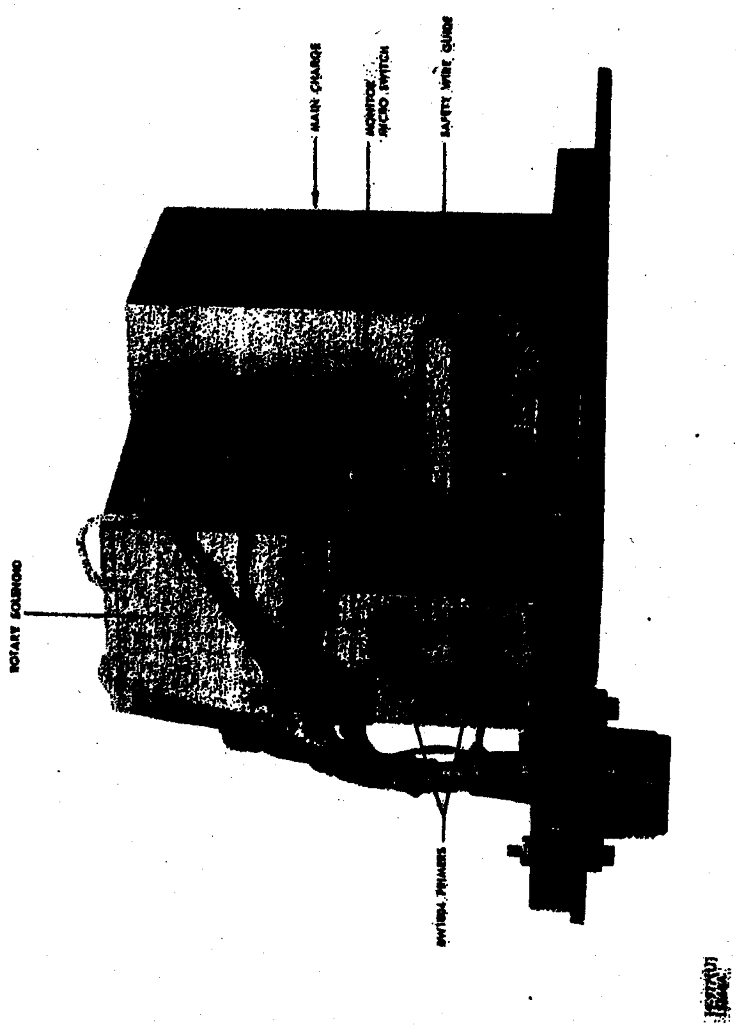

Figure 1-17. Destructor Unit, Internal View

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1.10 BOOSTER BATTERIES. Batteries provide the power for internal operation of the flight termination subsystem. The Instrumentation and Range Safety System (IRSS) Battery, shown in Figure 1-19, feeds power through the Signal Conditioner and Power Control Unit to Receiver No. 1. The Main Missile Battery sends power through the Signal Conditioner for Receiver No. 2. Both batteries also serve other elements of the booster vehicle, the IRSS Battery serving the telemetry subsystem, and the Main Missile Battery serving all other electrical components in the booster.

1.11 SATELLITE DESTRUCT SYSTEM. The Missiles and Space Division, Lockheed Aircraft Corporation, has design control of the flight termination subsystem in the satellite vehicle. This subsystem was developed to meet current Range Safety requirements and to augment the flight termination system of the booster vehicle.

The satellite destruct system is of the command, disarm and lockout design, and is capable of being actuated either by command from the Range Safety Officer or upon premature separation of the satellite from the booster. This capability is assured through the use of reliable components and dual circuits. In addition, the system incorporates safety features to preclude inadvertent detonation of the destruct charge during pre-flight checkout of the vehicle on the launch pad, or during normal programmed separation.

1.12 SATELLITE DESTRUCT FUNCTION. The function of the Satellite Vehicle Destruct System is to terminate vehicle flight during the boost phase in the event that failure of any system causes erratic and uncontrollable operation of the flight vehicle.

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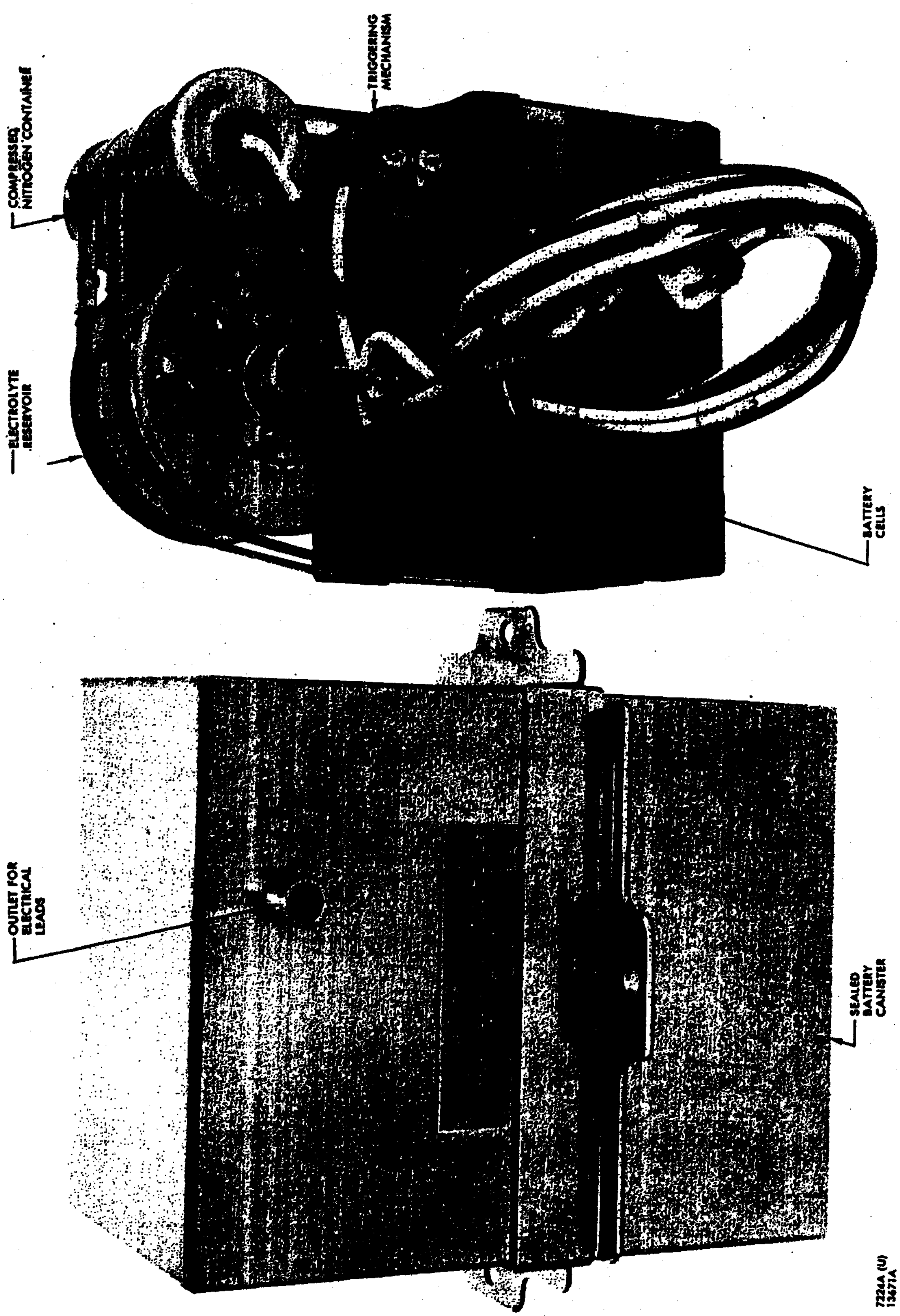

Figure 1-19. IRSS Battery, Yardney Part No. 19XPA-3

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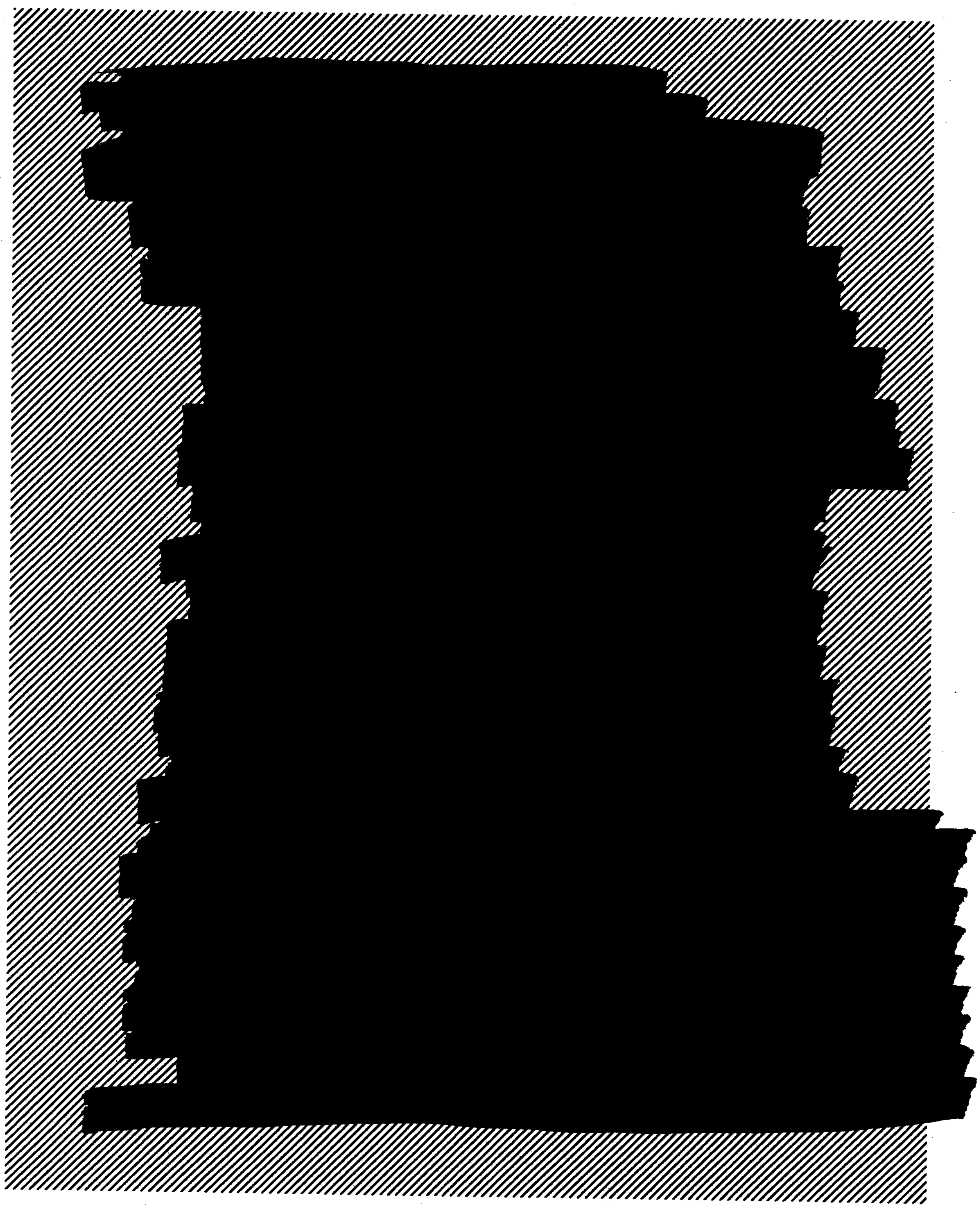

Figure 1-20. Satellite Vehicle Destruct System

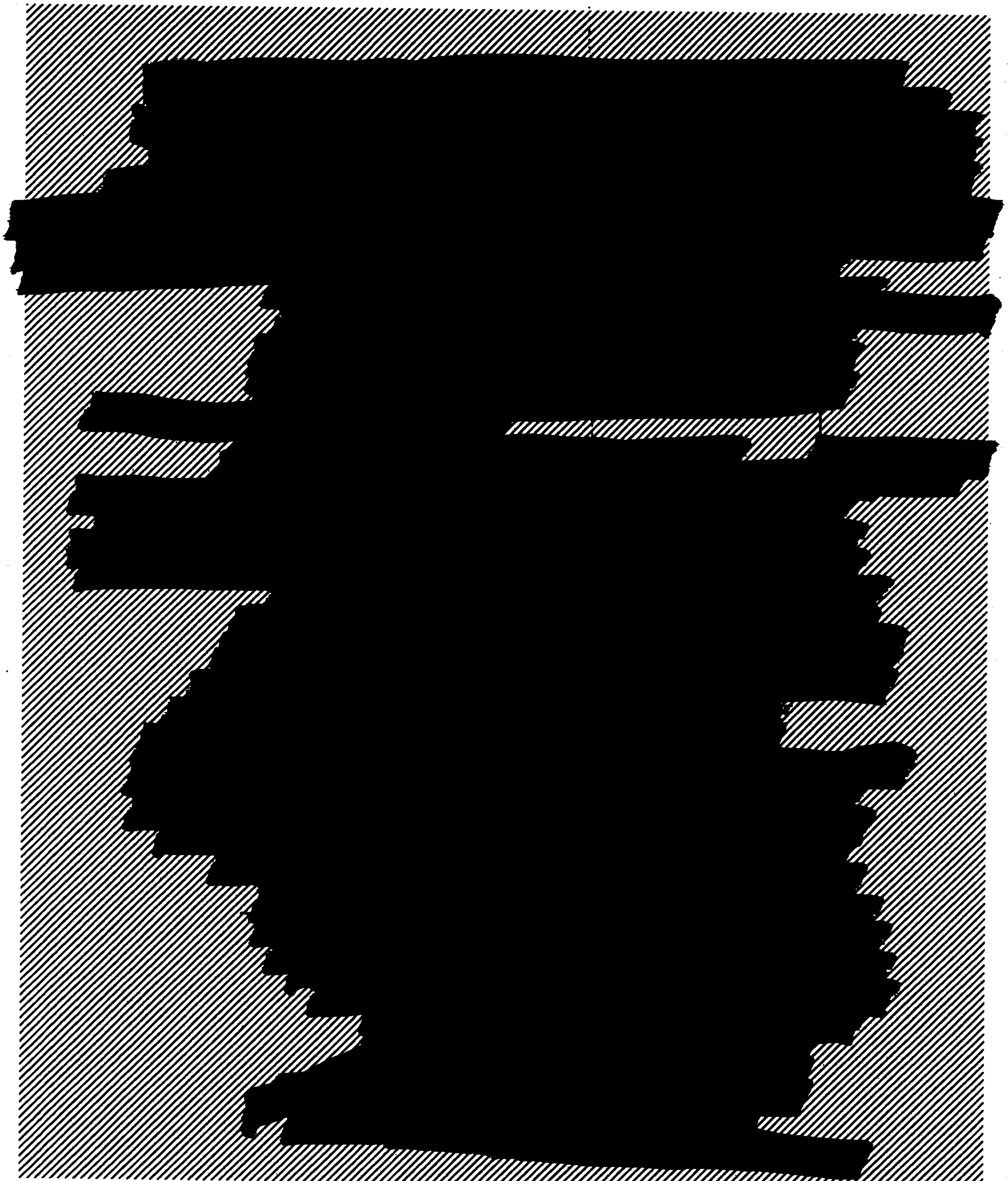
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Figure 1-21. Destruct Unit Installation

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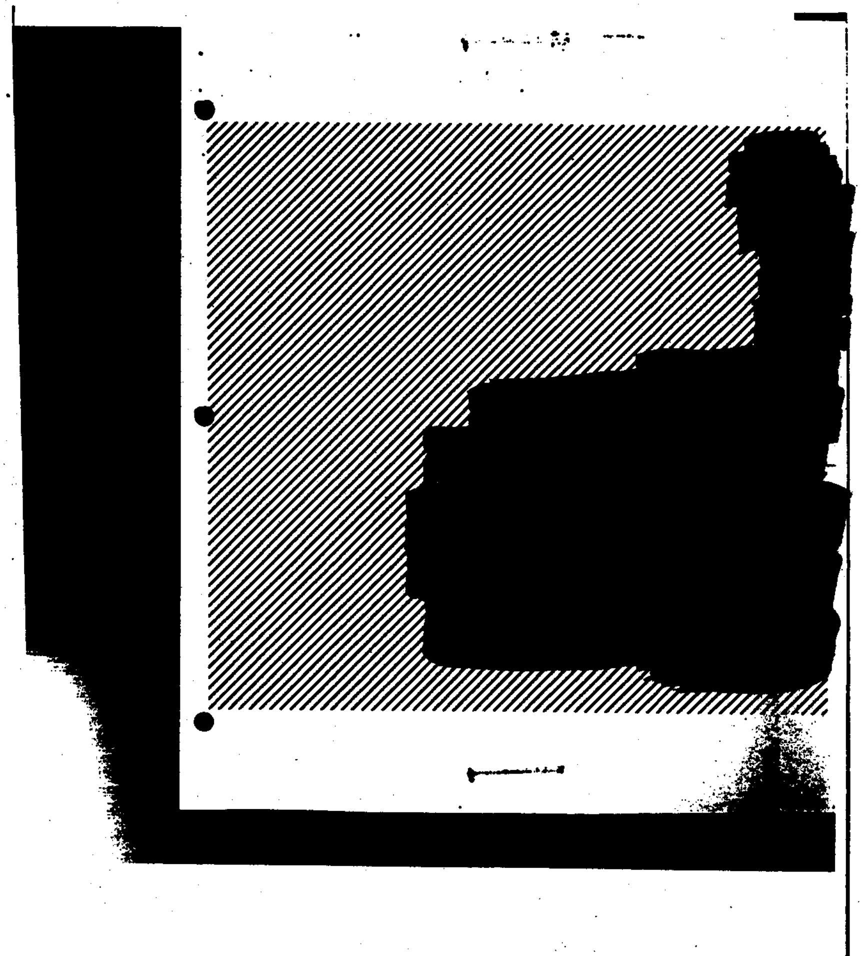

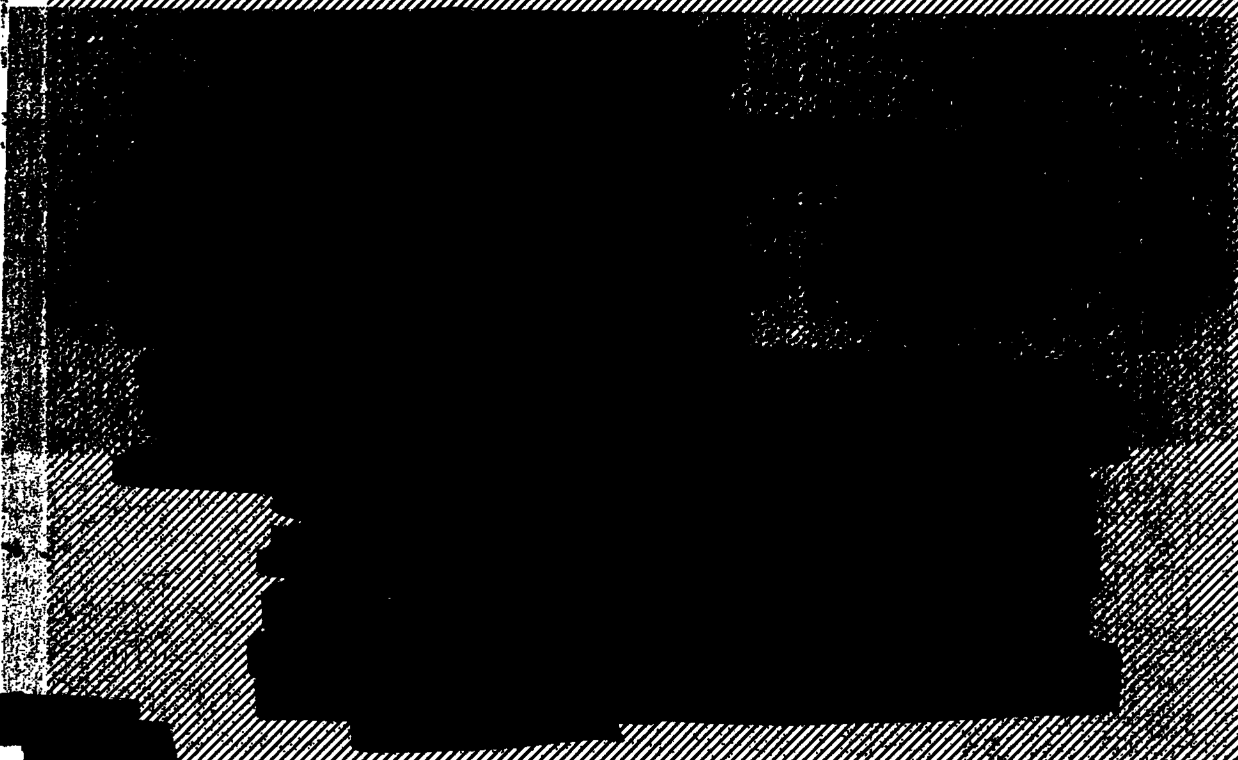

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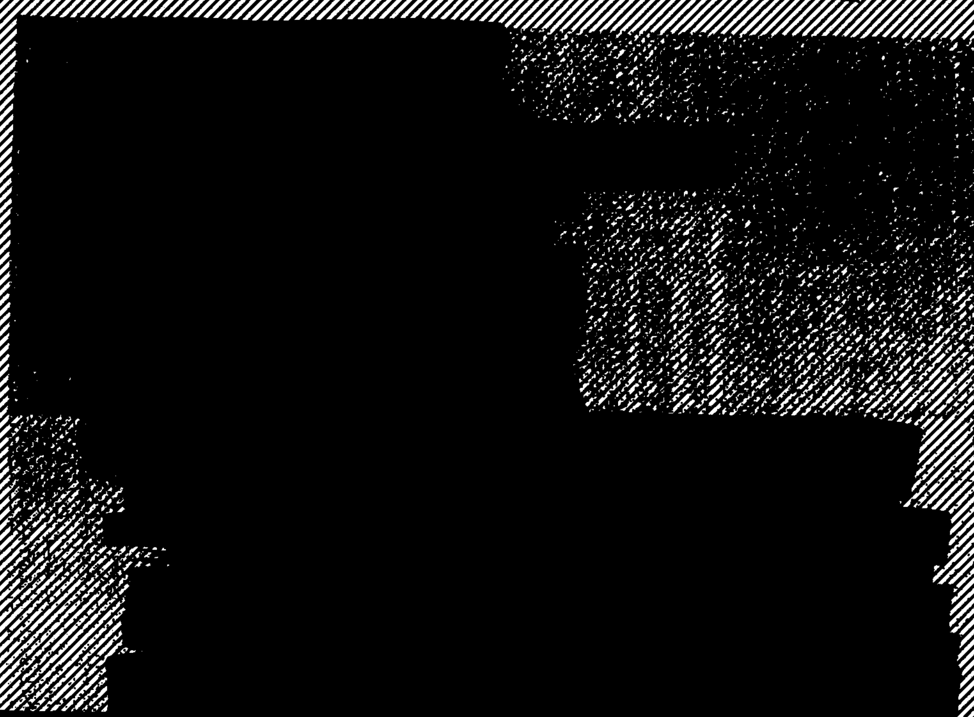

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Figure 1-25. Shaped Destruct Charge for 1X Tank

Figure 1-26. 1X Tank Viewed 180° From Destruct Charge Installation

Figure 1-27. 1X Tank Viewed 90° From Destruct Charge Installation

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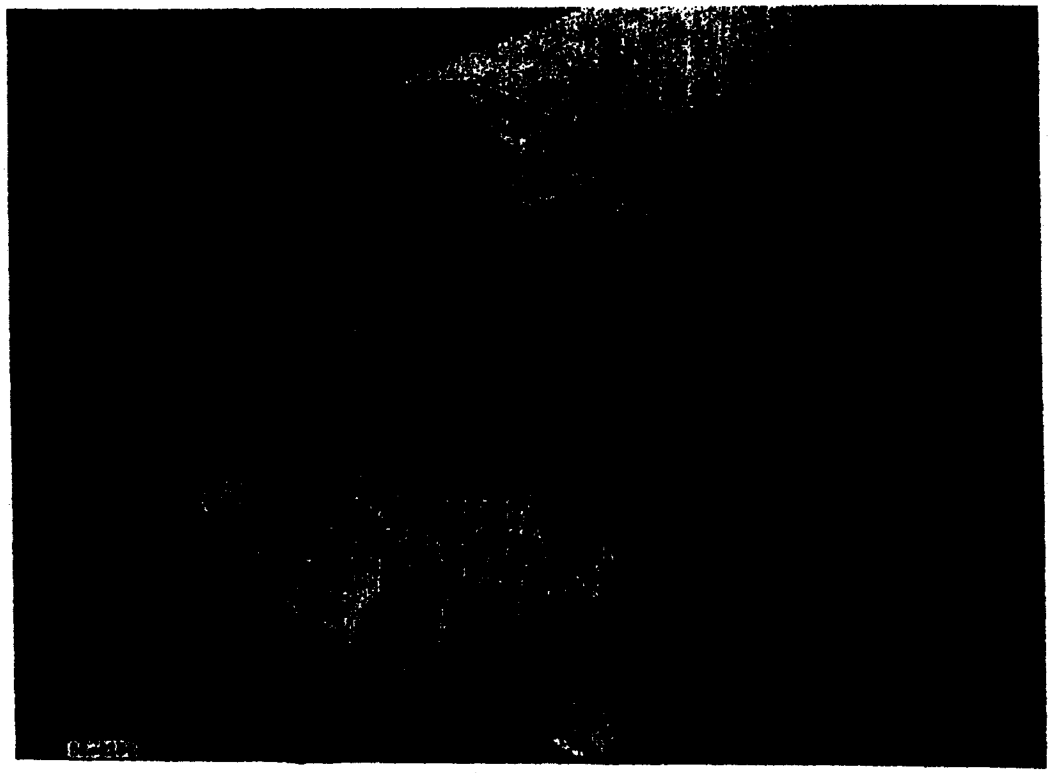

Figure 1-29. View of 2X Tank, Looking Aft

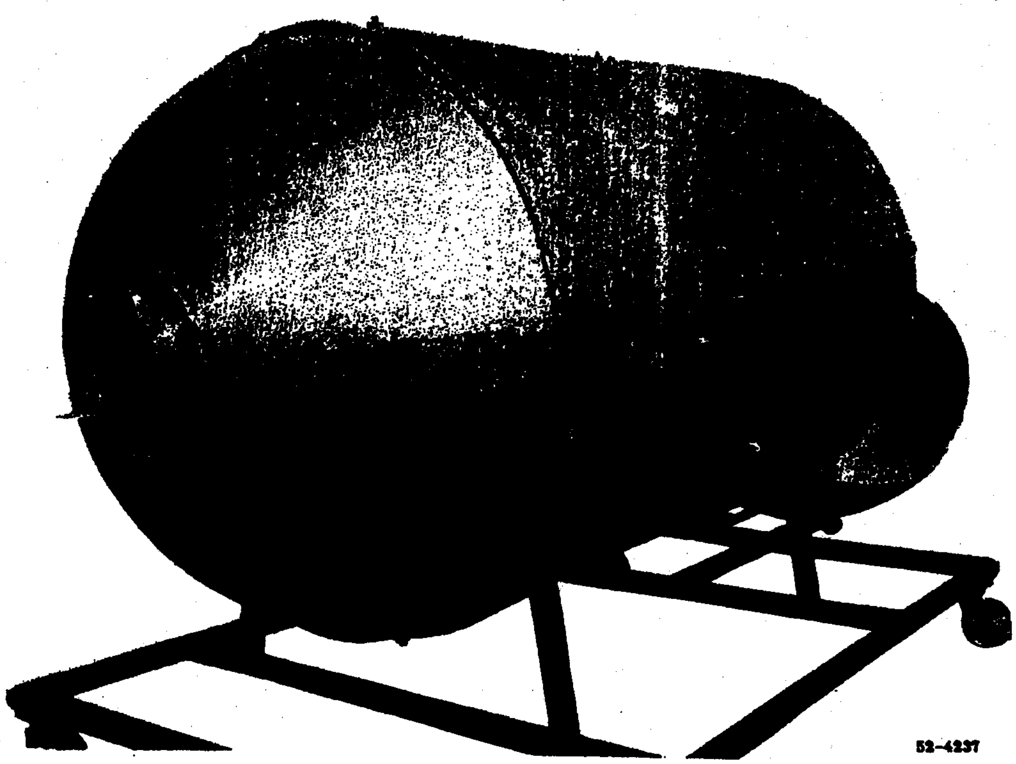

Figure 1-30. 3/4 View of 2X Tank, Looking Forward

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Figure 1-32. Internal View of Destruct Initiator

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Figure 1-34. Common Destruct Condition

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Failure to receive the discrete SCO and VCO commands, followed by failure of the booster subprogrammer fuel-depletion signal system, will result in no disarm function, and destruction of the satellite vehicle will occur on separation. This condition also provides for automatic destruct on initiation of an out-of-sequence separation by failure in the satellite-vehicle timer-start circuitry. Therefore, if through satellite-vehicle timer failure, separation occurs at a time other than that programmed for normal ascent (through the booster discrete system), destruct will automatically result.

In the event that the satellite engines fail to start, the satellite will follow essentially the same trajectory as the booster and will impact on the ocean range corridor. However, if erratic uncontrolled operation of the satellite vehicle occurs under engine thrust on separation, the vehicle will break up under these maneuvers or upon re-entry into the earth's atmosphere.

Tables 1-1 and 1-2 represent the ascent sequence of events for MIDAS Model 7205, S/N 1201. This sequence of events is typical for any of the Samos vehicles Model 4205 and 9205, and MIDAS vehicles Model 7205. Although the times of ascent events may vary 10 to 20 seconds according to the individual flight plan, the sequence of events will generally remain the same.

Table 1-1

ASCENT SEQUENCE OF EVENTS
MIDAS BOOSTER PROGRAMMER AND GUIDANCE DISCRETE COMMANDS

Events	Time, sec (approx)
Launcher-release sequence initiated; flight programmer timing cycle activated at 2" of vertical motion. Autopilot activated at 42" of vertical motion	0
Sustainer thrust chamber nulled in P-Y, vernier thrust chambers activated in roll (30° cant), booster thrust chambers activated in P-Y-R, programmed roll	3 - thru 14
Start programmed pitch	15
RT Enable staging command	126 + 2.5
G Guidance discrete staging command (SDC)	140.6
1 Booster cutoff (BCO)	140.6 + 0.1 ± 0.1
1 Stop programmed pitch	BCO
1 Null booster thrust chambers in P-Y-R	BCO
1 Activate sustainer thrust chamber in P-Y	BCO
1 Activate vernier thrust chambers in P-Y	BCO
RT Programmed backup signal for staging	143.6 ± 0.51

Table 1-1 (Continued)

ASCENT SEQUENCE OF EVENTS
MIDAS BOOSTER PROGRAMMER AND GUIDANCE DISCRETE COMMANDS

	Events	Time, sec (approx)
1	Null sustainer thrust chamber in P-Y	SDC + 3 ± 0.11
1	Jettison booster section	SDC + 3 ± 0.11 + 0.125 ± 0.025
1	Activate sustainer thrust chamber P-Y	SDC + 3 ± 0.11 + 0.7 + 0.11 - 0.00
1	Null vernier thrust chambers in P-Y (cant chambers to 50° in yaw)	SDC + 6.7 + 0.60
RT	Enable guidance steering command in P-Y	SDC + 5.1 ± 0.125
RT	Vernier tank pressurization command	167 + 0.2, - 4.2
RT	Enable sustainer cutoff command	172 + 6.0, - 1.10
G	Guidance discrete sustainer cutoff command	261.1 ± 3
3	Sustainer cutoff (SCO)	261.1
G	Start LMSD Timer	SCO + 7.5 ± 6.5
3	Activate vernier thrust chambers in P-Y	SCO + 0.5, + 0.6 - 0.10
3	Enable guidance discrete vernier cutoff command	SCO + 12.5 ± 0.51
G	Guidance discrete vernier cutoff command (uncage gyros and initiate satellite separation delay)	279.6 - 3 to +5
3	Programmed backup signal for vernier cutoff	SCO + 23.5 ± .20
G	Command separation	282.1 - 3 to +5

Notes: RT = "Real Time" subroutines (flight programmer)
0, 1, 2, 3, 4 = Subroutine numbers (flight programmer)
G = Guidance discretes

Table 1-2

ASCENT SEQUENCE OF EVENTS
MIDAS SATELLITE 7205-1201

	Nominal Time From Liftoff, sec	Event Description	Source of Signal	Computer Running Time, sec
SCO	261.14	Atlas Sustainer Cut-off	Atlas Guidance	0
		Agena Disarm Destruct	Atlas Guidance GE Relay #2	0

Table 1-2 (Continued)

ASCENT SEQUENCE OF EVENTS
MIDAS SATELLITE 7205-1201

	Nominal Time From Liftoff, sec	Event Description	Source of Signal	Computer Running Time, sec
SDT	269.0	Start Agena D-Timer	Atlas Guidance GE Relay #5	0
	269.1	Timer Safety	SS/D Timer	.1
SCO	279.64	Atlas Vernier Cut-off	Atlas Guidance GE Relay #3	
		Uncage Agena Gyros	Atlas Guidance GE Relay #3	
		Disarm Destruct	Atlas Guidance GE Relay #3	
		Arm Atlas/Agena Separation Circuit	Atlas Guidance GE Relay #3	
VCO Backup	281.14	Atlas Vernier Cutoff (Back-up)	Atlas Sub-Programmer	
		Uncage Agena Gyros (Back-up)	Atlas Sub-Programmer	
		Arm Atlas/Agena Separation Circuit (Back-up)	Atlas Sub-Programmer	
SEP	282.14	Atlas/Agena Separation	Atlas Guidance GE Relay #6	
		Fire Pin-Pullers	Atlas Guidance GE Relay #6	
		Fire Retro-Rockets	Atlas Guidance GE Relay #6	
SEP Backup	283.64	Atlas/Agena Separation (Back-up)	Atlas Sub-Programmer	
	286	Separation Complete		

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SECTION II

TEST PROGRAM

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SECTION III

INSTRUMENTATION

3.1 TELEMETERED DATA. Range safety command data telemetered during flight are as follows:

Meas. No.	Description
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SECTION IV

GROUND SUPPORT EQUIPMENT AND OPERATIONS

4.1 INTRODUCTION. The ground support equipment for the flight termination system is capable of performing all of the control and monitoring functions required for normal checkout and launch control of the missile FTS. This portion of the report will consider the functions of the test support equipment during prelaunch checkouts and will also describe typical launch control operations.

4.2 BOOSTER VEHICLE TEST SUPPORT EQUIPMENT. The following test support equipment is used for checkout of the Atlas portion of the FTS:

a) OPERATION & CHECKOUT CONSOLE, manufactured by Aerojet-General and consisting of:

1) Common Destruct Controls Panel, AJG Part No. F-AFC-0156-1

2) Safety & Arm Controls Panel, AJG Part No. F-AFC-0157-1

3) RF Signal Generator, Babcock Radio Engineering, Inc., BSG-11

4) RF Signal Generator Remote Control Panel, AJG Part No. F-AFC-0157-2

5) D-C Power Supply, Perkin Engineering Corp., Part No. MTR-28-30

b) Antenna Test Couplers (two required)

c) Destructor Substitution Test Unit (Yellow Box, one required).

The above equipment is identical to the equipment used for checkout and launch of the D/IOC confidence missiles at VAFB except for a few minor changes; i.e., changes to up-date the equipment, and changes to make the O&C Console control panel usable specifically for Atlas launches.

4.2.1 LOCATION OF EQUIPMENT. The O&C Console is located in the blockhouse in the same room with the test conductor and main launch control panels. The O&C Console operator should be connected by the communications system directly with the RSO.

The Antenna Test Couplers are connected directly over the airborne antennas so that tests may be made without outside radiation.

The Yellow Box is mounted on the missile and substituted for the RED Destructor Unit during all tests preceding the final countdown.

Cables from the O&C Console run down through the blockhouse basement, through the cable trough to the M&E room, and up to the airborne umbilical and antenna test coupler through numerous terminal boards and junction boxes. Only one coaxial cable connection is completely provided. This cabling provides essentially a through-wire connection between the umbilical and the O&C Console as shown on Convair-Astronautics Drawing 27-12278 and Figure 1-3.

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These antenna test couplers must be removed for flight, Countdown, or other tests in which the Ground Destruct Transmitter (GDT) is being used for simulation.

4.2.4 OPERATION AND CHECKOUT CONSOLE (O&C). For launch (or test) all control and monitor operations can be performed by the operator of the O&C Console. Control and monitoring of the power changeover function, external power, and safety/arm function, as well as command signal excitation are provided as follows:

Figures 4-3 and 4-4 present an overall view and a top view, respectively, of the O&C Console.

4.2.4.1 RF SIGNAL GENERATOR (BSG-11). The signal generator is designed to test FM receivers in the 406-420 megacycle range, with provision for deviations up to ±300 kilocycles by one to six subcarrier tone frequencies. It contains a calibrating RF-level meter, and provides crystal-controlled, frequency-modulated RF carrier signals. The output level is continuously variable between 1 and 100,000 microvolts. ON-OFF switches are provided for tones 1 through 6. A DEVIATION control knob and a DEVIATION meter are provided. The peak deviation indicated by the DEVIATION meter is correct only when a single tone is being used. If additional tones are turned on, and the DEVIATION control knob is not adjusted, the resulting peak deviation will be the single-tone deviation times the number of tones turned ON. Each tone will have the same deviation as set for any other single tone, since the generator does not contain a compressor. A carrier FREQUENCY selection switch, A-C POWER ON-OFF and CARRIER signal ON-OFF switches are also provided.

During FTS tests, the output of the signal generator must be connected to one or the other of the antenna test couplers through the coaxial line. The attenuation of the coaxial line should be determined, and the fiducial ring on the signal generator attenuator should be adjusted so that the attenuator indicates the signal level impressed on the antenna test couplers.

The DEVIATION control should be adjusted to indicate ±30-kc deviation with only one tone turned on; this setting will cause ±60-kc deviation when two tones are applied, as is necessary for command operation. Commands may then be given to the FTS by operation of the tone switches.

4.2.4.2 RF SIGNAL GENERATOR REMOTE CONTROL PANEL. Since the RF Signal Generator is located beneath the table-top of the O&C Console and is rather inaccessible, a remote control RF signal generator panel, shown in Figure 4-5, is provided above the table-top. This panel can be activated by placing the REMOTE/LOCAL control switch of the RF Signal Generator in the REMOTE position. This remote control panel allows the operator to easily turn ON or OFF the carrier signal or any of the 6 tones.

4.2.4.3 D.C. POWER SUPPLY (Perkin MTR-28-30). The D.C. Power Supply in the O&C Console furnishes all of the external power required to operate, control, and monitor the FTS and the telemetry portion of the IRSS during test and launch. Its nominal output voltage should be 28 volts, dc. Its maximum specified current is 40 amperes. The maximum current drain

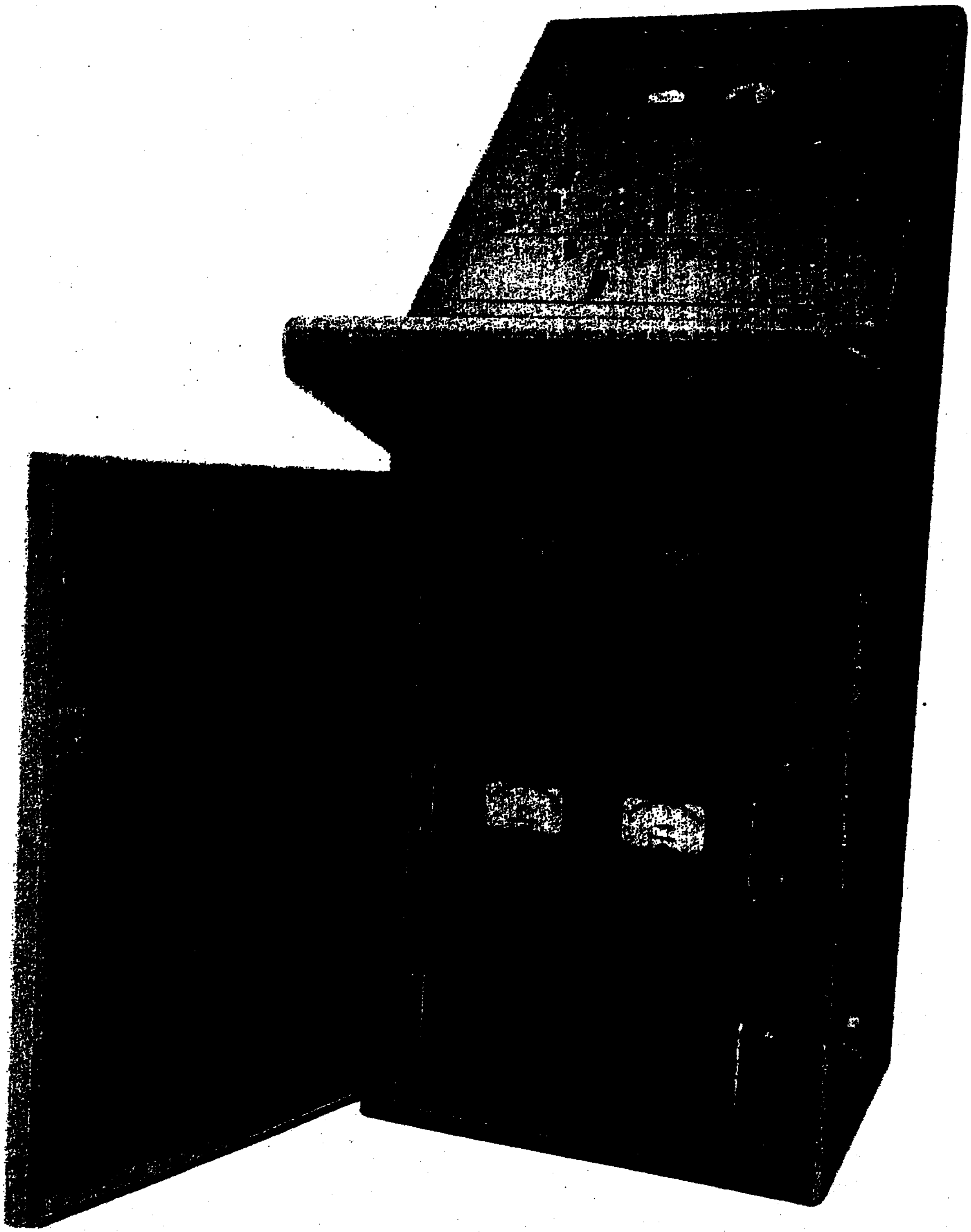

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Figure 4-3. Operation and Checkout Console Aerojet-General Part No. F-AFC-0072

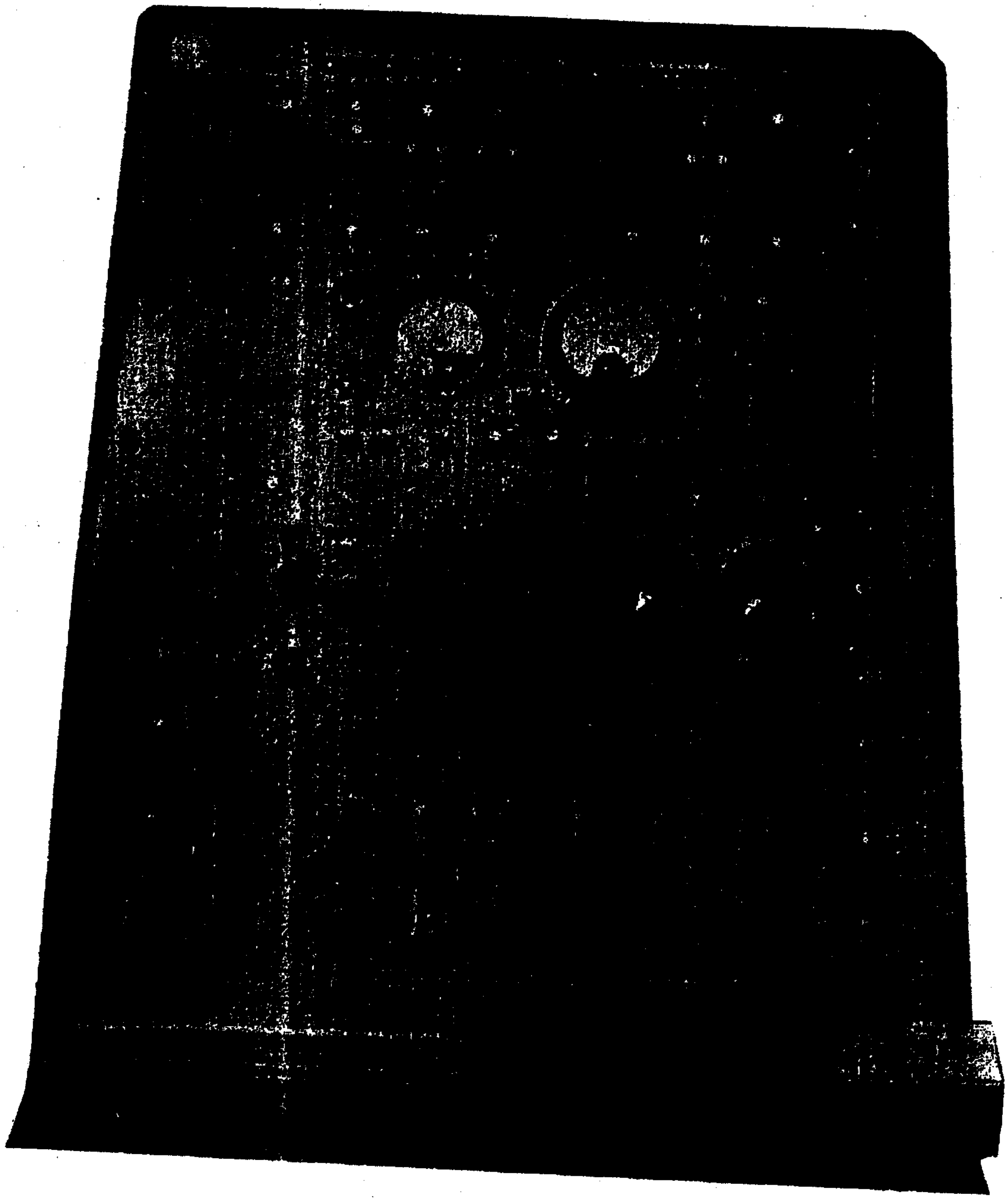

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Figure 4-4. Operation and Checkout Console, Top View

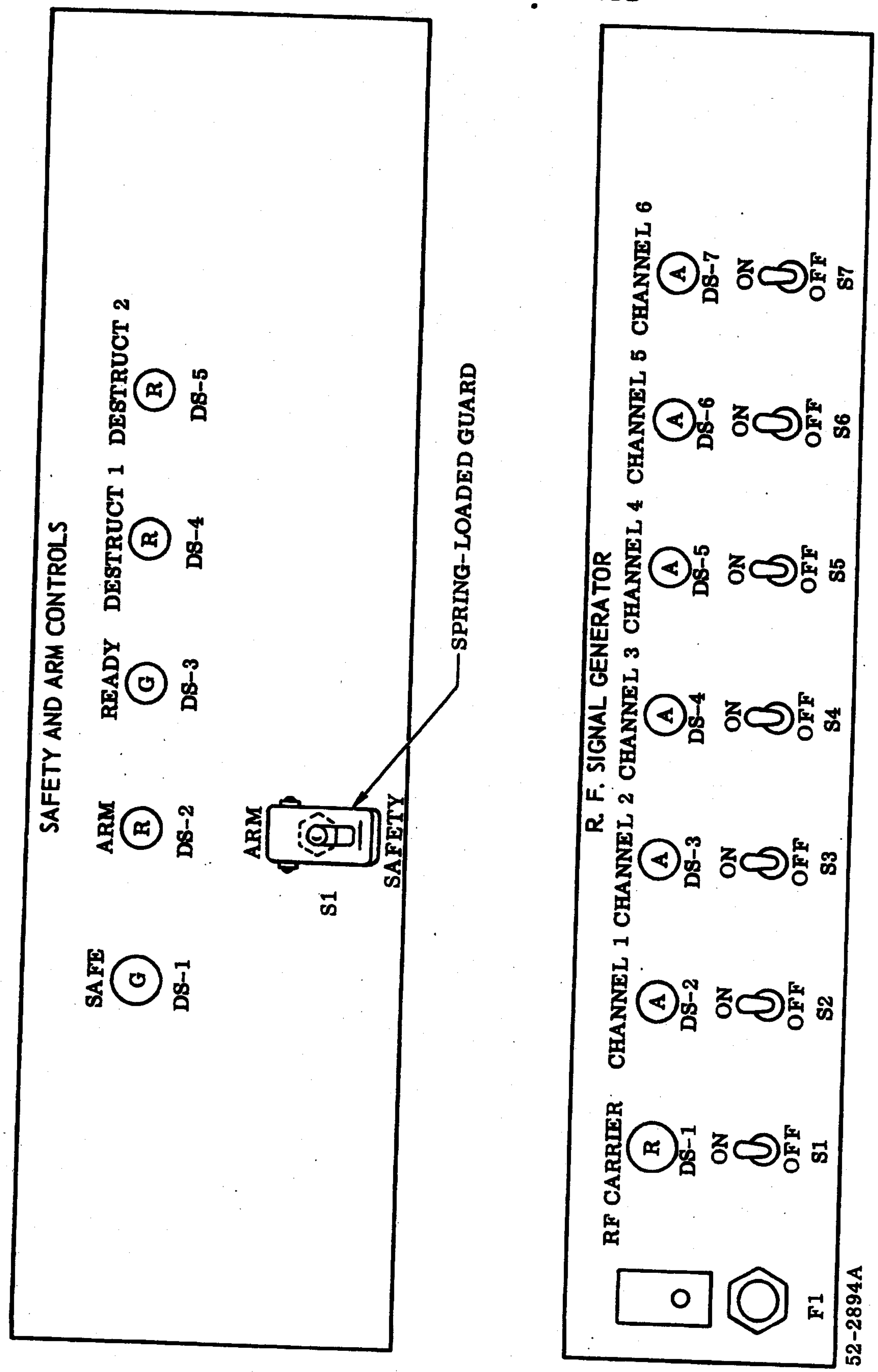

Figure 4-5. Safety and Arm Controls Panel and RF Signal Generator Remote Control Panel

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b) Satellite Destruct Simulator.

4.5.1 LAUNCH COORDINATOR CONSOLE. The Launch Status Panel of the Launch Coordinator's console (Figure 4-7) is connected to the satellite through the satellite electrical umbilical system and is designed to indicate both the arming status of the destruct initiator and the condition of the separation switches in the destruct circuit. The console, which is located in the Launch Operations Building (LOB), contains the REMOTE ARM/SAFE switch, the ARM/SAFE indicating lights, a press-to-test switch for checking the separation switches (RELAY AND SWITCH CHECK), duplicate SAFE indicator lights which monitor the position of the premature-separation switches, and a DESTRUCT SYSTEM ARM POWER ON-OFF switch.

The ARM POWER switch is labeled DISABLE and ENABLE, with ENABLE being the normal position.

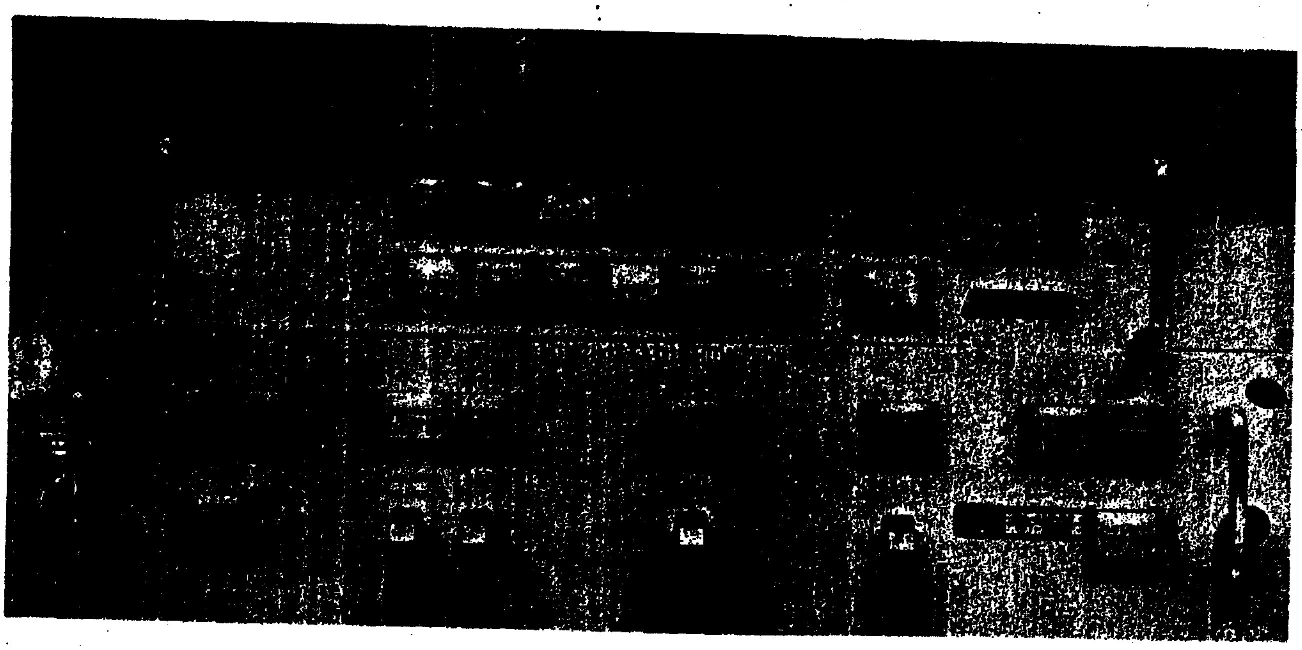

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Figure 4-7. Launch Coordinator's Console

4.5.2 SATELLITE DESTRUCT SIMULATOR. The destruct simulator, shown in Figure 4-8, is a testing and monitoring unit used in place of the satellite destruct assembly while the satellite vehicle is on the launch pad. It is designed to simulate all the functions and characteristics of the destruct assembly and is installed prior to making any power check. The following checks are made with the use of the simulator:

a) Range Safety Command Destruct

b) Arming Command

c) Stray Current and Continuity Check

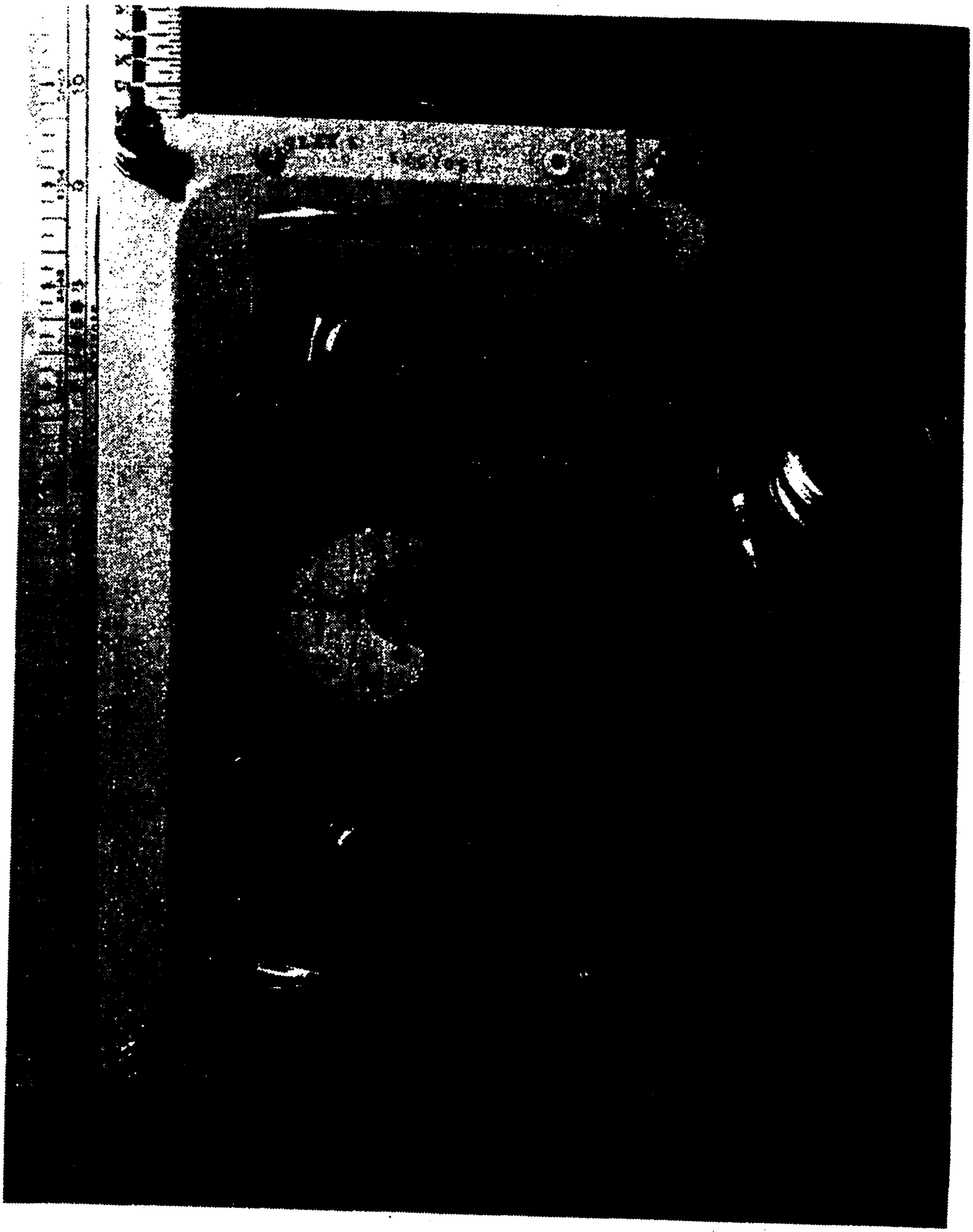

Figure 4-8. Satellite Destructor Simulator

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When the pyrotechnics are installed in the satellite vehicle, the simulator is electrically connected to the destruct system through a plug. At final countdown, this plug will connect the destruct assembly to the destruct system. The command-destruct signal check is registered on the extended scale of the simulator ammeter. The destruct voltage in each of the two destruct systems is checked separately by turning the selector knob to TEST 1 or TEST 2. The arming command is checked at the same time. This command is registered on the Arm/Safe lights on the simulator. Any time the simulator is plugged in, one of these lights will be on.

Stray current checks may be made by placing the selector knob at MONITOR, thereby causing either of two 1/8-amp fuses to simulate either of the squibs in the initiator. If more than 140 to 150 milliamps of stray current enters either one of the two destruct systems in the destruct circuit, a fuse will blow, thereby setting off an alarm system. A current of over 200 milliamps is required to ignite the primer; therefore, a margin of safety of at least 50 ma is allowed between ignition current and maximum allowable stray current. Also, stray current and continuity checks can be made with the ammeter or by using a special unit and connecting it to the destruct system through the external monitor jack on the simulator. The simulator is electrically connected to a pneumatic box located on the ground. Relays in the pneumatic box, when energized, set off a nitrogen horn (alarm system). To turn off the horn, the fuse in the simulator must be replaced and the alarm circuit in both the simulator and the pneumatic box must be reset. This ensures that the cause of the malfunction that resulted in a blown fuse is checked immediately. Figure 4-9 is a schematic diagram of the destruct simulator and the alarm relays in the pneumatic box.

After the final Range Safety Officer command-destruct checks have been made (during the countdown) and the satellite vehicle subsystem checks have been completed, the simulator is removed and the destruct assembly is electrically connected to the destruct circuit.

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APPENDIX A

LIST OF DRAWINGS

Number	Title
	BOOSTER VEHICLE
7-36044	Ring Coupler
27-04306	Destructor
27-36244	Arming Device, Range Safety Command
27-12507	Antenna, Range Safety Command
27-12281	Schematic, Receiver, Range Safety Command
27-60037	Electrical Installation, Range Safety Command
27-61106	Equipment Installation, Range Safety Command Receivers
27-60521	Circuit Diagram, Range Safety Command Subsystem
27-60121	Schematic, Electrical, Range Safety Command Subsystem
27-61864	Harness, IRSS, Coaxial
27-61839	Harness, Power Umbilical Receptacle to Components
27-61869	Harness, Range Safety, Power Unit, to Components
	SATELLITE VEHICLE (Samos Model 9205)
1060598	Destruct Initiator (only)
1062095	Battery-Secondary, Type III
1062569	Charge-Shaped-Destruct
1310402	Vehicle Complete Equipment
1313631	Top Electrical Harness Drawing
1318463	Equipment Installation, Destruct Charge

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APPENDIX A (Continued)

Number	Title
	(Samos Model 9205) (Continued)
1318634	Schematic Diagram
1320197	Switch Installation, Destruct Lockout
	(Samos Model 4205)
1060598	Destruct Assembly, Arming and Charge
1062095	Battery-Secondary, Type III
1304804	Vehicle Complete Equipment
1307380	Wiring Diagram Basic Vehicle
	a. Umbilical
	b. Guidance and Computer Package
	c. Vehicle Squibs and Propellant Equipment
	d. Power Systems
1307381	Electrical Plug and Receptacle Drawing.
1307388	Top Harness Drawing
1307569	Equipment Installation, Destruct Charge
1308873	Schematic Diagram, Destruct System
1318574	Switch Installation, Destruct Lockout
	(Midas Model 7205)
1060598	Destruct Initiator (only)
1062095	Battery-Secondary, Type III
1062569	Charge-Shaped-Destruct
1308290	Switch Installation, Destruct Lockout
1308315	Vehicle Complete Equipment
1310780	Top Electrical Summary Drawing
1312644	Schematic Diagrams

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APPENDIX A (Continued)

Number	Title
	(Midas Model 7205) (Continued)
1312645	Harness Drawing Complete
1318463	Equipment Installation Destruct Charge

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APPENDIX B

LIST OF SPECIFICATIONS

Number	Title
	BOOSTER VEHICLE
7-03272	Ring Coupler, Range Safety Command
7-04306	Destructor Unit, Explosive, Airborne
27-01270	Instrumentation and Range Safety System - Midas/Samos, Point Arguello, Airborne
27-03008	Arming Device, Range Safety Command
AZM-27-339	Electrical Interconnections for SM-65 R&D Series Missiles (Midas/Samos for Point Arguello Launches)
	SATELLITE VEHICLE
Military	
MIL-STD-129B	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-302	40-ft Drop Test
MIL-STD-304	Temperature and Humidity Test for Use in Development of Fuses
MIL-STD-315	Static Detonator Safety Test for Use in Development of Fuses
MIL-STD-638	Terminology, Dimensions, and Materials of Explosive Components for Use in Fuses
JAN-C-401	Composition B
MIL-G-2550	General Specification for Ammunition
MIL-D-5028	Drawings and Data Lists
MIL-E-5272C	Environmental Testing, Aeronautical and Associated Equipment
MIL-Q-5923C	Quality Control Requirements, General

APPENDIX B (Continued)

Number	Title
MIL-F-7179	Finishes and Coatings, General Specification
MIL-E-8189A	Electronics Equipment, Guided Missiles, General Specification for
MIL-D-20462A	Detonator, Electrical, M36A1, Loading, Assembling and Packing
MIL-D-70327	Drawings, Engineering and Associated, List
COM-PMR Instr. 5100.2A	Policy Criteria and Procedures for In-Flight Range Safety at the Pacific Missile Range
COM-PMR Instr. 5100.4	Airborne Flight Termination Systems Required for In-Flight Safety

Lockheed Aircraft Corp.

LMSD 6117-A	General Environmental Specification (Lockheed Aircraft Corp.)
106500	General Procurements Requirements (Design Control Spec.)
1067050	Battery-Secondary, Type III (Design Control Spec.)
1067259	Shaped Charge-Destruct (Design Control Spec.)
1072105	Destruct Initiator, (Acceptance Test Spec.)

Beckman & Whitley

2125D-02	Initiator Specification

APPENDIX C

LIST OF QUALIFICATION TEST PROCEDURES & REPORTS

Number	Qualification Test Procedures
	BOOSTER VEHICLE
7A2055	Pre-Production Test of the Electrical Arming Device
27A392	Production Evaluation Test of the Destructor Unit
27A2432	Pre-Production Test of the Signal Conditioner and Power Control Unit (Similarity to D/IOC 27-11008 Unit)
7A561, 7A1569	Pre-Production Test and Reliability Test, Respectively, of the Ring Coupler
7A1830, 7B2083	Pre-Production Test of the Range Safety Command and Telemetry Antennas

SATELLITE VEHICLE

Number	Test
Wyle Research Corp., Report No. 7830	Destruct Initiator
Wyle Research Corp., Report No. 7827	Destruct Charge 1X Tank
American Labs Qualification Report 9-8418-LA	Destruct Charge 2X Tank
TA 2556	Battery-Secondary, Type III
TA 4532, TA 10854 (XN)	Separation Switches

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