Contract NAS9-9462

FAMILIARIZATION AND SUPPORT MANUAL FOR APOLLO LUNAR SURFACE DRILL

(ISSUE 3)

MARTIN MARIETTA CORPORATION DENVER DIVISION

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FOR

APOLLO LUNAR SURFACE DRILL (ALSD)

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Familiarization and Support Manual

for

Apollo Lunar Surface Drill (ALSD)

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Issue 3

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FOREWORD

This document is prepared and submitted in accordance with the requirements of Contract NAS9-9462, Article III B, items 11 & 16 and Exhibit C paragraphs 2.13, 2.14, and 2.8.

This document supersedes Martin Marietta Report number ER 14756; DSM-1 and DSM-2 prepared under Contract NAS9-6587.

This document includes a description of the Apollo Lunar Surface Drill with associated Ground Support Equipment, lunar mission requirements, operating and service instructions, spare parts distribution, and transportation and storage requirements.

This document is approved per NASA-MSC letter EA22/11-19/L362.

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GLOSSARY OF TERMS

ADL.	A. D. Little Inc.
ALHTC.	Apollo Lunar Hand Tool Carrier
ALSD	Apollo Lunar Surface Drill
ALSEP.	Apollo Lunar Surface Experiments Package
BXA.	The Bendix Corporation - Aerospace Systems Division
B/D.	Black and Decker Mfg. Co.
BPM.	Blows Per Minute
C/L.	Chicago Latrobe
ECS.	Environmental Control System
GFE.	Government Furnished Equipment
GSE.	Ground Support Equipment
HFE.	Heat Flow Experiment
KSC.	Kennedy Space Center
LGE.	Lunar Geological Equipment
LM	Lunar Module
LRL.	Lunar Receiving Laboratory
MESA	Modularized Equipment Stowage Assembly
MMC.	Martin Marietta Corporation
MSC.	Manned Spacecraft Center
SEQ.	Scientific Equipment Bay, a bay in LM
SRC.	Sample Return Container
YEC.	Yardney Electric Company

I. SUMMARY AND INTRODUCTION

1.0 GENERAL CONTENTS

The ALSD Familiarization and Support Manual contains equipment descriptions, operating procedures and support instructions necessary to maintain the Apollo Lunar Surface Drill at a field level of operation. Major areas contained in the manual include:

- Interfaces with the Apollo Lunar Surface Experiments Package (ALSEP)
- Operational Requirements
- Equipment descriptions with major part number identifications
- ALSD Operating Procedures
- Service Instructions
- BXA and KSC Prelaunch Operations
- Spare Parts Distribution
- Transportation and storage requirements

2.0 EQUIPMENT CHECKOUT AND MAINTENANCE CONCEPTS

The field level checkout and maintenance requirements for the ALSD have been minimized because of the relatively short service life, simplicity, and portability of the equipment. Elaborate GSE for the ALSD system was eliminated during concept definition. Extensive factory checkout requirements of the ALSD and the relative simplicity of the equipment provides a high degree of confidence that it will function properly during the lunar mission.

Since Training Unit No. 2 will be subjected to greater usage than the flight units, a periodic inspection check list has been established for it. Training Unit No. 1 is a lightweight, nonoperational model to simulate the 1/6 G lunar gravitational environment. It is a deployment training model for use by the astronauts for procedure rehearsal, and scientific experiment positioning on the simulated lunar surface at the MSC Houston. The training units will be returned to the factory for detailed inspection and repairs if required. A spare parts inventory has been established to support both field level and factory level maintenance requirements.

The checkout and maintenance summary chart for both the flight and training unit ALSD's is diagrammatically illustrated in Figure I-1. It is recommended that Martin Marietta Corporation technical assistance be provided when performing checkout and maintenance activities.

3.0 SPARES

The spares provisioning and distribution system for the ALSD system is established in conformance with the checkout and maintenance concepts. Spares which are readily replaceable at the "black box" level are provided at the required field locations. Other more complex components requiring factory level installation, adjustments, and testing will be maintained in the factory GFE inventory until required. A list of spares for the ALSD program is tabulated in a later section of this manual.

Figure I-2 diagrammatically illustrates the spares distribution system for the ALSD.

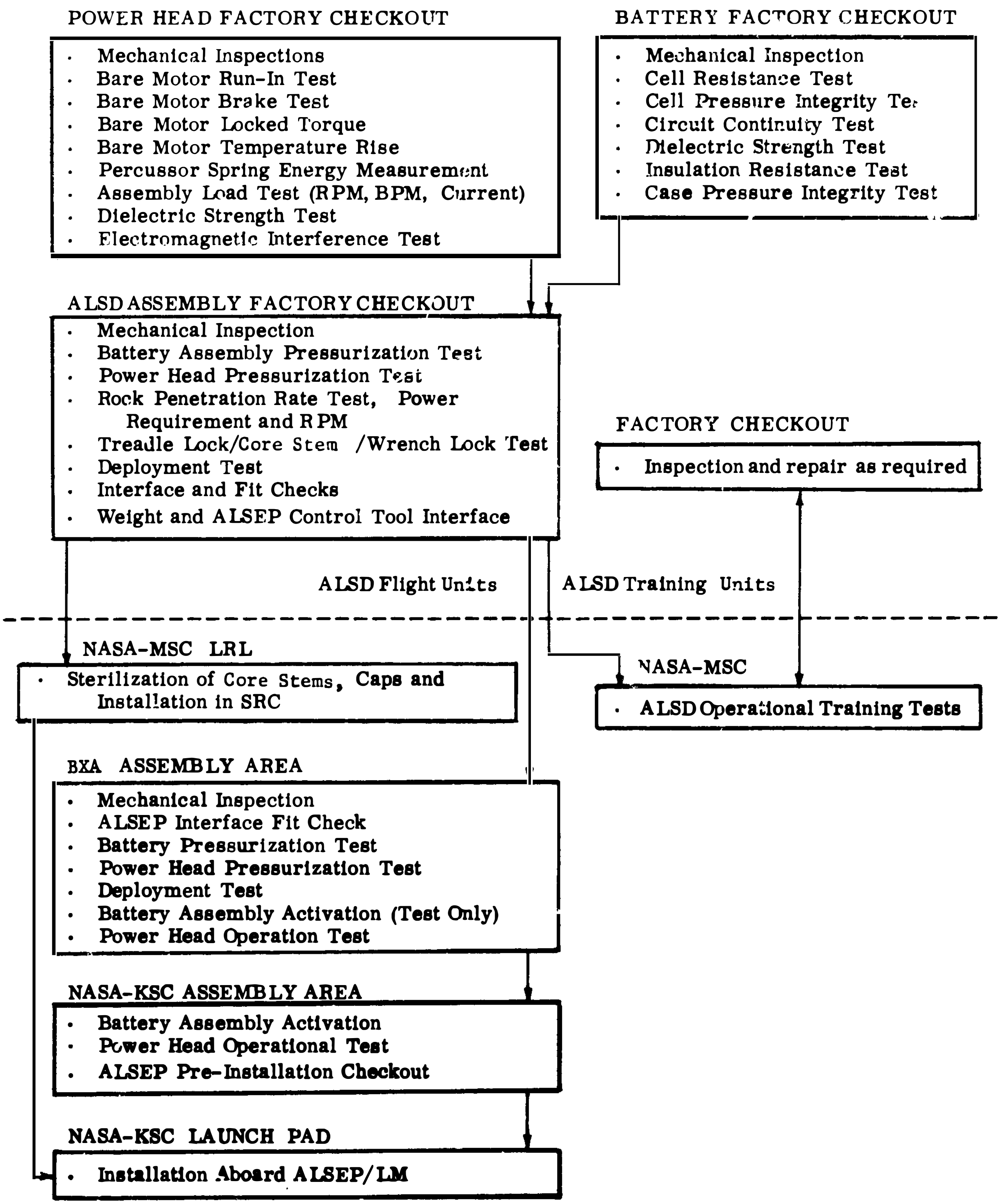


Figure I-1. Recommended ALSD Checkout and Maintenance Summary Chart

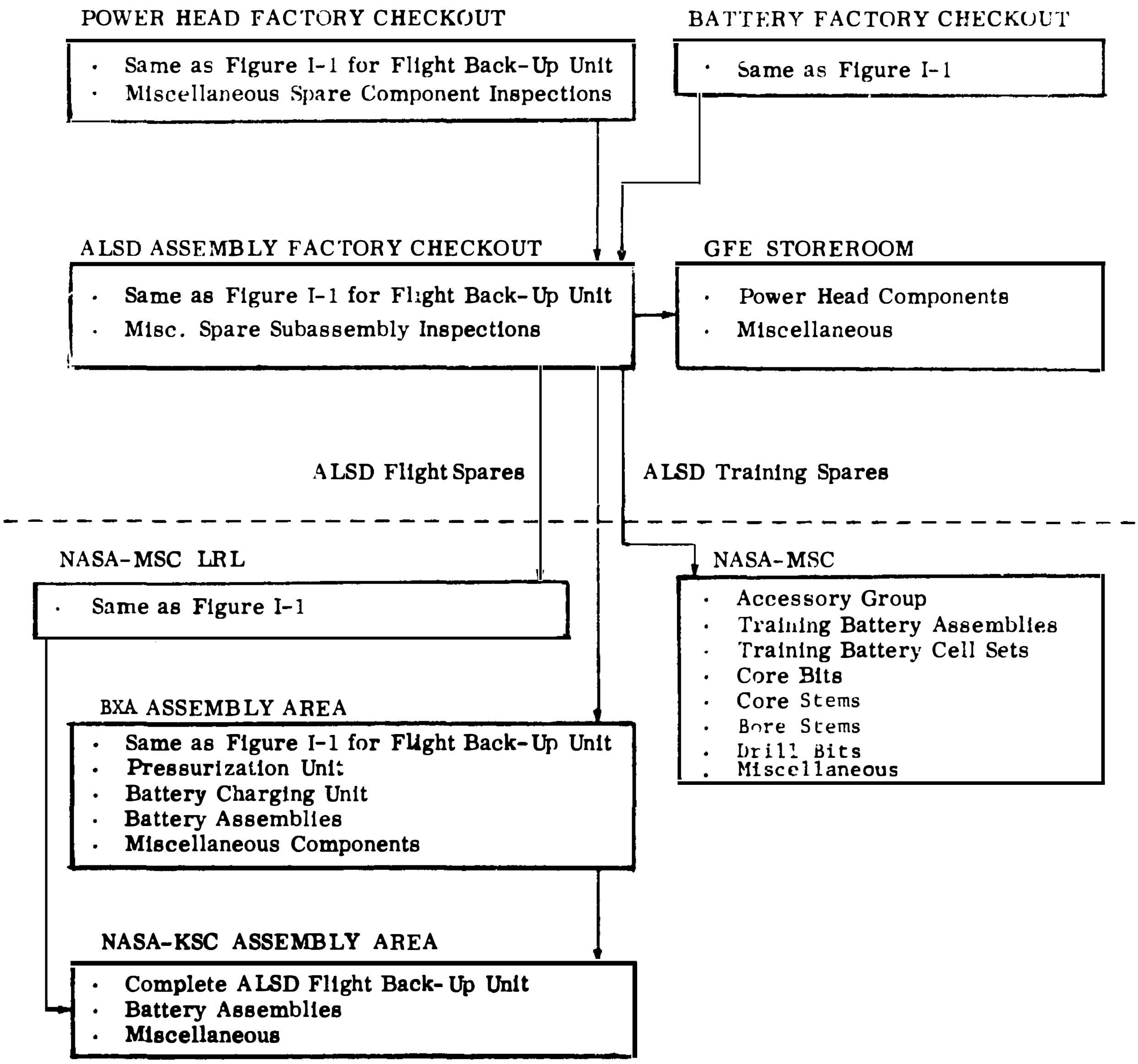


Figure I-2. ALSD Spares Distribution

II. ALSD MISSION REQUIREMENTS AND GENERAL SYSTEM DESCRIPTION

1.0 APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE (ALSEP)

The ALSEP is a group of scientific experiment and support subsystems which will be deployed on the surface of the moon by the Apollo astronauts. The ALSEP will measure lunar physical and environmental characteristics and transmit the data to receiving stations on Earth up to one year after departure of the astronauts. This data will be used to derive information on the composition and structure of the lunar body, magnetic field, atmosphere, and the solar wind.

The ALSEP consists of the following subsystems:

- Structural/thermal subsystem
- Electrical power subsystem
- Data subsystem
- Eight experiments in varying combinations
- Apollo lunar hand tools subsystem

The eight experiments consist of the following subsystems:

- Passive seismic
- Magnetometer
- Solar wind
- Suprathermal ion detector
- Active seismic
- Heat flow with supporting ALSD
- Charged particle lunar environment
- Cold cathode gauge

The purpose of the ALSD is to provide a means for a single astronaut to emplace Heat Flow Experiment (HFE) probes below the lunar surface and to collect subsurface cores. Emplacement of the HFE probes requires the boring of two subsurface holes to a maximum depth of three meters. The bore stems remain in position in the lunar soil and function as an encasement to preclude cave-in of unconsolidated lunar material, and to facilitate insertion of the probes. A subsurface core is to be obtained by powering six core stems into the lunar soil, removing and capping the stems for subsequent transport to Earth in a Sample Return Container (SRC).

2.0 ALSD/ALSEP INTERFACES

The ALSD is designed as a totally integrated system which mechanically interfaces with the ALSEP Subpackage Number 2 during transit from Earth to the lunar surface in the Lunar Module (LM) Scientific Equipment Bay (SEQ). Conceptual illustrations depicting these interfaces are presented in Figures II-1 and II-2. ALSEP Subpackage No. 2 is shown in Figure II-3.

Upon arrival on the lunar surface the ALSEP subpackages are removed from the LM-SEQ by the astronaut. The ALSD is detached from the ALSEP subpackage by the astronaut, and the subsequent drilling operations are performed completely independent of the ALSEP.

The ALSD core bit, core stems and caps are stowed in the SRC during the outbound flight. These items are subsequently removed from the SRC by the astronaut and integrated with the ALSD during the post-landing preparations.

3.0 OPERATIONAL REQUIREMENTS

3.1 Drilling

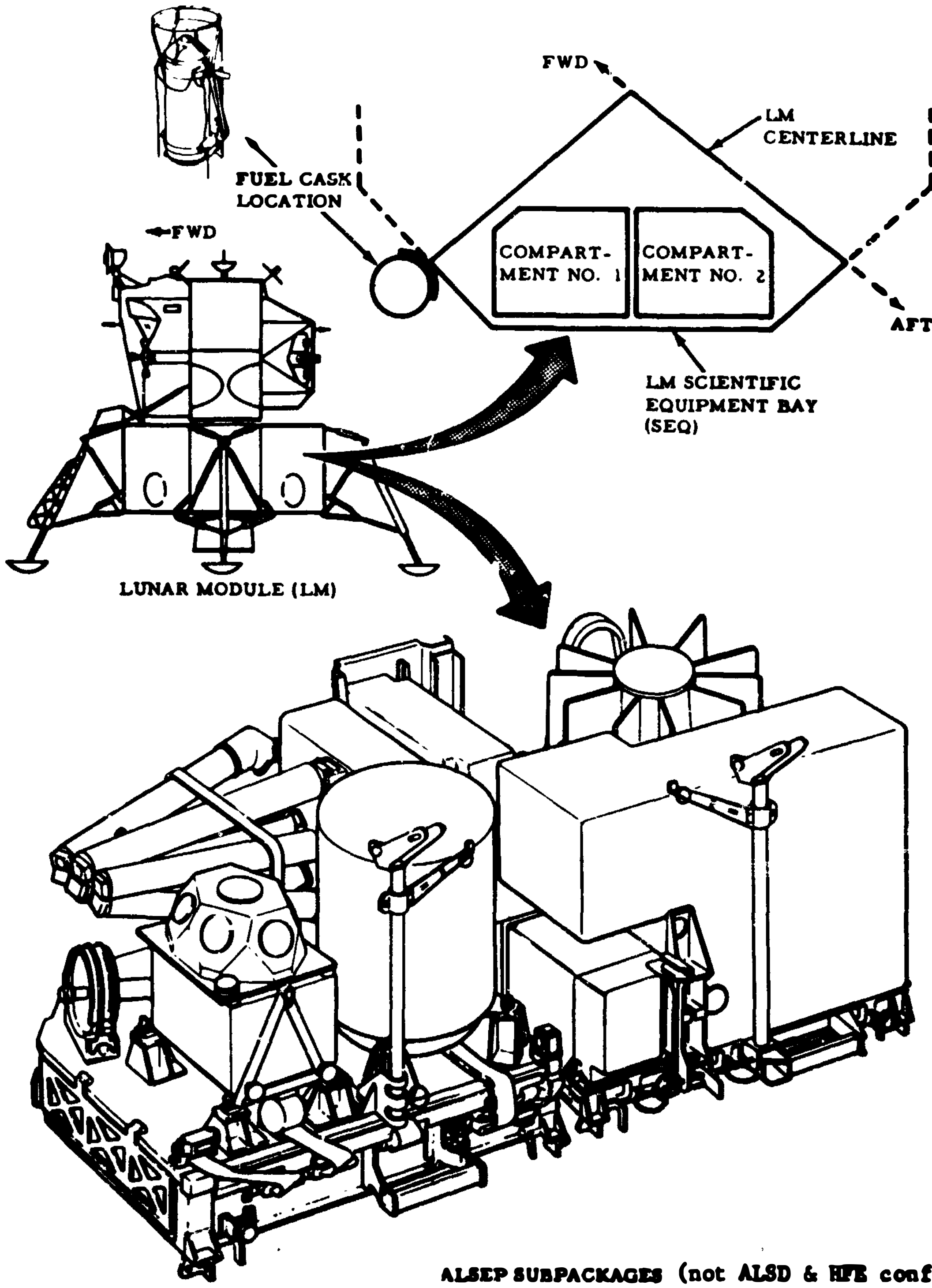
The ALSD possesses the capability of boring and coring in all anticipated lunar surface materials ranging from low density, fragmental material to dense basalt. Contractually defined lunar surface model simulations for ALSD design guidelines include:

1) Two holes, three meters in depth in materials having particle sizes ranging from less than 3 millimeters in diameter to approximately 16 inches in diameter.

2) Two holes, three meters in depth, in materials similar to 1) above, but part of this model includes two tabular pieces of 40% vesicular basalt, one 10 inches thick, buried 5 feet below the model surface and one 5 inches thick 10 feet below the model surface.

3.2 Environmental

The ALSD possesses the capability of performing the lunar surface



ALSEP SUBPACKAGES (not ALSD & HFE configuration)

Figure II-1. ALSEP/LM Interface

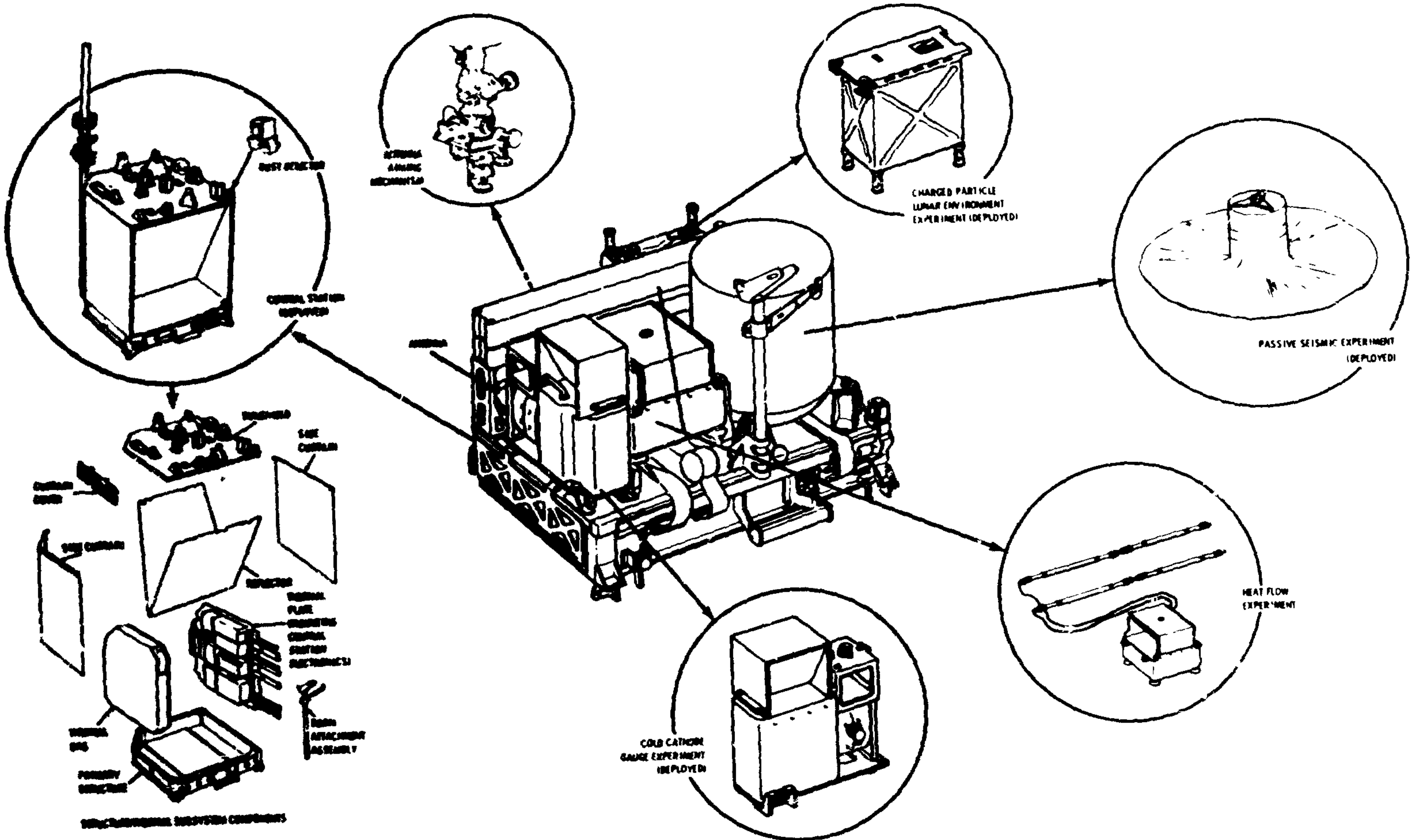


Figure II-2 ALSEP Subpackage No. 1/HFE Interface

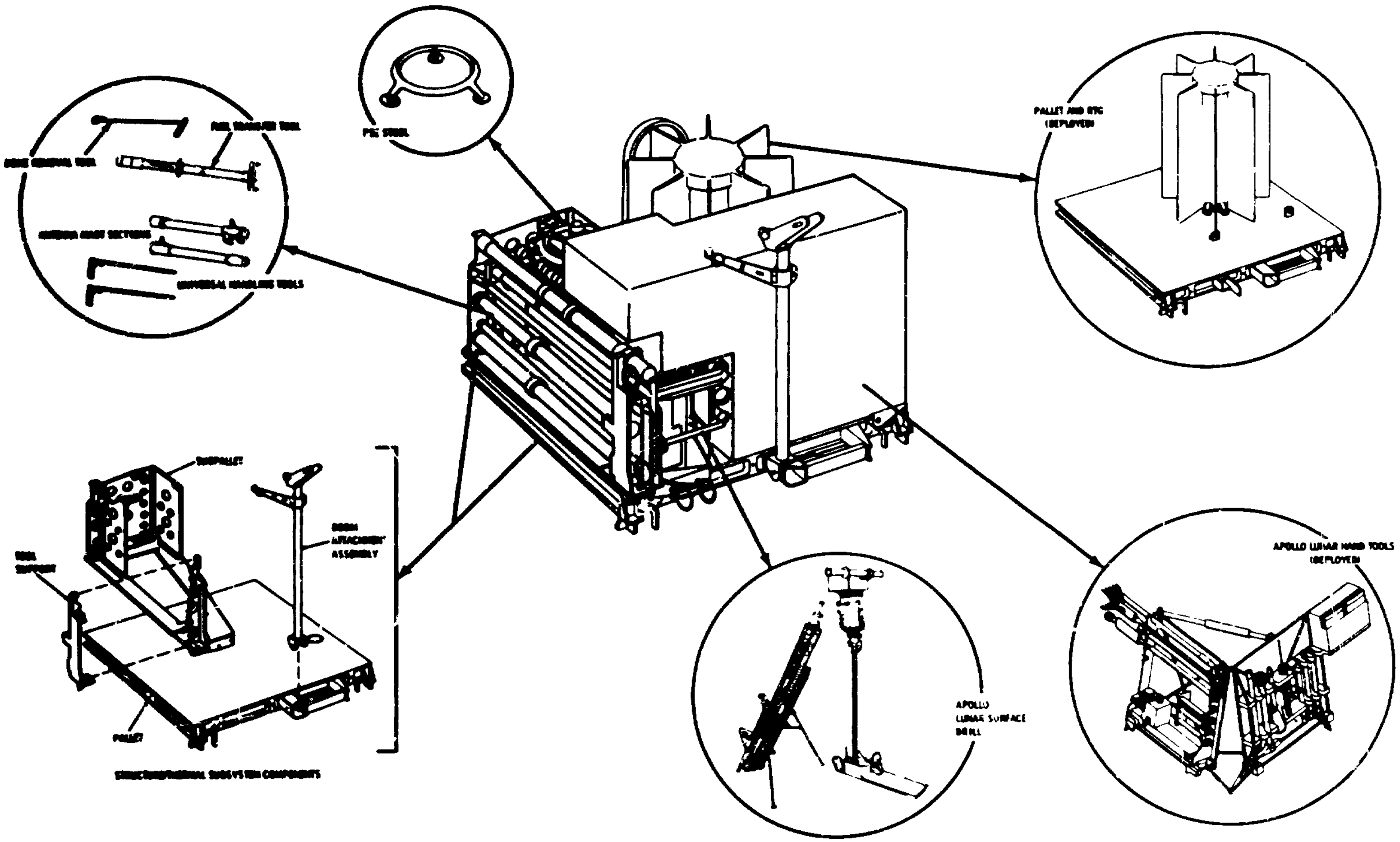


Figure II-3 ALSEP Subpackage No. 2/ALSD/ALHT Carrier Interface drilling mission described in paragraph 3.1 after being subjected to the translunar and lunar environments. Major environmental criteria which influenced the system design included:

1) Translunar

   a) Shock, vibration, and acceleration of levels and durations specified in applicable contractual documents.

   b) Thermal-vacuum exposure to ambient pressure levels of 10^{-8} torr, and SEQ wall temperatures between 20°F and 160°F. Nominal exposure time during the translunar portion of the mission is 106 hours.

2) Lunar Surface

   a) 1/6-G gravitational field.

   b) Thermal-vacuum exposure resulting from the low ambient pressure (10^{-13} torr range) on the lunar surface, and sun angles between 9° and 45° above the local horizon. Maximum exposure time during the lunar surface mission is 36 hours.

3.3 Weight and Volume

Limitations of the SEQ and ALSEP require that the ALSD (exclusive of core stem and caps) be packaged within a volume not to exceed 7 x 9.6 x 22.68 inches. A maximum weight limitation of 31.0 pounds has been imposed upon the ALSD. The flight configuration weight is less than 30.0 pounds.

4.0 GENERAL SYSTEM DESCRIPTION

The drilling device which will be employed to produce the lunar subsurface holes is a hand-held, battery-powered, rotary-percussion drill. The rotary-percussion drilling principle was selected for this application because: (1) the axial bit pressure and rotary torque requirements for efficient drilling are considerably less than that required for rotary drilling; (2) the drill bit operating temperatures are sufficiently low to preclude the requirement for a drill bit coolant such as air or water; and (3) the tungsten-carbide bit cutters will drill with reasonable efficiency in the presence of a small dust layer in the bottom of the hole which is inherent with a mechanical cuttings transport system.

The ALSD is inherently capable of coring a 1.032-inch diameter hole in dense basalt (22,000 psi compressive strength) at a maximum rate of 2.5 inches per minute, or 43% porosity vesicular basalt at a maximum rate of 6 to 8 inches per minute, with an optimum applied axial bit pressure of 60 pounds. Under actual lunar surface drilling conditions, the maximum drilling penetration rate is degraded in proportion to the hole depth and available axial bit pressure which can be manually applied by the astronaut. For a hole depth of 1.5 meters and nominal astronaut applied axial bit pressure of 10 to 12 pounds, the dense and vesicular basalt penetration rates are reduced to approximately 1 and 5 inches per minute respectively. Penetration rates in conglomerate or pumice type materials vary from 30 to 120 inches per minute. Boring performance of the ALSD is essentially the same with the boron-fiberglas stems and solid face bit except the hole diameter increases to 1.125 inches.

The ALSD is designed as a totally integrated system which interfaces with the ALSEP pallet located in the LM-SEQ during transit from Earth to the moon's surface. The drill, with its various subsystems, can be removed as a single package from the ALSEP subpackage and transported by the astronaut to the selected drilling site for subsequent assembly and operation. The core bit, core stems, and caps are transported separately to the lunar surface in a sample return container.

A brief description of the ALSD subsystems, (Ref. Figure II-4), required to perform the lunar surface drilling mission follows:

1) Battery - Provides the total electrical power capacity required to perform a three-hole lunar surface drilling mission.

2) Battery Thermal Shroud - Provides low temperature protection for the battery during lunar surface operations at a low sun angle.

3) Power Head - Contains the electric motor, percussion and rotation systems required for powering the drill bit and core bit.

4) Power Head Thermal Guard - Prevents the astronaut from accidentally contacting areas of the power head which may exceed + 250°F during drilling operations.

5) Handle and Switch Actuator Assembly - Provides the astronaut with a means of manual restraint and motor control of the drill.

6) Drill and Core Bits - Provide the cutting capability required for rock penetration.

7) Bore Stem - Transmits the rotary-percussion energy from the power head to the bit and mechanically transports cuttings from the bit to the surface.

8) Core Stem - Transmits the rotary-percussive energy from the power head to the bit and provides a means for core collection.

9) Core Stem Caps - Precludes loss of core material from the core stems.

10) Bore Stem Adapter - Couples bore stem to power head output spindle.

11) Wrench - Provides a means of decoupling core stems, and an alternate method for adapter removal.

12) Rack Assembly - Provides outbound mission stowage restraint for bore stems, wrench, and handle assembly, and provides temporary vertical stowage of bore stems, core stems, core stem caps and wrench during lunar drilling/coring operations.

13) Treadle Assembly - Provides structural restraint for the entire ALSD system during outbound mission stowage, and houses the core string lock used in conjunction with the wrench for core stem decoupling operations.

Major items of GSE required to support the ALSD include the following:

1) Shipping Container - Provides a convenient means for shipping or hand-carrying the ALSD assembly.

2) Pressurization Unit - Provides capability for sequentially pressurizing the battery and power head for verification of relief valve operation and seal integrity.

3) Battery Charging Unit - Provides capability for recharging of battery if required.

4) Battery Activation Kit - Contains electrolyte for individually activating the sixteen battery cells.

5.0 GENERAL MISSION SEQUENCE DESCRIPTION

5.1 ALSD Fabrication and Assembly

All elements of the ALSD are fabricated and integrated into the basic system at the prime contractor's facility. The system is subjected to a rigid acceptance test consisting of the following major steps prior to shipment:

1) Power head and battery pressurization and seal integrity verification,

2) Power head and battery electrical circuit checkout,

3) Mechanical interface of all subsystems,

4) Operational coring test inclusive of rotational speed, power requirement, and basalt penetration rate measurements,

5) Bore stem operational release test,

6) Operational deployment test,

7) Mechanical interface with ALSEP control tool,

8) Mass properties and envelope measurement.

9) Vibration

Upon completion of acceptance tests, all elements of the flight unit drill systems are cleaned, bagged, and packaged in a special aluminum shipping container. Battery activation electrolyte is packaged and shipped separately. The core bit, core stems and caps are shipped to the LRL located at NASA-MSC. These elements are subsequently sterilized and integrated into the SRC for stowage during the outbound mission.

5.2 KSC Checkout and Integration with ALSEP Aboard LM

The ALSD will be removed from the ALSEP and held in the KSC Assembly Area for battery activation and final checkout. Installation of the ALSD with a freshly activated battery on the ALSEP (previously installed in the LM-SEQ) will be accomplished within two days prior to the scheduled launch.

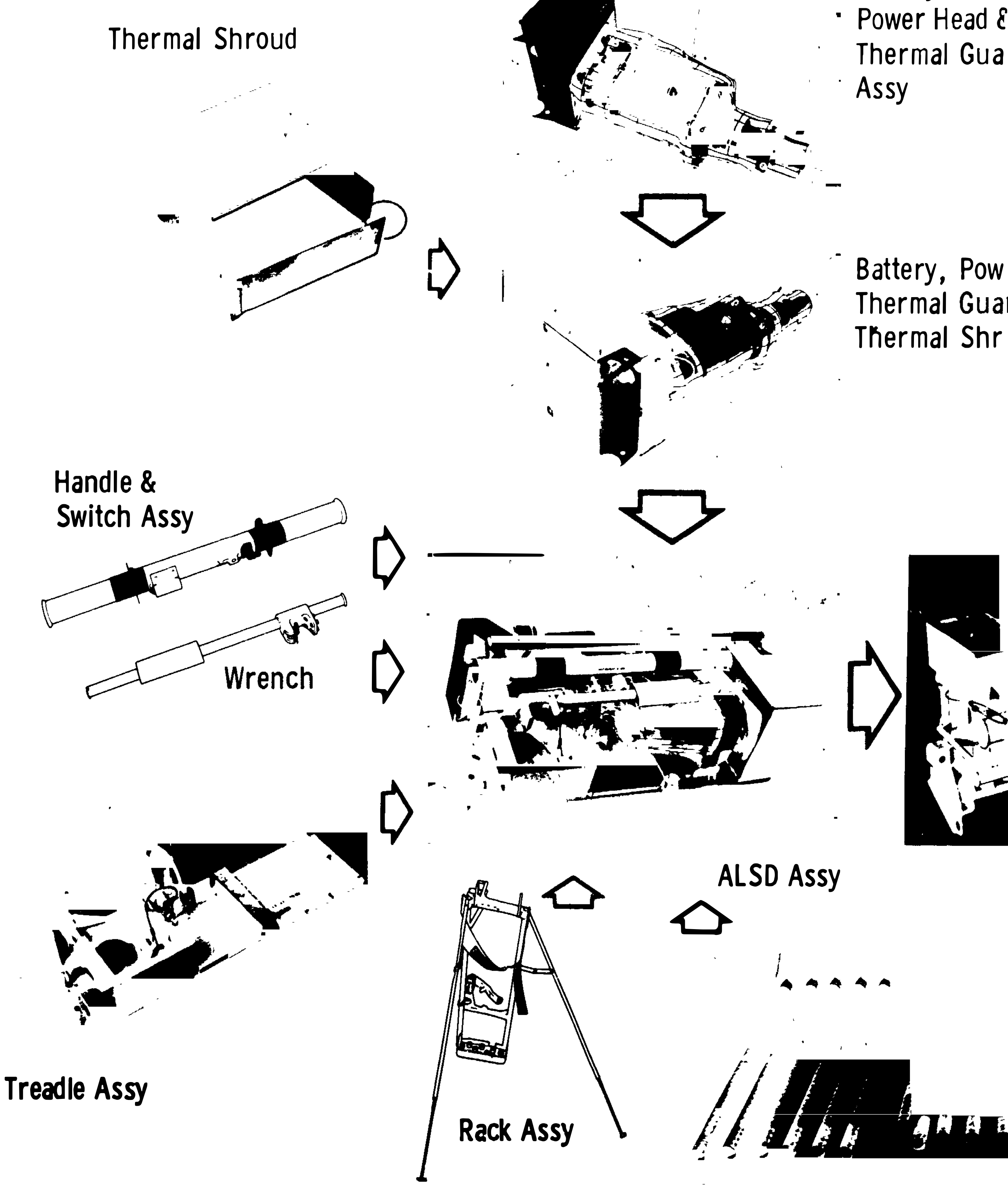
5.3 Lunar Surface Transport Mode

Upon arrival on the lunar surface, the ALSEP subpackage will be removed from the LM-SEQ, and the ALSD removed from the subpackage. The core stems and core stem caps will be removed from the SRC and placed in the ALHT carrier or ALSD rack. Transport modes are described in Chapter V.

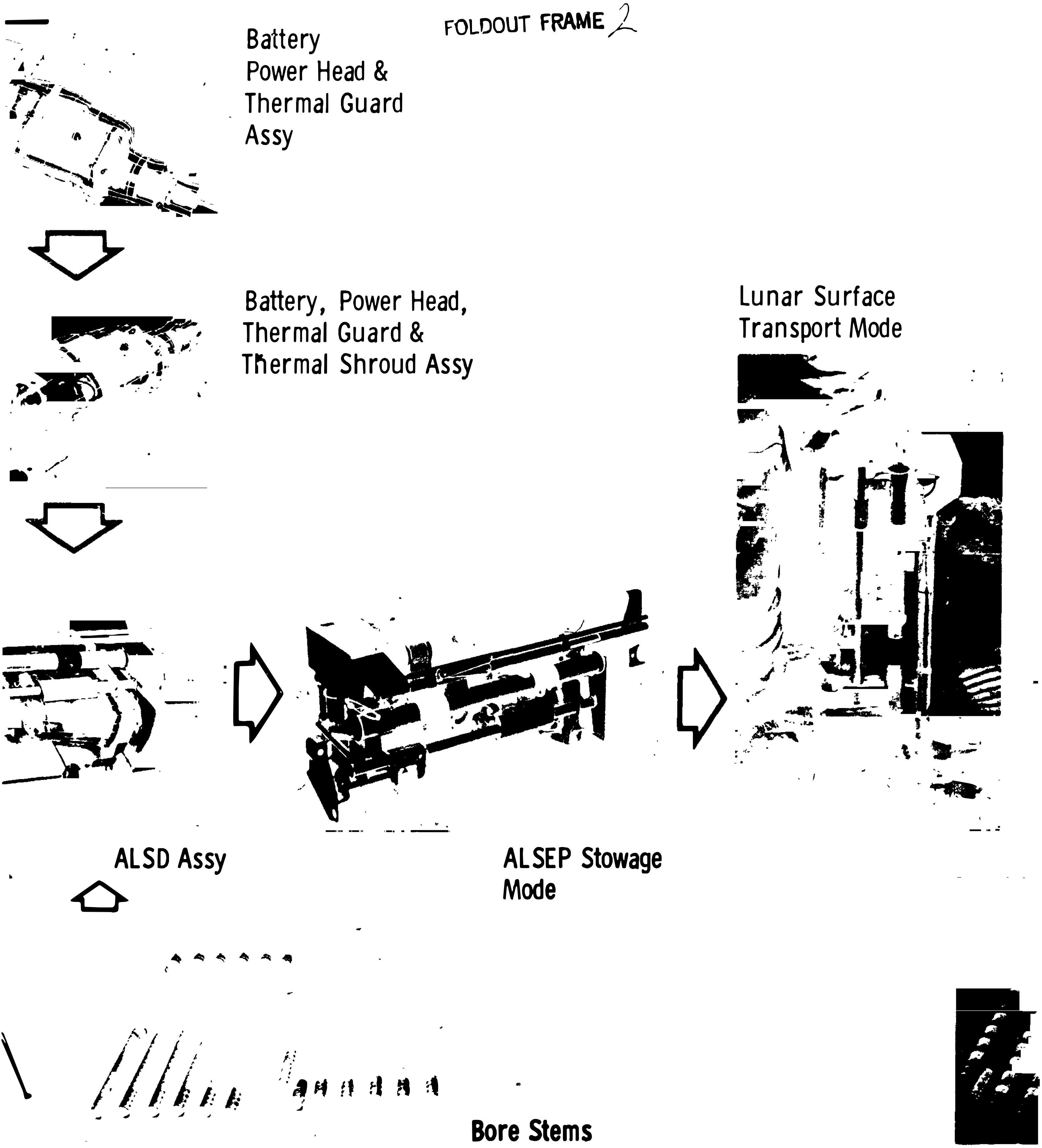
5.4 Lunar Surface Operating Mode

The astronaut will employ either the MESA SRC table or the ALHT carrier as a work platform for assembly of the ALSD. Detailed operating procedures for the ALSD are presented in Chapter V.

FOLDOUT FRAME 1



FOLDOUT FRAME 2



Figu

FOLDOUT FRAME 3

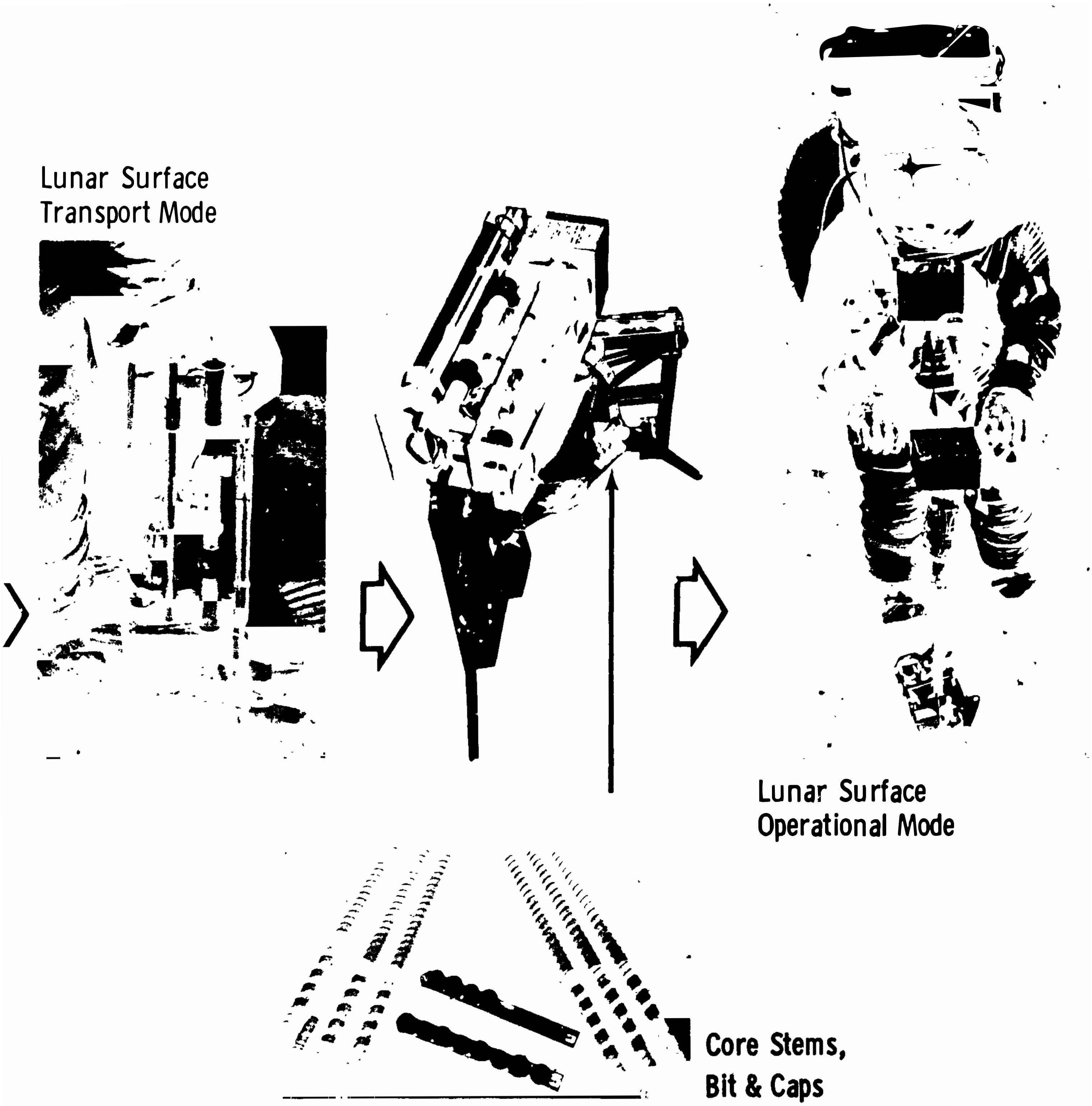


Figure 4 ALSD Assembly, Stowage and Lunar Operating Sequence

III. ALSD SUBSYSTEM DESCRIPTION

1.0 CONTAINER FOR ALSD (Ref. Figures III-1, -2)

1.1 General - A shipping container is provided for transporting or hand-carrying the basic ALSD assembly in the stowage mode prior to installation aboard the ALSEP subpackage. Commercial transportation regulations require that the battery activation kit with electrolyte be shipped in a separate container. Core stems and cap assemblies are also packaged separately for transport to the NASA-LRL for integration with the SRC.

1.2 Construction - The basic element of the shipping container is a commercial-type, aluminum carrying case. Polyethylene closed-cell foam is bonded to the bottom and lid of the case in a manner to preclude excessive movement of the ALSD assembly during transport.

2.0 ALSD CONTAMINATION CONTROL (Ref. Figure III-2)

2.1 General-The ALSD Flight Unit Subassemblies, final assemblies, and spare batteries are carefully cleaned, after final painting and acceptance testing, in the Martin Marietta Corporation's Certified Contamination Control Room to the following levels of cleanliness:

> No hydrocarbons detectable under ultra-violet light (Black-light).

2.2 Contamination Control Bags - Upon certified completion of the cleaning process, the ALSDs are sealed in Polyethylene bags.

2.3 Contamination Control Samples - In order to ensure an identifiable control of ALSD equipment which may contact the return lunar material specimens, control samples are maintained and ultimately forwarded to the NASA-LRL. These control samples are fabricated from the same raw material stock as the flight unit components, and are subjected to all manufacturing, painting, and final cleaning processes.

For each flight unit the following contamination control samples are provided:

1) Three core bits,

2) One Core Stem,

3) One Wrench,

4) Three core stem caps and a cap retainer.

3.0 ALSD STOWAGE MODE ASSEMBLY (Ref. Figures III-3, -4, -5)

3.1 Assembly Integration - The ALSD assembly consists of three major subassemblies:

1) Battery, thermal shroud, power head and thermal guard assembly,

2) Rack assembly, inclusive of the wrench, handle and switch actuator assembly and bore stems,

3) Treadle assembly

The treadle assembly provides the major restraining element of the ALSD stowage mode assembly. The combined battery, thermal shroud, power head and thermal guard assembly is restrained to the treadle by means of the power head support bracket (Ref. Figures III-3, -14) and the battery camloc (Ref. Figures III-5, -14). The rack hinged mounting bracket also provides restraint to the rear of the power head by a hold-down tab which bears against the power head. The rack is restrained to the treadle assembly by means of the rack hinged mounting bracket camloc (Ref. Figure III-3, -14), the rack-to-treadle forward support pin (Ref. Figures III-3, -14) and the rack-to-treadle rear pull pin (Ref. Figures III-5, -14).

3.2 ALSD/ALSEP Interface - The ALSD is stowed on the ALSEP subpackage in the orientation illustrated by Figures III-4 and -5. Restraint to the ALSEP is accomplished by means of four support pins:

1) Two round nose support pins mounted on posts located in the bottom end of the ALSEP subpackage engage two mating receptacles (through oversize holes in the battery shroud) located on the ALSD battery as illustrated in Figure III-5,

2) One support pin located on the upper surface of the ALSEP subpackage which engages a mating ALSD receptacle as illustrated in Figure III-4,

3) One ball detent pin which inserts through a hole in the ALSD hold-down bracket illustrated in Figure III-4 engages a mating receptacle mounted in the ALSEP structure.

The proper size and location of all ALSEP interface points on the ALSD are controlled by an interface tool furnished by BXA.

4.0 BATTERY (Ref. Figures III-6, -7)

4.1 <u>General</u> - The purpose of the battery subsystem is to provide the power necessary for a single lunar surface drilling mission. It has the capability for being detached from the power head for prelaunch activation and checkout. It comprises as major components a case, battery cells, power switch, electrical connector, pressure relief valve, thermal coating, and mounting brackets for the handle and switch actuator assembly. All components have been designed for an optimum performance-to-weight ratio.

4.2 <u>Case</u> - The battery case consists of an AZ31B-H24 magnesium alloy enclosure, 6.28 x 5.86 x 3.9 inches, with provisions for a pressure relief valve, electrical receptacle, and power switch. Integral with the case are threaded bosses for securing the case to the power head, and brackets for securing the handle and switch actuator to the case. The top of the case incorporates support pin receptacles for securing the ALSD system to the ALSEP subpackage, and an access cover for prelaunch battery activation. The external surfaces of the case are coated for a high ratio of thermal emissivity-to-absorptivity to control the battery temperature profile during lunar surface operation. The internal surfaces of the case are coated with a monoseal resin to reduce the possibility of cell-to-case high resistance paths in the event of minor losses of electrolyte. The case material provides shielding of active circuit elements and conductors for containment of potential electromagnetic interference radiation sources. The construction of the case is sufficient to support a pressure in excess of the 5 $\pm$ 1 psi control level of the pressure relief valve.

Construction of the training battery cases is similar, except stainless steel is substituted for the magnesium alloy used in flight units.

4.3 Battery Cells - The battery cell assembly is a primary silver oxide-zinc system consisting of 16 individual cells which operate at a nominal output of 23.0 ± 1 VDC at 18.75 amperes for 40 minutes. Each cell has a vent valve to maintain a cell pressure of 8 ± 3 psi while allowing relief of any excess gases. The battery is activated by filling each cell with electrolyte (17 cc of 40% KOH) as part of the prelaunch operations. Cell cases are fabricated from a high temperature plastic (cycolac X-27) which can function safely at temperatures up to 225°F if required.

Training battery cells are of the secondary type possessing a multiple recharge capability. These cells, fabricated from Bakelite C-11 with a softening temperature of +185°F, are heavier than the flight cells. They can deliver the required power for approximately 16 minutes. Activation electrolyte for each cell consists of 21 cc of 42% KOH.

4.4 Power Switch - The power switch is a single pole, single throw, heavy duty microswitch with a push-to-activate mechanism. The switch portion of the assembly is contained by the battery case with the push-to-activate mechanism protruding through the case for external operation. Seal integrity is maintained by means of an APM Hexseal boot. The Hexseal boot, in turn, interfaces with the handle and switch actuator assembly mechanism when the latter is installed on the battery.

4.5 Electrical Connector - The electrical connector is necessary to permit decoupling of the electrical power circuit when the battery subsystem is removed from the power head. The shell of the connector is overlapped by the shell of the male connector on the power head when joined. This overlap serves as shielding to contain any electromagnetic interference emanating from the conductors. Case/connector seal integrity is maintained by a preformed "O" ring. The mated battery and power head connectors are encircled by a .007-inch wall co-netic AA sleeve to further reduce the level of radiated electromagnetic interference.

4.6 Pressure Relief Valve-The pressure relief valve maintains an absolute pressure of 5 ± 1.0 psi of nitrogen in the battery case to preclude electrolyte vaporization in the event of a cell vent valve failure.

4.7 Handle Mounting Brackets - The handle brackets extend from the battery case and are used to support the ALSD handle and switch actuator assembly during ALSD operation. Due to spacecraft stowage volume limitations, the handle is stowed separately from the mounting brackets during transit to the lunar surface.

4.8 Thermal Control System - Temperature control of the battery is essential for proper operating performance. An operating temperature range of +20° to +225°F has been established for the battery.

Internally generated heat within the cells during drilling operations is conducted outward through the cell pack to the outer walls of the battery. Thermally conductive silver-silicone grease is employed to fill the voids between the cell block and the outer walls. The pressurizing medium also provides, to a lesser degree, conductance of internally generated heat to the outer case surfaces. The battery is isolated from the higher operating temperature power head by means of thermal isolation bushings at the mechanical interface. Radiation from the power head to the battery is minimized by a thermal shield comprised of multiple layers of aluminized mylar between the two units. The external surfaces of the battery are painted with a finish possessing an absorptivity (α) of 0.21, and emissivity (ϵ) of 0.88, which radiates the heat to space and the lunar surface.

Under low temperature operating conditions (low SEQ temperature and low lunar sun angle above the horizon) the thermal finish utilized on the battery case possesses incorrect characteristics for stabilizing the battery temperature. A removable battery shroud is employed for the low temperature profile mission. A more detailed description of the shroud is presented in the following paragraph.

5.0 THERMAL SHROUD (Ref. Figures III-6, -8)

5.1 General - A thermal shroud is assembled to the battery to provide temperature compensation when operating under the combined effects of minimum SEQ temperature (20°F) and low sun angles above the lunar horizon in the range of 9 to 22 degrees. The thermal shroud will always be installed on the battery during the trans-lunar portion of the mission under the currently defined SEQ environment, which includes SEQ wall temperature extremes of 20° and 160°F with an emissivity (ϵ) of 0.5. Temporary stowage of the ALSD (nonoperating mode) on the lunar surface at sun angles in the range of 9 to 22 degrees must be accomplished with the shroud installed. Under these conditions, the combined effects of low SEQ temperature and low sun angle will result in a minimum nonoperating battery cell temperature of +21°F, which is well within that required for successful power head operation. At sun angles higher than 22 degrees above the horizon, the shroud will be removed from the ALSD.

Under all sun angle conditions, the shroud will be removed when the ALSD is used to perform the drilling mission. The shroud can easily be removed by pulling the release ring illustrated in Figure III-6.

The shroud also limits the maximum temperature of the battery during the trans-lunar portion of flight. Under the upper extreme temperature condition, the SEQ walls rise from a stabilized 100^{o} to 160^{o}F during lunar descent, followed by a linear decrease to 120^{o}F over a 35 hour period. The maximum temperature experienced by the shrouded battery under these conditions within the SEQ after lunar surface touchdown is less than 160^{o}F.

5.2 Construction - The shroud is fabricated predominately from 0.012 inch thick 2024-T3 aluminum alloy sheet. A diagonal split across the top of the shroud, combined with the front hinge and lanyard release locking tabs allows the unit to completely open during the removal process. Two oversize holes are provided on the top rear of the shroud coincident with the rear ALSEP support pin receptacles in the battery to facilitate installation aboard the ALSEP.

Thermal isolation from the basic battery is accomplished by a series of 0.030 inch thick epoxy laminated sheet glass cloth strips bonded to the inner surfaces of the shroud. An aluminum paint with an absorptivity (α) of 0.25, and emissivity (ϵ) of 0.25 is applied to the surfaces of the shroud.

6.0 POWER HEAD (Ref. Figures III-6, -9, -10)

6.1 General - The power head subsystem converts the electrical energy from the battery into mechanical rotary-percussive energy for delivery to the core stem or bore stem bits. A rotary-percussion ratio has been selected which will provide the ultimate in drilling efficiency consistent with the life parameters of the bits. The power head is self-contained within a housing which will operate in any position, and which interfaces directly with the battery and core stems, and indirectly with the bore stems through a coupling adapter. The power head is mechanically more complex than the other ALSD subsystems. Therefore, component description is limited to the major elements of the subsystem.

6.2 Housing - The power head outer housing consists predominantly of three QE-22A-T6 magnesium alloy investment castings which are mated together by external sealed flanges threaded for socket head screws. The front end housing which encloses the output spindle is machined from 2024T351 aluminum alloy. The internal surfaces of the investment castings are impregnated with a polyester resin sealant to preclude possible leakage through the walls.

Training Unit No. 2 power head is identical to the flight units, with the exception that the rear housing which attaches to the battery is fabricated from a structurally reinforced ALMAG-35 aluminum alloy sand casting. This substitution was made to increase the operating life of the power head.

6.3 Motor - (Ref. Figure III-10) - The power head motor is a nominal 0.4 horsepower, brush commutated, direct current device employing as its field a permanent magnet for maximum reliability and efficiency. The armature is wound with copper wire protected by high temperature insulation. The Genox R6-C ceramic magnets exhibit excellent low and high temperature operating characteristics. The hollow shaft (for weight reduction) armature contains a small fan to facilitate circulation of the nitrogen pressurizing medium around all heat generating elements. The motor possesses a peak efficiency of approximately 70% when operating at its nominal 9,300 rpm at an input voltage and current of 23.0 VDC and 18.75 amperes respectively. A reduction gear couples the output shaft of the motor to the power train.

A 0.007 inch thick co-netic AA shield is emplaced around the internal connector wiring and brush and commutator elements to reduce radiated electromagnetic interference.

6.4 Power Train (Ref. Figure III-10) - The motor-driven power train consists of reduction gears which provide the proper rotational speeds for the percussor cam gear and output drive spindle of 2270 blows per minute and 280 revolutions per minute respectively. Lubrication of all moving elements within the power head is accomplished by use of a teflon base fluorinated grease and oil (DuPont Krytox 143-AC oil; Krytox 240-AC grease).

6.5 Clutch Assembly (Ref. Figure III-10) - The clutch assembly limits the reactive torque load to a level which can be safely controlled by the astronaut. The clutch is designed for a nominal slip value of 20 foot-pounds, but can be factory adjusted to other alues. The assembly consists of a metal disc emplaced between two bronze discs. Friction between the discs is maintained by a preloaded spring. The clutch assembly is in series with the power train behind the final output drive gear.

6.6 Percussor System (Ref. Figure III-10) - The percussor system converts the uniform rotary output motion of the power train into pulsating, high energy, short duration linear impact blows which are delivered to the output spindle. This action is accomplished by a rotating cam riding against a spring-loaded cam follower, which is an integral part of the impact percussor assembly. As the cam gear rotates, the cam rise against the cam follower causes the spring/percussor system to compress approximately 0.5 inches. As the high point on the cam passes under the cam follower, the spring/percussor system is released, and the percussor head impacts the output spindle, transmitting a percussive shock pulse through the spindle to the drill string.

6.7 Shock Absorber (Ref. Figure III-10) - The shock absorber consists of a telescoping titanium tube element (internally concentric with the percussor spring) which is restrained by the center housing. The front end of the shock absorber is impacted by the percussor at any time when both the output spindle and percussor are fully extended, thus creating a "clearance gap" between the two elements. When the end of the shock absorber is impacted by the percussor head, the titanium tube elements extend under tension thus dissipating the percussor energy into heat. A portion of the energy (approximately 2100 pounds) is transmitted to the center housing.

The action described above occurs when drilling in low density materials, or in the total absence of a drilling load such as the percussive core removal technique. In either case, the shock absorber tends to dissipate the energy into heat rather than transmit the entire impact blow energy into the relatively thin-wall magnesium housings.

6.8 Output Spindle (Ref. Figure III-10) - Percussive energy from the percussor head, and rotary power from the bit rotation gear is transmitted to the rotary ball-spline driven spindle, and subsequently to the drill string. The output spindle contains a female double lead thread, one revolution per inch pitch, which mates interchangeably with any core stem and the bore stem adapter. The black adapter retention clips (Ref. Figure V-32) serve as a positive means of determining spindle rotation.

6.9 Pressurization System (Ref. Figure III-10) - Pressure integrity of the power head is maintained by eight static seals, one linear bellows dynamic seal, and two rotary dynamic seals. The static seals are employed between the three housing sections, front end section, and the various components such as the connector, pressure relief valve, and lubrication ports. The lubricated dynamic seals are employed with the output spindle. Internal pressure of the power head is controlled by a 15 ± 1 psi relief valve.

6.10 Thermal Control -Temperature control of the power head is accomplished passively. Heat generated by internal components (armature, brushes, percussor spring, cam faces, etc), is transmitted to the housing walls through a combination of radiation, conduction through metallic thermal paths, and conduction through the nitrogen medium. The outer surfaces of the power head are painted with a finish possessing an absorptivity (α) of 0.21, and an emissivity (ϵ) of 0.88, which radiates the heat to space and the lunar surface.

7.0 THERMAL GUARD (Ref. Figures III-6, -9)

7.1 General - The thermal guard consists of a wire cage mounted integral to the external surfaces of the power head to preclude the astronaut from accidentally brushing against the power head. Under combined extreme temperature operating conditions (SEQ wall temperatures of 160°F during SEQ nonoperating stowage, 45 degree lunar sun angle, drilling of two maximum power requirement lunar surface holes) the outer surface temperatures of the power head housings may approach 330°F at the end of the second hole drilling. This temperature could degrade the spacesuit if it momentarily contacted the power head.

7.2 Construction - The thermal guard is fabricated predominantly from A151 type 304 austenitic chrome-nickel stainless steel seamless tubes, .059 inches in diameter with a .009 inch wall thickness. These tubes are formed to fit the axial and circumferential contours of the power head, and are brazed together to form a rectangular cage pattern. The guard is supported by four bulkheads, three of which are mounted to the power head casting mating flanges, and the fourth is clamped to the front end section. The guard completely encloses the power head from the battery attachment flanges to the front end of the output spindle. A lanyard is provided on the forward end of the guard to facilitate retrieval of the battery-power head assembly after temporary stowage on the lunar surface during drilling operations.

7.3 Thermal Control - The thermal guard support bulkheads are mounted to the power head with insulating bushings to minimize thermal conduction. Wire spacing on the guard is sufficient to allow heat radiation from the power head to deep space and the lunar surface. The guard tubes are finished with "half-and-half" thermal control surfaces; the inner half of each tube facing the power head is a polished natural finish, possessing an absorptivity (α) of 0.45, and emissivity (ϵ) of 0.1, and the outer surfaces of each tube facing deep space and the lunar surface possess an(α)of 0.21 and(ϵ)of 0.88. This "half-and-half" thermal finish technique was devised to minimize radiation from the power head to the guard, and to maximize heat radiation from the guard to deep space and the lunar surface. The thermal guard temperature will not exceed 250°F under a combination of all extreme operating conditions delineated in paragraph II-3.2.

8.0 HANDLE AND SWITCH ACTUATOR ASSEMBLY :(Ref. Figure III-11)

8.1 General - The handle and switch actuator assembly performs two major functions: 1) enables the astronaut to provide the rotary restraint and axial force required for operating the power head motor, 2) enables the astronaut to control the electrical power from the battery to the power head. Volume limitations of the ALSEP stowage mode required that the handle be packaged separately from its normal battery-mounted operating position.

8.2 Construction - The handle of the assembly is fabricated from 6061-T6 aluminum alloy tubing with a closed flare on each end. Attachment to the battery is accomplished by fixed and spring-loaded lock pins. During assembly, the round-nosed, fixed lock pin of the handle is inserted into the right lock pin receptacle of the battery as illustrated in Figures III-6 and -11. The left side of the handle is then depressed in the direction of the left battery mounting bracket until the tapered, spring-loaded lock pin begins to engage. Further depression causes the lock pin to retract into its housing until it aligns with the bracket receptacle. The spring pressure will then force the tapered lock pin into engagement with the mounting bracket receptacle, and the handle is firmly attached to the battery. Disengagement of the spring-loaded locking pins requires the application of pressure with a screwdriver on the opposite side of the flange. This operation is not required of the astronaut on the lunar surface.

The assembly of the handle to the battery case is pictorially illustrated in a later section of this manual.

Operation of the power head motor is accomplished by a series of mechanical elements including: 1) two actuating switch collars installed concentrically with the handle, 2) a double actuating cam mechanism installed internally in the handle tube, and 3) a microswitch actuating plunger which protrudes from the cam mechanism through the bottom of the handle tube and aligns with the battery microswitch (Ref. Figure III-6) when the handle is installed. Actuation of the battery microswitch through the Hexseal boot energizes the power head motor. In order to energize the power head motor, both the left and right spring-loaded handle actuating switches must be depressed parallel to the major handle axis toward the center of the tube. Depression of one actuating switch (either left or right) results in partial extension of the microswitch actuating plunger; depression of both switches is required before the microswitch actuating plunger will extend sufficiently to engage and actuate the battery microswitch through the Hexseal boot.

The double actuating fail-safe switches were provided for two reasons: 1) during drilling operations the astronaut can rapidly de-energize the power head motor by releasing either the left or right hand, or by sliding either hand outward, and 2) during normal drilling operations the power head and battery assembly may be temporarily stowed on the surface with the battery and handle down against the surface. The double actuating switch precludes inadvertent operation of the power head in this stowage mode.

The concentric handle switch configuration provides the astronaut with the same operating profile regardless of the handle height above the surface. Switch collars are identified with a black finish contrasting with the white handle to visually aid the astronaut under lunar lighting conditions.

The handle-to-battery locking pins, switch collars, and all moving parts within the handle tube assembly are lubricated with Everlube 620 to preclude galling in the vacuum environment.

8.3 Thermal Control - The handle is finished with a white thermal paint possessing an absorptivity (α) of 0.26 and emissivity (ϵ) of 0.75 which provides a maximum lunar surface stabilization temperature of 145^{o}F. Thermal conduction from the battery, which operates at a low temperature relative to the power head, is insignificant.

9.0 WRENCH (Ref. Figure III-11)

9.1 General - The wrench is a multi-purpose tool employed to perform four functions: 1) decouple emplaced core stems in conjunction with the treadle lock, 2) aid in retracting the core stems after completion of coring, 3) aid in retrieving objects from surface level such as core stems, and 4) provide a backup mode for removing the adapter from the power head output spindle.

9.2 Construction - The wrench assembly consists of a handle and concentrically installed wrench head. The handle is fabricated from a 2024-T3 aluminum alloy tube which is flared on both ends and slotted on the end opposite the wrench head. When the wrench head is engaged to a bore stem and the handle rotated, the pivot jaw automatically engages and locks to the flutes of the core stem. The wrench can also be used for decoupling the bore stem adapter as a contingency by engaging the slotted end of the handle into a mating key located in the inner collet of the adapter. The grip portion of the handle is elliptical and of sufficient size for pressurized glove operation. Everlube 620 is used for lubrication of all moving parts in the wrench head.

9.3 Thermal Control - The handle and head of the wrench are finished with a white thermal paint possessing an absorptivity (α) of 0.26 and emissivity (ϵ) of 0.75 which provides a maximum lunar surface stabilization temperature of 145^{o}F.

10.0 BORE STEMS (Ref. Figure III-12)

10.1 General - The bore stems provide the mechanical coupling required for the transmission of the rotary-percussive energy from the power head, via the adapter, to the solid face drill bit. The stems are hollow to permit insertion of the heat flow probe upon completion of the drilling operation.

10.2 Construction/Configuration - The bore stems consist of a composite of three layers of axially aligned boron filament between layers of circumferentially wrapped, epoxy impregnated fiberglas. The bore stem system consists of two sets of fluted boron/fiberglas tubes, one set for each heat flow probe. Each set consists of five standard stems approximately 21.8 inches long and one shorter section with a titanium adapter. The short stem is designed so that when a drill bit is coupled to the adapter, the overall length is the same as the other five stems. The stems couple by means of tapered, locking joints. The standard stems are functionally interchangeable and each is capable of engagement with the male taper of the drill bit stem. Each section has two molded fiberglas helical flutes on the outer diameter for the purpose of transporting the cuttings from the drill bit to the lunar surface. Each bore stem set weighs approximately 1.8 pounds. The adapter/drill bit stem incorporates a 5.5 inch phenolic honeycomb plug epoxied above the drill bit for proper mechanical positioning and thermal interfacing with the heat flow probe. A spring clip is epoxied into the top of the phenolic honeycomb plug to engage the heat flow probe and preclude inadvertent retraction during withdrawal of the heat flow probe emplacement tool. Training Unit No. 1 drill stem set consists of fiberglas tubes, simulating the configuration of the boron/fiberglas stems. A drill bit is coupled to one of the stems. Training Unit No. 2 has a retrieval nut, instead of the phenolic honeycomb plug, epoxied above the drill bit. A retraction tool can be used to engage the retrieval nut to facilitate removal of an emplaced drill string if normal means of withdrawal are not successful.

A 1/2-inch wide orange band is painted on the inner wall circumference at the top of the male taper for the two drill bit stems so that they can be readily identified by the astronaut when the stems are stowed in the rack. **One set is identified from the other by a one inch yellow band below the male taper.**

Each bore stem set is capable of drilling to a 10 foot depth in a lunar surface model consisting of unsorted, uncohesive conglomerate inclusive of a minimum of 15 inches of vesicular basalt.

11.0 BORE STEM DRILL BIT (Ref. Figure III-12)

The solid face drill bit consists of a hy-tuf steel matrix in which five tungsten-carbide tips are brazed. In addition, a solid plug with a tungsten-carbide cutter is brazed in the center of the bit. Five ports are located in the wall of the steel matrix for material removal. The drill bit engages the 1 inch lead thread of the titanium adapter of the bore stem. The drill bit is designed for a weight of 0.2 pounds.

12.0 BORE STEM ADAPTER (Ref. Figure III-13)

12.1 General - The bore stem adapter provides the interfaces between the power head spindle and the bore stem sections, transmitting rotary-percussive energy from the power head to the bore stems. Heat flow experiment restrictions preclude the use of the threaded coupling technique used for the drill bit, core bit and core stems.

12.2 Construction - The adapter is fabricated from 6Al-4V titanium alloy. It is a three-part system assembled with a snap ring. A matched taper exists between a collet in the adapter and the outer wall so that a sufficient grip of the bore stem is developed to efficiently transmit the rotary-percussive energy of the power head. Spring-loaded key blocks are positioned during the bore stem release mode operation using power head energy to separate the matched tapers. The collet inside taper mates with the bore stem male taper. The threaded extension of the adapter outer shell engages the threads in the power head spindle. Two spring-loaded steel retainer clips brazed to the outer diameter of the power head spindle engage two spiral grooves machined into the outer diameter of the adapter to preclude adapter rotation sufficient to disengage it from the power head spindle. The grooves are of such length that adapter rotation is limited to approximately 100 degrees. A key is provided in the rear face of the collet which will interface with the slotted wrench handle if required for removal of the adapter from the power head spindle.

12.3 Operation - In the driving mode the spring-loaded key blocks are restrained within the power head spindle such that the rotary-percussive energy is transmitted to the shoulder of the outer shell, to the collet and to the bore stem taper. To release the adapter from the bore stem taper, the power head is rotated approximately 90 degrees counterclockwise which enables the spring-loaded key blocks to spring outward from within the spindle (ref. Figure V-32). This action changes the path for transmitting power head energy, such that the percussive energy travels from the spindle to the key blocks to the shoulder of the collet thus providing a separation force relative to the outer shell. Simultaneously, the rotary action of the power head advances the outer shell of the adapter into the spindle, providing approximately 0.25 inches of travel of the collet relative to the outer shell. This results in release of the collet grip on the bore stem taper (ref. Figure V-34). To reset the adapter for the driving mode, the collet is pressed back into the outer shell thus re-engaging the tapers, and the spring-loaded key blocks are depressed, and the adapter screwed back into the power head spindle. The adapter can be completely removed from the power head spindle in preparation for a coring operation by manually rotating counterclockwise beyond the limits of the retainer clip grooves.

13.0 RACK ASSEMBLY (Ref. Figures III-15 through 19)

13.1 General - The rack assembly provides basic restraint for the twelve bore stems, wrench, and handle and switch actuator assembly within the ALSD assembly (stowage mode) during the outbound translunar phase of the mission. On the lunar surface, the rack is deployed into a tripod configuration which provides stowage for the core stems and core caps, in addition to the bore stems.

13.2 Construction - The rack assembly is fabricated predominantly from AZ31B magnesium alloy and 6061-T6 aluminum alloy. It consists of the following major elements:

1) A lower support bulkhead with positioning plugs, an extendable dacron strap, and a removable cover (pull pin release) for bore stem restraint,

2) Two sets of spring-loaded clips for restraint of the wrench and handle and switch actuator assemblies,

3) Spring-loaded, hinged, telescoping upper and lower support legs used for supporting the rack assembly on the lunar surface at a suitable work height, when deployed in the tripod configuration,

4) A spring-loaded extension leg which provides the third support of the tripod configuration for use on the lunar surface. This leg is retracted in a telescoping manner during the outbound mission in order to maintain ALSEP envelope requirements.

The three legs are color coded to indicate when approaching the fully extended and locked position. The legs are manually locked in place. There is a small pad welded to the bottom of each leg to minimize leg penetration into the lunar surface material. There is a red band on the rack at the rack pin to treadle receptacle interface.

13.3 Thermal Control - The rack is finished with a white thermal paint possessing an absorptivity (α) of 0.26 and an emissivity (ϵ) of 0.75 which provides a maximum lunar surface stabilization temperature of 145°F.

14.0 TREADLE ASSEMBLY (Ref. Figures III-3, -14)

14.1 General - The treadle assembly provides the structural restraint for the rack assembly and battery-power head assembly during outbound mission stowage on the ALSEP subpackage. On the lunar surface the treadle assembly core stem lock is used in conjunction with the wrench for uncoupling core stem joints.

14.2 <u>Construction</u> - The basic treadle board is fabricated from 0.012 inch thick 2024-T4 aluminum alloy sheet bonded to 0.470 inch thick honeycomb core. Other elements of the treadle assembly include:

1) Two camloc receptacles bonded into the honeycomb for tie-down of the battery and rack assemblies,

2) A pull-pin receptacle for tie-down of the rack assembly,

3) A support pin receptacle for tie-down of the rack assembly,

4) A hinged support bracket with pull-pin release for tie-down of the powerhead front end,

5) A carrying handle for manual transport of the ALSD assembly on earth or on the lunar surface,

6) Supporting brackets and receptacles for interface with the ALSEP pallet forward vertical support pin and ball detent support pin,

7) A treadle box for structural support of the rack support pin receptacle and ALSEP restraint pin receptacles. The treadle box also provides stowage for rock cuttings which may be transported to the surface during the coring operation,

8) A lanyard for retrieving the treadle from the surface with the wrench, if required,

9) A fitting to engage an ALHT carrier pin (Figure V-8)

10) A velcro strap to engage velcro strips on the ALHT carrier handle (Figure V-8).

An eleventh major element of the treadle assembly is the core stem lock. This assembly consists of a steel tooth locking pawl which is pivot-mounted within a 6Al-4V titanium housing. The pawl is spring-loaded lightly to the center position of the core string guide hole by a silicone rubber boot as illustrated in Figure III-20. The radial distance from the pivot to the pawl teeth increases in the counterclockwise direction to a maximum and then decreases as viewed from the top of the treadle. Insertion of a core stem through the core bit pilot with a clockwise rotation causes the minimum radius side of the locking pawl to ride lightly against the core stem flutes. This effect continues during normal coring operations when the core stems are power-driven. When the core string is manually rotated counterclockwise for decoupling, the pivoted pawl is rotated in such a manner that the pivot-to-pawl teeth radius at the point of contact with the core stem flutes increases until the stem is firmly forced against the opposite side of the housing. Continued manual counterclockwise rotation of the core string with the wrench or power head causes the high point of the pawl teeth to rotate past the point of contact with the core stem flutes thus resulting in a firm, over-center lock of the core string. Th core string can subsequently be disengaged from the locked position by rotating in a clockwise direction. All moving parts of the lock assembly are lubricated with Everlube 620.

The inner surface of the core bit pilot is painted black to give the astronaut a visual alignment cue when inserting the core bit and core stem.

There is a red band at the end of the rack pin receptacle as a visual aid for rack to treadle engagement.

15.0 CORE BIT (Figure III-21)

15.1 <u>General</u> - The core bit provides the cutting capability required for coring the hole in any lunar surface material which may be encountered ranging in hardness from dense [illegible]t to unconsolidated conglomerate. It is an integral part of the co[illegible]tring which, when completely assembled, consists of eight titanium core stems and the core bit. Initially it is planned to use only six of the eight stems for one core sample. The core bit receives the rotary-percussive energy from the power head output spindle (via the core stems) and delivers it to the rock. The percussive element of the input energy fractures the rock by exceeding its compressive strength under each cutting tip. The rotary element repositions the cutting tips for subsequent rock fracturing and provides the means for transporting the rock cutting upward to the surface via the helical transport flutes.

15.2 <u>Construction</u> - The rock cutting capability of the core bit is provided by five tungsten-carbide tips which are brazed into a hy-tuf steel body. The geometry and hardness (RA 89.3) of the tips have been selected on the basis of an optimized compromise between drilling efficiency (penetration rate and power per unit volume of drilled rock) and reliability. The tungsten-carbide tip supporting body is 2.5 inches in length, 1,000 inches outside diameter, and 0.802 inches inside diameter. The carbide tips possess a radial width of 0.140 inches, and are brazed into the hy-tuf steel body in a position to provide an outside cutting diameter of 1.032 inches, and an inside cutting diameter of 0.752 inches which produces a rock core of equivalent diameter. These dimensions provide radial cutting clearances of 0.016 inches between the outside bit body and hole wall, and 0.025 inches between the inside bit body and rock core.

Four helical flutes, with grooves 0.030 inches in depth, and a lead of one inch, are machined into the outer diameter of the bit body. The flutes (ramps) transport the rock cuttings from the face of the cutting tips upward to the double flute system of the core stems and subsequently to the surface.

Coupling of the core bit to the core stems is accomplished by a double start acme-type male thread, each with a one-inch lead.

16.0 CORE STEMS (Ref. Figure III-21)

16.1 General - The core stems provide the mechanical coupling required for transmitting the rotary-percussive energy from the power head output spindle to the core bit. During normal coring operations the core stems are added two at a time until the desired core depth is obtained.

The core stems and core bit are sterilized and transported in the SRC during the translunar portion of the mission and are transferred to the ALHT carrier sample bag or to the ALSD rack by the astronaut upon arrival on the lunar surface.

16.2 Construction - The seven 16.75-inch, and one 15.25-inch core stems are fabricated from 6Al-4V titanium in order to attain an optimum performance-to-weight ratio. The short core stem is required so that, when coupled to the core bit, it results in an overall length equivalent to the longer stems.

The core stems possess a 0.802 inch inside diameter (equivalent to the core bit) and a 0.982 inch outside diameter. Two helical flutes, with grooves 0.030 inches in depth, and a lead of one inch are machined into the outer diameter of the tube to provide a continuation of the rock cuttings transport from the core bit. A double acme-type, one-inch lead male coupling thread is machined on the upper end of each stem, and a female, on the lower end. The one-inch lead internal female threads are machined in alignment with the one-inch lead flute lands to utilize the maximum wall thickness of the tube for structural integrity. When assembled, the male end of each core stem engages the internal shoulder on the female of the mating tube in order to assure efficient transmission of the percussive strain wave pulses.

Lubrication of the coupling joints is accomplished by a proprietary "canadize" finish applied to the male and female threads of each core stem. This electro-chemical process (similar to an anodize) results in a hardened surface impregnated with a fluorocarbon with controlled porosity into which TFE is deposited. Teflon-type lubrication is the only lubricant currently approved for equipment which is transported in the SRC.

Visual cues are provided on each core stem to aid the astronaut in determining the location of the mating joints and proper positioning of the core string during the uncoupling process. A blue, anodized stripe approximately one inch in width (lower joint locator) is applied to the female end of each stem as illustrated in Figure III-21. A second blue, anodized stripe (upper joint locator) is applied approximately six inches above the first stripe. The upper joint locator, when visible above the treadle core bit pilot hole, provides the astronaut with a visual cue that the core string is in a proper position for locking with the treadle lock. The lower joint locator provides the visual cue for proper positioning of the wrench. **There is a blue, anodized "barber-pole" stripe between the locator stripes.**

16.3 Thermal Control - Use of thermal control paint on the core stems is prohibited due to the outgassing restrictions of the SRC. An alternate finish was selected which consists of grit blasting the outer machined surfaces. This finish provides an absorptivity (α) of 0.76, and emissivity (ϵ) of 0.76.

A maximum temperature of 150°F will be experienced by the core stems when stowed in the SRC. The stems are subsequently removed from the SRC and placed in the ALHT carrier sample bag or double stacked with the bore stems in the ALSD rack. The rack is oriented relative to the sun so that the bore stems shade the core stems. In this stowage mode the previously described grit blast finish provides sufficient cooling of the core stems to compensate for the internally generated heat during the coring of the most severe lunar surface model holes. The thermal control finish combined with appropriate rack orientation on the lunar surface will preclude the core stem temperature from exceeding 220°F.

17.0 CORE STEM CAPS (Figure III-21)

17.1 General - The core stem caps are installed on each end of the core stems in accordance with procedures in Chapter V. The caps preclude loss of core material from within the stems.

The core stem caps, along with the core stems and core bit, are sterilized and transported to the lunar surface in the SRC. Upon arrival on the lunar surface, the caps are stowed on the ALHTC or ALSD rack until required for the capping operation by the astronaut.

17.2 Construction - The caps are fabricated from teflon, the only nonmetallic material approved for use in the SRC. Restraint for the caps, both during transit in the SRC and during use by the astronaut, is provided by an aluminum alloy rack. The tops of the caps are circumscribed with a small groove which engages a track on the stowage rack. Six female, five male, and a special bit cap are required for the capping operation for six core stems. The caps are stowed on the rack in an appropriate order so that the astronaut can hold the core stem in one hand, the cap restraint rack in the other, and, using the rack as a handle he can rapidly press the cap into place on the core stem and slide the rack away from the cap. The caps are sequentially lettered so that stem sequence can be identified upon removal from the SRC in the LRL. There is a figure 2 cut into the tapered end of the second cap retainer assembly, to identify the caps used for the last two of six core stems.

18.0 ALSD SYBSYSTEM DESIGN PARAMETERS

A delineation of battery, power head, bore string and core string design parameters is tabulated in Table III-1.

19.0 ALSD FLIGHT UNIT SUBSYSTEM WEIGHT

A delineation of selected ALSD subsystem and component weight is tabulated in Table III-2.

20.0 ALSD SUBSYSTEM PART NUMBERS

A delineation of the major component and subsystem part numbers required for field level operations and maintenance is tabulated in Table III-3.

Table III-1. ALSD Subsystem Design Parameters

BATTERY ASSEMBLY (FLIGHT)

Silver-Zinc Cells (Yardney PM-5)	16 each
Open Circuit Voltage (Full Charge)	29.6 ± 0.5 VDC
Operating Voltage	23.0 ± 1.0 VDC
Nominal Operating Current	18.75 Amperes
Minimum Power Capacity (15 day min.)	300 Watt-Hours
Activated Storage Life	30 Days
Recharge Capability	3 Cycles
Dry Storage Life	2 Years
Electrolyte (17 cc/cell)	40% KOH
Cell Operating Pressure	8 ± 3 psia
Case Operating Pressure	5 ± 1.0 psia

BATTERY ASSEMBLY (TRAINING)

Silver-Zinc Cells (Yardney HR5DC-12X1)	16 each
Open Circuit Voltage (Full Charge)	29.8 ± 1 VDC
Operating Voltage	23.0 ± 1 VDC
Nominal Operating Current	18.75 Amperes
Minimum Power Capacity (15 day min.)	120 Watt-Hours
Activated Storage Life (minimum)	3 Months
Recharge Capability (minimum)	20 Cycles
Dry Storage Life	2 Years
Electrolyte (21 cc/cell)	42% KOH
Cell Operating Pressure	8 ± 3 psig
Case Operating Pressure	5 ± 1.0 psig

POWER HEAD

MOTOR

Operating Voltage	23.0 ± 1 VDC
Load Speed	9300 RPM
Load Current	18.75 Amperes
Efficiency	70%
H.P.	0.4

Table III-1. ALSD Subsystem Design Parameters (Cont.)

POWER HEAD	
PERCUSSOR	
Blow Repetition Rate	2270 BPM
Energy Per Blow	39 Inch-Pounds
Spring Energy	240 Pounds/Inch
Hammer Velocity	213 Inches/Second
Effective Hammer Weight	0.361 Pounds
POWER TRAIN	
Motor-to-Cam Ratio	4:1
Motor-to-Output Spindle Ratio	33:1
Output Spindle Speed	280 RPM
Blows Per Bit Revolution	8:1
CORE STRING ASSEMBLY	
Integrated Length (for 6 stems)	94 Inches
Core Stem Length	16.75 Inches
Core Bit	
Cutting Diameter	1.032 Inches
Body Outside Diameter	1.00 Inches
Body Inside Diameter	0.802 Inches
Length	2.5 Inches
Number of Carbide Tips	5
Cutting Kerf of Tips	0.140 Inches
Inside Cutting (Core) Diameter	0.752 Inches
BORE STRING ASSEMBLY	
Integrated Length	126 Inches
Bore Stem Length	21.80 Inches
Drill Bit	
Cutting Diameter	1.125 Inches
Body Outside Diameter	1.07 Inches
Body Inside Diameter	0.897 Inches
Length	2.5 Inches
Number of Carbide Tips	5
Cutting Kerf of Tips	0.140 Inches
Number of Cuttings Ports	5

Table III-2. ALSD Flight Unit Subsystem Weight (Nominal)

Nomenclature	Unit Weight (Lbs.)	Subsystem Weight (Lbs.)
Battery		7.28
Power Head		8.56
Core String		2.58
Titanium Core Stems (6)	2.48	
Core Bit	.10	
Accessory Group		10.97
Treadle Assembly	2.72	
Bore Stems (12)	3.72	
Bore Stem Adapter	0.23	
Drill Bits (2)	0.40	
Rack Assembly	1.48	
Thermal Shroud	0.24	
Thermal Guard	0.56	
Handle & Actuator Assembly	0.43	
Wrench (2)	0.90 (modified handle)	
Core Stem Caps & Retainer (2)	.29	
Total		29.39

Notes:

(1) Flight Unit weight expected to be within ± 2% of the total weight indicated.

(2) Training Unit No. 2 weighs 31.69 pounds due to the heavier stainless steel battery case, structurally reinforced rear power head casting, and heavier thermal guard.

(3) Training Unit No. 1 weighs 13.5 pounds.

(4) Flight battery weight includes 0.89 (17 cc's/cell) pounds of electrolyte and 0.03 pounds of cell pads which are normally stored separately until time of activation.

(5) Weight of ALSD carrying case is approximately 11 pounds.

Table III-3. ALSD Subsystem Part Numbers

Fig. No. III-	Nomenclature	Effectivity	Part Identification		
			Part Number	Qty/Unit	Mfg.
1	Container for ALSD	Fl., Tr. 1, 2	467A8050003-009	1	MMC
3	ALSD-Flight Unit ALSD-Training Unit ALSD-Training Unit	Fl. Tr. 1 Tr. 2	467A8060000-069 467A8045000-009 467A8060000-059	1 1 1	MMC MMC MMC
7	Battery, ALSD Flight Cells Silvercel Fill. Kit Battery, ALSD Train. Cells Silvercel Fill. Kit	Fl. Fl. Fl. Tr. 1, 2 Tr. 1, 2 Tr. 1, 2	PS9403000014-003 PM 5 Special 11310 PS9403000014-001 HR 5 Special 11294	1 16 1 1 16 1	YEC YEC YEC YEC YEC YEC
8	Thermal Shroud	Fl. Tr. 1, 2	467A8050029-009 -049	1 1	MMC MMC
9-10	Power head, Flight Power head, Train.	Fl. Tr. 1, 2	PS955000002-007 -005	1 1	B/D B/D
6	Thermal Guard	Tr. 2 Fl. Tr. 1	467A8050030-119 -089 -009	1 1 1	MMC MMC MMC
9	Insulation (Thermal)	Fl., Tr. 1, 2	467A8040000-001	25	MMC
-	Retainer	Fl., Tr. 1, 2	467A8040000-023	1	MMC
-	Shield, Connector	Fl., Tr. 1, 2	12062-94	1	B/D
11	Handle & Sw. Actuator	Fl., Tr. 2 Tr. 1	467A8050013-099 -009	1 1	MMC MMC

Abbrev. Notes: MMC = Martin Marietta Corporation

B/D = Black & Decker Mfg. Co.

YEC = Yardney Electric Corporation

ADL = A. D. Little Inc.

Fl. = All Flight Units

Tr. 1 = Training Unit S/N 001, etc.

C/L = Chicago Latrobe

Table III-3. ALSD Subsystem Part Numbers (Cont.)

Fig. No. III-	Nomenclature	Effectivity	Part Identification: Part Number	Qty/Unit	Mfg.
11	Wrench	Fl., Tr. 2	467A8060010-009	2	MMC
		Tr. 1	467A8050014-009	1	MMC
12	Bore Stems	Fl.	PD 6000 189-003	5	ADL
		(PD 6000 189-003)	467A8060008-001*	5	ADL
		(PD 6000 189-001)	467A8060001-009	1	ADL
		(PD 6000 189-001)	467A8060001-039*	1	ADL
		Tr. 2	PD 6000 189-003	5	ADL
		(PD 6000 189-003)	467A8060008-001*	5	ADL
		(PD 6000 189-001)	467A8060001-029	1	ADL
		(PD 6000 189-001)	467A8060001-049*	1	ADL
		Tr. 1	467A8045001-001	10	MMC
			-009	2	MMC
9, 13	Adapter	Fl., Tr. 2	467A8060002-009	1	MMC
			467A8045006-009	1	MMC
39, 40, 41, 42	Rack Assembly	Fl.	467A8060006-229	1	MMC
		Tr. 2	-219	1	MMC
		Tr. 1	467A8045006-009	1	MMC
14	Treadle Assembly	Fl., Tr. 2	467A8060005-039	1	MMC
		Tr. 1	467A8045005-009	1	MMC
14	Lock Pin Assembly (with attached camloc)	Fl., Tr. 2	467A8050015-069	1	MMC
		Tr. 1	-059	1	MMC
14	Lock Pin Assembly	Fl., Tr. 1, 2	467A8050009-029	2	MMC
2	Kit, Accessory Details	Fl., Tr. 2	467A8060000-079	1	MMC
	Core Stem (PS 600100022-005)		467A8060009-001	5	C/L
	Core Stem (PS 600100022-007)		467A8060009-003	1	C/L
	Core Bit (PS 600100023-011)		467A8050000-011	1	C/L
	Core Stem Caps & Retainer	Fl., Tr. 2	467A8060003-029	1	MMC
			-039	1	MMC
		Tr. 1	467A8060003-009	1	MMC
			-019	1	MMC
	Lanyard, Power Head	Fl., Tr. 2	467A8060004-019	1	MMC

* Yellow Band

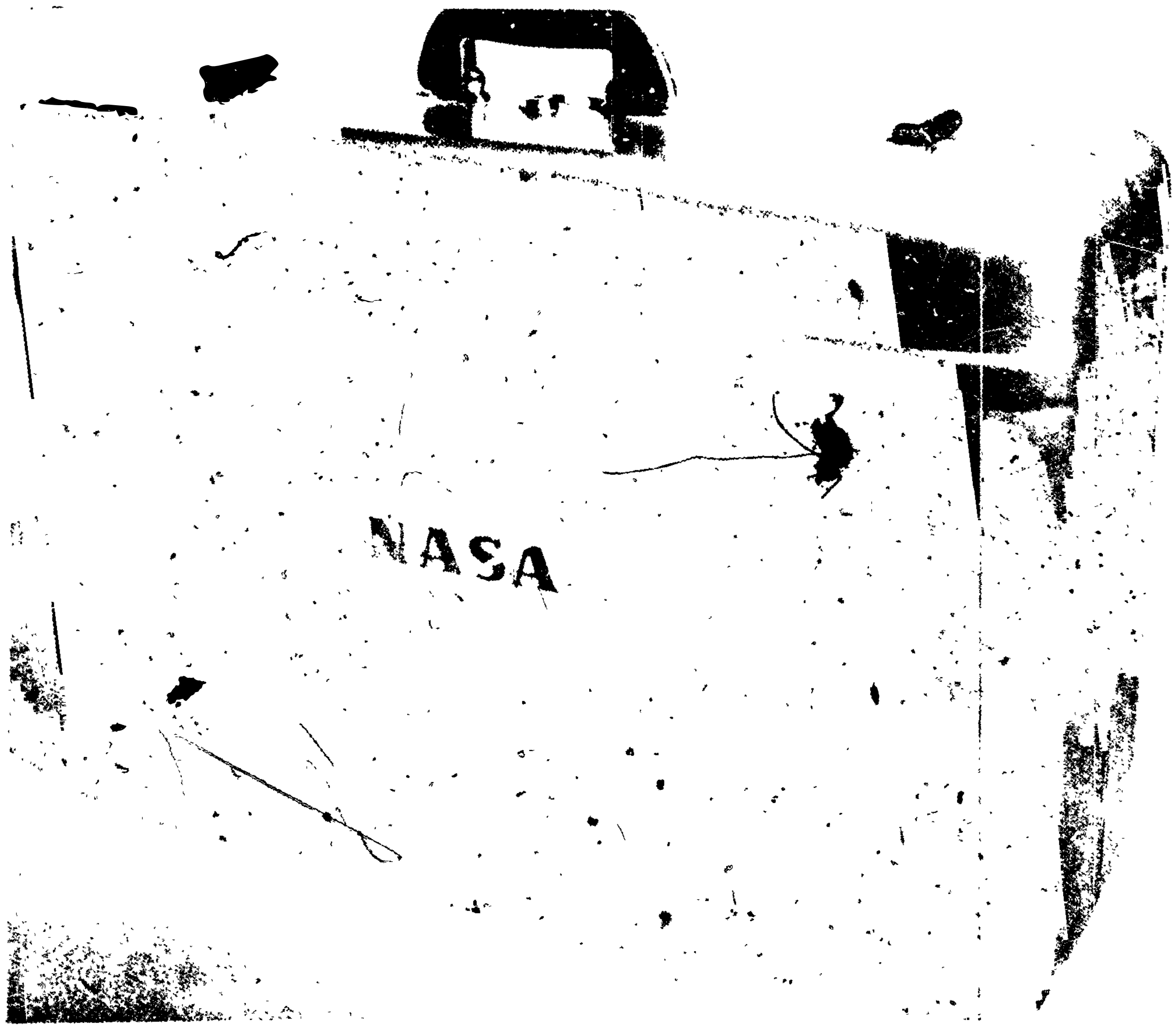


Figure III-1. Container For ALSD (For Shipping Only)

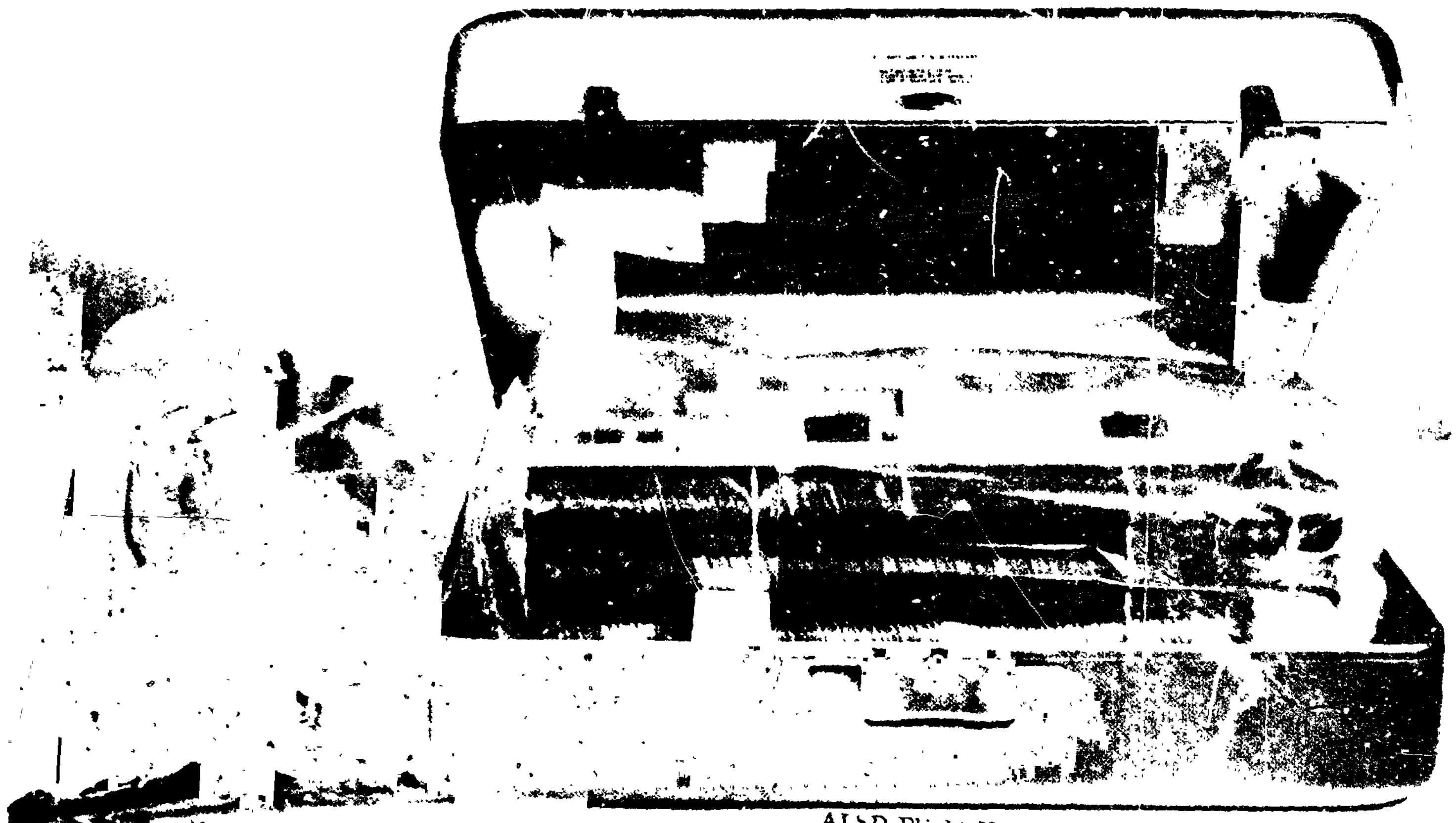


Figure III-2. ALSD Contamination Control Bags

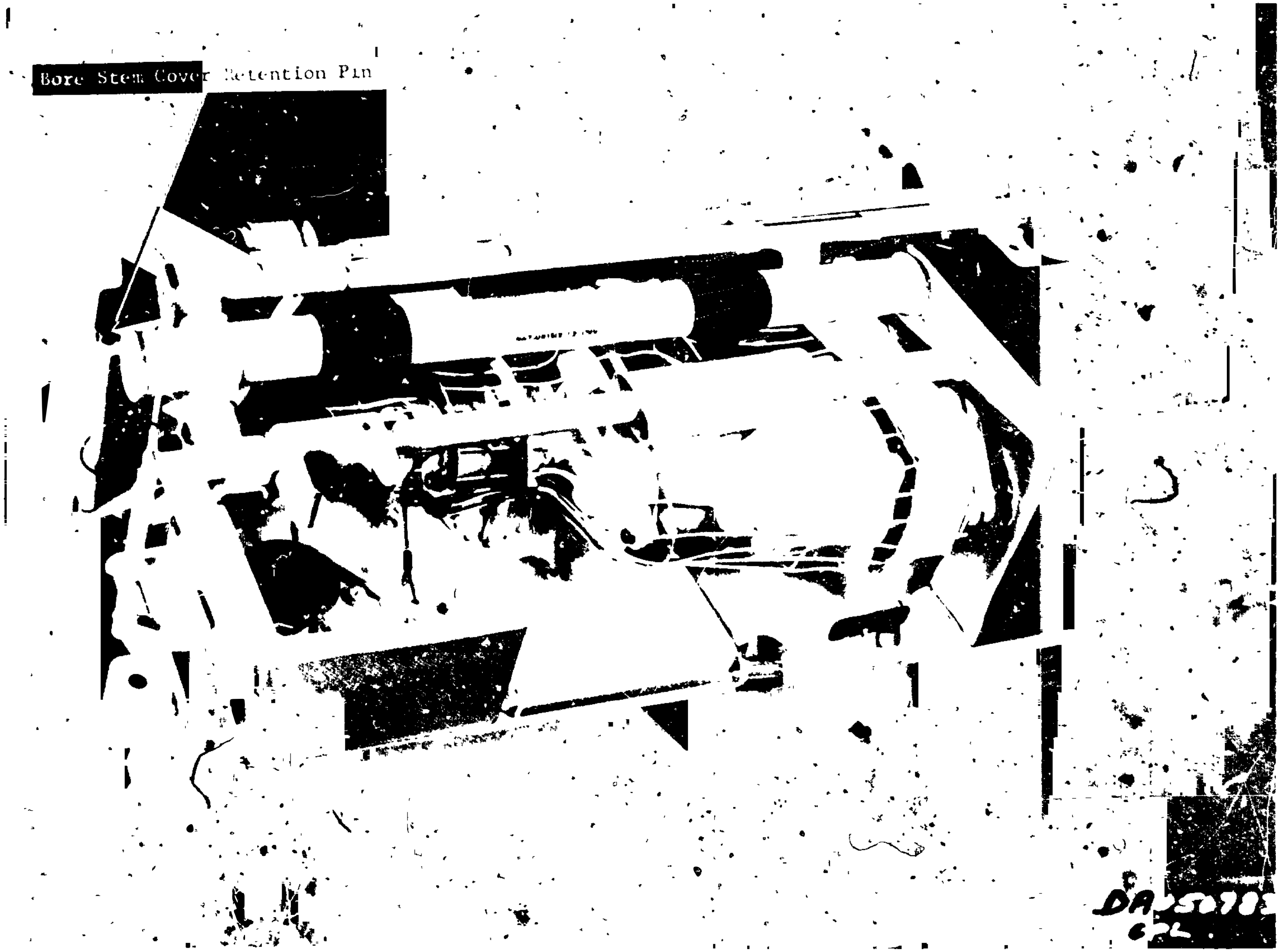


Figure III-3.- ALSD/ALSEP Stowage Mode

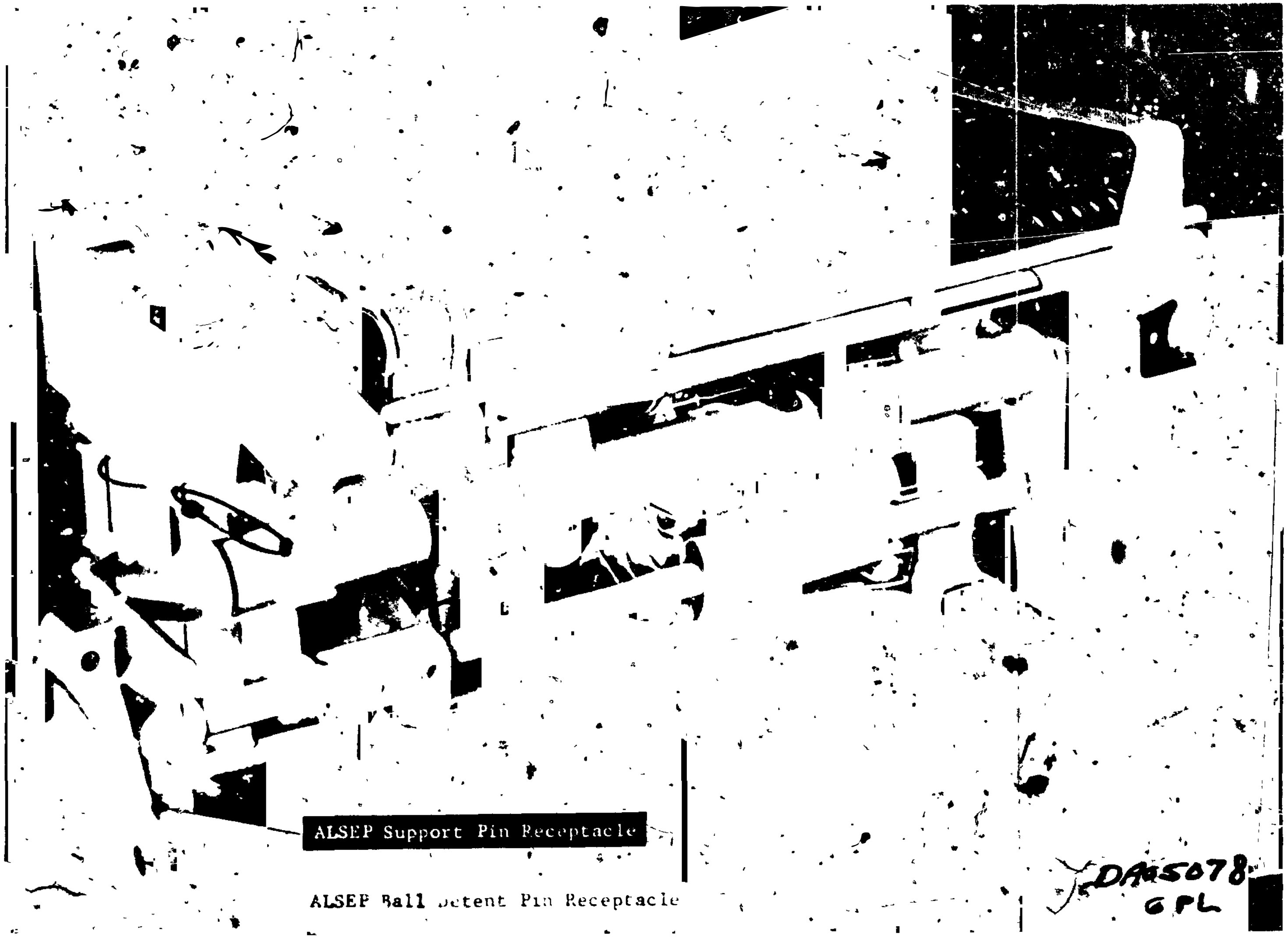


Figure III-4. - ALSD/ALSEP Stowage Mode

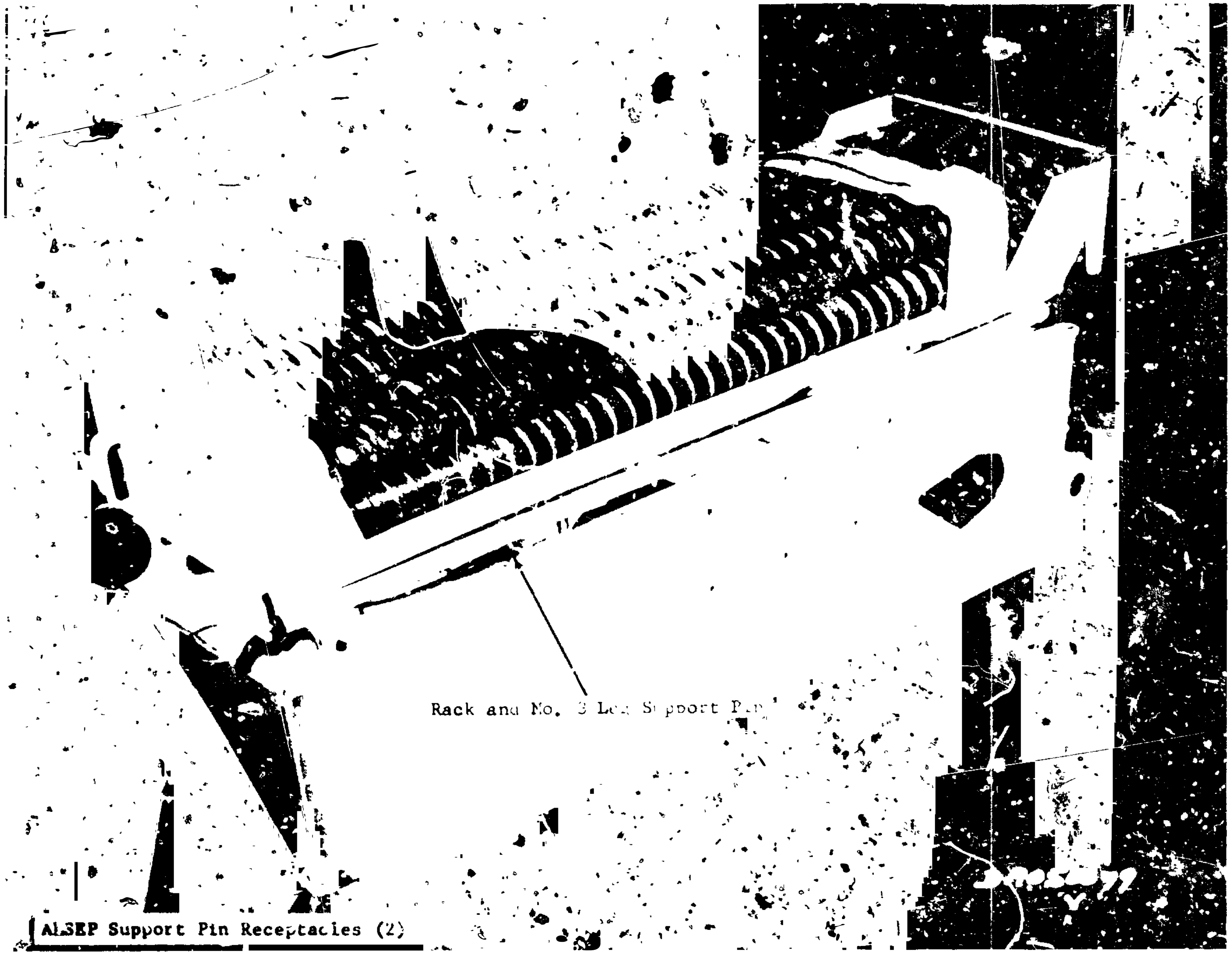


Figure III-5. - ALSD/ALSEP Stowage Mode

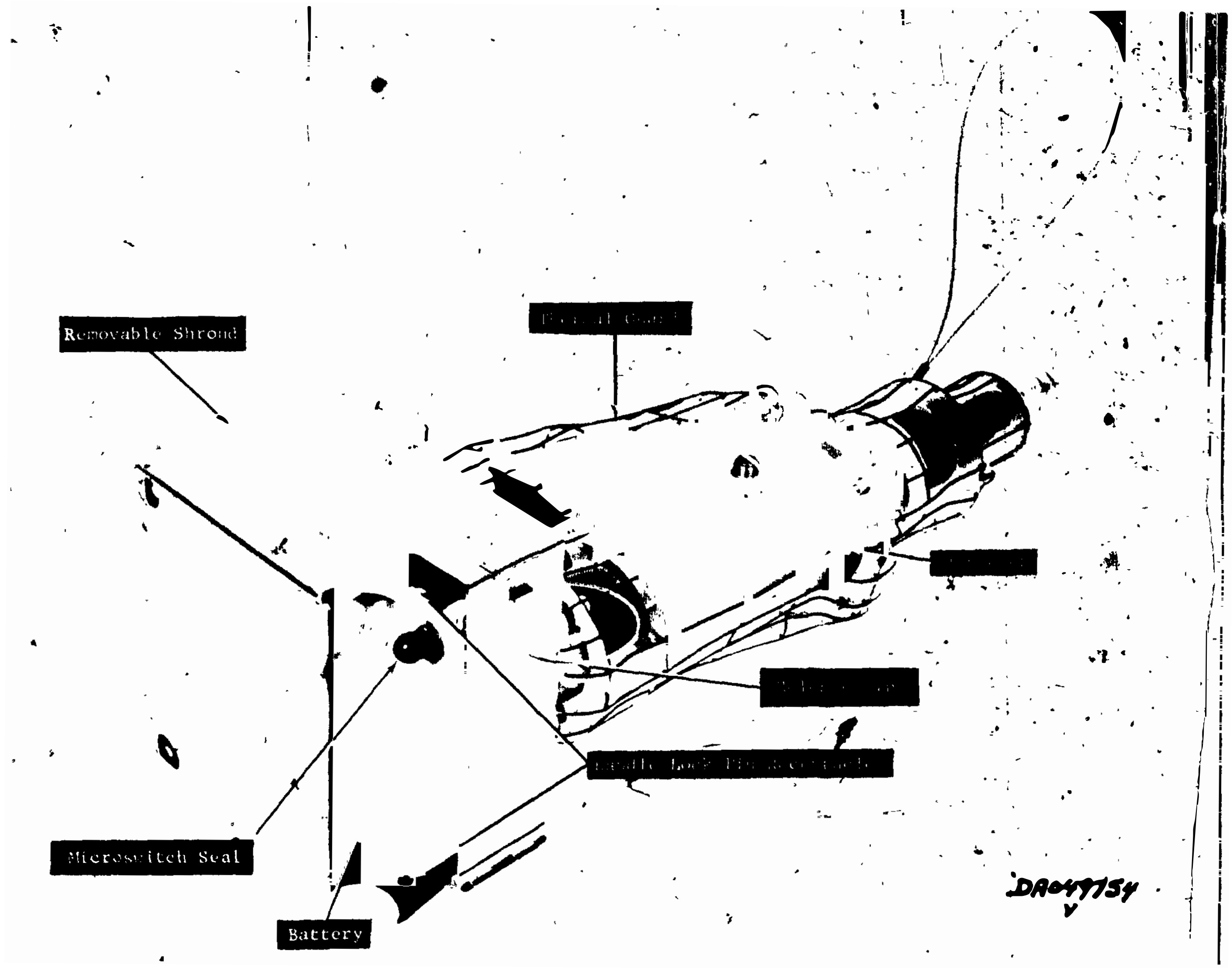


Figure III-6. - Battery, Thermal Shroud, Power Head and Thermal Guard Assembly

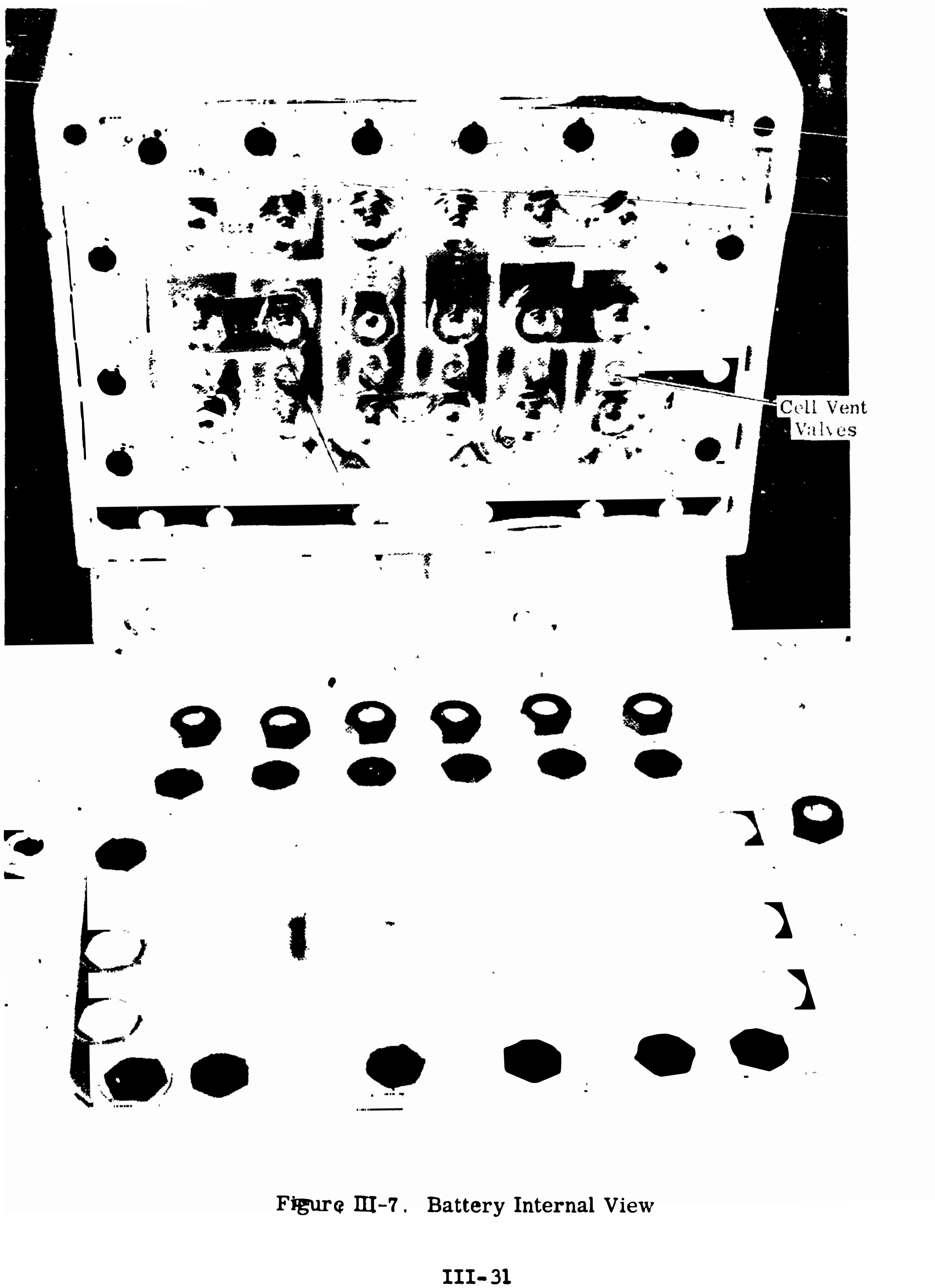


Figure III-7. Battery Internal View

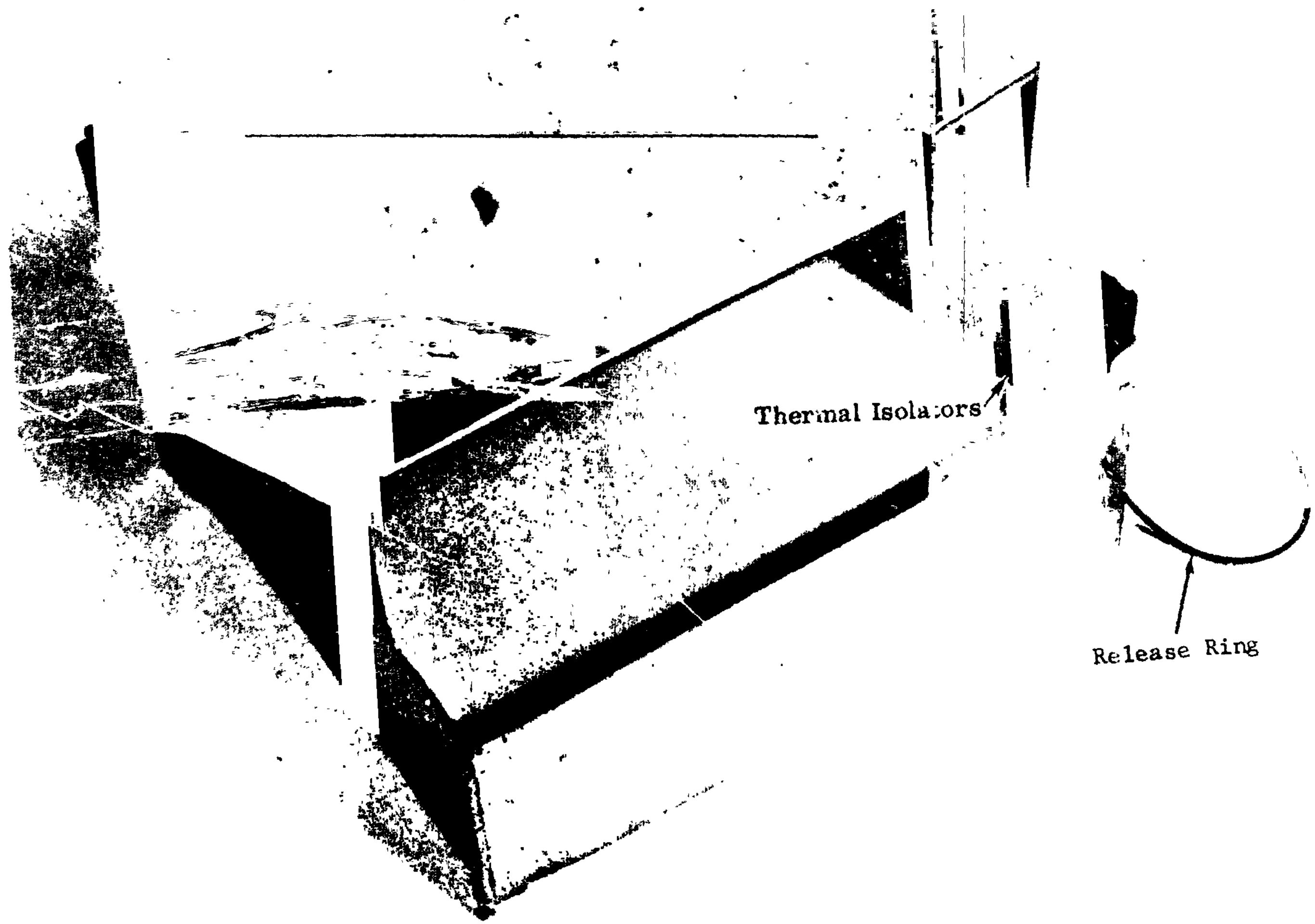


Figure III-8. Battery Thermal Shroud

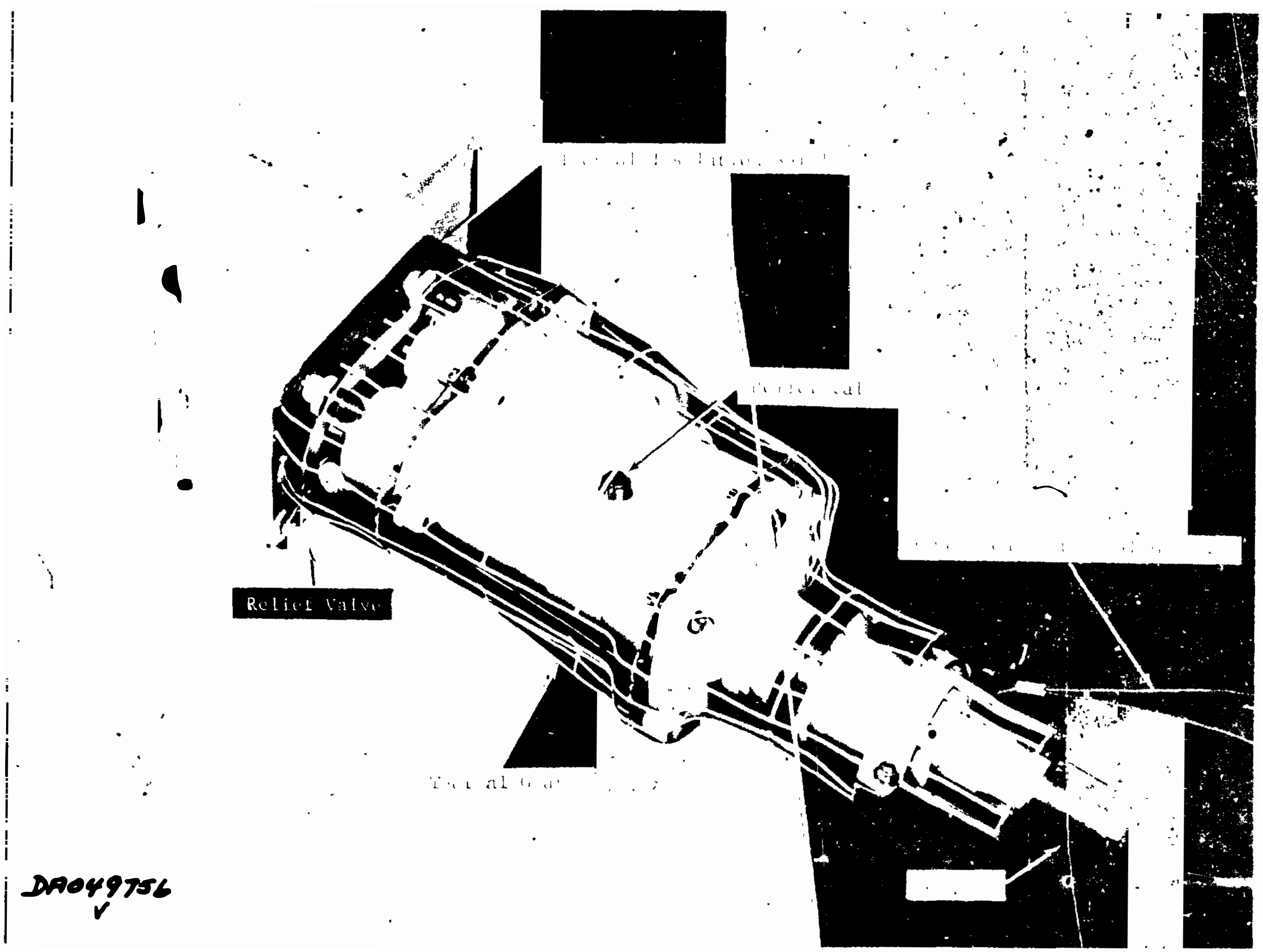


Figure III-9. - Battery, Power Head and Thermal Guard Assembly

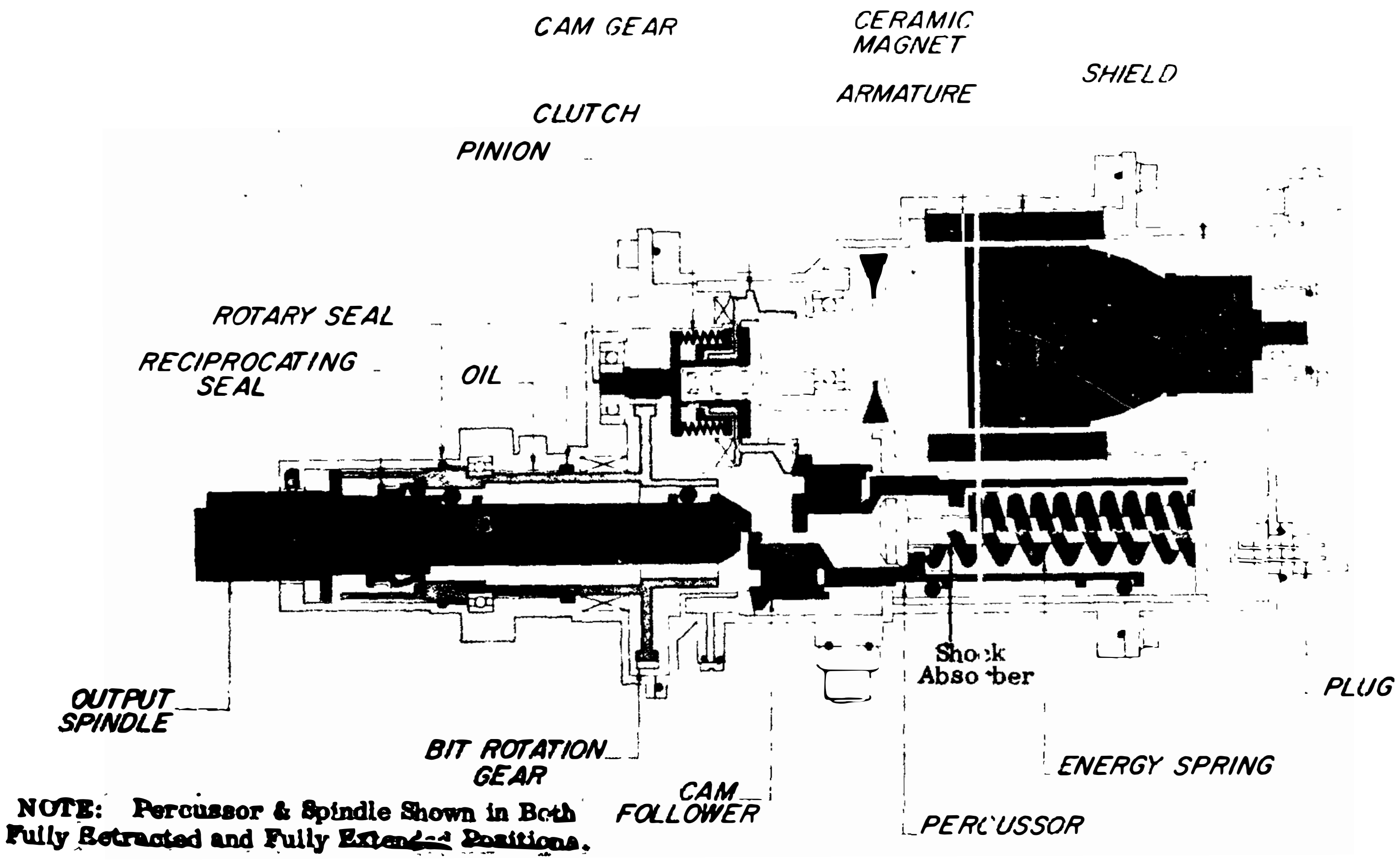


Figure III-10. Simplified Power Head Internal Components

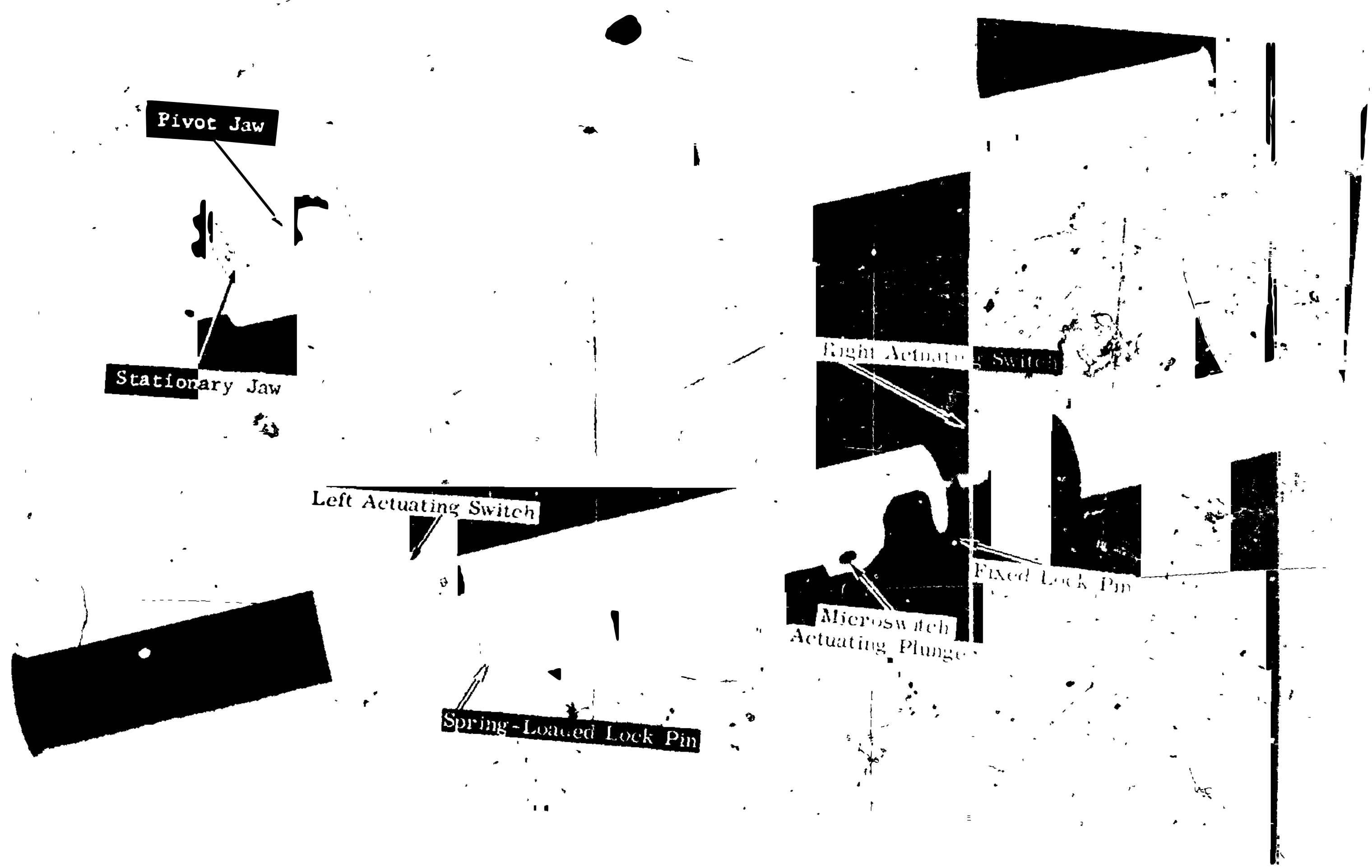


Figure III-11. Wrench, Handle and Switch Actuator Assy's.

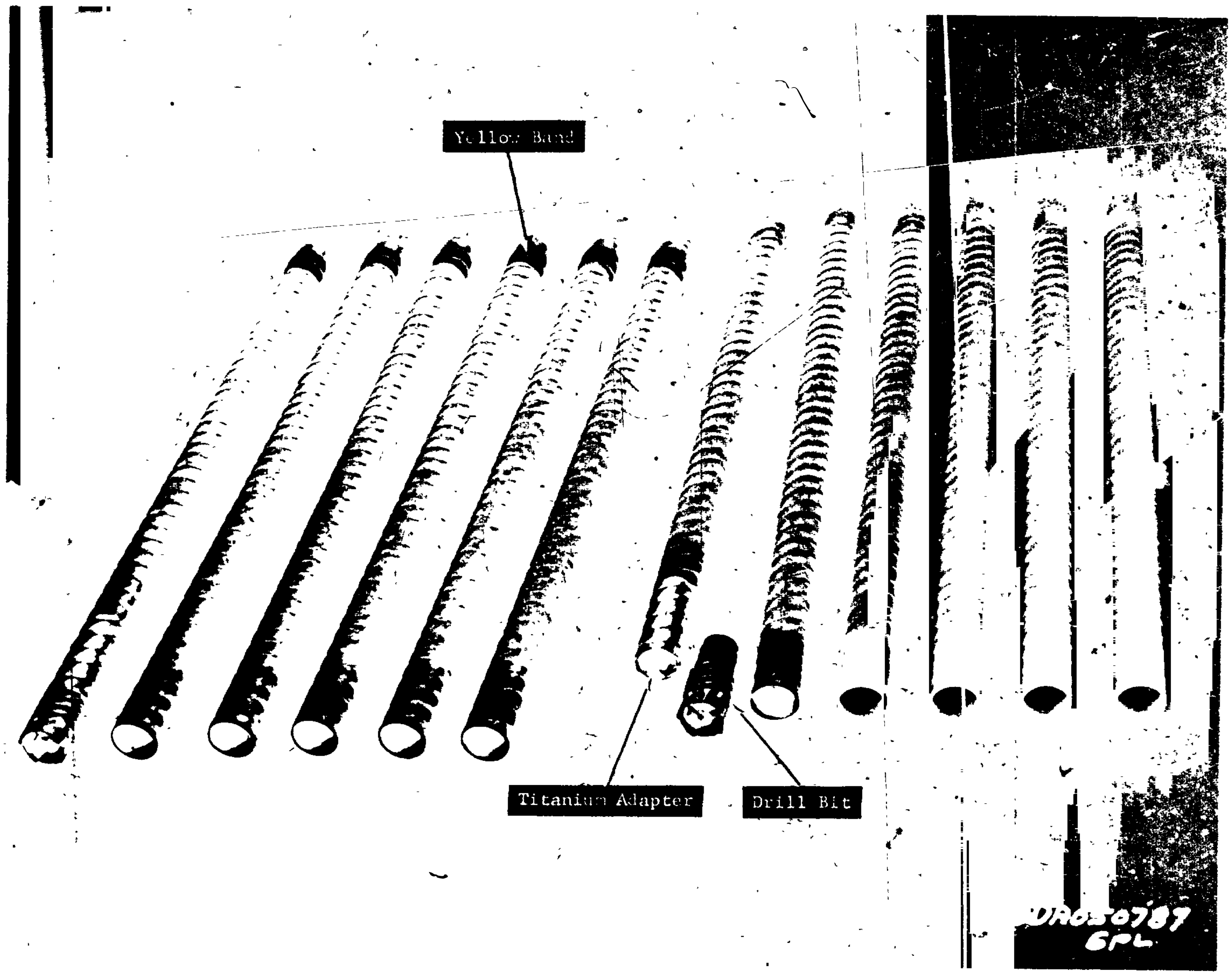


Figure III-12. Bore Stem Set

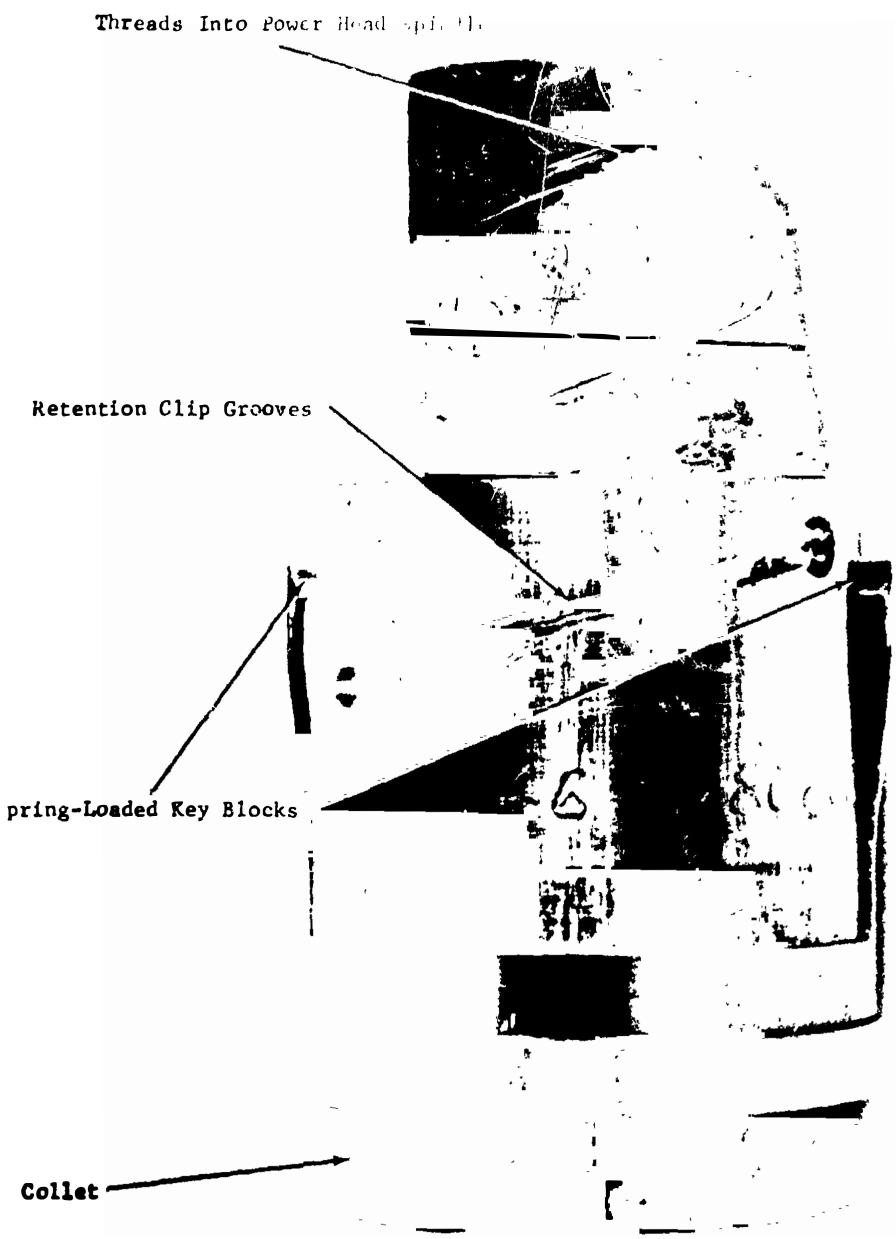


Figure III-13. - Bore Stem to Power Head Spindle Adapter

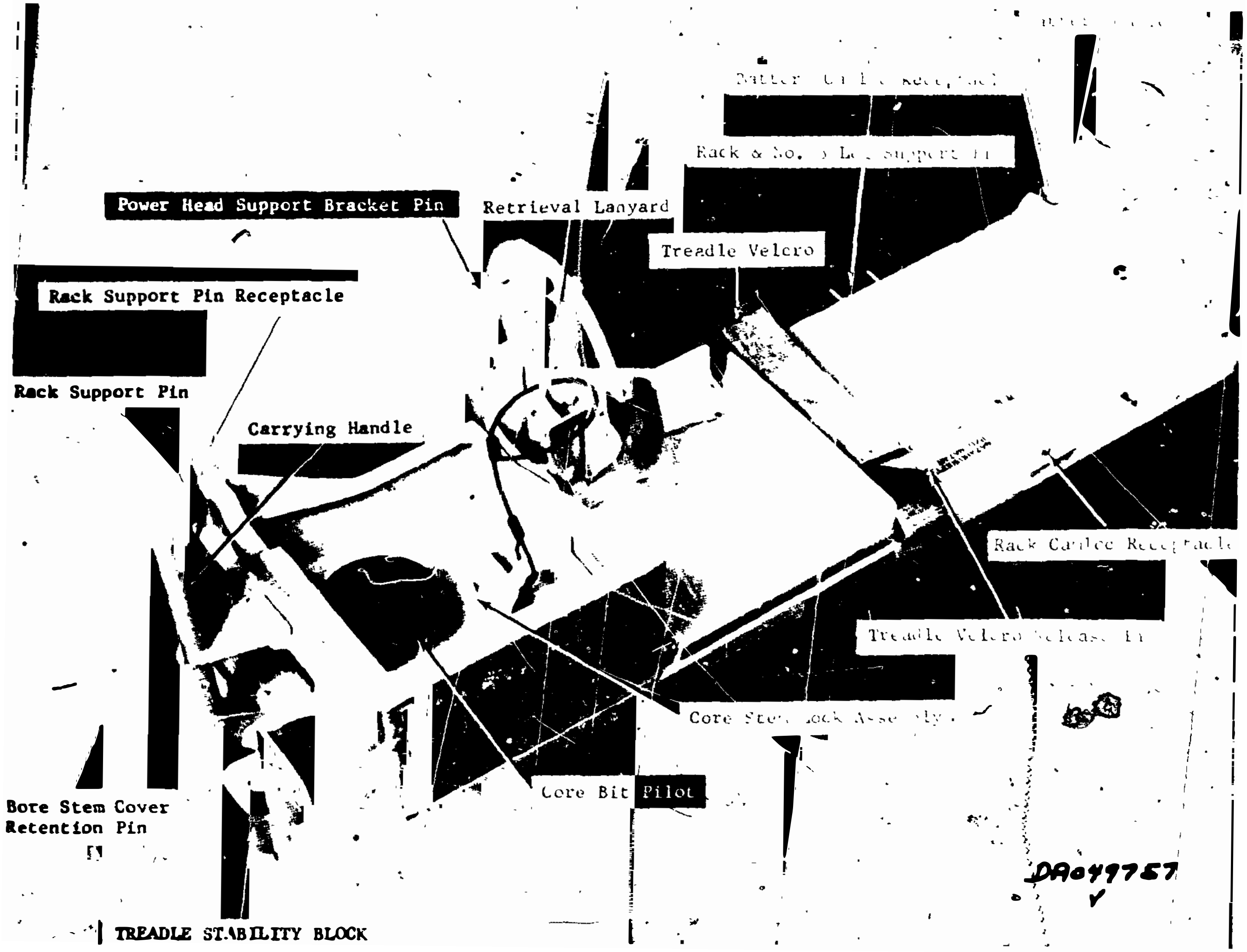


Figure III-14. - Treadle Assembly

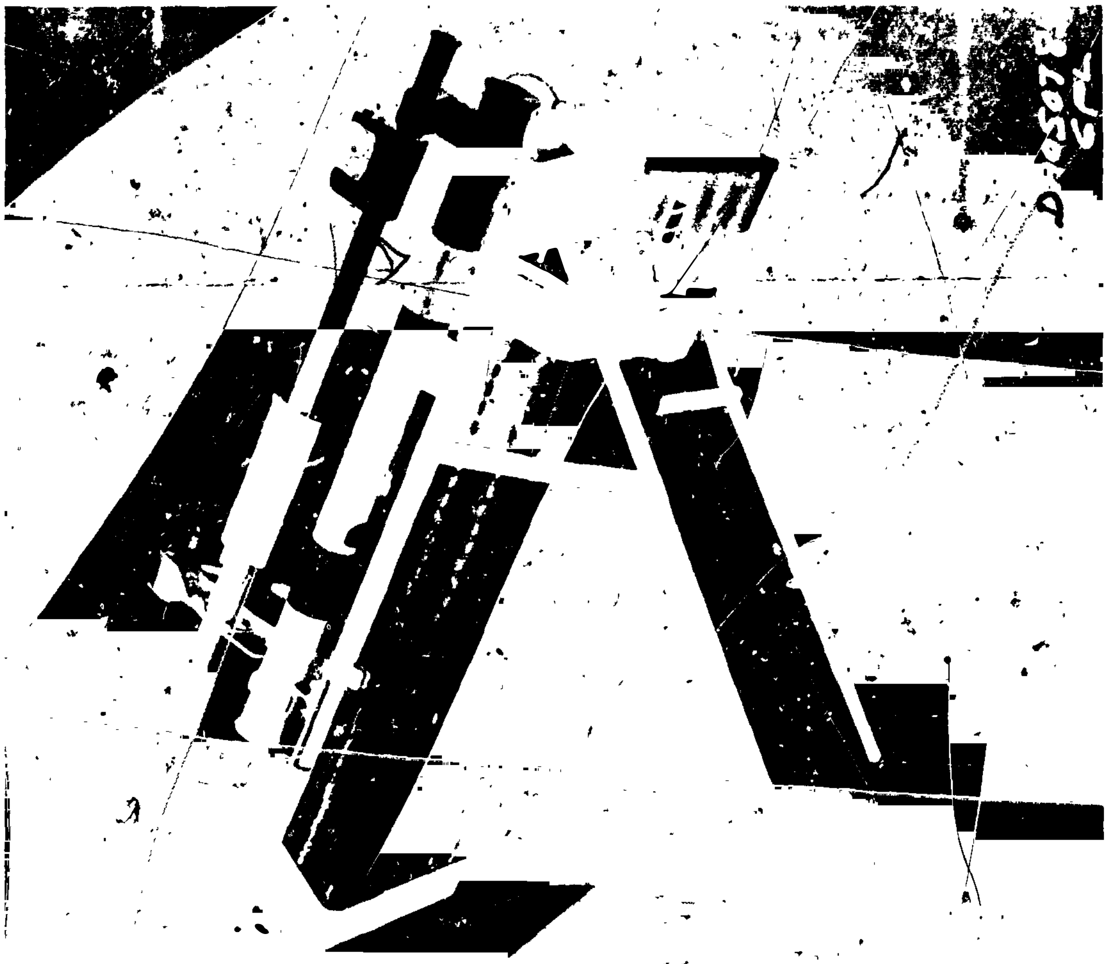


Figure III-15. - Rack Assembly with Components

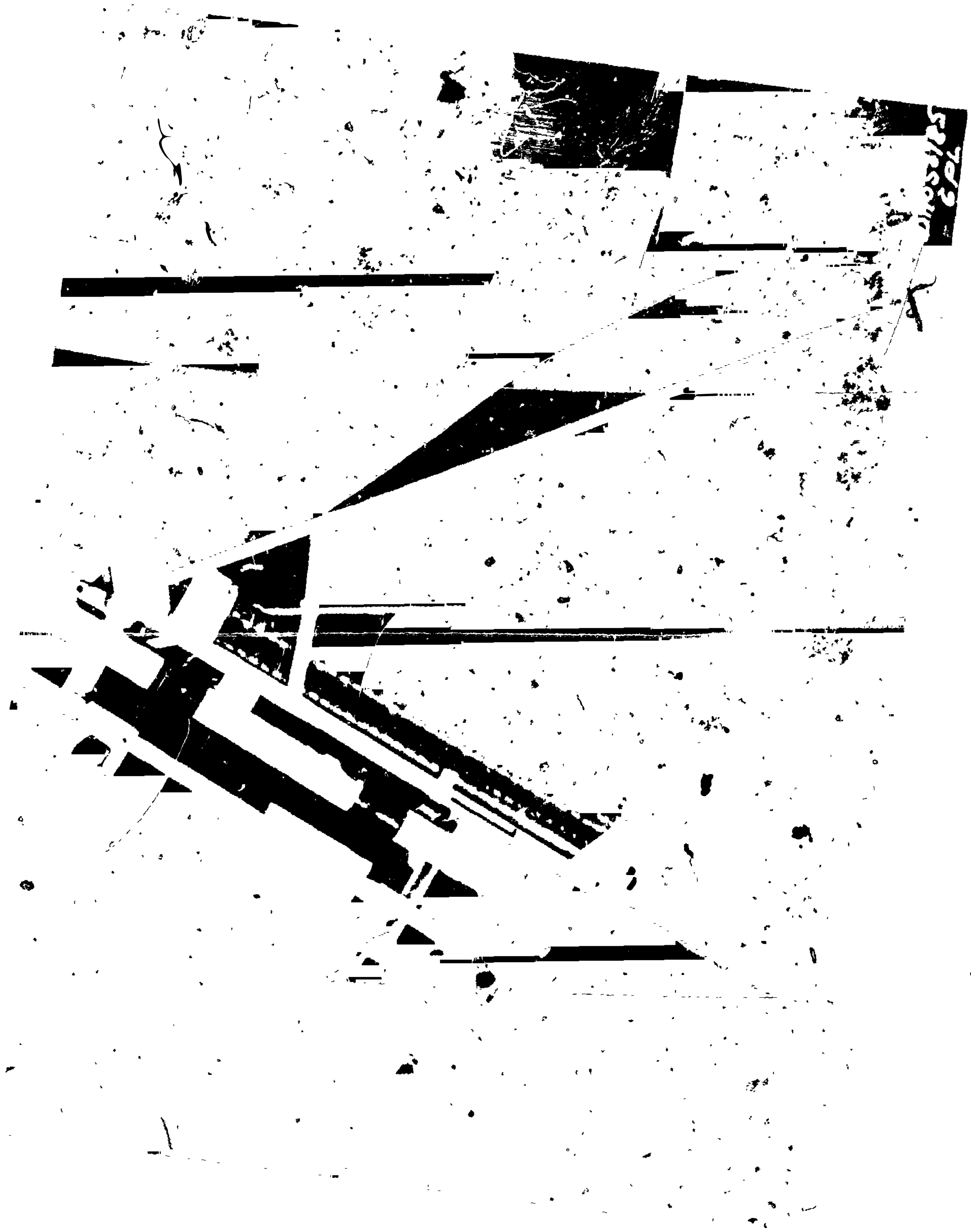


Figure III-16. - Rack Assembly with Components

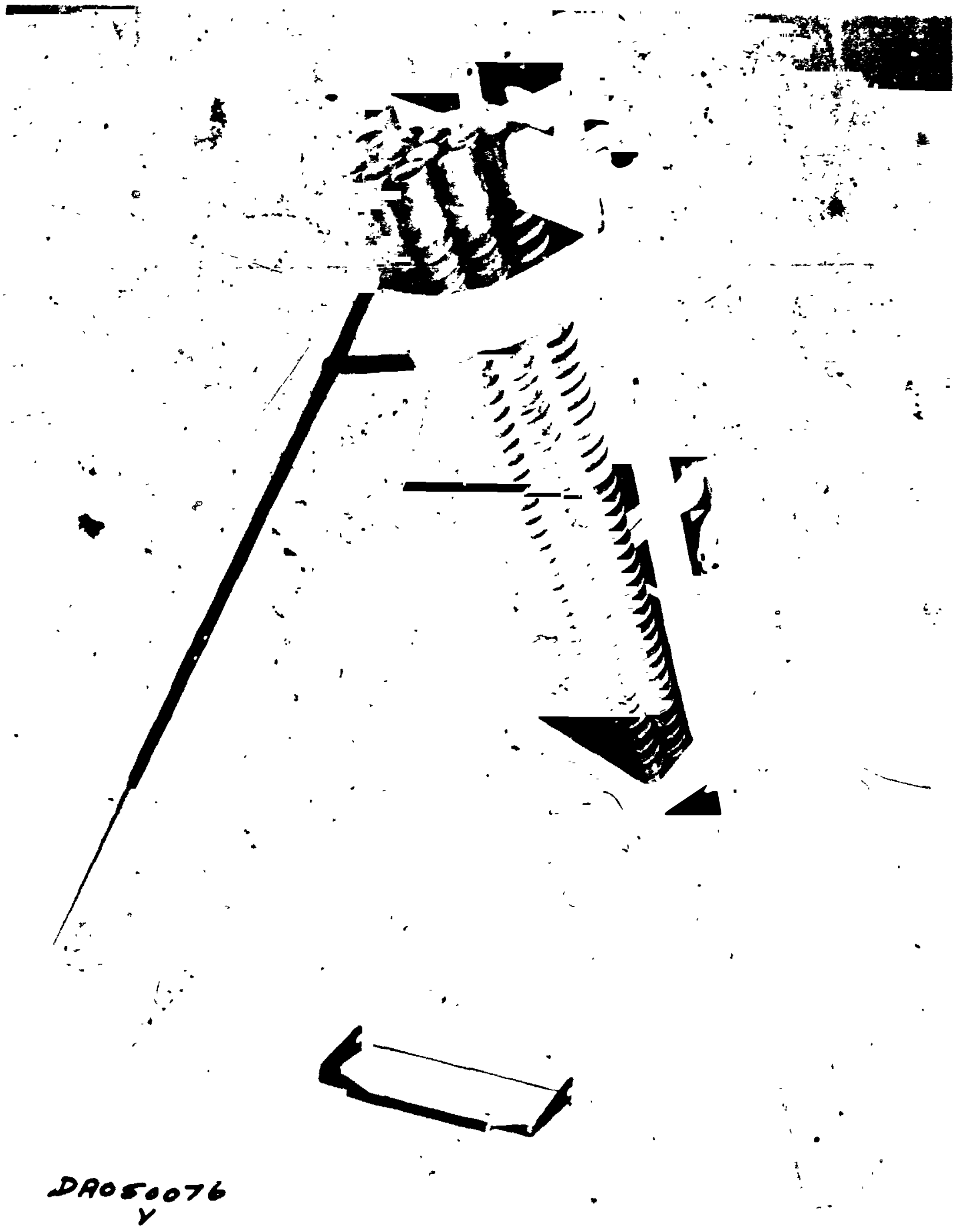


Figure III-17. - Rack - Deployed Configuration
(Handle and Stem Cover Removed)

Figure III-18. - Cap Stowage Location on Rack

Figure III-19. - Bore Stem Retention Plugs

Figure III-20. - Core Stem Lock - Bottom View

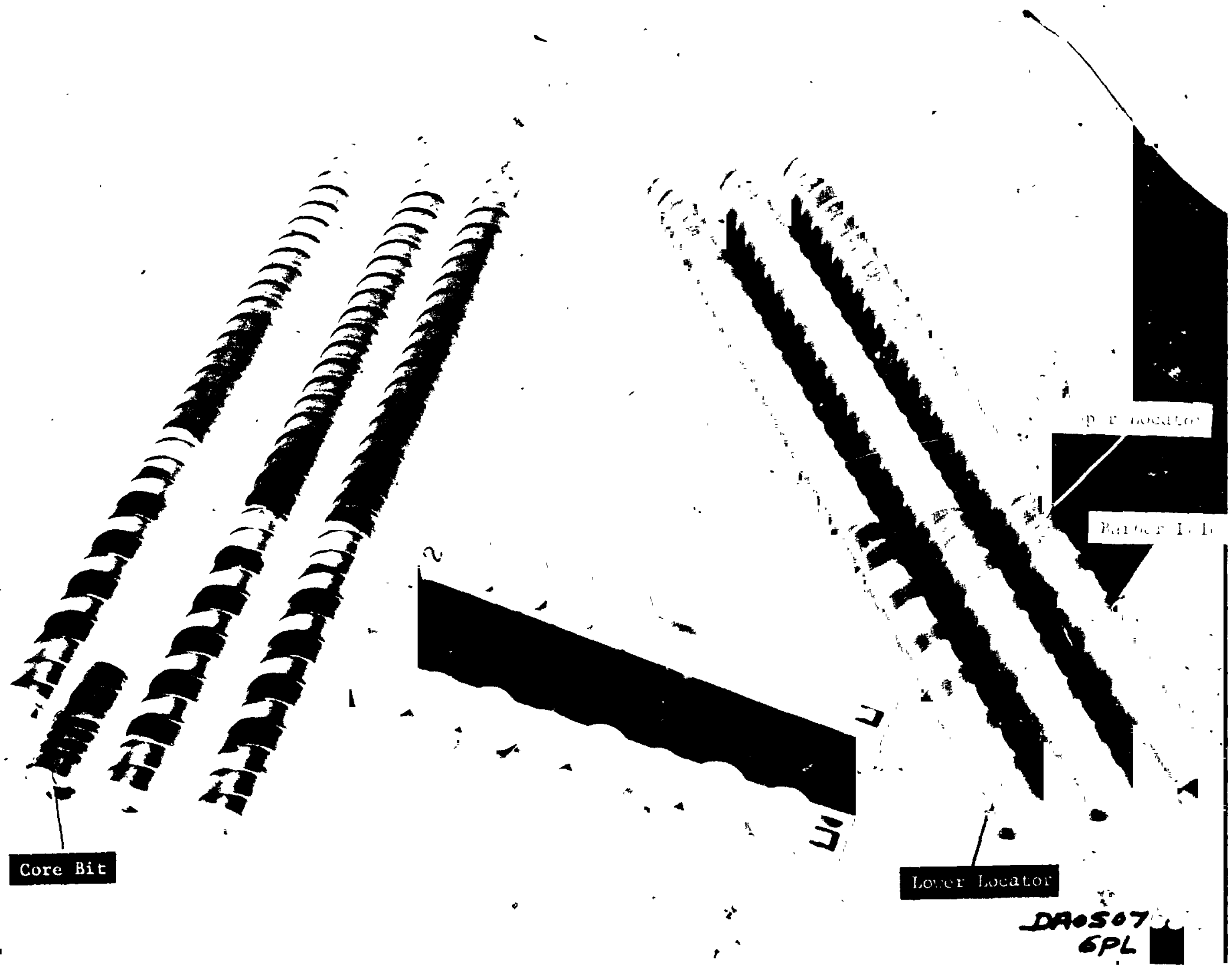


Figure III-21. - Core Stems, Core Bit, Core Stem Caps

IV. ALSD GROUND SUPPORT EQUIPMENT DESCRIPTION

1.0 PRESSURIZATION UNIT (Ref. Fig. IV-1)

1.1 General - The pressurization unit is used to verify seal integrity and proper pressure relief valve operation of the battery and power head. During test, the battery, or power head, is pressurized to gauge pressures of 5 to 15 psig respectively to verify relief valve "cracking" pressures. This operation is followed by static leakage tests of both units. The nitrogen pressurizing gas is furnished as GFE for the tester.

1.2 Construction - The components and pneumatic plumbing are installed within a metal enclosure containing a front panel for access to the controls and meters. Major elements comprising the pressurization unit include:

1) Supply Valve - controls entrance of nitrogen gas to pressurization unit from the external source.

2) Relief Valve (125 psig) - prevents over-pressurization of tester.

3) Regulator Valve - regulates gas pressure from source (150 psig max.) to operating pressure (0 to 30 psig).

4) Bleed Valve - depressurizes system prior to disconnect of units under test.

5) Low Pressure Relief Valve Control - connects low pressure relief valve (6 psig) to pressurization loop to prevent over-pressurization of battery.

6) Low Pressure Relief Valve (6 psig) - prevents over-pressurization of battery.

7) Relief Valve (28 psig) - prevents over-pressurization of power head.

8) Isolation Valve - isolates unit under test from pressure source during leakage rate tests.

9) Pressure Gauge (0-30 psig) - monitors system pressure.

10) Manometer - monitors battery case pressure during leakage rate tests.

11) Manometer Isolation Valve - isolates manometer during high pressure tests.

12) Miscellaneous T-Fittings and Hose - connects output of pressurization unit to power head or battery.

During pressurization tests, a standard 2000 psig nitrogen bottle with regulator is connected to the inlet of the pressurization unit. The relief valve of the unit under test (power head or battery) is removed and installed in a T-fitting, and the T-fitting is installed in the unit. An outlet hose is connected between the pressurization unit and the inlet side of the T-fitting. Pressure is applied to the system and the cracking pressure of the relief valve under test is verified. The system pressure is then reduced below the relief valve cracking pressure, the system isolation valve is closed, and a seal leakage test performed.

2.0 BATTERY CHARGING UNIT (Ref. Fig. IV-3)

2.1 General - The battery charging unit is used to support the flight battery activation and test requirements during prelaunch checkout of the ALSD, and to provide a multiple recharge capability for training unit batteries. Electrolyte for both the flight and training batteries is shipped separately to the required location. During the activation process, a pre-measured quantity of electrolyte is transferred from a plastic storage bottle to each cell through the cell vent valve boss as illustrated in Figure IV-2. The flight and training batteries are both dry-charged. Addition of the electrolyte, followed by a six-hour soak period, results in a fully charged battery.

2.2 Construction - The battery charging unit consists of a Yardney Electric Corporation SILVERCEL Charger, Model VC 24-10, and a battery adapter unit as illustrated in Figure IV-3. The VC 24-10 unit, which operates from a 105 to 120 VAC, 60 cps single phase power source, is capable of charging any number of silver-zinc cells from 1 to 24, at any charging rate up to 10 amperes. For ALSD operation the unit is operated in the 16-cell mode.

The charger consists of a lower panel assembly containing a power supply and variable transformer, and an upper panel assembly containing a cell selector switch, ammeter, voltage cutoff meter and charging circuit.

The power supply consists of a transformer and a full wave selenium rectifier circuit. A variable transformer is used in the AC input circuit for fine control of the DC output. The ammeter on the upper panel assembly has a dual scale and selector switch for use on a 1 or 10 ampere operating range.

Charge termination is controlled by a voltage cutoff meter which interrupts the charging power when the battery terminal voltage attains its predetermined level. In conjunction with the cutoff meter, the cell selector switch must be set to the 16-cell position for the ALSD battery. The selector switch inserts an appropriate multiplier resistance in series with the cutoff meter, which assures termination of charge at the proper battery "end" voltage.

If a failure of the AC voltage occurs, the battery automatically resumes charging when power is restored. Since the cutoff circuit is of the relay type, a reset circuit with a panel-mounted push-button switch is provided to ensure convenient recycling of the battery in the event that a power line surge activates the cutoff meter prematurely. Pilot lights on the upper panel assembly indicate whether the battery is "on charge" or "off charge".

The adapter unit consists of a small chassis for mechanically restraining the ALSD battery during the charging process. The unit also contains a battery mating electrical connector, a charging cable for routing the electrical power from the VC 24-10 charger to the battery, and a lock for depressing the battery microswitch during the charging process.

3.0 BATTERY FILLING KIT (Ref. Fig. IV-4)

3.1 General - The battery filling kit contains the electrolyte and tools required for activating the sixteen cells of a complete battery assembly.

3.2 Kit Contents - The battery filling kits contain the following items:

Qty. Per Kit	Nomenclature
1	Chipboard Box per YEC 1008, consisting of 24 compartments (6 x 4), each compartment 1-1/4 x 2-7/8 inches high
18	1 oz. polyethylene bottles with caps containing 17 cc of 40% KOH electrolyte (21 cc 42% KOH for training batteries) (2 spares)
2	Filler caps for 1 oz. bottle, special YEC P/N 10312-1
18	Vent Cleaners
1 Pair	Tweezers
1/4 Oz.	Absorbent Cotton
5	Cell Screw Valve Assembly Spares, YEC P/N 10954
1 Set	Operating Instructions
3	Electrolyte Trap Assembly (1 spare), YEC P/N 11801 (Flight batteries only)

4.0 GSE PART NUMBERS AND WEIGHT

A delineation of the major part numbers required for field level operations and maintenance is tabulated in Table IV-1.

TABLE IV-1. GSE PART NUMBERS AND WEIGHT

Figure No.	Nomenclature	Weight (Lbs.)	Part Identification	
			Part Number	Mfg.
IV-1	Pressurization Unit, ALSD	63	467A8090000-009	MMC
IV-3	Battery Charging Unit	110	467A8080000-009	MMC
IV-4	Silvercel Filling Kit (Flight)	1	11310	YEC
"	" " " (Trng.)	1	11294	YEC

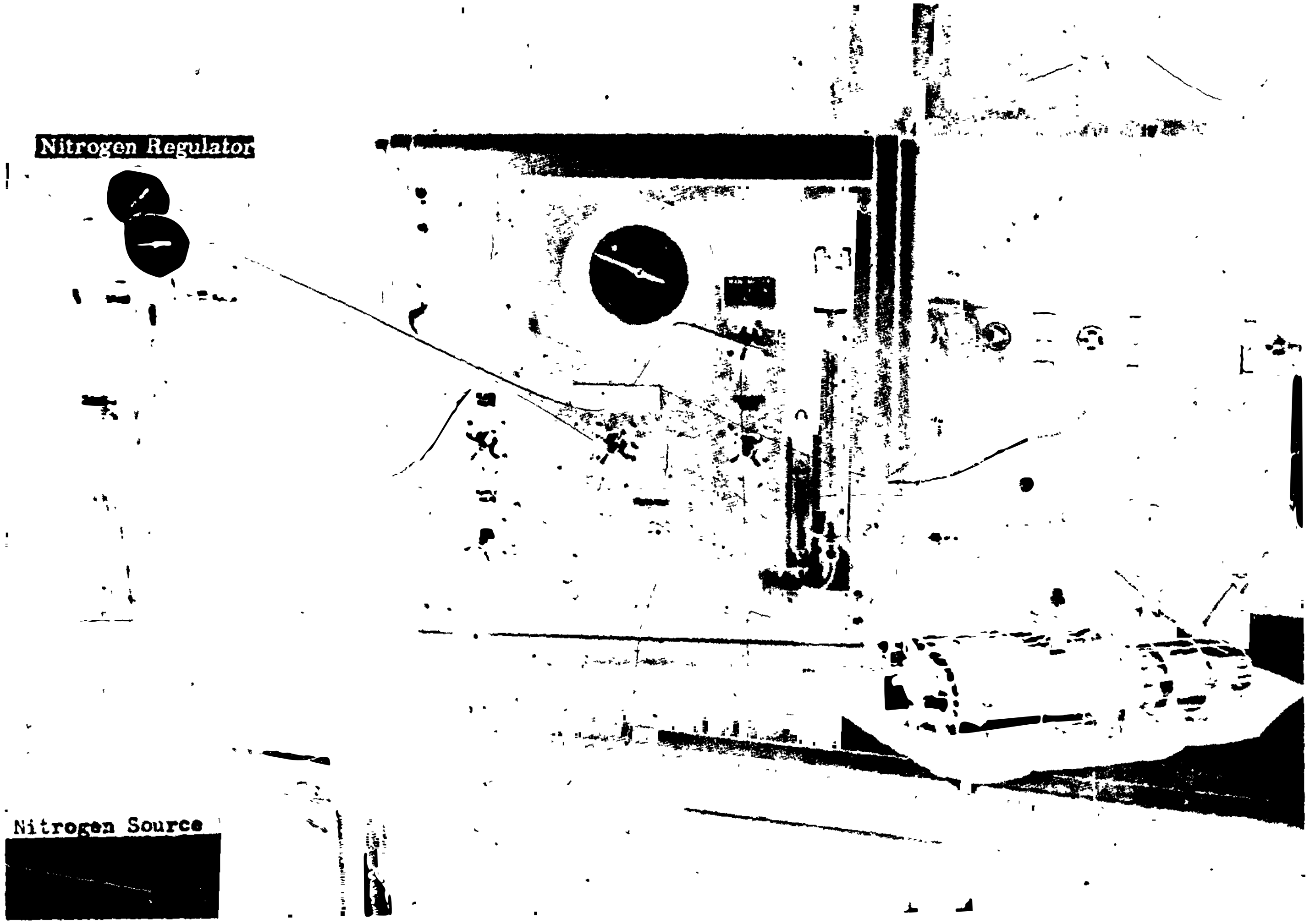


Figure IV-1. ALSD Pressurization Unit

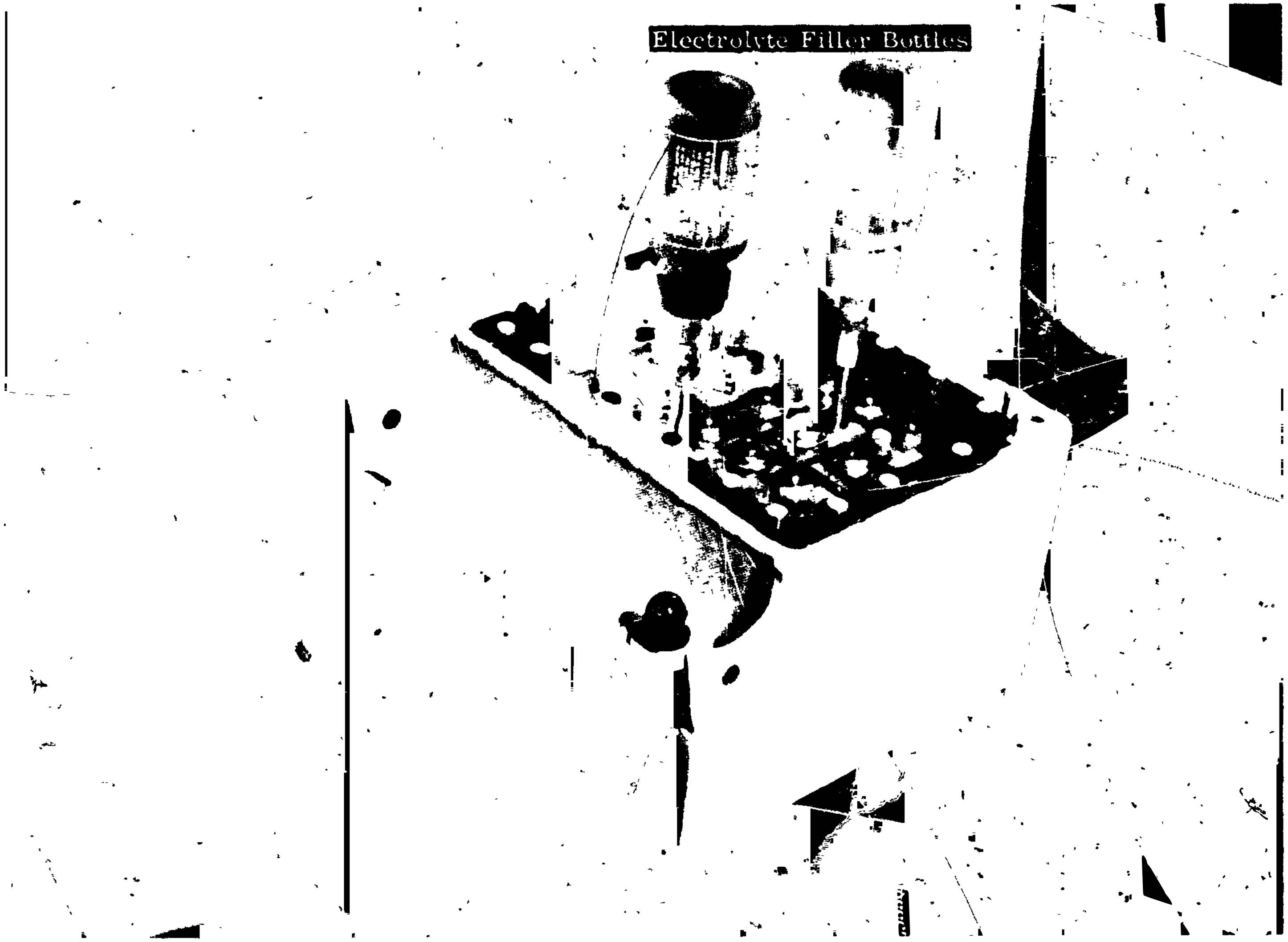


Figure IV-2. Battery Activation

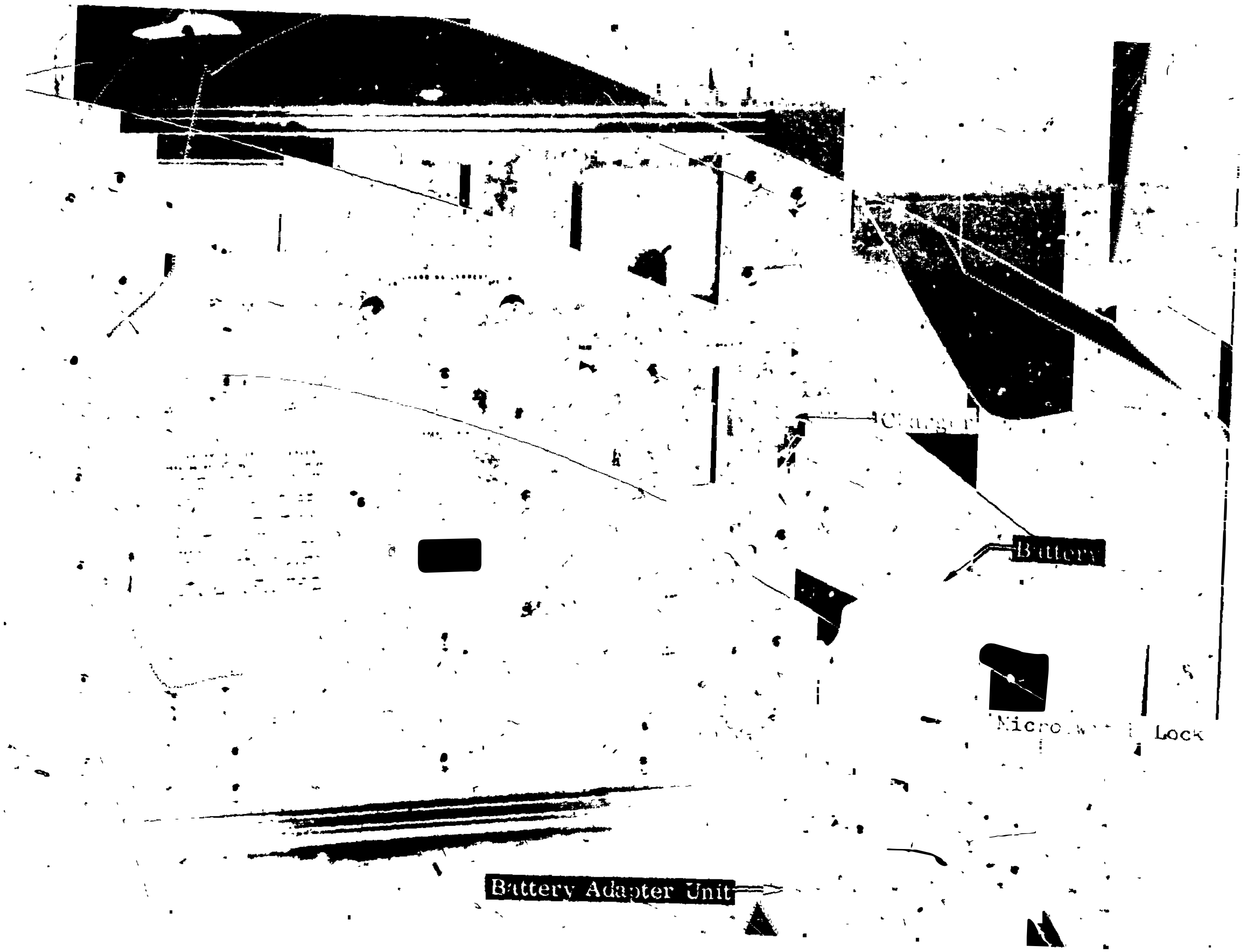


Figure IV-3. ALSD Battery Charging Unit

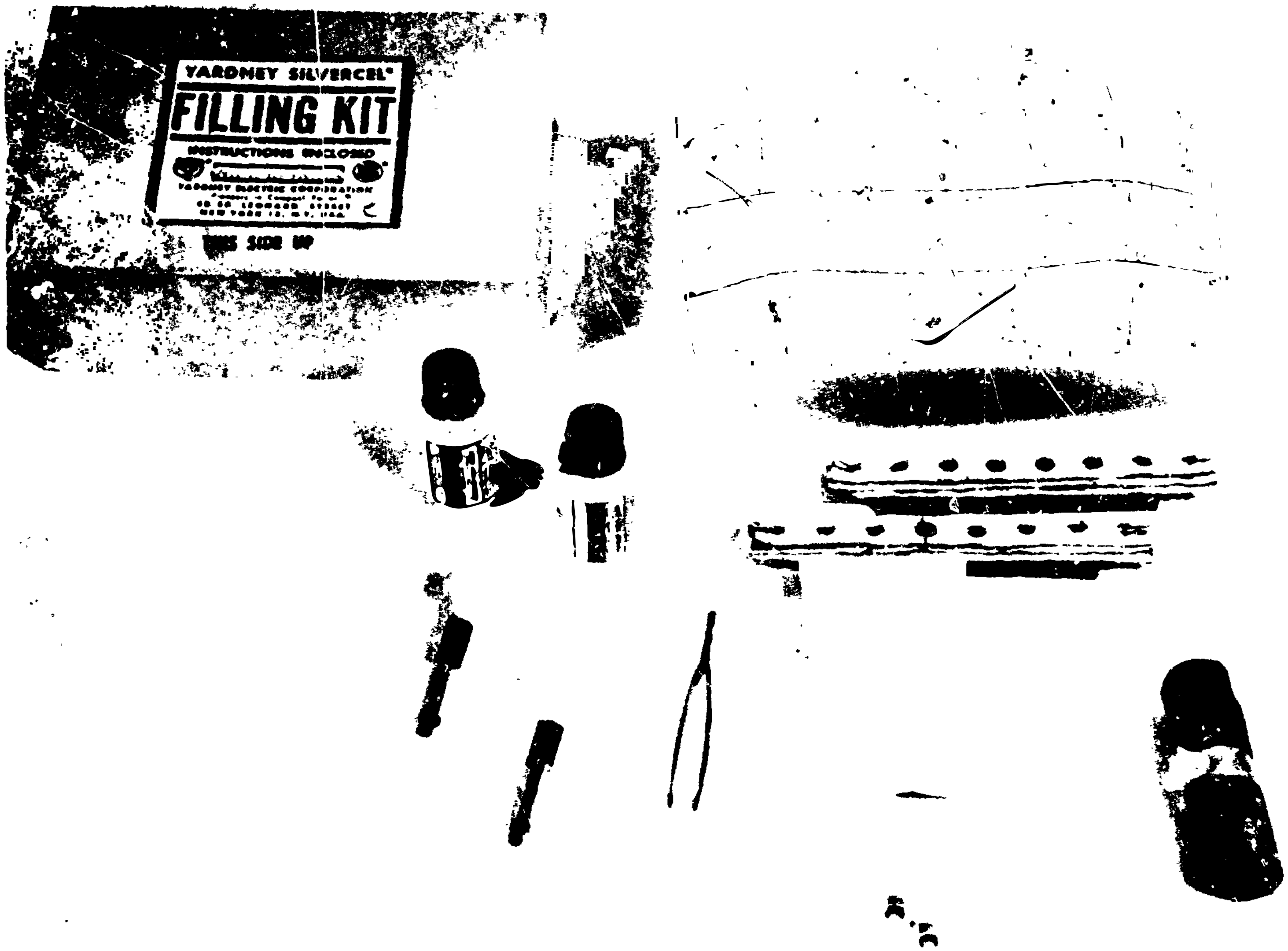


Figure IV-4. ALSD Battery Filling Kit

V. LUNAR SURFACE OPERATING INSTRUCTIONS AND PROCEDURES

1.0 GENERAL

The following paragraphs describe the procedures for ALSD removal from the pallet of ALSEP subpackage number two; subsequent deployment procedures; and specific astronaut tasks. Procedures are presented for drill assembly employing the MESA SRC table and the ALHT carrier. Contingency instructions are provided in Table V-1.

2.0 HOLE BORING - TWO HOLES FOR HEAT FLOW EXPERIMENT PROBES; HOLE CORING - ONE HOLE FOR CORE SAMPLE

2.1 Primary Method

The ALSD is deployed utilizing the ALHT carrier located at the HFE site (30' SE of the Central Station).

2.1.1 Hole Boring

1) Remove the ALSD from the pallet in ALSEP subpackage No. 2 (Figure II-3) using the following procedure:

   a) Remove ALSEP ball detent pin.

   b) Push ALSD assembly forward to disengage top horizontal support pin on pallet from receptacle in treadle.

   c) Orient ALSD to a near vertical position. Pull straight up on ALSD carry handle to disengage two pallet vertical support pins from ALSD battery receptacles.

   NOTE: Unless the ALSD is pulled upward in a near vertical orientation, the two support pins will bind in the battery receptacles, making removal difficult and resulting in possible damage to the battery casing.

   CAUTION: After removal of the ALSD from the subpackage and prior to drill deployment, if temporary (30 minutes or longer) storage on the lunar surface is required, the ALSD shall be placed on the surface with the battery end down and the battery oriented toward the sun. Ensure that the battery is not shaded by the bore stems or treadle. Do not place the ALSD package in the shadow of the LM or other shaded area.

2) Remove the ALHT carrier (Figure V-1) from ALSEP subpackage No. 2.

3) Place deployed ALHT carrier on surface near MESA.

4) Remove SRC No. 1 from MESA stowage and place on SRC table (Figure V-2)

5) Open SRC (Figures V-3 and V-4).

6) Remove core stems from SRC and place in ALHTC sample bag.* Place stem with bit in bag with bit end up.

7) Remove core stem cap retainer assemblies and clip onto side of sample bag at special pocket area. Clip so that cap assemblies are in the sample bag.

8) NASA option: Remove additional ALSD wrench from MESA stowage and place in ALHTC sample bag.

9) Transport ALSD (Figure V-5) and place on surface adjacent to ALHTC (Figure V-6).

10) Transport ALSD and ALHTC to HFE site (30' SE of Central Station) and place both on surface.

11) Lift ALSD by carrying handle with left hand and place ALSD on ALHTC so that ALHTC pin (SEB 39101529 Rev. C) engages hole in treadle stability block.* Place treadle on ALHTC so that treadle velcro can readily engage velcro clipped to ALHTC handle (SEB 39100709-002).

12) Hold left side of ALSD steady with left hand. Pull treadle velcro tab with right hand (Figure V-7) and engage treadle velcro strap with velcro on ALHTC handle. ALSD orientation on ALHTC is depicted in Figure V-8.*

13) Steady ALSD with left hand. Depress drill actuator switch with right index finger (Figure V-9). Check for power head operation by observing spindle rotation.

14) Hold ALSD steady with right hand. Remove bore stem cover retention pin by pulling ring vertically (Figure V-10). (Pin No. 1).

* Contingency Instruction

15) Hold ALSD steady with right hand. Remove rack support pin by pulling ring horizontally and sharply to the left (Figure V-11). (Pin No. 2).

16) Rotate rack camloc 90° counterclockwise (Figure V-12). Release camloc but do not rotate bracket. (Pin No. 3).

17) Hold ALSD steady with left hand. Rotate battery camloc 90° counterclockwise (Figure V-13). Release camloc and lift vertically. Remove camloc and rack support Pin No. 2 by pulling release lanyard ring horizontally and sharply to the right (Figure V-14). (Pin No. 4).

18) Steady ALSD with left hand. Place middle fingers of right hand against leg #1 between stowage clip and leg foot pad (Figure V-15). Push leg out of clip with fingers. Catch leg in left hand as it unfolds outward.

19) Grasp leg foot pad with right hand. Steady ALSD with left hand. Extend leg by pulling on pad. Check color coding as leg approaches locked position. Fully extend leg to locked position (Figure V-16). Verify locked position by gently pulling and pushing leg. Release leg to permit full outward deployment.

20) Steady ALSD with left hand. Grasp leg #2 foot pad with right hand. Extend leg by pulling on pad. Check color coding as leg approaches locked position. Fully extend leg to locked position (Figure V-17). Verify locked position by gently pulling and pushing leg.

21) Rotate rack away from treadle several inches by pushing horizontally on right side of rack.

22) Remove handle and switch actuator assembly from stowage clips (Figure V-18).

23) Grasp handle in right hand and fit handle fixed lock pin into battery receptacle (Figure V-19). MAKE CERTAIN PIN IS FULLY ENGAGED.

24) Pull upward on handle with left hand making certain upper fixed pin remains fully engaged into the receptacle (Figure V-20). Slap the bottom of the handle inward. Spring-loaded pin will engage and lock into lower receptacle. Ensure that handle is securely and positively locked in position. *

* Contingency Instruction

25) Rotate rack camloc and bracket upward (away).

26) With left hand under upper bore stem retention bulkhead and right hand under lower bore stem retention bulkhead, lift rack vertically from treadle (Figure V-21). Leg #3 will deploy downward. *

27) With right hand, grasp jaw assembly of wrench. Hold rack in vertical position. With left hand grasp No. 3 leg foot pad. Extend leg by pulling on pad. Check color coding as leg approaches locked position. Fully extend leg to locked position. Verify locked position by gently pushing and pulling the leg.

28) Rotate rack camloc and bracket fully inward. Place rack on surface.

29) Reset adapter. Push collet in. Depress spring-loaded key blocks and thread adapter fully into spindle (Figure V-22).

30) Steady drill with right hand. Remove power head retention bracket pin by pulling ring horizontally and sharply to the left (Figure V-23). (Pin No. 5). Rotate bracket (toward).

31) Remove power head and battery assembly from treadle by lifting on upper part of handle with right hand and simultaneously lifting on lanyard with left hand (Figure V-24). * Life vertically and move horizontally to right slightly.

32) Place power head and battery assembly on surface adjacent to rack (Figure V-25).

33) With lanyard, lift power head and battery assembly. Cradle or hold assembly under right arm.

34) Lift rack with left hand. Orient so that leg #3 is away from body to eliminate trip hazard.

35) Transport rack and power head assembly to first HFE probe site. 16' SW of HFE site.

36) Place rack and power head on surface.

37) Remove bore stem cover (Figure V-26).

* Contingency Instruction

38) Discard cover, making certain that it is at least six feet from heat flow probe hole.

39) Pull bore stem retention strap release tab (Figure V-27).

40) Select one of the two bore stems with drill bit attached (Figure V-28). These stems are identified by an orange stripe on inside of male taper. One is always stowed in the upper left position and the other in the upper right position. *

41) Select a standard stem and fit to the selected bit stem.

42) Fit this double stem section to the power head adapter with the power head assembly on the surface (Figure V-29). Firmly engage these stems. Lean on and push stems while rotating them clockwise into the adapter.

43) With lanyard, lift power head assembly from surface. Do not lift with stems. Rotate assembly and place drill bit into surface.

44) Remove thermal shroud by pulling release ring (Figure V-30). Discard shroud. Ensure that it is at least 6 feet from heat flow probe hole.

<u>CAUTION</u>: If, after removal of thermal shroud, ALSD operations are delayed for more than 30 minutes and the sun angle is less than 22° above the horizon, the shroud shall be replaced until resumption of drill operation.

45) Check verticality of bore stems (stems to be within 15° of vertical).

46) Energize power head by pushing inward on both handles. Drill to lower handle height limit.

47) Release adapter by rotating power head 90° counterclockwise and then rotate clockwise 90° to the normal drilling position. Energize power head for a few seconds and simultaneously lift power head vertically. If the adapter does not release after first attempt, repeat procedure up to three times. * Figure V-31 depicts adapter in driving mode. This is position prior to rotating power head 90° counterclockwise. Figure V-32 depicts adapter configuration after 90° counterclockwise rotation. Spring-loaded key blocks are released. After

* Contingency Instruction

adapter release, de-energize power head prior to moving drill horizontally from stem to preclude contact of rotating retention clips and adapter with suit. Figure V-33 depicts adapter in release mode. Figure V-34 depicts stem release.

48) Reset adapter. This may be accomplished in either of the following ways:

    a) Place power head on surface. Reset collet by pushing it into adapter with palm of hand (Figure V-36). Depress key block springs with thumb and index finger. Rethread adapter into spindle (Figure V-37).

    b) Hold power head with left hand and push collet in with palm of right hand (Figure V-38). Depress key block springs with thumb and index finger. Rethread adapter into spindle. (Figures V-39 and V-40). Power head may be held vertically or horizontally.

49) If adapter was reset while holding power head in hand, place power head on surface upon completion of task. Fit a standard bore stem to stem protruding from surface (Figure V-41).

50) Fit power head adapter to this bore stem (Figure V-42).

51) Sequentially drive bore stems until first six are emplaced.

52) Emplace heat flow probe in accordance with procedures.

53) Lift power head assembly and place under right arm.

54) Lift rack with left hand.

55) Proceed directly to second heat flow probe site (16' E of HFE site).

56) Follow same procedures for the boring of the 2nd heat flow probe hole as for the first. (All bore stems have now been emplaced.)

57) Emplace heat flow probe.

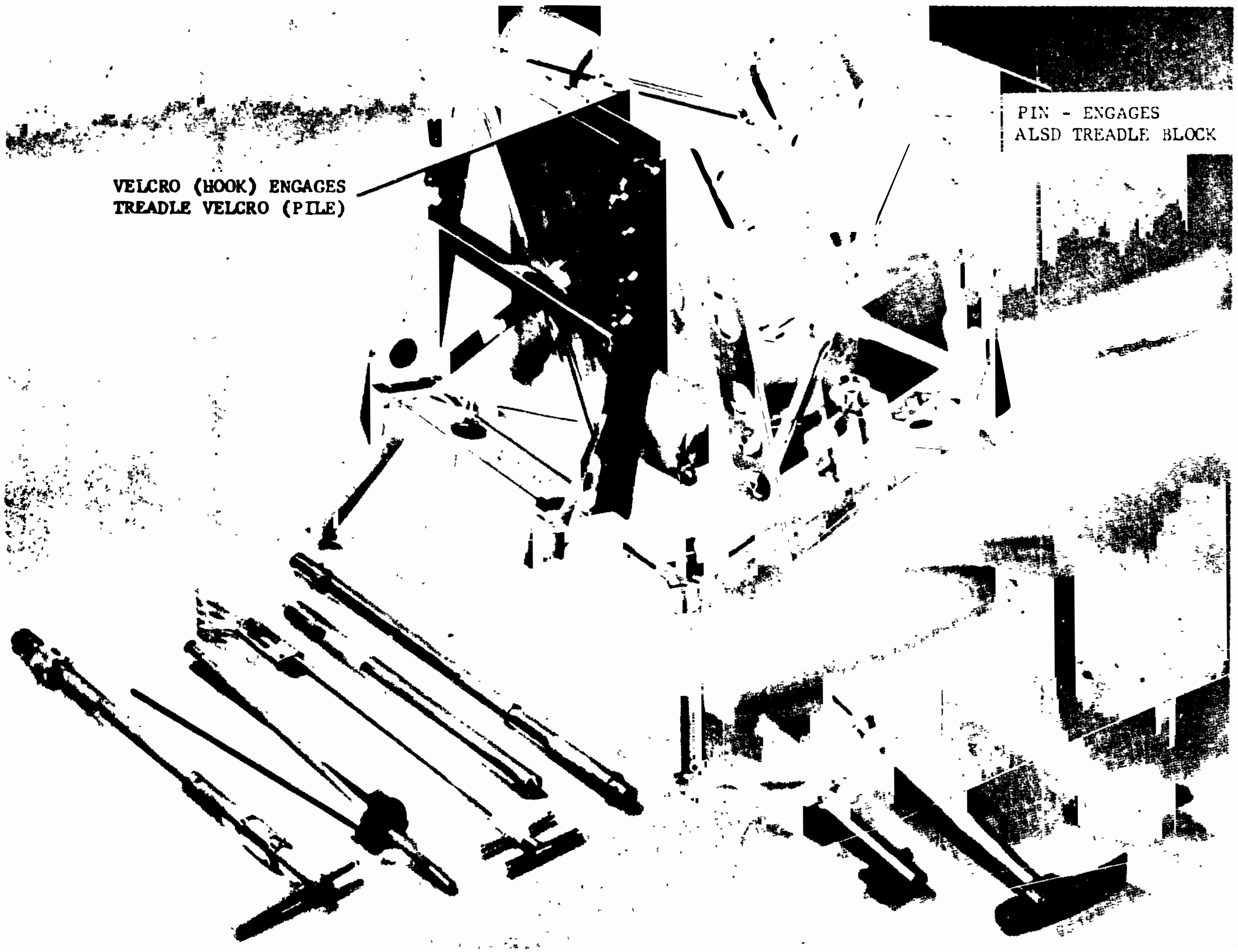


Fig. V-1. Apollo Lunar Hand Tool Carrier

Fig. V-2 Modularized Equipment Stowage Assembly

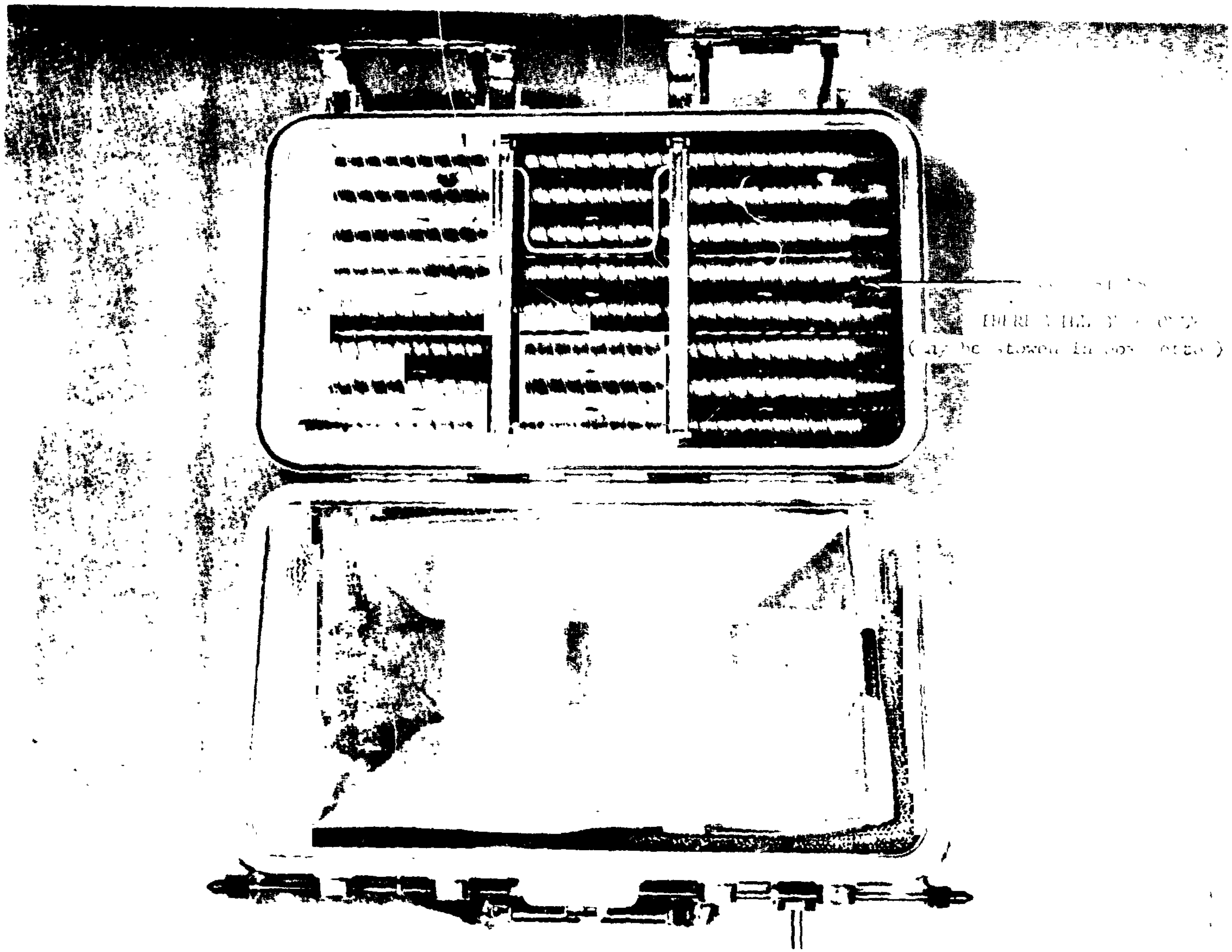


Fig. V-3 SRC - Core Stems in Lid

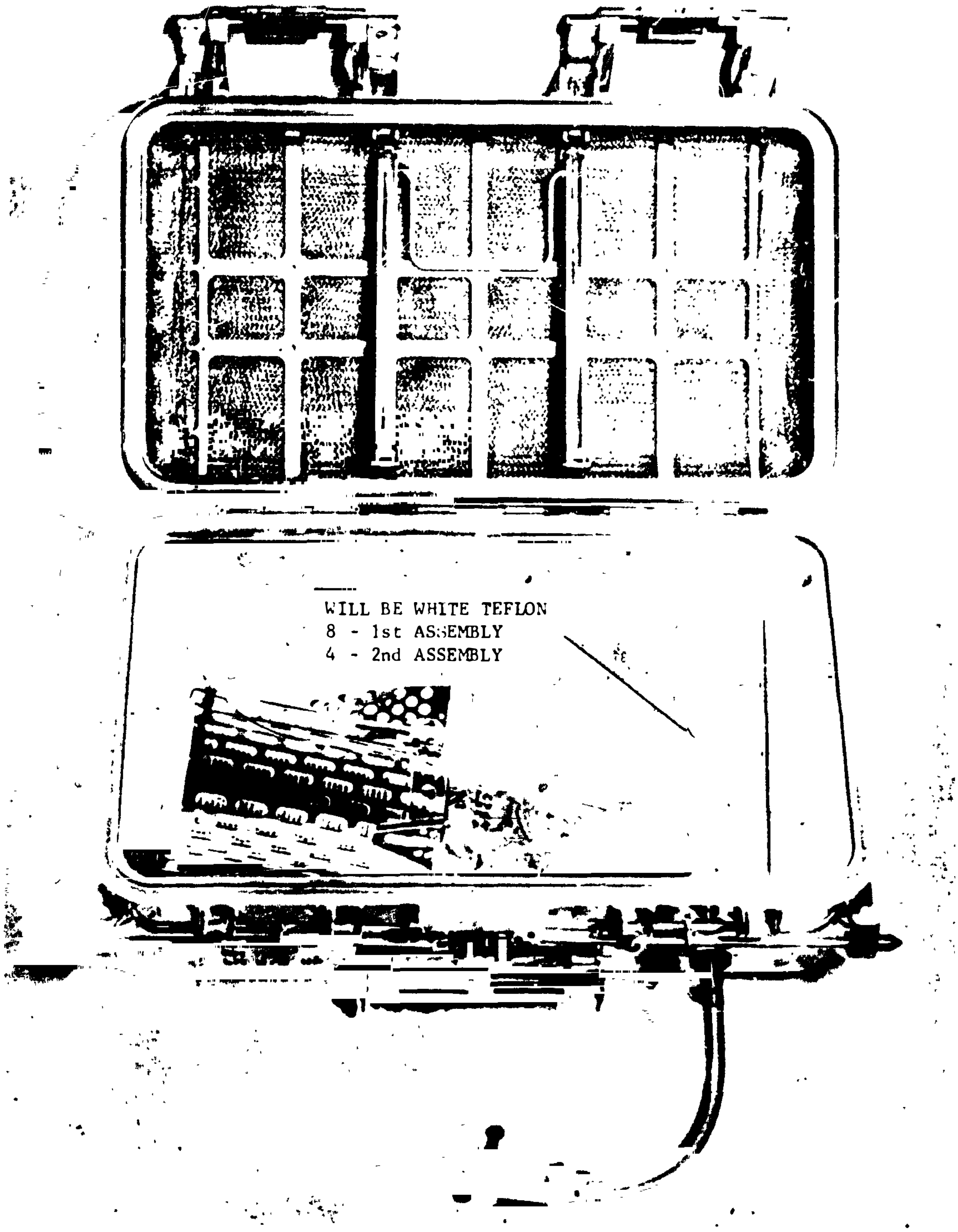


Fig. V-4 SRC - Core Stem Caps

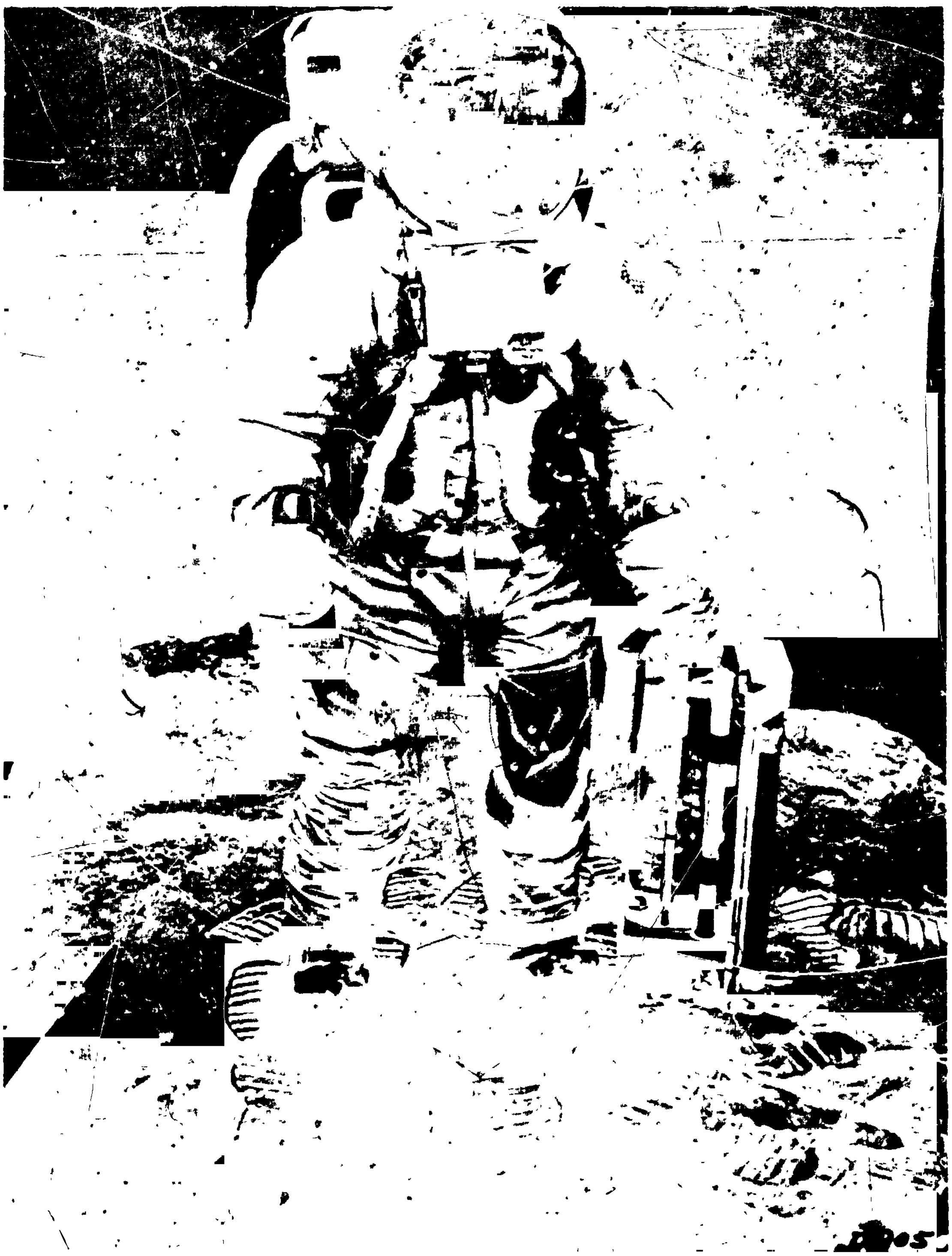


Fig. V-5 ALSD Transport Mode

Fig. V-6 ALHT Carrier, Core Stems, Caps,
2nd Wrench, and ALSD Package

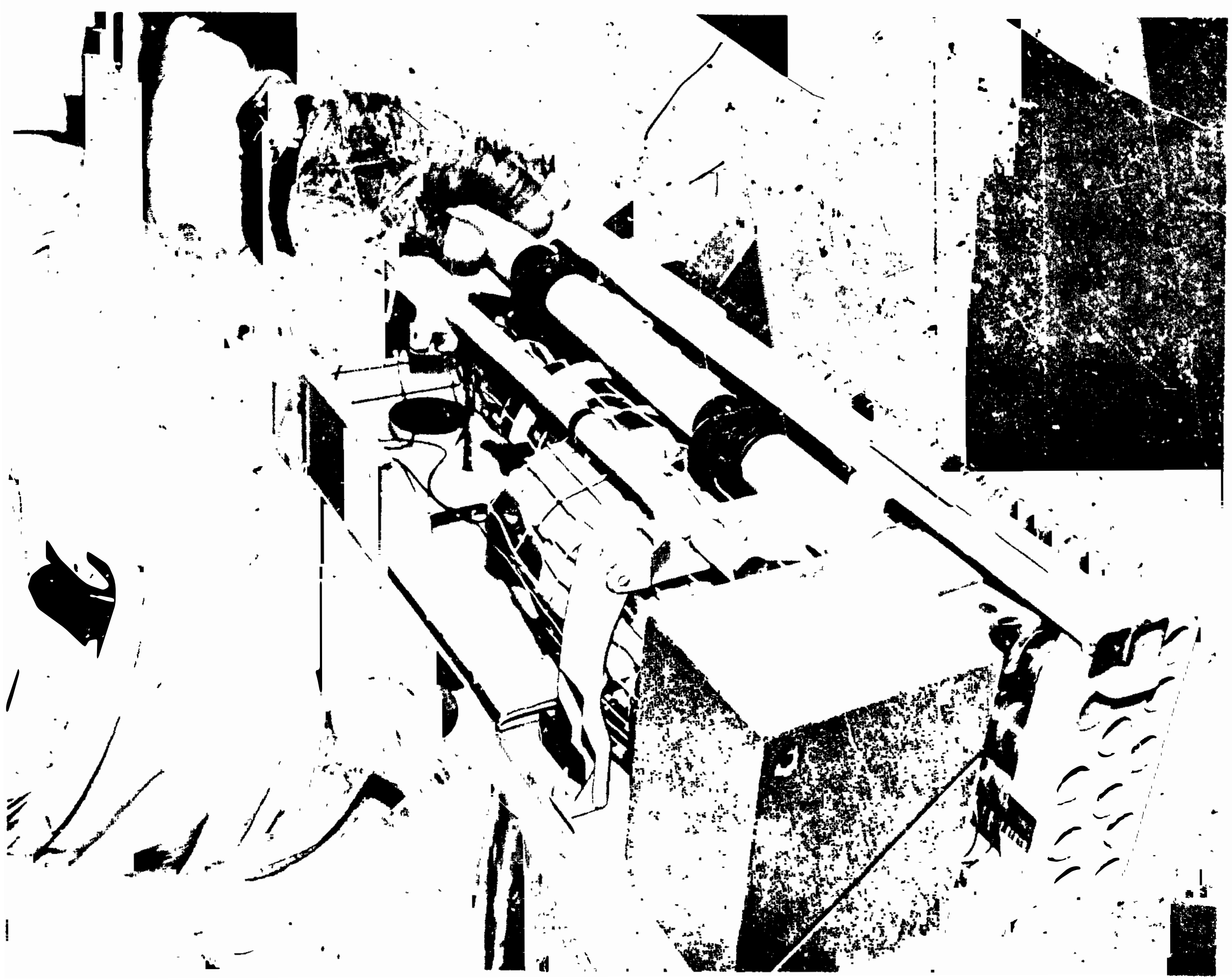


Fig. V-7 ALSD Treadle Velcro Strap Release Tab

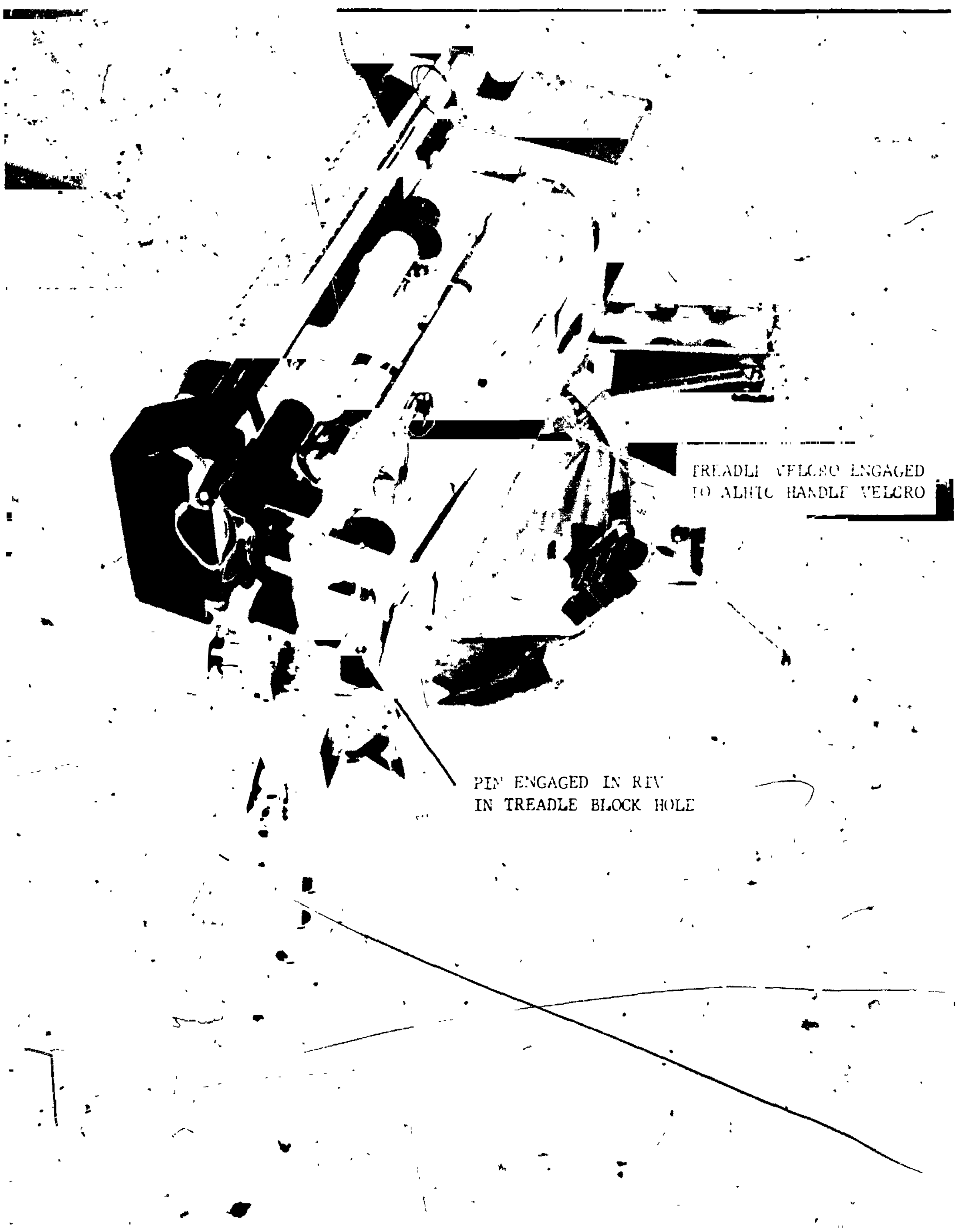


Fig. V-8 ALSD Placed on ALHTC

Fig. V-9 Power Head Operation Check

Fig. V-10 Bore Stem Cover Retention Pin Removal

Fig. V-11 Rack Support Pin Removal

Fig. V-12 Rack Camloc Release

Fig. V-13 Battery Camloc Release

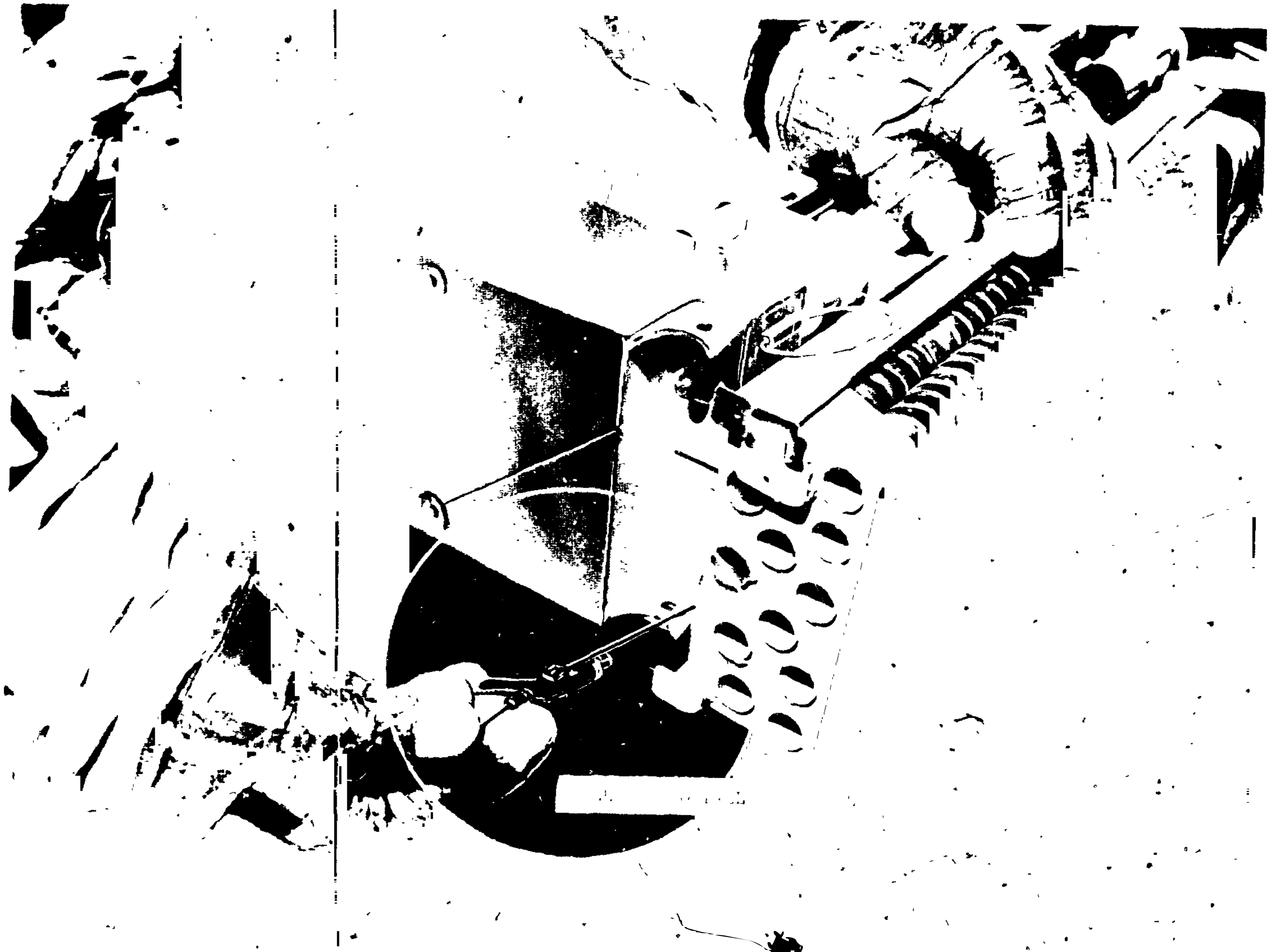


Fig. V-14 Battery Camloc and Rack Support Pin No. 2 Removal

Fig. V-15 Leg No. 1 Release From Stowage Clip

Fig. V-16 Leg No. 1 Extension to Locked Position

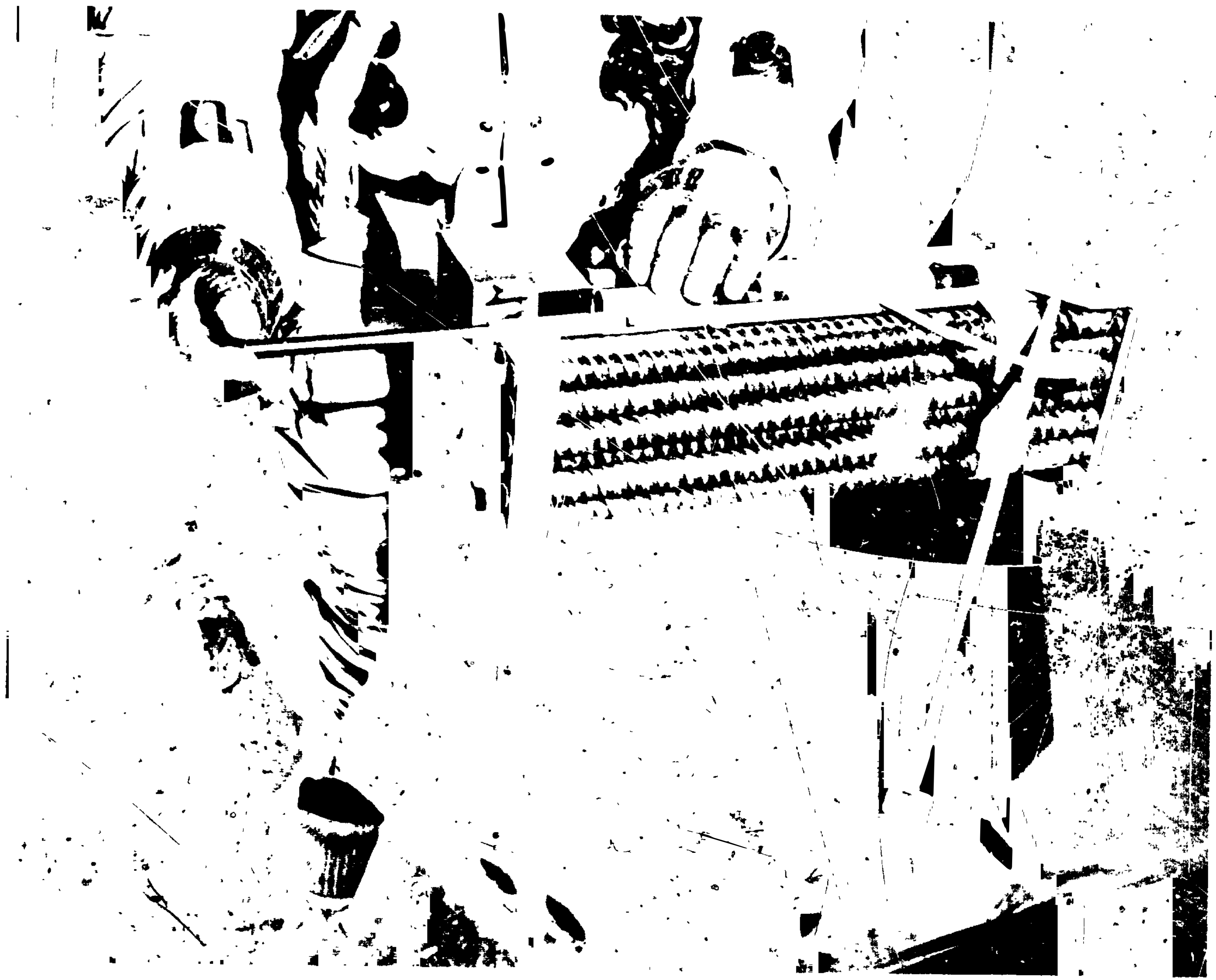


Fig. V-17 Leg No. 2 Extension to Locked Position

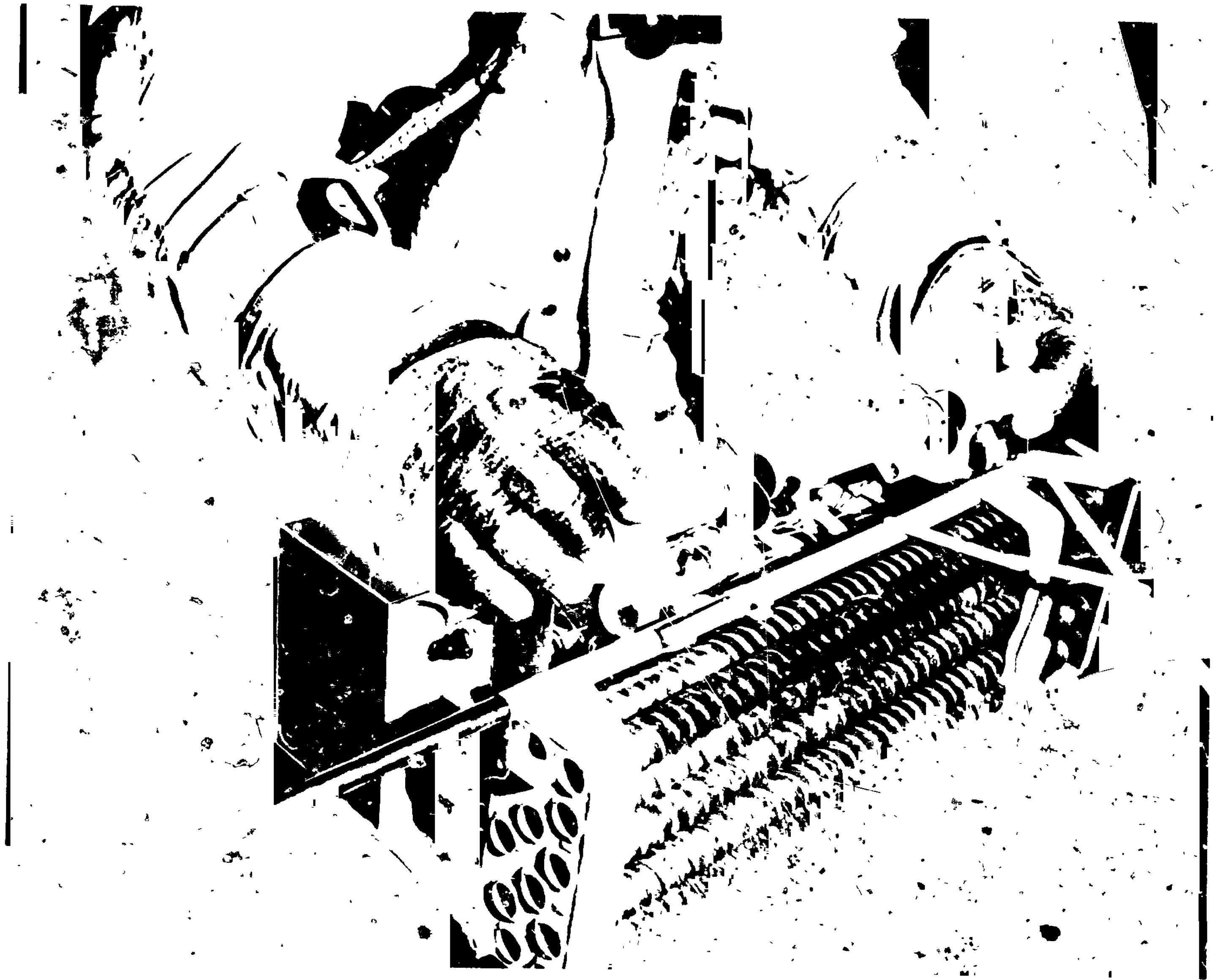


Fig. V-18 Handle Removal From Stowage Clips

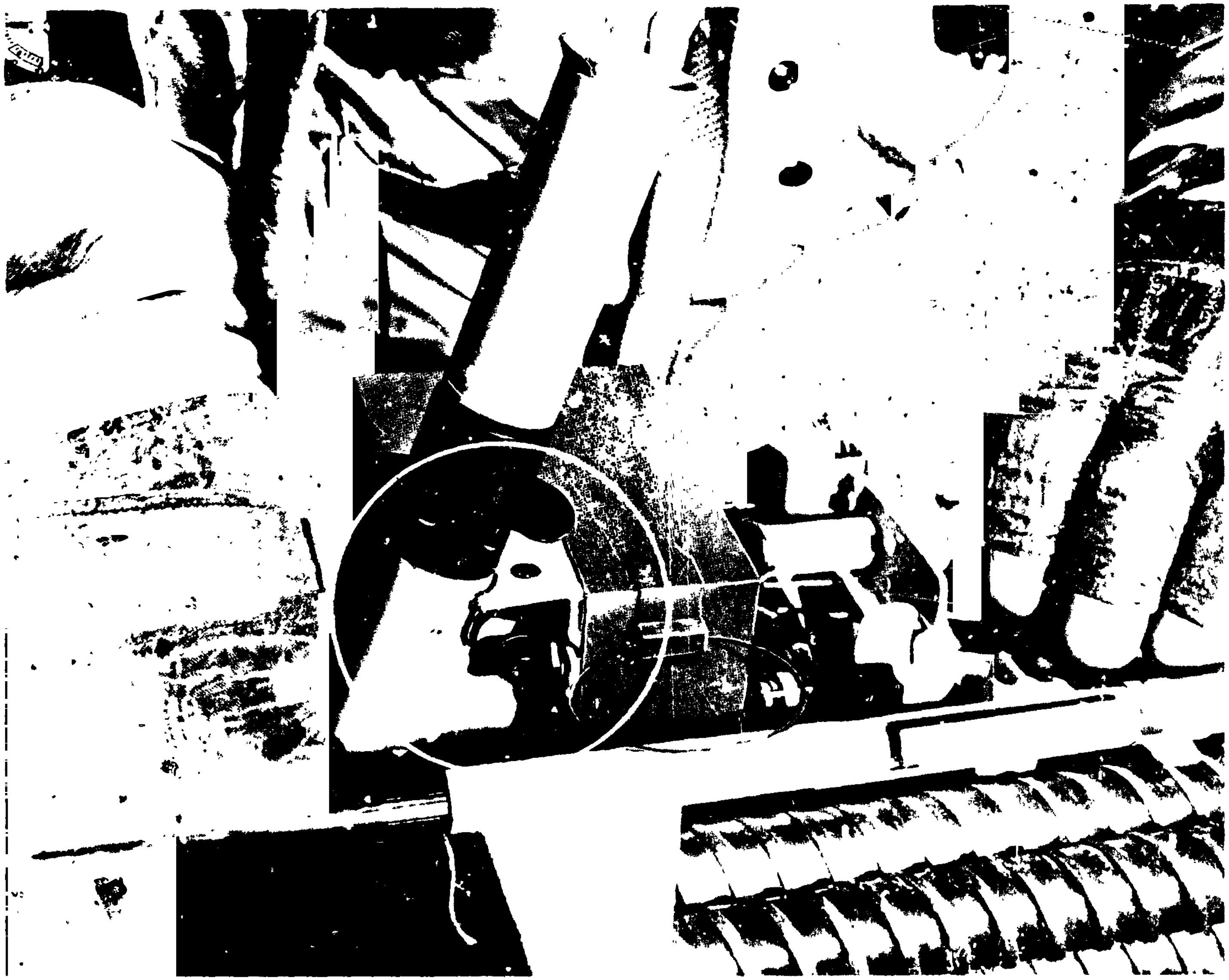


Fig. V-19 Handle Fixed Lock Pin Into Battery Receptacle

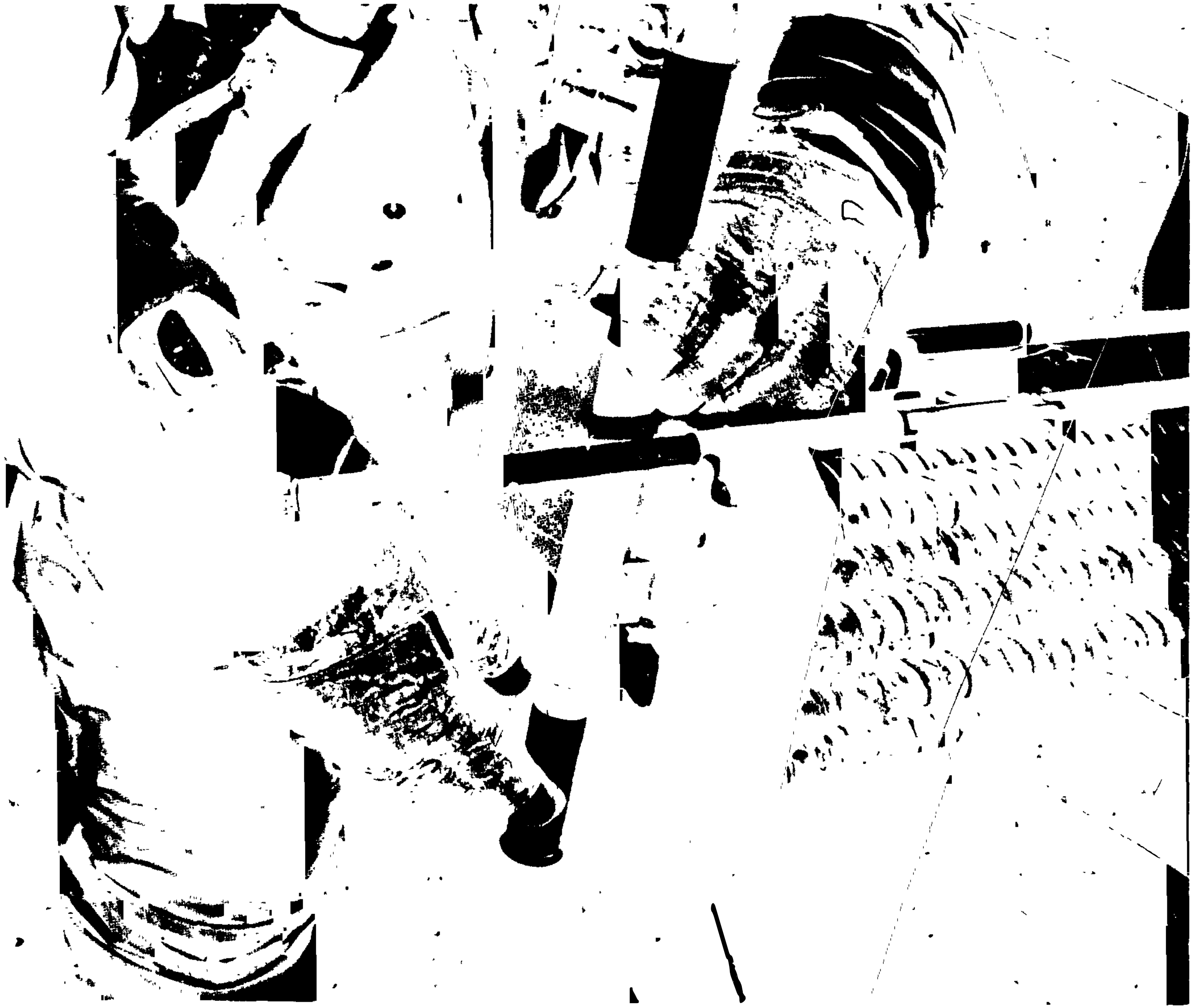


Fig. V-20 Handle Position Prior to Slapping Spring-Loaded Lock Pin Into Position

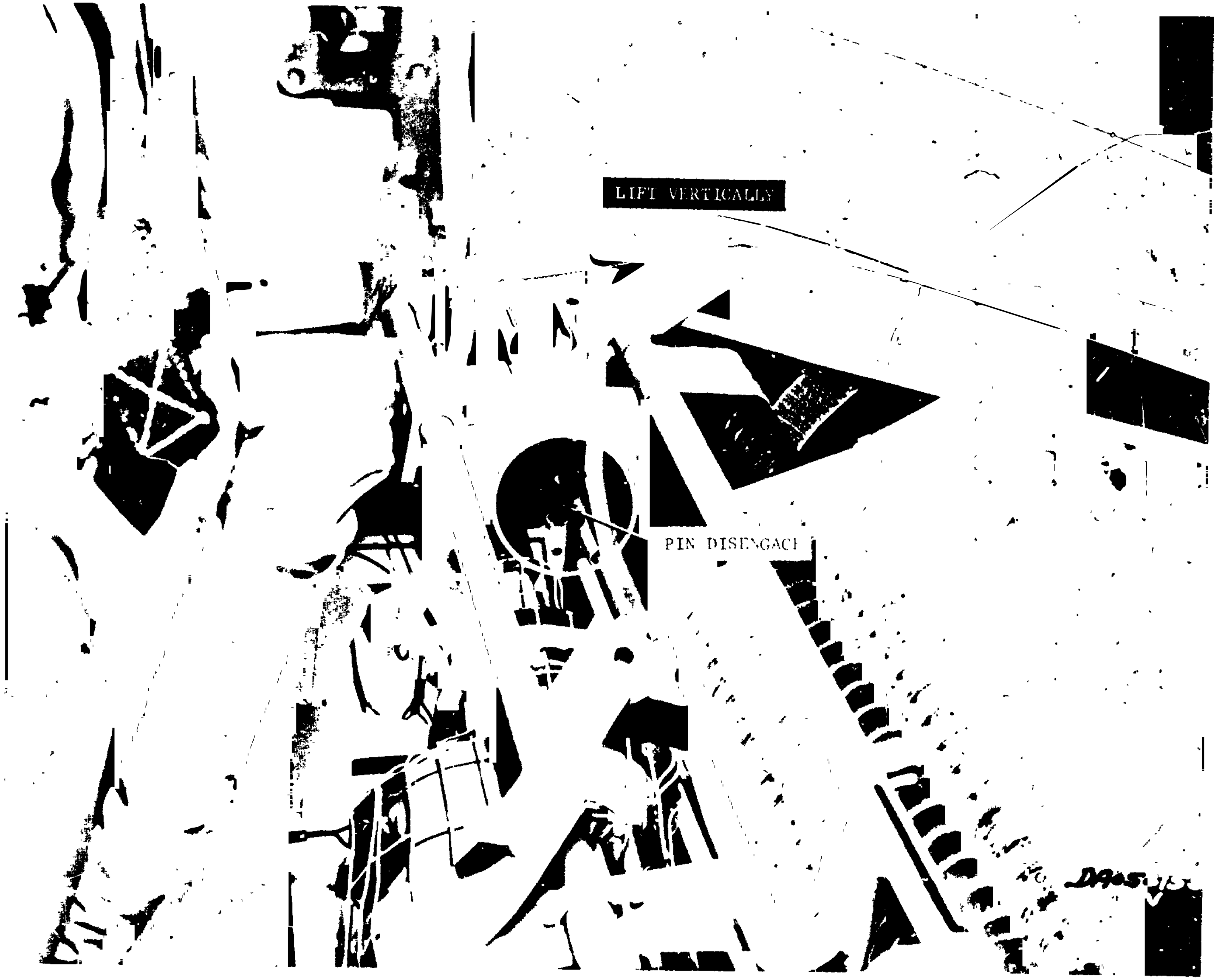


Fig. V-21 Rack Removal From Treadle

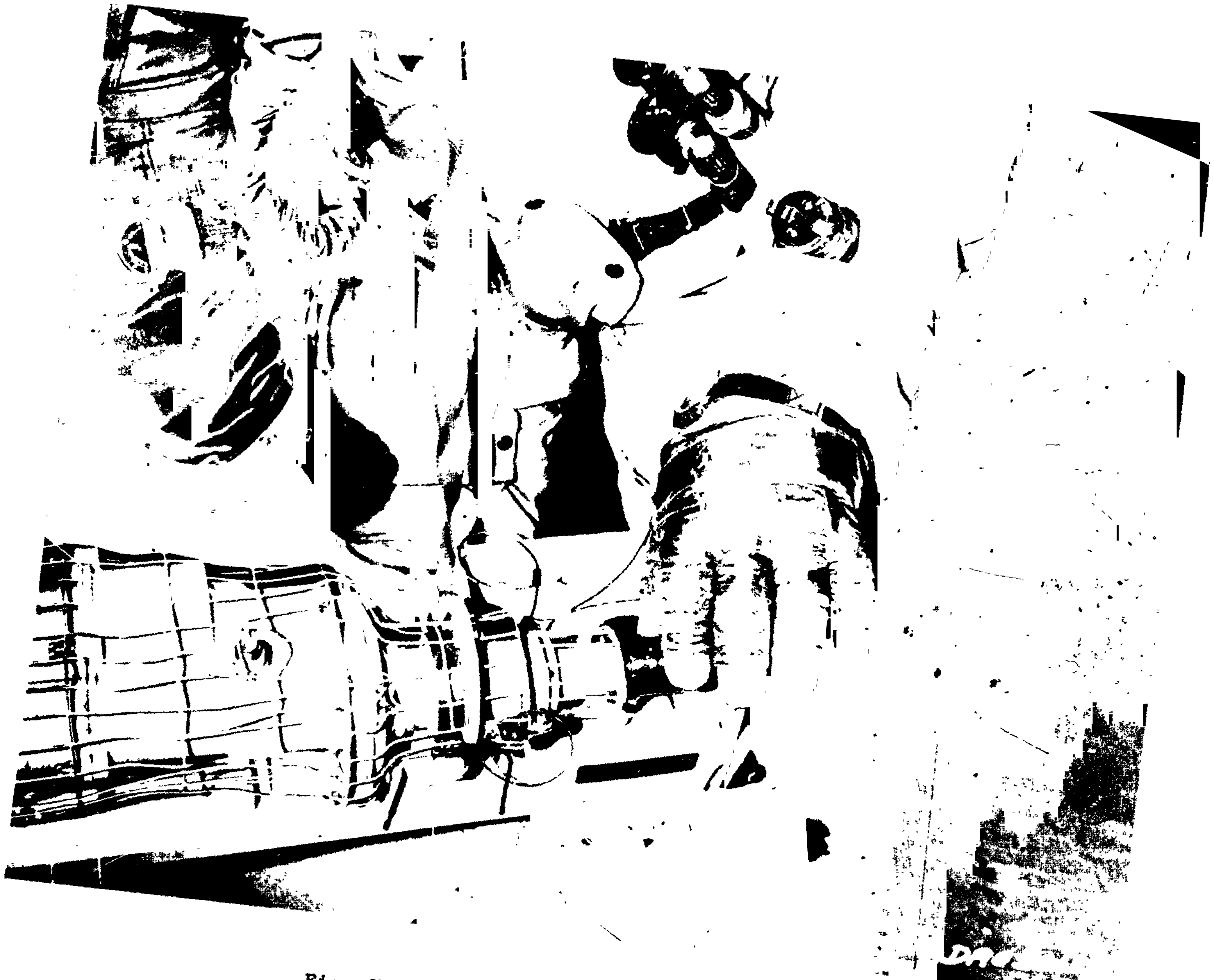


Fig. V-22 Adapter Reset

Fig. V-23 Power Head Retention Bracket Pin Removal

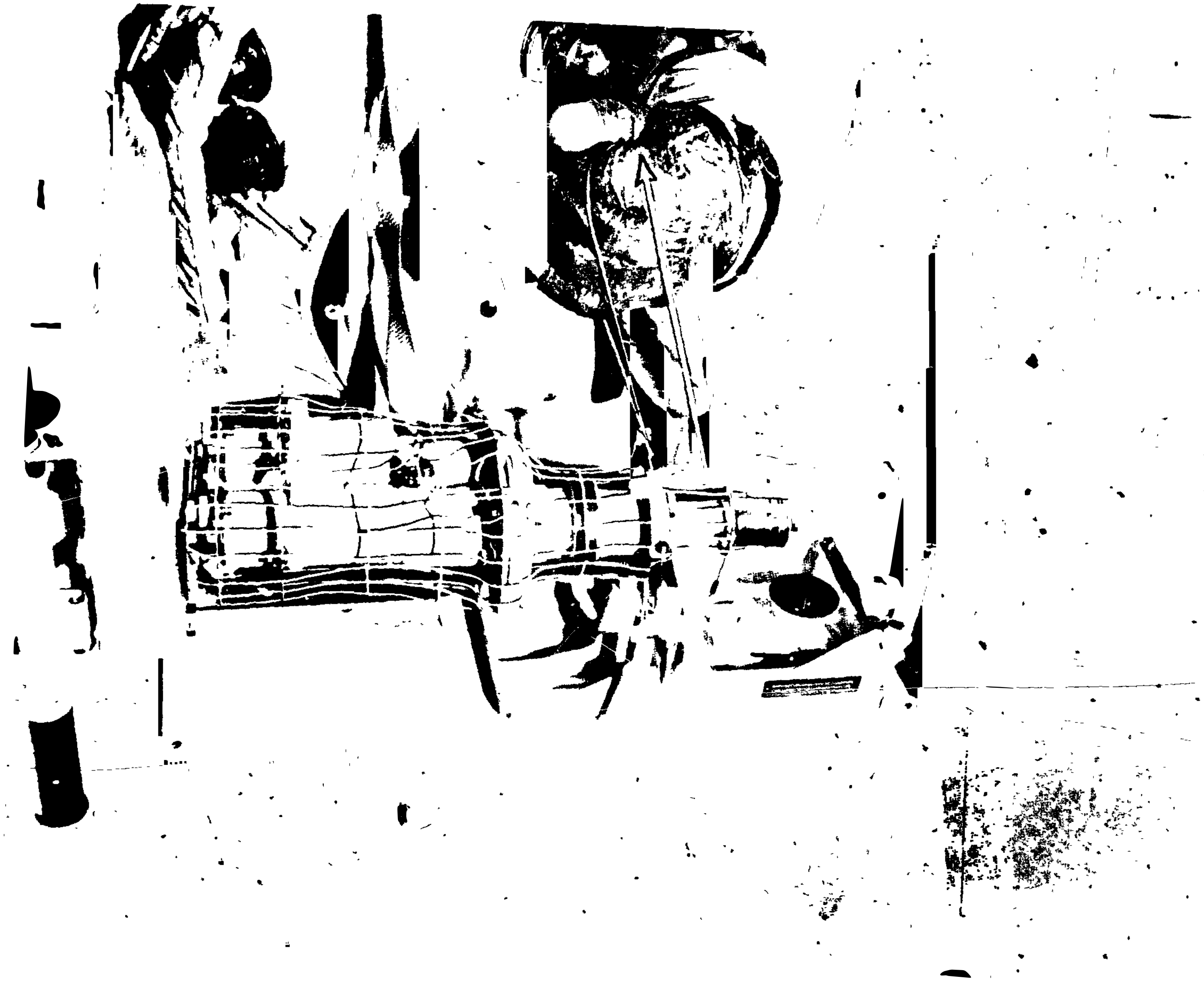


Fig. V-24 Power Head and Battery Assembly Removal From Treadle

Fig. V-25 Rack and Power Head Assembly on Surface

Fig. V-26 Bore Stem Cover Removal

Fig. V-27 Bore Stem Retention Strap Release

Fig. V-28 Bit Bore Stem Rèmcval From Rack

Fig. V-29 Bore Stems Fitted to Power Head Assembly

Fig. V-30 Thermal Shroud Removal

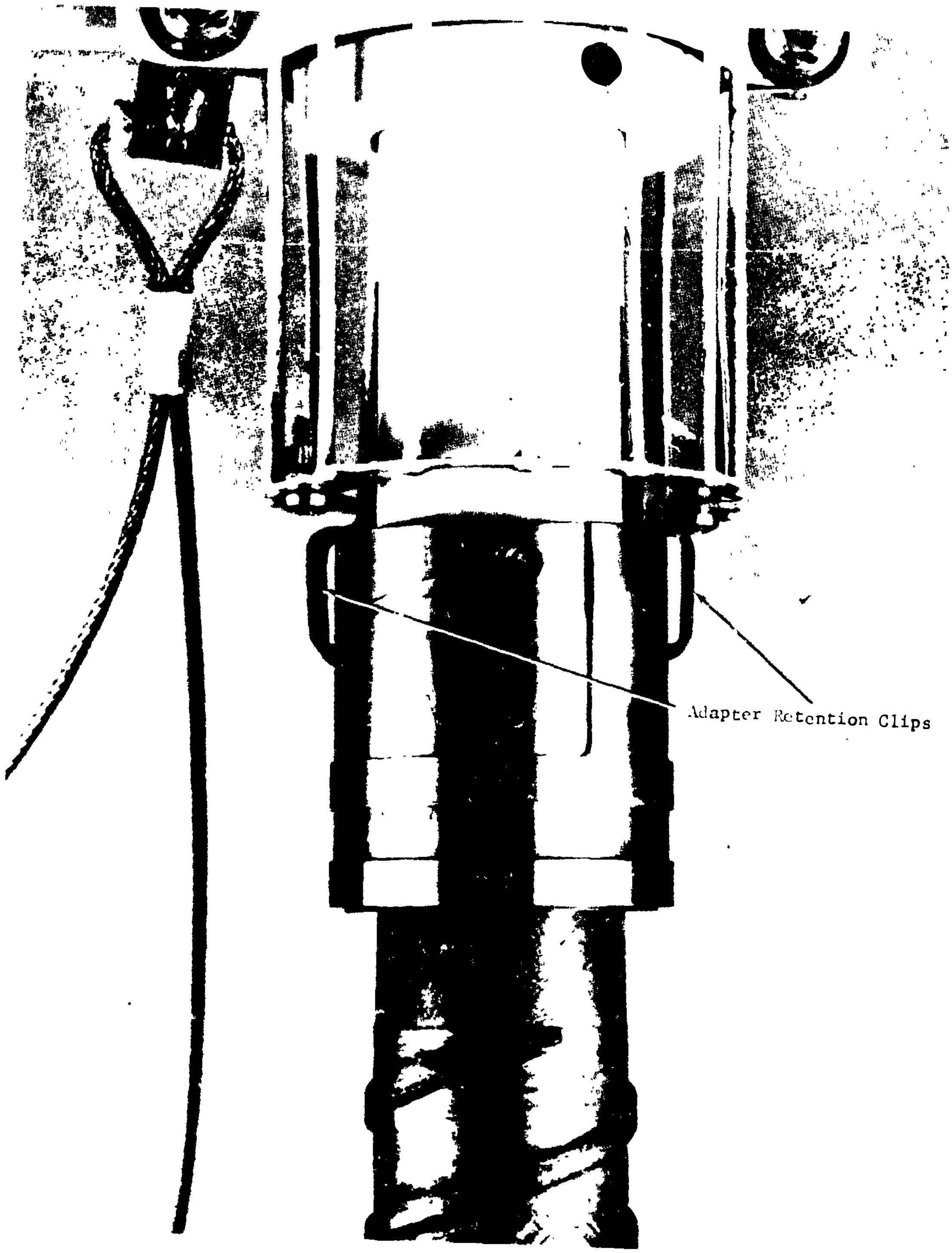


Fig. V-31 Adapter Driving Mode

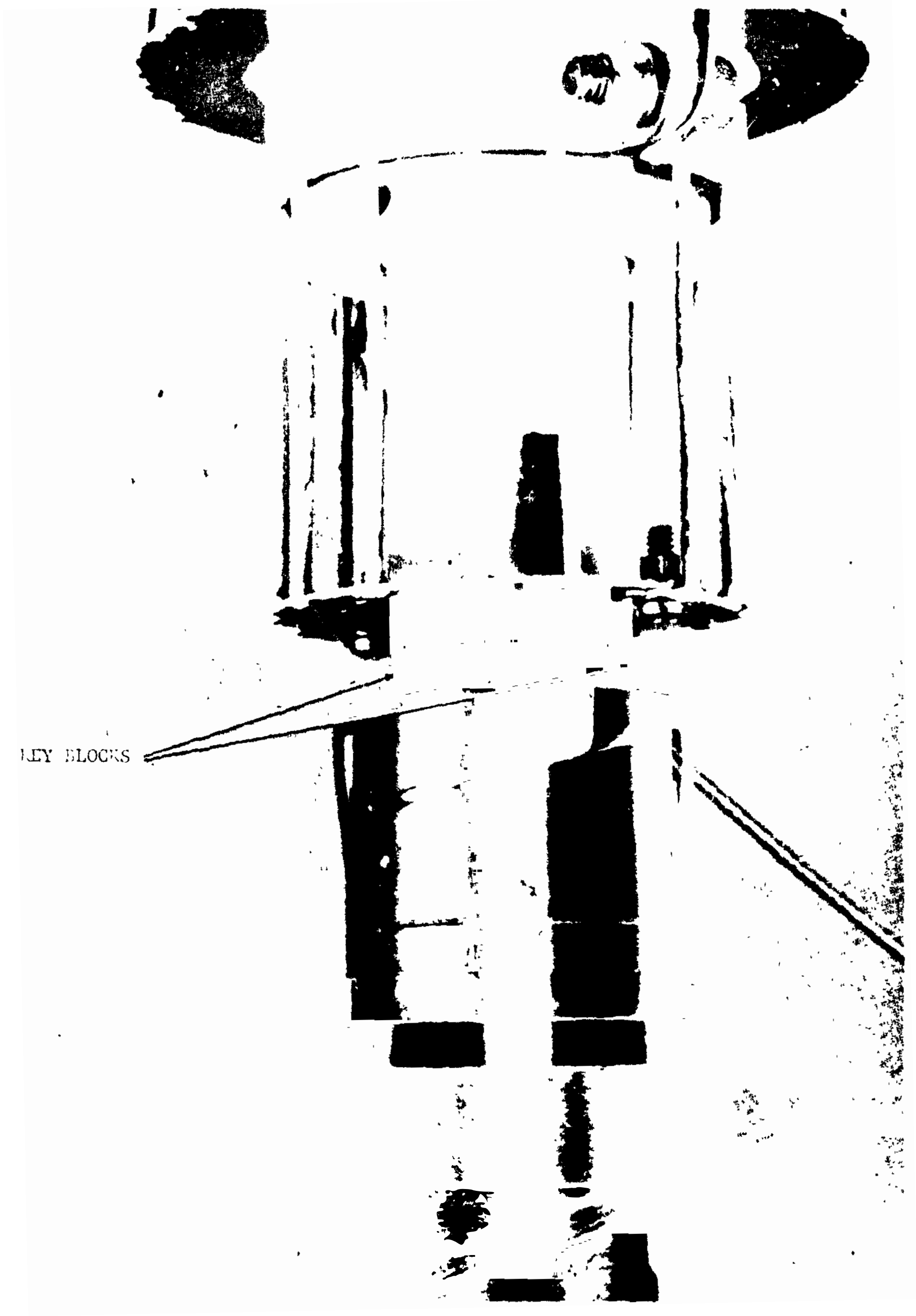


Fig. V-32 Adapter Spring-Load^d Key Block Release

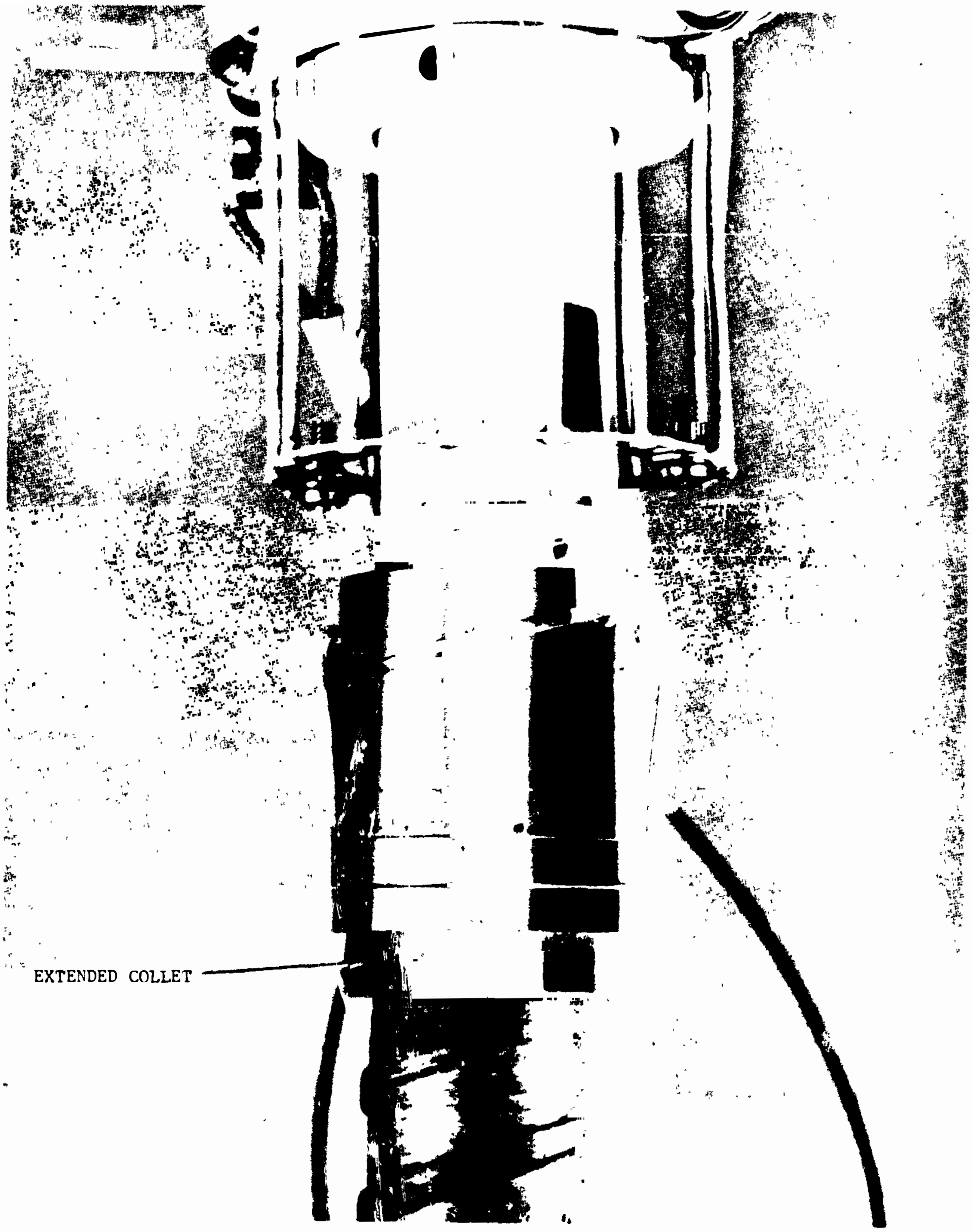


Fig. V-33 Adapter Release Mode

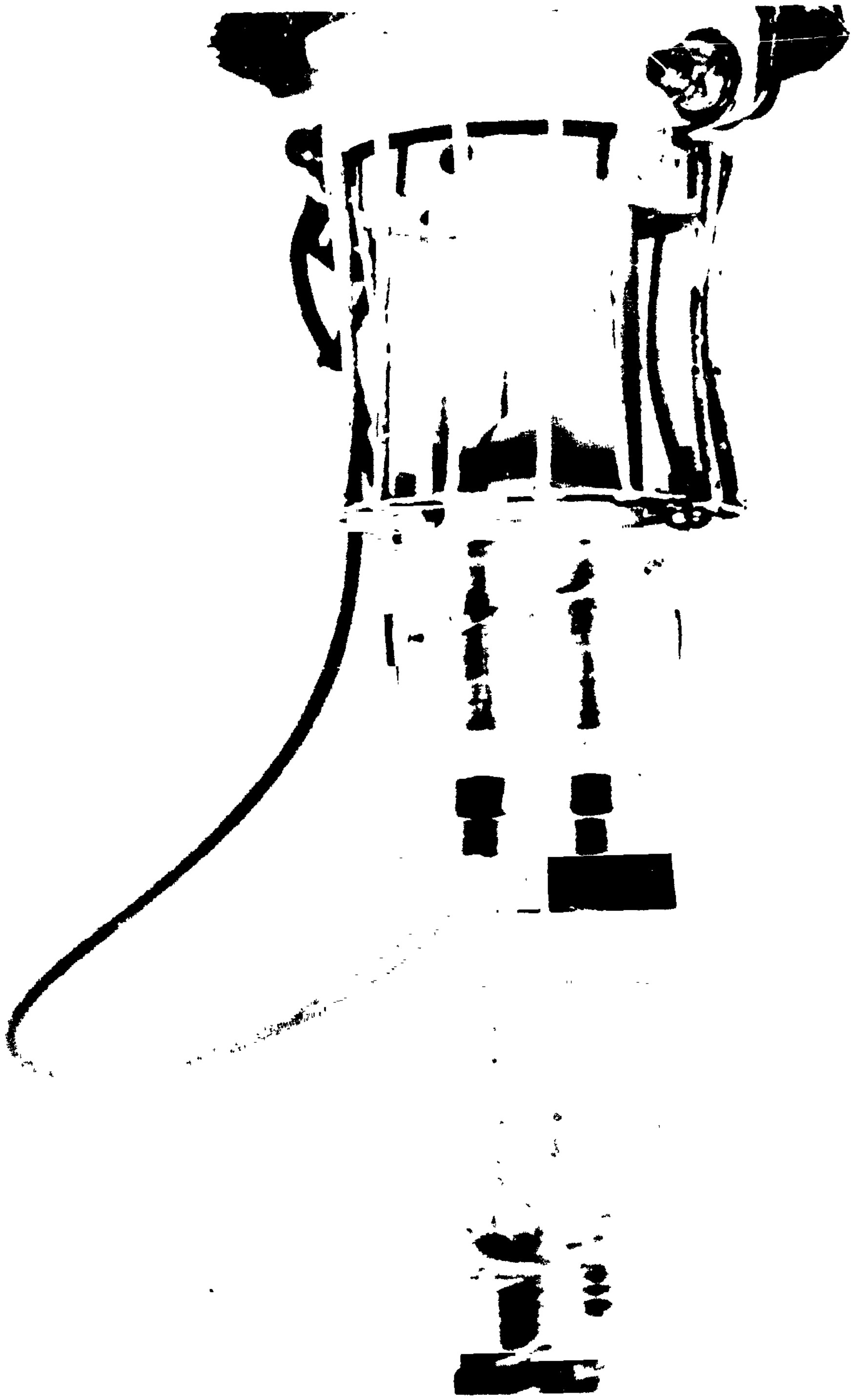


Fig. V-34 Stem Release

Fig. V-35 Adapter Release Contingency

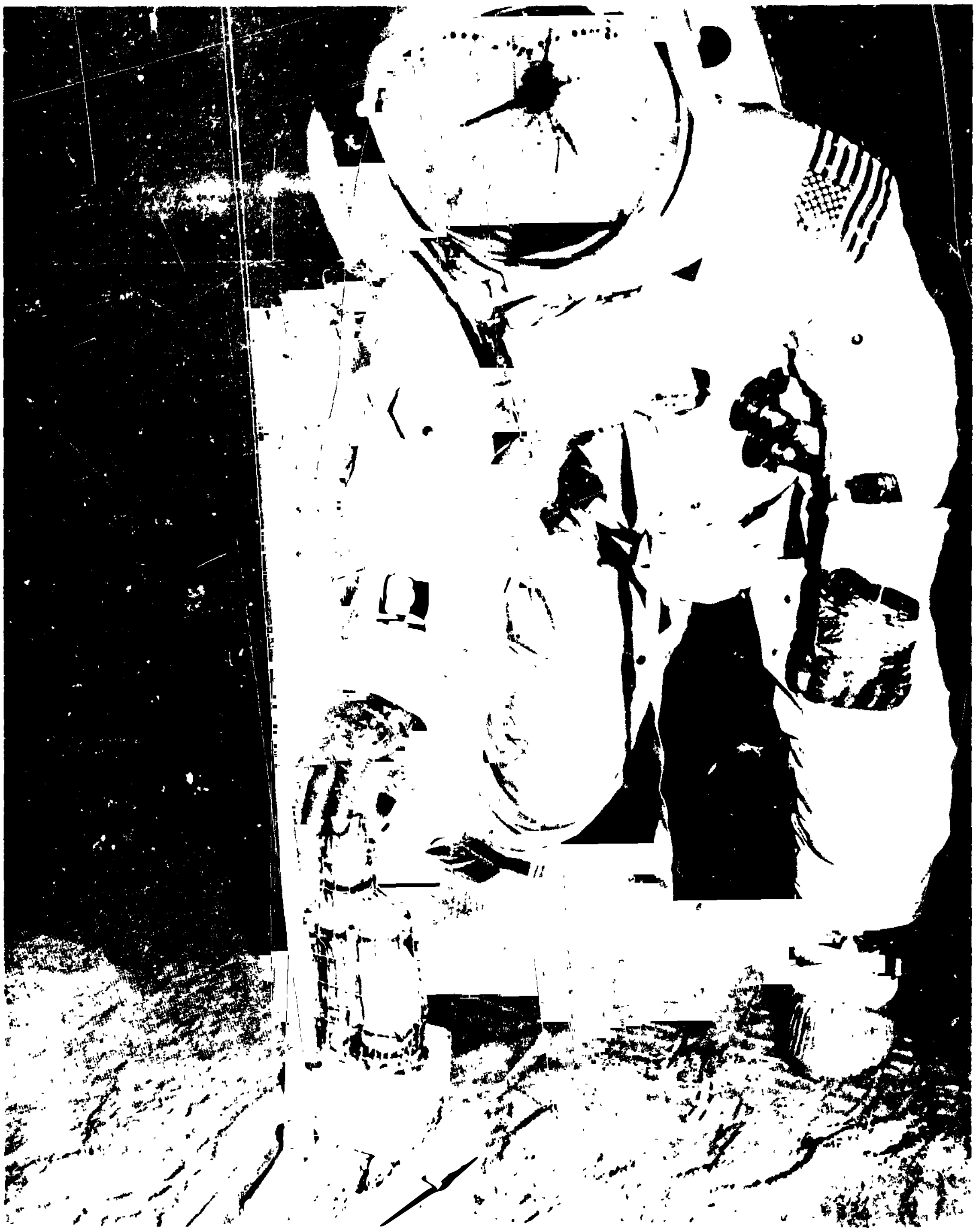


Fig. V-36 Resetting Collec

Fig. V-37 Rethreading Adapter into Spindle

Fig. V-38 Resetting Collet (Alternate Method)

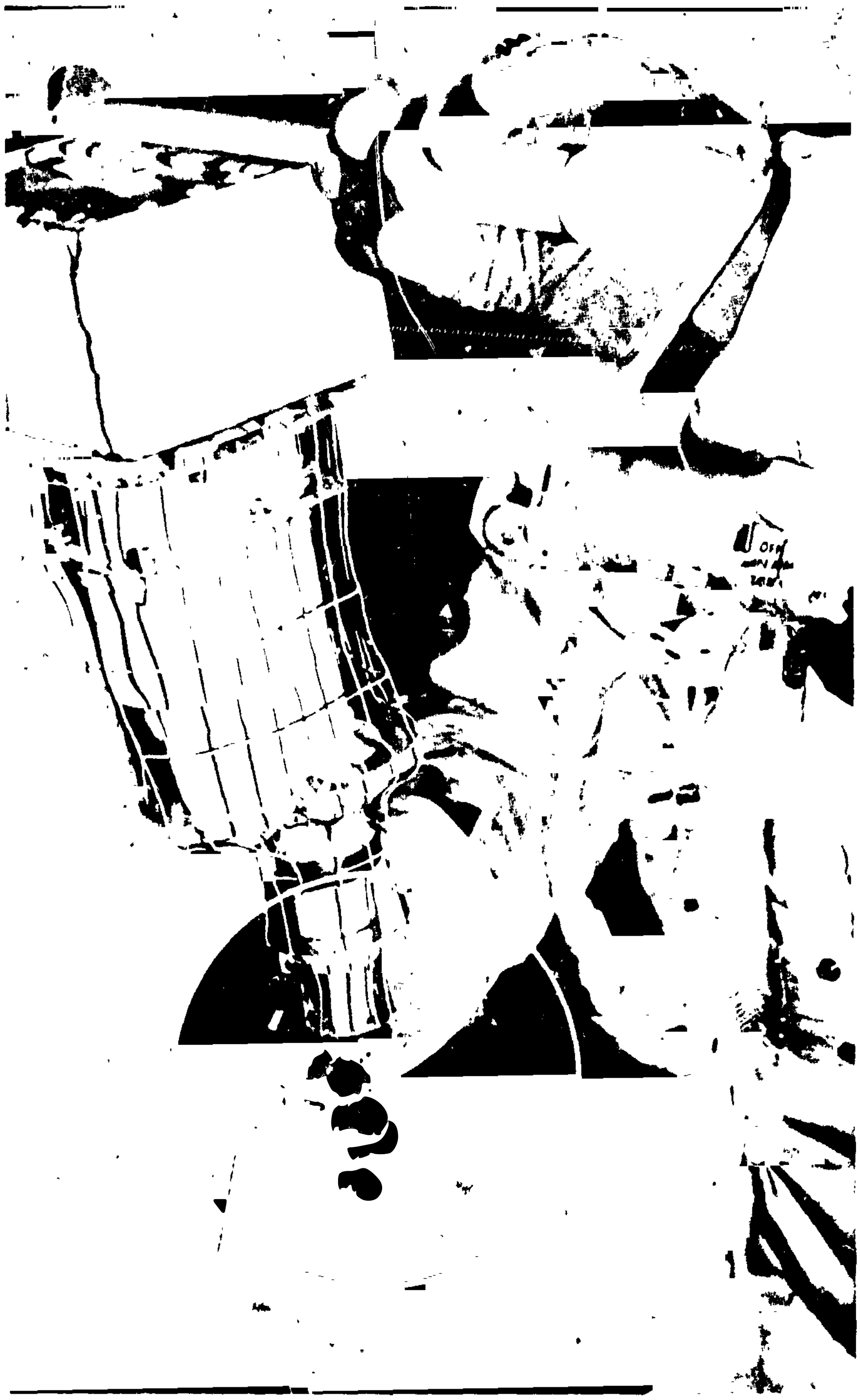


Fig. V-39 Rethreading Adapter into Spindle (Alternate Method 1)

Fig. V-40 Rethreading Adapter Into Spindle (Alternate Method 2)

Fig. V-41 Addition of Bore Stem

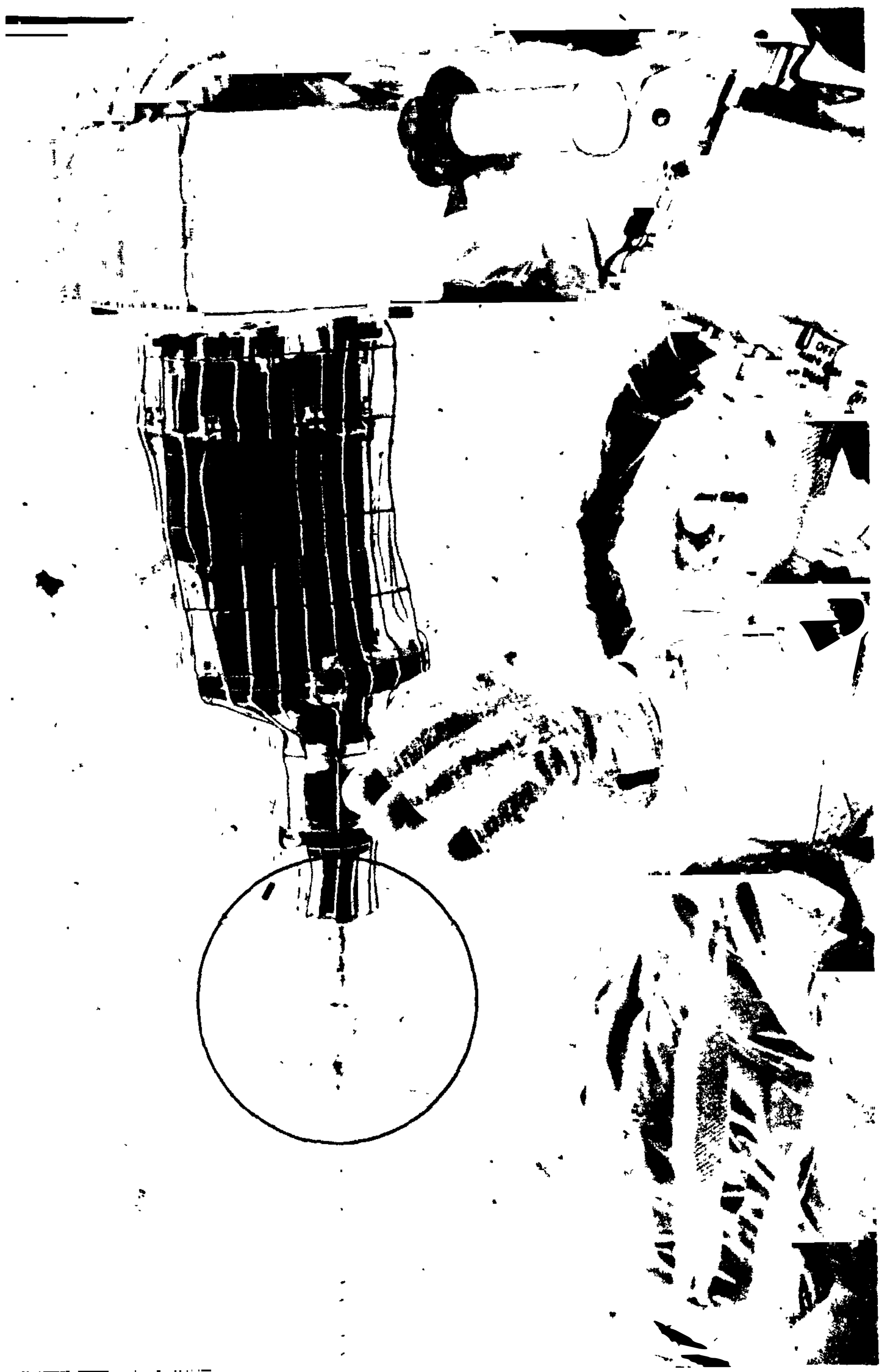


Fig. V-42 Fitting of Power Head to Bore Stem

2.1.2 Hole Coring

1) Remove adapter from power head spindle using any of the following procedures:

   a) With power head on surface, grasp adapter and rotate counterclockwise until free of spindle (Figure V-43).

   b) With power head on surface, insert slotted end of wrench into adapter (Figure V-44). Rotate wrench until slots engage mating key in adapter. Grasping wrench by jaws, rotate counterclockwise until adapter is free of spindle.

   c) Hold power head with either hand. Insert wrench and proceed as in b) above (Figure V-45).

   d) When ALHTC is brought to coring site, use treadle as a working platform to perform removal task per a) and b) above.

2) Discard adapter, making certain that it is at least 6 feet from the heat flow probe.

3) Return to the HFE site. Transport ALHTC to a position between 6 and 9 feet east of the 2nd heat flow probe. Avoid cable from HFE site to probe.

4) Return to 2nd heat flow probe site. Pick up rack and power head. Transport them to ALHTC location (Figure V-46). Make certain all equipment is greater than 6 feet from 2nd heat flow probe. While in vicinity of heat flow probe, be careful not to contact probe or cable.

5) Disengage treadle velcro from ALHTC arm velcro. Fold velcro, engage and place on treadle.

6) Remove treadle from ALHTC, rotate power head retention bracket to closed position. Drop treadle on surface in desired coring spot.

7) Remove wrench from rack and stow on ALHTC.*

8) Remove core stem with bit from ALHTC sample bag.

9) Remove another core stem and couple to bit stem.* Bring stems together such that initial contact is at an approximate 45°

* Contingency Instruction

angle. Rotate into alignment and gently engage threads. Gently rotate until threads are fully engaged.

10) Thread this double core stem section into power head spindle (Figures V-47 and V-48).* Use same technique as for coupling core stems.

11) Lift and rotate power head assembly. Place core bit into treadle pilot while rotating power head clockwise until bit drops through lock.*

12) Place a foot on treadle to stabilize it. Make certain treadle is reasonably level. Check verticality of core stems. Energize power head. Drill to lower handle height limit (Figure V-49).

13) Keeping foot on treadle, rotate power head counterclockwise one and one-half turns and lift to disengage power head from core stem.*

14) Place power head on surface.

15) Remove two more core stems from sample bag and couple.

16) Thread this double core stem section into stem protruding from surface (Figure V-50).

17) Lift power head and fit to core stem. Initial contact to be about 45°. Rotate to vertical and gently rotate clockwise to engage threads. Continue rotating clockwise until threads are fully engaged (about 1-1/2 turns)* (Figure V-51).

18) Repeat procedures 12) through 17). Drill to lower handle operating limit (Figure V-51a).

19) Rotate power head clockwise and then lift and continue rotating power head clockwise. When handle is approximately at waist height, shift hands to under side of handle (Figure V-52). Continue rotating power head clockwise and lifting until two stems clear treadle pilot. Use visual cues on stems as described in Chapter III. Do not energize power head unless retraction cannot accomplished manually. During this event keep treadle flat on surface.

20) Remove wrench from ALHTC. Place foot on treadle. Engage wrench on first stem below power head (Figure V-53). Hold

* Contingency Instruction

wrench in one hand and rotate power head counterclockwise 1-1/2 turns and lift vertically free of core stem. Place power head on surface. Return wrench to ALHTC or treadle handle.

21) Remove core stem cap retainer assembly containing eight caps from ALHTC. Caps come off square end of retainer assembly. Cap the open core stem (Figure V-54). Return cap retainer assembly to ALHTC.

22) Remove wrench from ALHTC. Place foot on treadle. Make certain treadle is flat on surface. Rotate top core stem counterclockwise one-quarter turn to loosen joint (Figure V-55).

23) Rotate core stem string clockwise. It may be necessary to use wrench to loosen treadle lock. Continue rotating core stem string clockwise and simultaneously lift vertically until another stem is withdrawn.

24) With wrench rotate second stem from top counterclockwise one-quarter turn to loosen joint.

25) Repeat steps 23) and 24) until last stem joint is loosened. Replace wrench on ALHTC. Remove first set of core stem caps (7 remaining).

26) Completely withdraw core stem string (Figure V-56). Cap core stem bit (Figure V-57).

27) Lean core stem string against ALHTC or rack with bit end on surface (Figure V-58).

28) Separate stems one at a time (Figure V-59). Cap ends in sequence (Figure V-60). After first four stems are capped on both ends, remove second core stem cap retainer assembly from ALHTC. It contains only four caps and has a number 2 cut into the tapered end. Place capped stems in ALHTC sample bag (Figure V-61) as they are capped.

29) Make certain all items to be left at core site are at least 6 feet from the heat flow probe.

30) Return to LM and place capped core stems in a Sample Return Container.

Fig. V-43 Adapter Removal

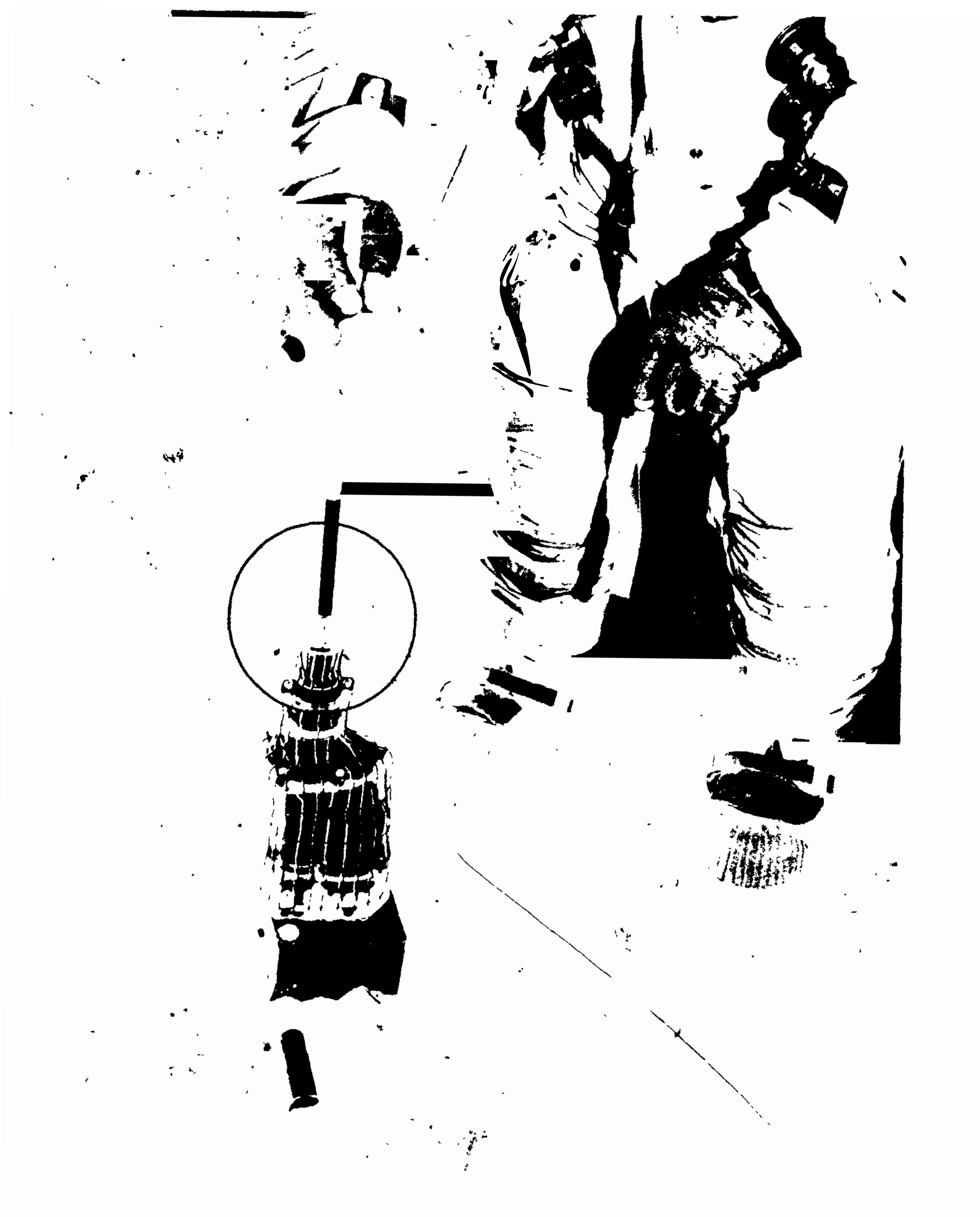


Fig. V-44 Adapter Removal (Alternate Method 1)

Fig. V-45 Adapter Removal (Alternate Method 2)

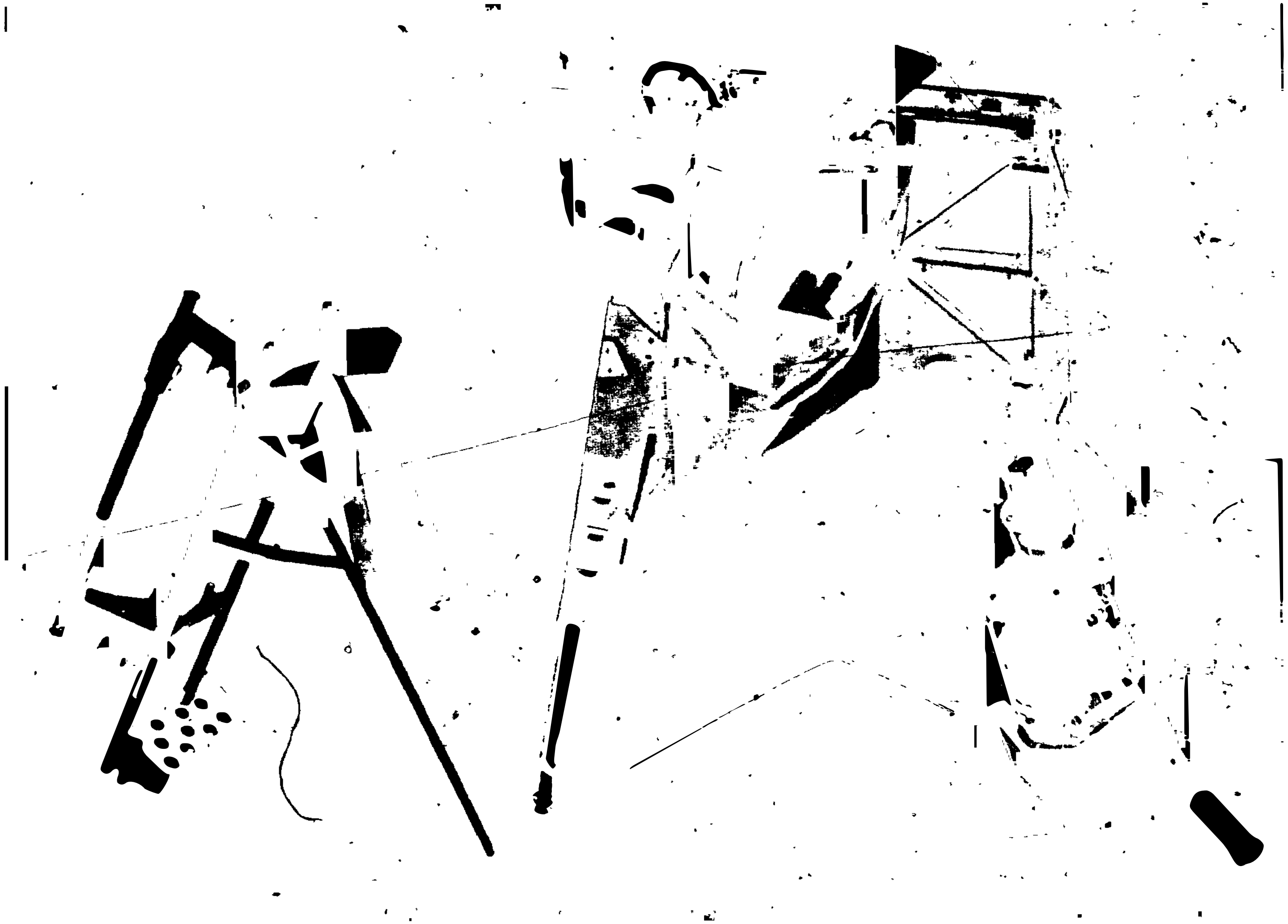


Fig. V-46 Power Head, Rack, ALHTC on Surface at Coring Site

Fig. V-47 Threading Core Stems Into Spindle

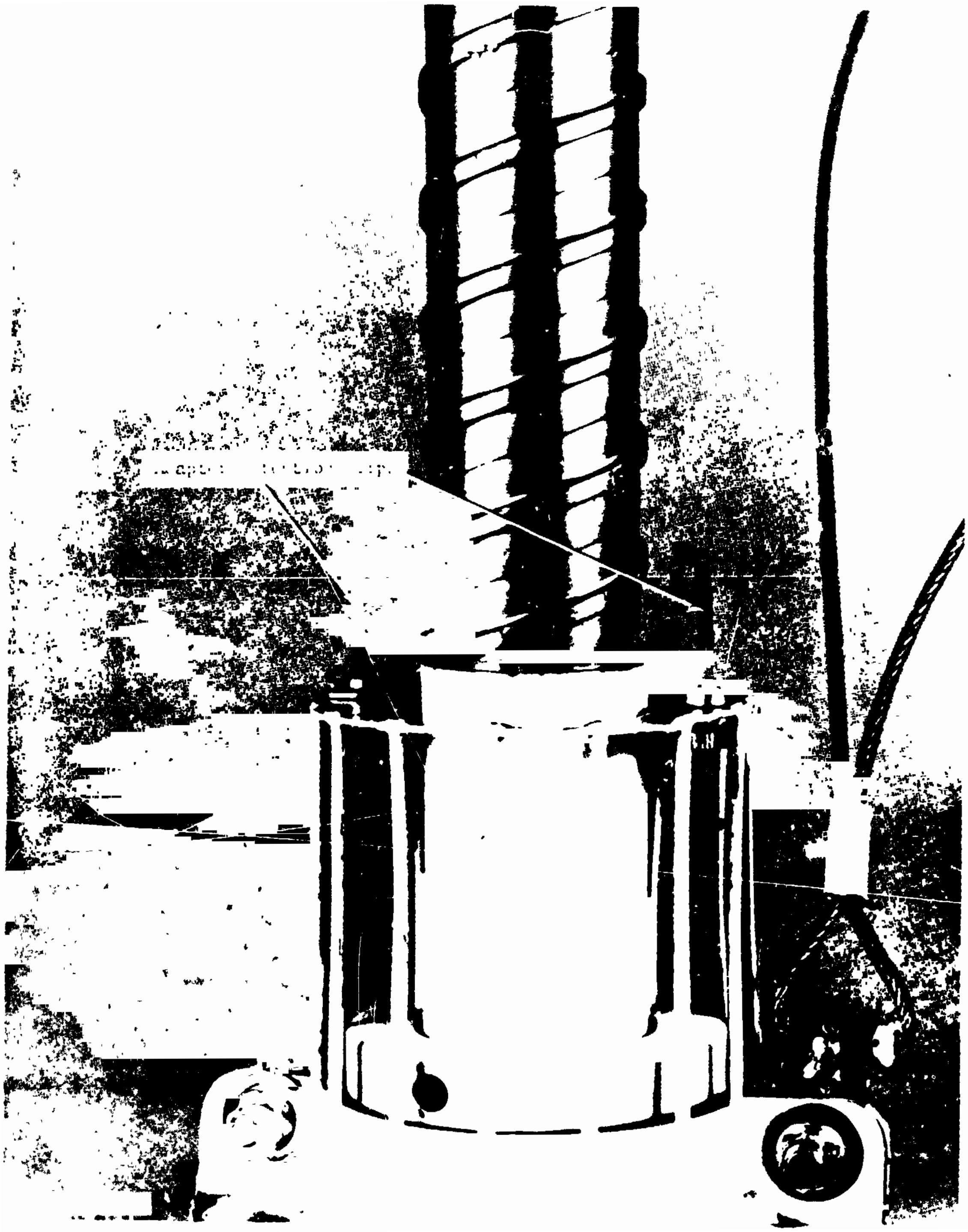


Fig. V-48 Core Stem Threaded Into Spindle

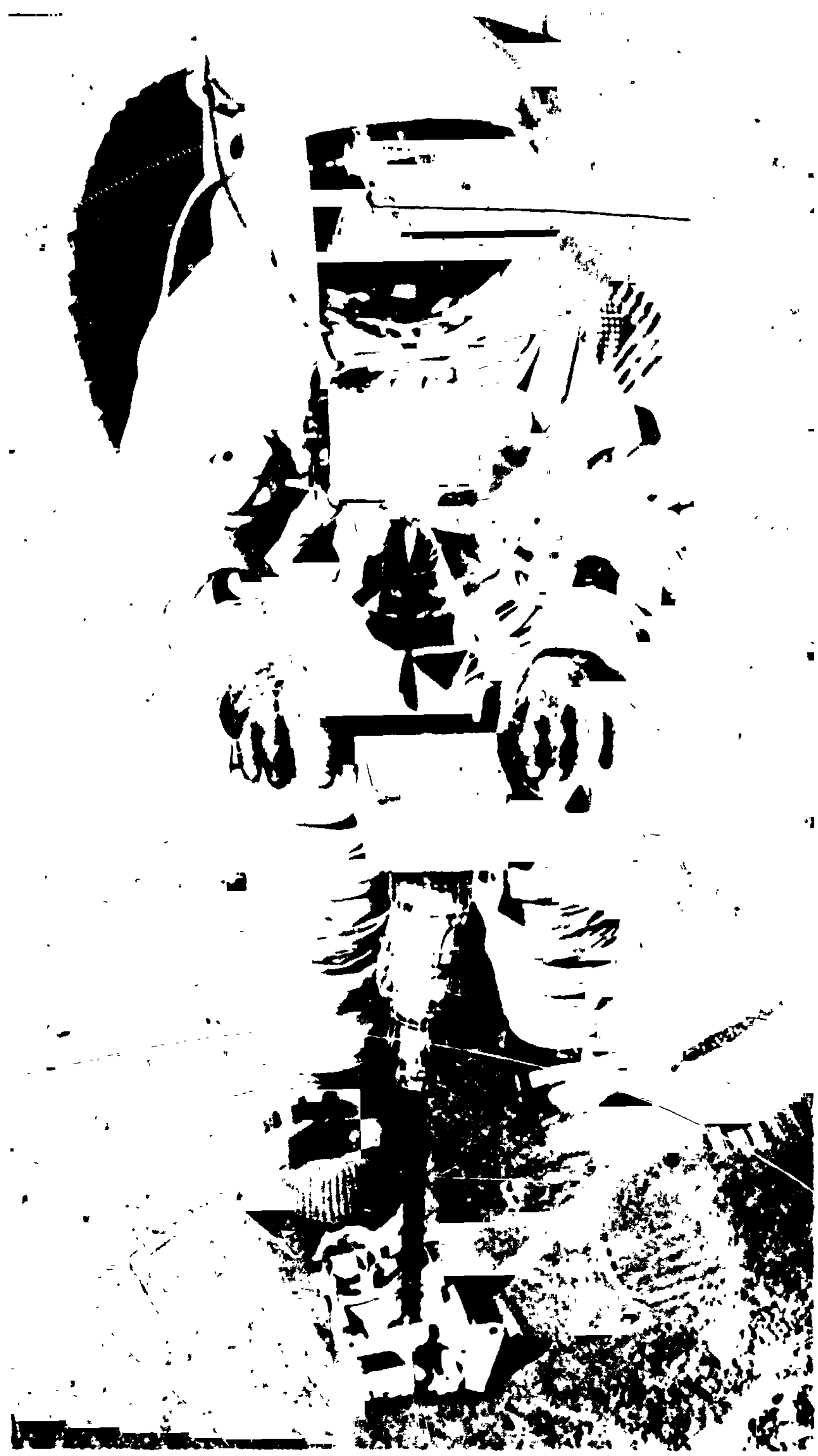


Fig. V-49 Emplacing First Two Core Stems

Fig. V-59 Addition of Two Core Stems

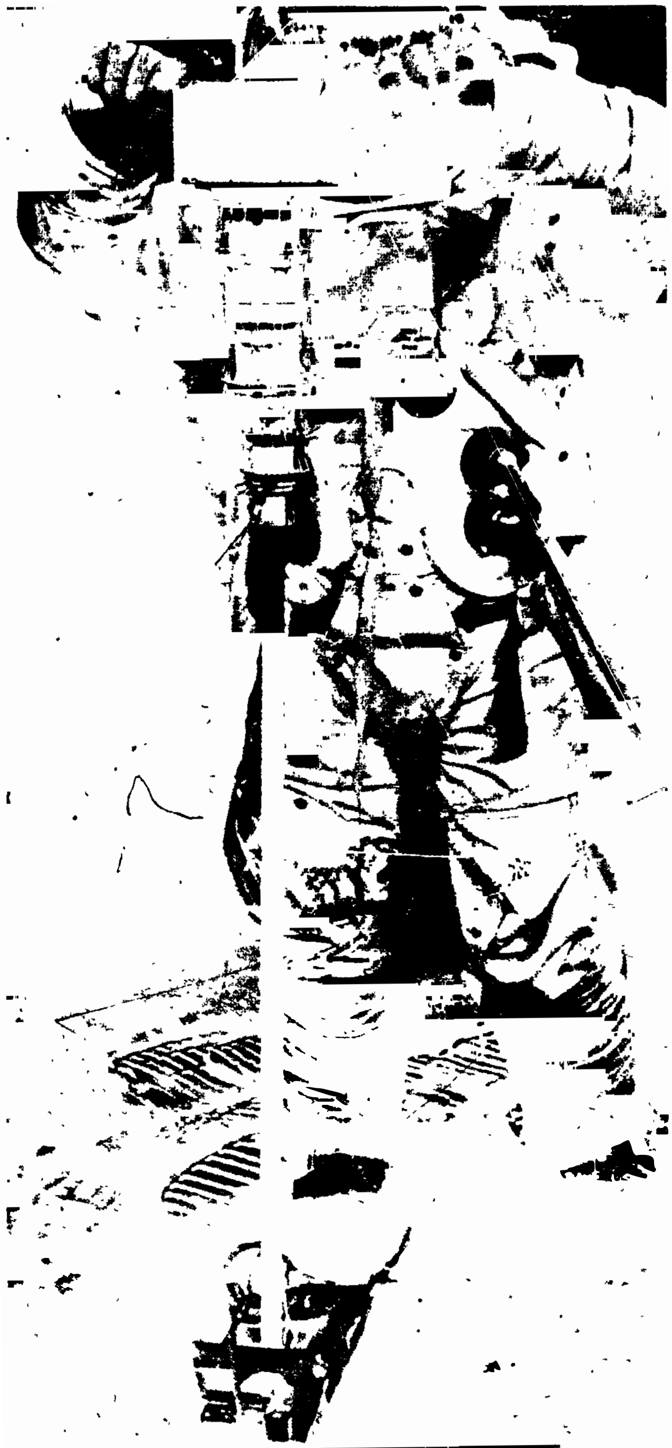


Fig. V-51 Threading of Power Head to Stem

Fig. V-51a Emplacing of Last Two Core Stems

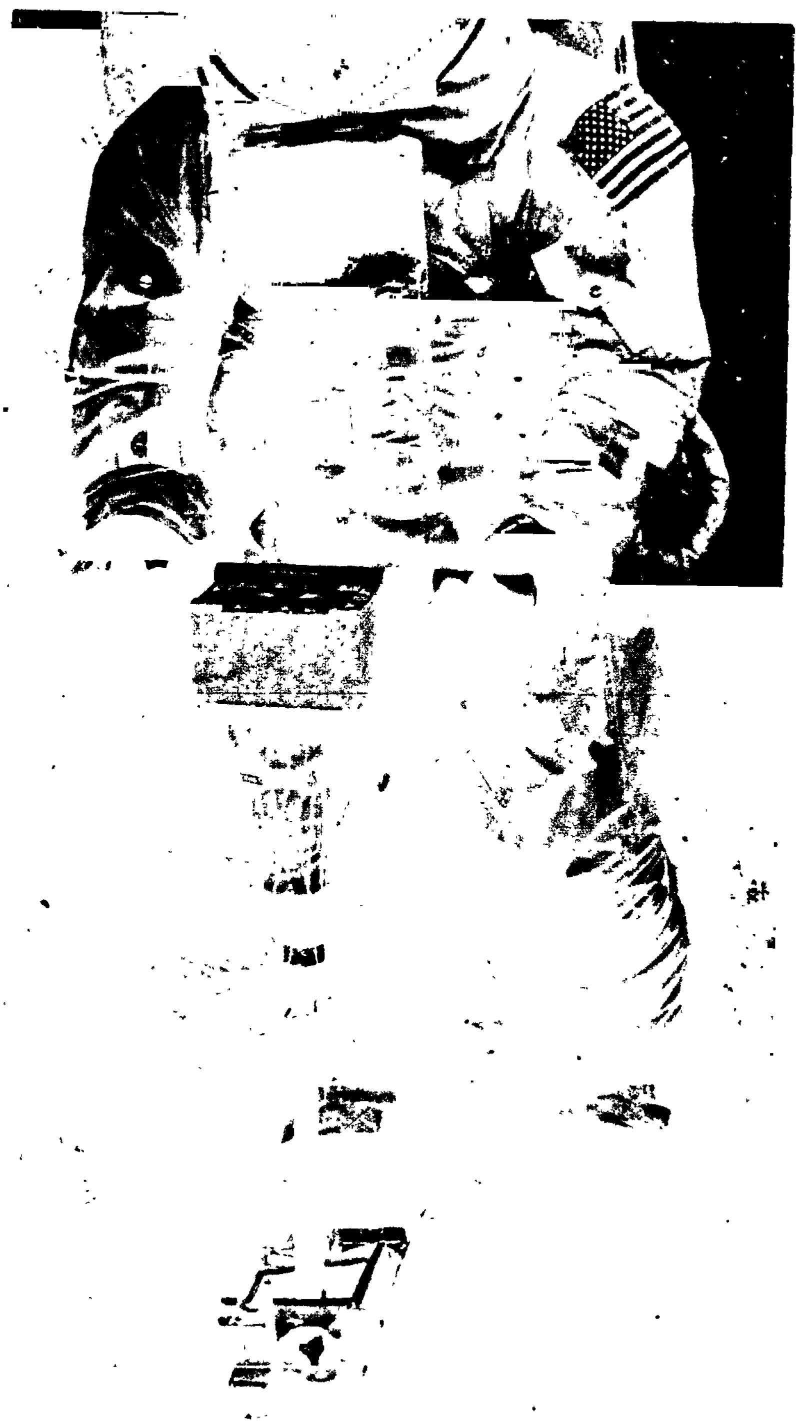


Fig. V-52 Underhand Position For Core Ster. String Withdrawal

Fig. V-53 Power Head Removal

Fig. V-54 Capping Open End

Fig. V-55 Loosening First Joint

Fig. V-56 Core Stem String Withdrawal

Fig. V-57 Capping Bit End

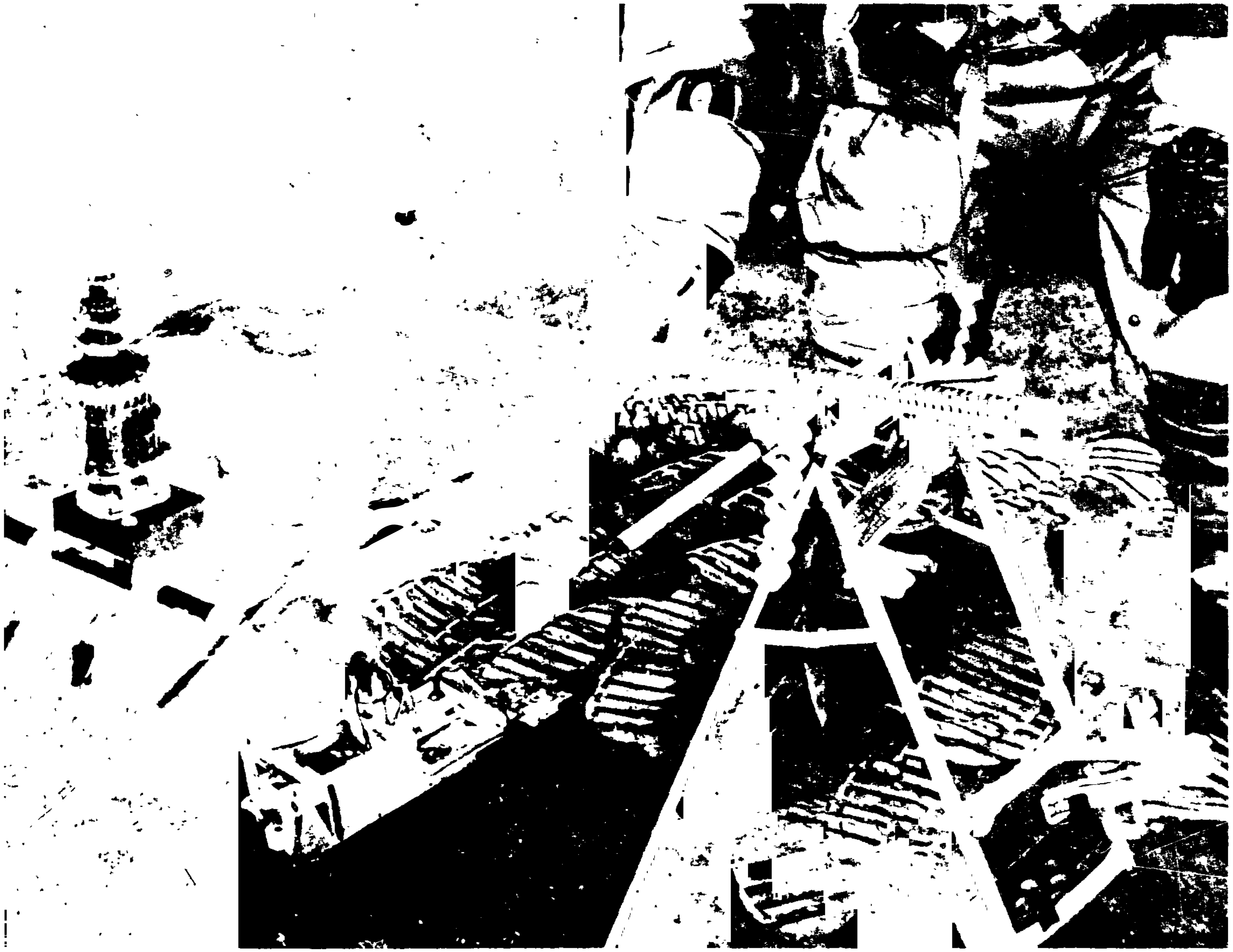


Fig. V-58 Positioning of Core Stem String For Uncoupling and Capping

Fig. V-59 Uncoupling Core Stems for Capping

Fig. V-60 Placing Cap on Stem

Fig. V-61 Capped Core Stems in ALHTC Sample Bag

2.2 First Alternate Method

The ALSD is deployed from the ALHT carrier in the vicinity of the LM.

2.2.1 Hole Boring

1) Remove the ALSD and the ALHT carrier from ALSEP subpackage No. 2 and place on surface adjacent to the MESA.

2) Perform tasks 11) through 28) of 2.1.1.

3) Remove and discard bore stem cover.

4) Pull bore stem retention strap release tab.

5) Reset adapter.

6) Withdraw drill bit bore stem located in upper right position in rack.

7) Withdraw standard bore stem directly below stem withdrawn in 6).

8) Couple these stems (Figure V-62) and fit to adapter. (Figure V-63). Fit snugly. Push stems forcibly into adapter while rotating stems clockwise.

9) Remove power head retention bracket pin.

10) Remove power head and battery assembly from treadle.

11) Place power head and battery assembly on surface adjacent to rack (Figure V-64).

12) Disengage treadle velcro from velcro on ALHT carrier handle. Rotate power head retention bracket to closed position.

13) Fit treadle to rack by engaging rack pin to treadle receptacle, red to red (Figure V-65). Carry handle is parallel to rack pin. Wrap treadle velcro strap around the wrench handle, overlapping and meshing the velcro strap (Figure V-66).

14) Remove SRC No. 1 from MESA stowage receptacle.

15) Open SRC.

16) Remove two standard core stems, couple and place in rack over plug in lower right corner of stem holder. Male end up.

17) Remove bit core stem and a standard stem. Couple these stems and place over plug in upper right corner of stem holder, bit end up.

18) Remove bore stem in lower left corner of stem holder. Couple this stem with drill bit bore stem directly above it. Couple firmly by pushing and rotating. Cutting blade of bit engaged into slot prevents stem rotation.

19) Remove last two core stems from SRC. Couple these stems and place over plug in lower left corner of stem, male end up. Stem orientation is depicted in Figures V-67 and V-68.

20) Remove core stem cap retainer assemblies from the SRC and stow on rack as shown in Figures V-69 and V-70. It is important that they be stowed on side depicted to preclude being inadvertently dislodged by astronaut during transport of rack.

21) Grasp power head lanyard in right hand and rack handle (not treadle handle) in left hand (Figure V-71) and proceed to first heat flow probe site. Cradle bore stem between thumb and index finger to minimize power head rotation, to stabilize stems and to keep stems away from astronaut's side and helmet. If traverse distance is rather great, double stack two more bore stems in rack, remove the double section from the adapter and place in rack, bit down. Carry power head under right arm. (Lanyard carry without stems results in power head rotation and presents a trip hazard.)

22) Follow procedures 40) through 45) of 2.1.1.

23) Energize power head (Figure V-72).

24) Follow procedures 47) through 57) of 2.1.1. When selecting bore stem to fit protruding stem, choose the one farthest from retention strap.

Fig. V-62 Coupling Bore Bit Stem to Standard Stem

Fig. V-63 Fitting Double Bore Stem Section to Adapter

Fig. V-64 Power Head Placement on Surface

Fig. V-65 Treadle to Rack Engagement

Fig. V-66 Treadle Velcro Strap Wrap Around Wrench Handle

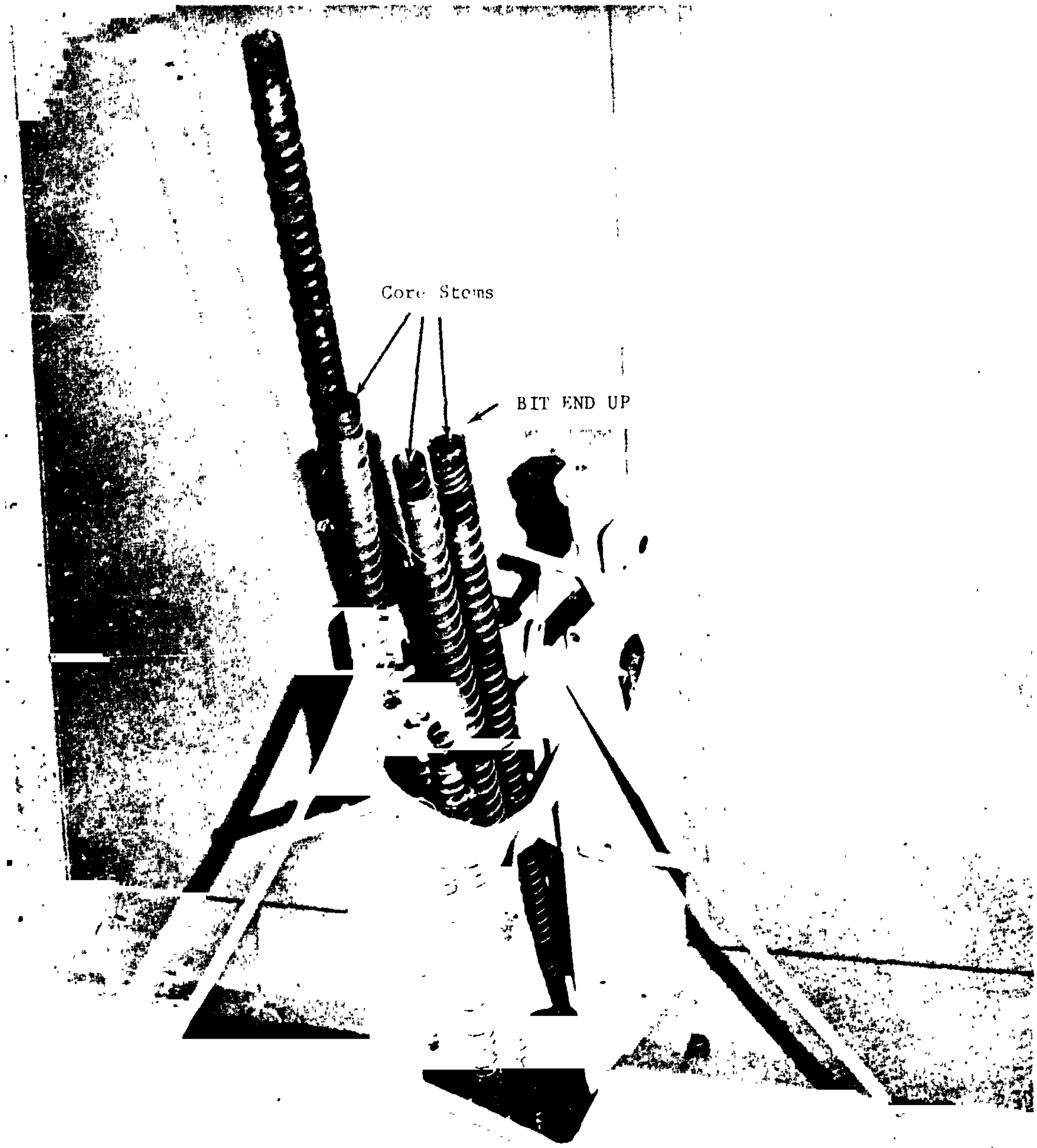


Fig. V-67 Core Stem and Bore Stem Orientation in Rack

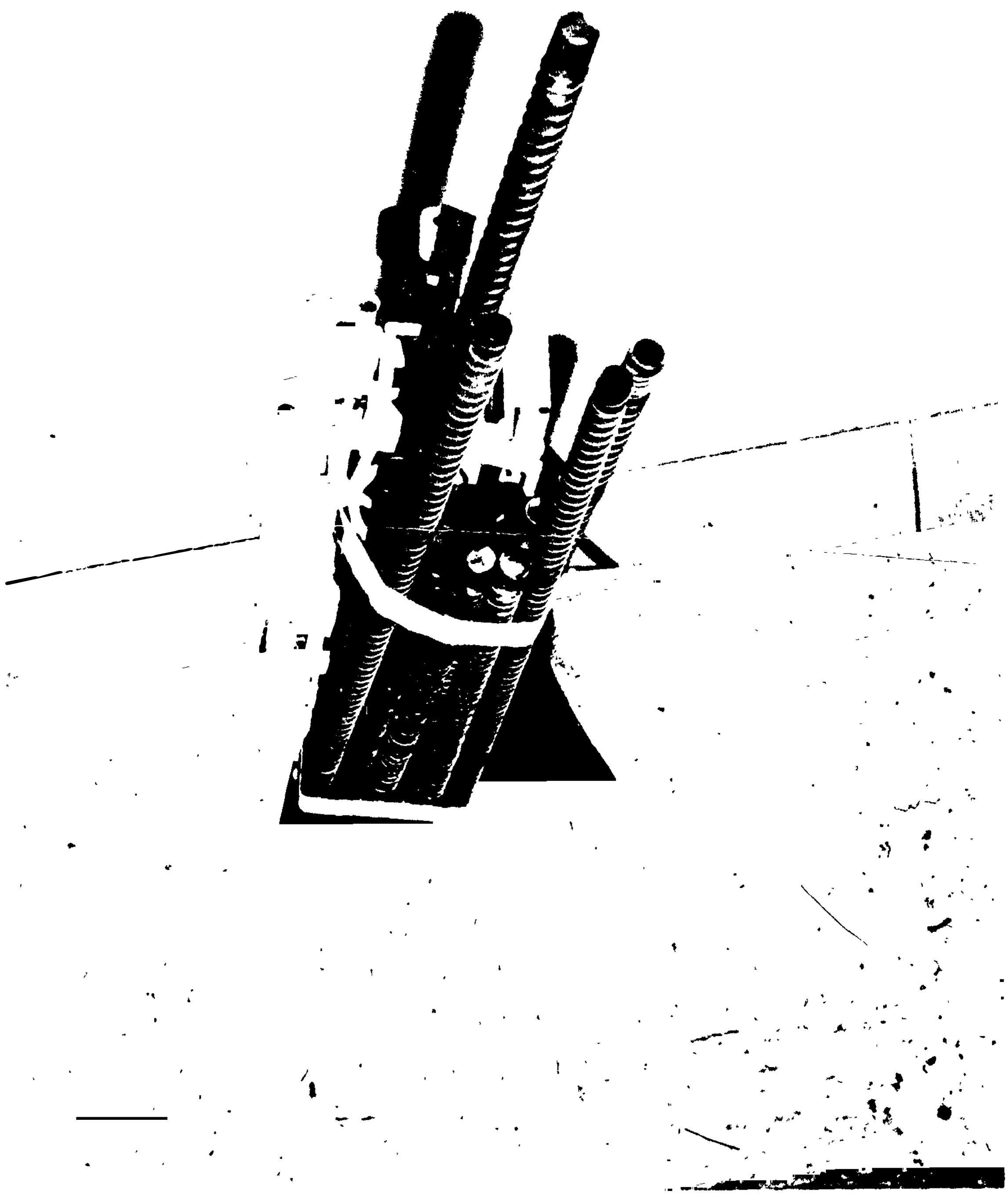


Fig. V-68 Core Stem and Bore Stem Orientation in Rack

Fig. V-69 Core Stem Cap Stowage on Rack

Fig. V-70 Core Stem Cap Stowage on Rack

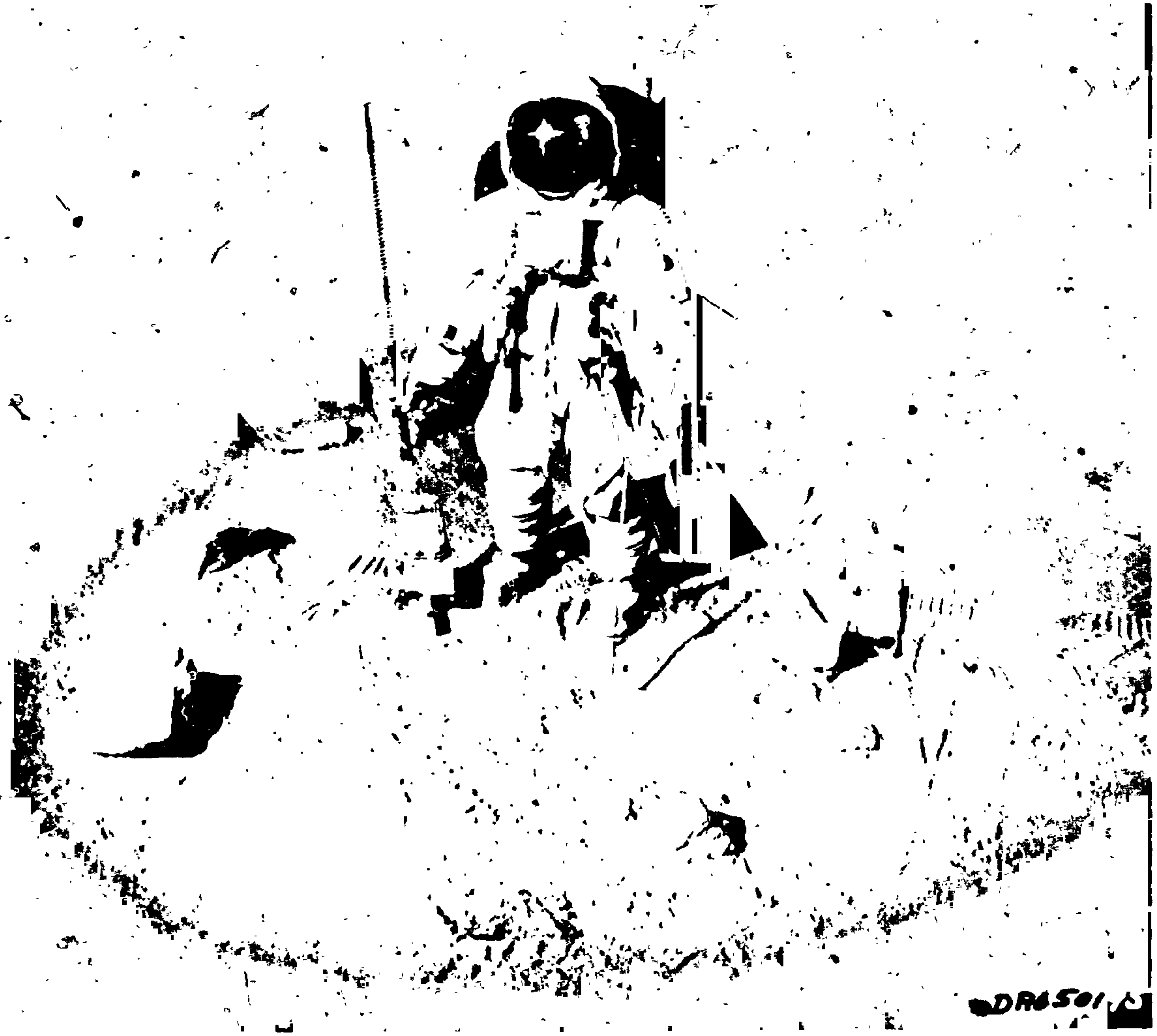


Fig. V-71 Transport Mode

Fig. V-72. Emplanting Bore Stems

2.2.2 Hole Coring

1) Proceed to core site between 6 and 9 feet east of second heat flow probe. Place rack and power head on surface.

2) Follow procedures 1) and 2) of 2.1.2.

3) Disengage treadle velcro from wrench handle.

4) Remove treadle from rack. Place velcro strap in stow position for coring.

5) Drop treadle on surface in desired coring area.

6) Remove double core stem section with core bit. Thread to power head spindle while power head is on surface.

7) Lift and rotate power head assembly. Place core bit into treadle pilot while rotating power head clockwise until bit drops through lock.

8) Place a foot on treadle to stabilize it. Make certain treadle is reasonably level. Check vertically of core stems. Energize power head. Drill to lower handle height limit.

9) Rotate power head counterclockwise one and one-half turns and lift to disengage power head from core stem.

10) Place power head on surface.

11) Remove double core stem section from rack and thread to protruding stems.

12) Lift power head and fit to core stem. Initial contact to be about 45°. Rotate to vertical and gently rotate clockwise to engage threads. Continue rotating clockwise until threads are fully engaged (about 1-1/2 turns).

13) Repeat procedures 8) through 12). Drill to lower handle operating height.

14) Follow procedures 19) of 2.1.2.

15) Remove wrench from rack by disengaging it from upper stowage clip. Grasp jaws of wrench. Pull outward and upward simultaneously.

16) Place foot on treadle. Engage wrench on first stem below power head. Hold wrench in one hand and rotate power head counterclockwise 1-1/2 turns and lift vertically from stem. Place power head on surface. Stow wrench on rack or treadle handle.

17) Remove core stem cap retainer assembly containing eight caps from rack. Caps come off square end of retainer assembly. Cap the open core stem. Return cap retainer assembly to rack.

18) Remove wrench from rack. Place foot on treadle. Make certain treadle is flat on surface. Rotate top core stem counter-clockwise one-quarter turn to loosen joint.

19) Rotate core stem string clockwise. It may be necessary to use wrench to loosen treadle lock. Continue rotating core stem string clockwise and simultaneously lift vertically until another stem is withdrawn.

20) With wrench, rotate second stem from top counterclockwise one-quarter turn to loosen joint.

21) Repeat steps 19) and 20) until last stem joint is loosened. Replace wrench in rack. Remove first set of core stem caps (7 remaining).

22) Completely withdraw core stem string. Cape core stem bit.

23) Lean core stem string against rack with bit end on surface.

24) Separate stems one at a time. Cap ends in sequence. After first four stems are capped on both ends, remove second core stem cap retainer from rack. It contains only 4 caps and has a number 2 cut into the tapered end. Lean stems against rack (lower support for handle and wrench) as they are capped.

25) Make certain all items left at core site are 6 feet or more from the heat flow probe.

26) Pick up and carry capped stems to LM and place in SRC.

2.3 Second Alternate Method - Drill Deployment from MESA SRC Table

2.3.1 Hole Boring and Hole Coring

1) Transport the ALSD (Figure V-5) to the MESA. Figures V-73 and V-74 depict views of the MESA.

2) After properly adjusting SRC table, place ALSD on table as shown in Figures V-75, 76 and 77.

3) Deploy drill in accordance with procedures 13) through 28) of 2.1.1, and 3) through 13) of 2.2.1. ALSD package may rock somewhat on the table because of the interface of plugs and tubes at table corners with ALSD structure. One plug interferes with rack rotation prior to handle installation. When deployed, leg #1 may get caught in MESA equipment and leg #3 may get caught in table structure. If these events occur, do not pull or jerk rack to free legs, as this action may disengage leg locks.

4) Remove SRC #1 and place on MESA SRC table.

5) Remove core stems from SRC, couple and stow in rack as described in 16) through 19) of 2.2.1.

6) Remove core stem cap retainer assemblies and stow on rack as shown in Figures V-69 and V-70.

7) Boring and coring procedures are the same as described in procedures 21) through 24) of 2.2.1 and 1) through 26) of 2.2.2.

Fig. V-73 MESA

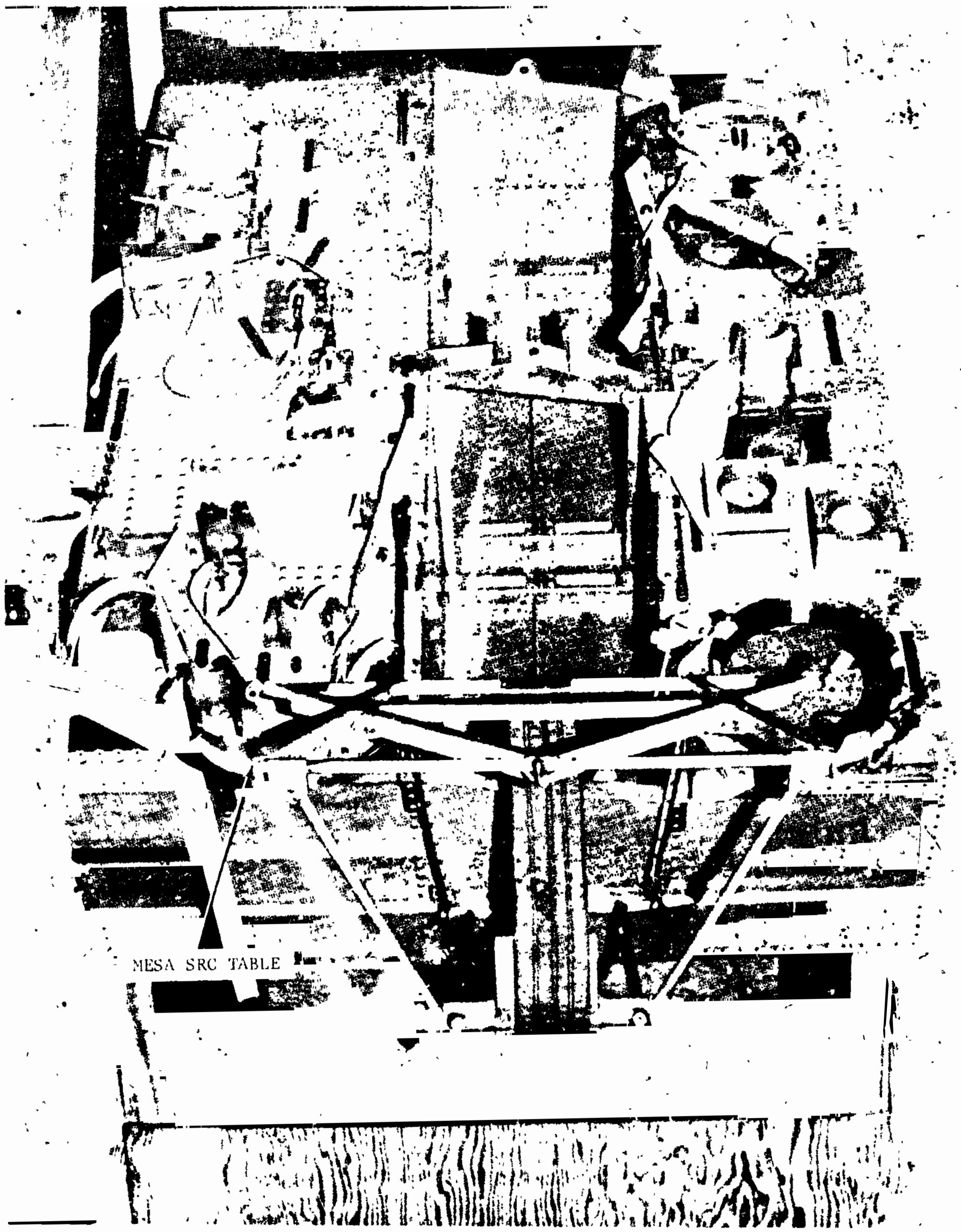


Fig. V-74 MESA (Mockup)

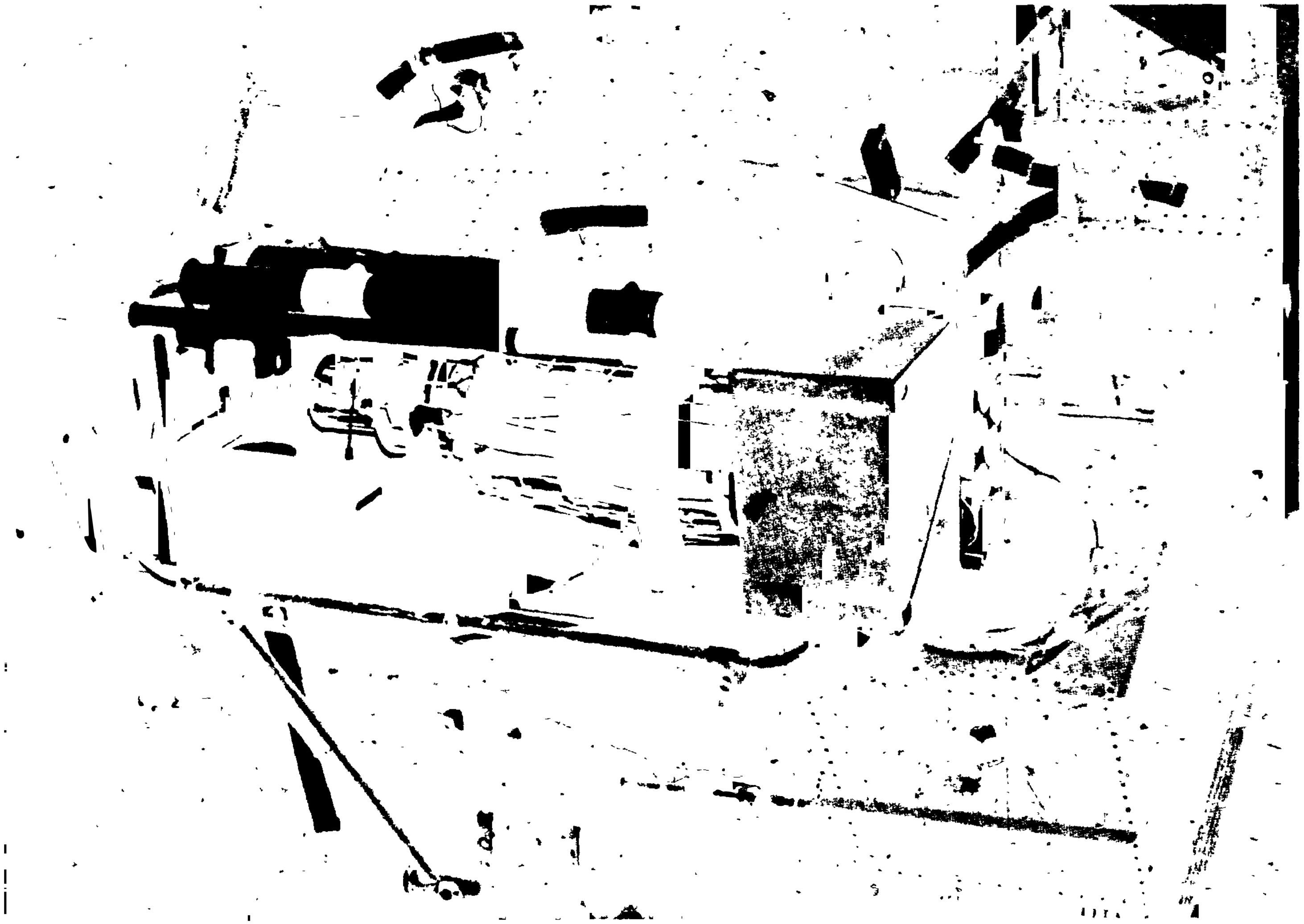


Fig. V-75 ALSD On MESA SRC Table

Fig. V-76 ALSD On MESA SRC Table

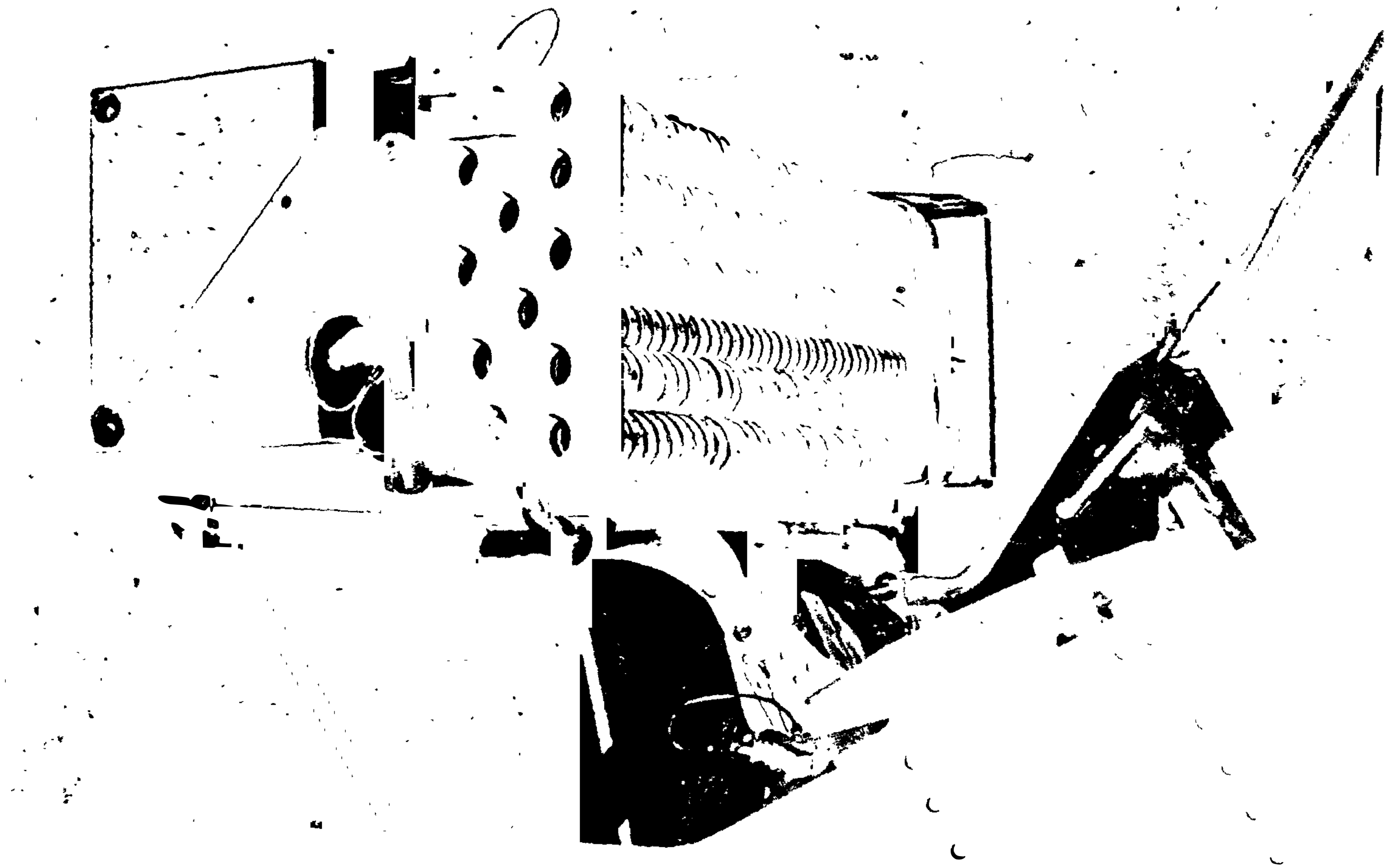


Fig. V-77 ALSD On MESA SRC Table

TABLE V-1

Contingency Instructions

Para. Ref. *	Contingency Instruction
2.1.1 6)	Core Stem Retrieval - If a core stem is dropped, engage end of wrench into stem and lift at a low angle.
2.1.1 11)	Lifting ALSD to ALHT Carrier or MESA - Difficulty may be experienced in lifting ALSD package high enough to place ALHT carrier or MESA table. This is alleviated by swinging package with left hand and catching battery end of package with the right hand.
2.1.1 12)	ALHT Carrier Stability - If ALSD is stable on ALHT but the ALHT carrier is unstable, press down on ALSD such that the apex leg of the ALHT carrier penetrates the surface sufficiently to provide stability.
2.1.1 24)	Handle Engagement - If handle fails to lock properly into battery, check alignment of handle, and ensure that handle is free from interference. Ensure that fixed pin is fully engaged in hole by pulling on end of handle adjacent to fixed pin. If lower lock pin will not depress properly, hold handle in position with left hand and again slap lower end of handle toward battery with right hand.
2.1.1 26)	Rack/Treadle Separation - If experience difficulty, grasp rack in area where rack support legs converge. Pull rack up while holding treadle assembly down on ALHT carrier or MESA with free hand.
2.1.1 31)	Power Head/Treadle Separation - A tight fit of the power head in the power head support bracket may cause difficulty in removal from the treadle. In this instance, grasp bore stem near spindle with left hand and press down on treadle with thumb. When the power head breaks loose from the bracket, bring power head level with right hand and lift vertically clear of treadle.

TABLE V-1 (Cont.)

Para. Ref. *	Contingency Instruction
2.1.1 40)	Bore Stem Retrieval - If a bore stem is dropped, engage end of wrench into stem and lift at a low angle.
2.1.1 47)	Adapter Release - (a) Rotate power head 90° counterclockwise and simultaneously energize power head. De-energize and rotate 90° to normal drilling position. Energize for a few seconds and lift vertically. (b) Withdraw bore stem, with or without power, to position such that bore stem engaging adapter can be grasped by hand. Hold power head and rotate stem 90° clockwise (Figure V-35) or hold stem and rotate power head 90° counterclockwise. Return power head to normal drilling position. Drive bore stems to lower handle operating height. Pull power head vertically from stem.
2.1.2 7)	Wrench Retrieval - If the wrench is dropped, engage end of handle into a double core stem section and lift at a low angle.
2.1.2 9)	Coupling of Core Stems - During coupling of the male and female ends, proper axial alignment is important to prevent binding. If high torques are encountered during coupling, double check axial alignment. If binding is severe, separate sections by pulling and rocking, and re-couple.
2.1.2 10)	Core Stem Coupling to Power Head - If difficulty is encountered when coupling the core stem assembly into the power head spindle, hold the core stem assembly closer to the bit end. Slowly move the core stem about a point until a reduction in torque is felt, indicating proper axial alignment. If difficulty is still encountered, stand at the bit end of the core stem assembly and repeat above procedure.
2.1.2 11)	Treadle Lock - If core bit hangs up as it passes by the treadle lock, hold power head steady and rotate treadle assembly counterclockwise with foot. If core stem turns in spindle, use the wrench to prevent the core stem from turning and repeat above procedure.

TABLE V-1 (Cont.)

Para.
Ref. * Contingency Instruction

2.1.2 13) Power Head/Core Stem Decoupling - The power head spindle may tend to cling to the male end of the core stem after the mating threads have separated due to vertical misalignment. Removal is assured without difficulty by cradling the handle assembly between the thumbs and forefingers and lifting up and pulling slightly forward. When the vertical alignment point is reached, the power head will easily lift off of the core stem.

2.1.2 17) Core Stem/Power Head Coupling - Coupling of the power head to a core stem can be expedited by holding the power head spindle approximately 45 degrees to the core stem, lifting it onto the male end of the core stem at this angle, and bringing the power head vertical until the spindle bottoms out on the core stem threads. Hold this alignment while turning the power head until full thread engagement is achieved.

NOTES:

1. ALSD drilling and coring operations shall be accomplished as soon as possible after ALSD removal from ALSEP subpackage #2 pallet

2. Drilling descent rate varies with subsurface material. Low density materials (pumice, conglomerate, etc.) require 4 to 6 pounds axial force whereas high density material (basalt, scoria, etc.) require 10 to 15 pounds axial force. If drill string jamming begins to occur (detected by increasing torque forces), drilling descent rate should be reduced by a corresponding reduction of axial force. If severe jamming of the drill string is encountered, an upward force should be applied to the drill handle until torque forces return to normal. Drilling can then be resumed.

3.0 SPECIAL TRAINING INSTRUCTIONS

3.1 Lunar Gravity Simulation

Operating procedures may be performed with the subject and power head/battery assembly counterbalanced to 1/6-G as directed by training personnel. It is recommended that all ALSD bore stem emplacement exercises be performed with the power head/battery assembly counterbalanced to 1/6-G weight (approximately 3 pounds) to preclude excessive loading and possible failure of bore stem taper joints.

3.2 Training Unit Bore Stems

The ALSD training unit bore stems are reusable if reasonable care is exercised during removal of the bore stem string from the lunar surface simulation model. The bore stem string may normally be removed as a complete assembly from the lunar model by manually rotating the protruding stem sections in a counterclockwise direction while simultaneously exerting an upward force. A T-handle retrieval rod, threaded to interface with the aluminum nut (7/16-14 UNC-2B) epoxied in the lower tip section, should be employed to ensure complete bore stem string recovery in the event of a subsurface taper joint separation during the removal process.

The taper joints of a recovered bore stem string are usually mated too tightly for manual separation as a result of the rotary-percussive forces applied by the power head. The taper joints can be mechanically separated using a specially design separation tool. As an alternate, a machine shop lathe or similar machine may be used. Separation force should be applied axially along the bore stem string to preclude side-loading and subsequent breakage of the taper joints. If a metal collet or jaw is used for applying the axial separation force, a rubber shim should be employed to preclude damage to the boron/fiberglas material.

3.3 Training Unit Preventive Maintenance

The design and materials employed for the training units are nearly identical (except for battery and power head castings) to the flight units for the following reasons: 1) Extreme emphasis was placed upon weight reduction during performance of the program. Training unit No 2 was contractually required to be designed within 20 percent of the flight unit weight. Training Unit No. 1 was designed to be approximately 1/6 the weight of the flight units. 2) The philosophy adopted by the contractor was that the training units should not be "beefed up" to increase operating life at the expense of providing a false indication of lunar surface operational characteristics of light-weight flight units. Therefore, it is recommended that the following preventive maintenance instructions be performed following each training exercise to prolong the useful operating life of the Training Unit No. 2.

1) Initiate and maintain a log for the following items:

04

a. ALSD Assembly - Type of training exercise, maintenance actions, and dates.

b. Power Head - Operating time, maintenance actions, and dates.

c. Battery - Cell activation date, operating time, number of recharge cycles, maintenance actions, and dates.

2) Perform battery and power head maintenance in accordance with the checklist delineated in Section IX of this manual.

3) Thoroughly clean the ALSD assembly using a soft cloth and clean pressurized air source. Particular attention should be given to the following items:

a. Lanyard pull pins and receptacles are clean and free of burrs.

b. Camlocs and receptacles are clean and operable.

c. Treadle lock pawl is clean and operates freely.

d. Rack assembly leg hinges and springs are clean and operate freely.

e. Rack support pin and its treadle support receptacle are clean, free of burrs, and engage/disengage freely.

f. Handle and Switch Actuator Assembly battery locking pins, actuating switch collars, and microswitch actuating plunger are clean and operate freely.

g. Wrench fixed and pivot jaws are clean and operate freely.

h. Bore stem adapter inner collet and spring-loaded key blocks are clean and operate freely.

i. Coupling threads on the core stems, bore stem adapter, and power head are clean, free of burrs, and will couple/decouple freely.

j. Bore and core bit tungsten carbide cutting tips are free from fractures or large chips.

NOTES: 1) Training battery case pressure relief valves should be permanently removed to preclude accumulation of gas within the case during long term storage.

2) ALSD's with activated batteries should be oriented such that the battery lid is facing up during long term storage.

3) A light film of General Electric G-300 or Du Pont Krytox 240-AC grease may be used on core stem coupling joints if the original canadize finish becomes worn or abraded through excessive usage.

VI. GSE OPERATIONAL READINESS VERIFICATION

1.0 ALSD PRESSURIZATION UNIT

1.1 Purpose - This procedure establishes the inspection and test requirements for detecting any malfunctioning or defective components within the ALSD Pressurization Unit.

1.2 Time Interval - This procedure shall be performed in accordance with the following schedule:

a. Upon receipt of equipment at the field location.

b. At intervals thereafter not exceeding six (6) months.

1.3 Test Equipment Requirements

a. Gaseous nitrogen source to conform with MIL-P-27401B, Type I

b. Source regulator and gauge system capable of 0 - 100 (min.) psi range.

c. Source-to-Pressurization Unit hose capable of attaching to inlet port fitting, AN832-4D.

d. Calibration Lab capable of calibrating 0 - 30 psi pressure gauge.

e. Manometer, Standard (0 - 8 inches Hg range).

1.4 Failure/Malfunction Criteria - Failure of the unit to meet the performance requirements specified herein shall constitute a malfunction. Each malfunction will require an investigation to determine cause.

1.5 Visual Examination - This unit shall be visually examined for cleanliness. Particular attention shall be given to the following:

a. Condition of material finishes.

b. Satisfactory tightness of assembly bolts and screws.

c. Freedom from contamination, such as corrosion products, scale, grease, etc.

1.6 Equipment Description - The ALSD Pressurization Unit is a manifold assembly consisting of a pressure regulator, pressure gauge, manometer, and relief valve for purging, sequentially pressurizing and verifying seal integrity of the power head and the battery assembly of the ALSD. Nitrogen is supplied to the unit by a standard gas cylinder. A schematic of the unit is presented in Figure VI-1.

1.7 Performance Requirements

Note: Before starting test, the 0 - 30 psi pressure gauge shall be calibrated to an accuracy conforming to acceptable laboratory standards.

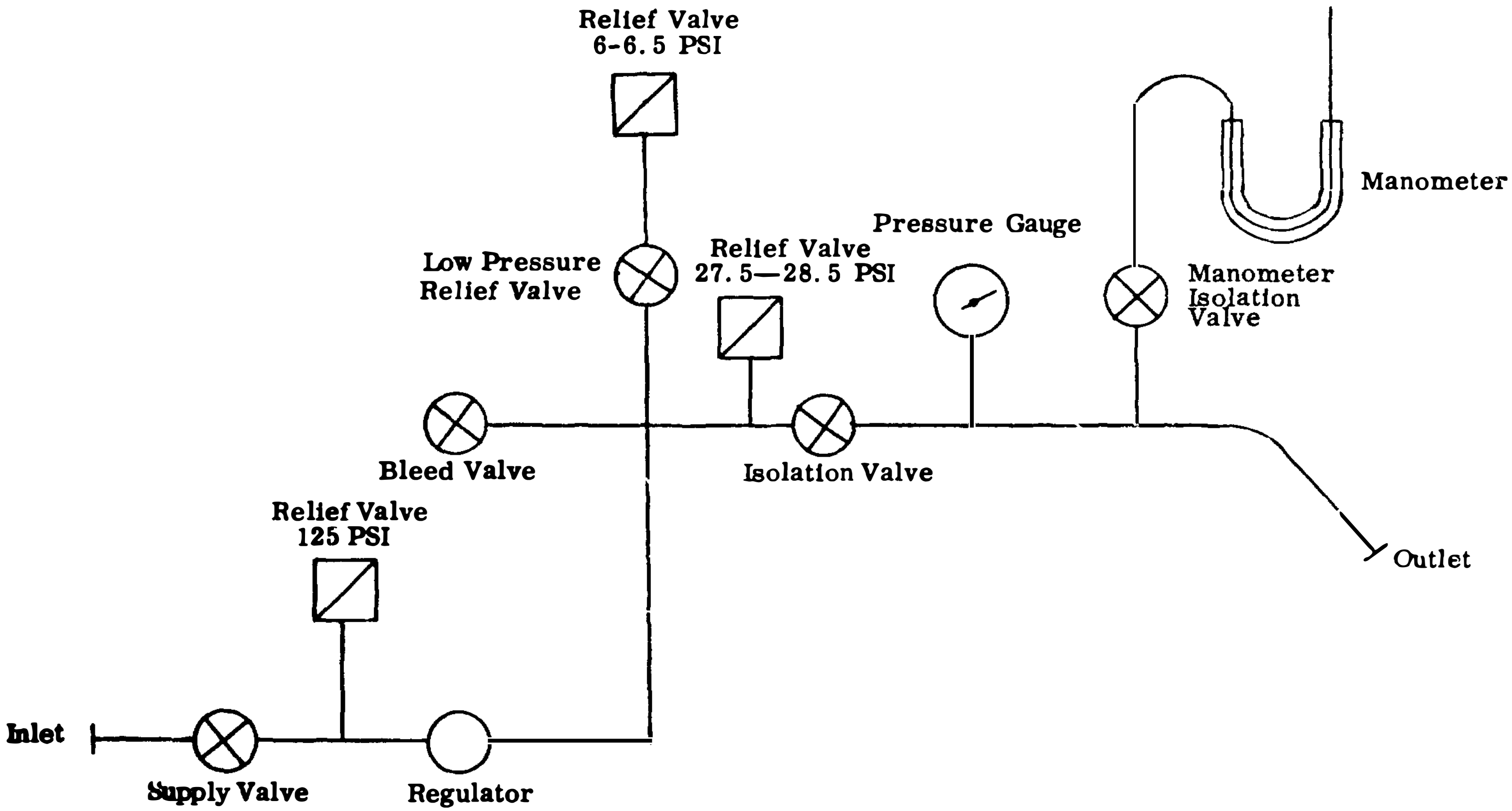


Figure VI-1. ALSD Pressurization Unit Schematic

a. Connect low pressure outlets of standard nitrogen dolly to inlet of Pressurization Unit.

b. Close all valves on unit and plug outlet line. Turn regulator hand wheel counter-clockwise to closed position.

c. Open supply valve and adjust nitrogen supply regulator on cylinder and apply pressure to unit for setting relief valve.

d. Set relief valve to relieve between 115 to 125 psi.

e. Reduce supply pressure to 75 psig.

f. Open low pressure relief valve and isolation valve.

g. Adjust regulator on unit and set relief valve to relieve at 6.0 to 6.5 psig, as read on the pressure gauge.

h. Close low pressure relief valve.

i. Adjust regulator and set relief valve to relieve at 27.5 to 28.5 psig. Check pressure indication on pressure gauge.

j. Adjust regulator to 24 to 26 psi as indicated on the pressure gauge. Close supply valve and regulator. Note and record pressure. Allow unit to remain pressurized for six (6) hours. Leakage should be less than 0.5 psig.

k. Open isolation valve and bleed valve to relieve pressure in system. Close isolation valve and bleed valve.

l. Connect a standard manometer to outlet line of unit.

m. Open supply valve, low pressure relief valve, isolation valve and manometer isolation valve.

n. Adjust regulator by turning slowly clockwise until 7.0 to 7.5 inches of mercury is obtained on standard manometer.

(CAUTION: Do not exceed 8 inches of mercury on unit manometer)

o. Compare readings on two manometers and adjust unit manometer to agree with standard manometer, if required.

p. Close isolation valve. Close supply valve and regulator. Note and record pressure on unit manometer. Allow unit to remain pressurized six (6) hours. Leakage should be less than 0.1 inches of mercury.

q. Open isolation valve and bleed valve to relieve pressure in system. Close all valves. Remove nitrogen supply from unit and cap inlet and outlet ports.

2.0 ALSD BATTERY CHARGING UNIT

2.1 Purpose - This procedure establishes the inspection and test requirements for detecting any malfunctioning or defective components with the ALSD Battery Charging Unit.

2.2 Time Interval - This procedure shall be performed in accordance with the following schedule:

a. Upon receipt of equipment at field location.

b. At intervals thereafter not exceeding six (6) months.

2.3 Test Equipment Requirements

a. Multimeter, Simpson Model 260 or equivalent.

b. Voltmeter, DC 0-50 Volts, Weston Model 901 or equivalent.

c. Ammeter, DC 0-10 Amperes, Weston Model 901 or equivalent.

d. Resistor, 10 ±20% Ohms, 200 Watts.

e. Power source, 105 to 120 VAC, 60 cps, single phase.

2.4 Failure/Malfunction Criteria - Failure of the unit to meet the performance requirements specified herein shall constitute a malfunction. Each malfunction will require an investigation to determine cause.

2.5 Visual Examination - This unit shall be visually examined for cleanliness. Particular attention shall be given to the following:

a. Condition of material finishes.

b. Satisfactory tightness of assembly bolts and screws.

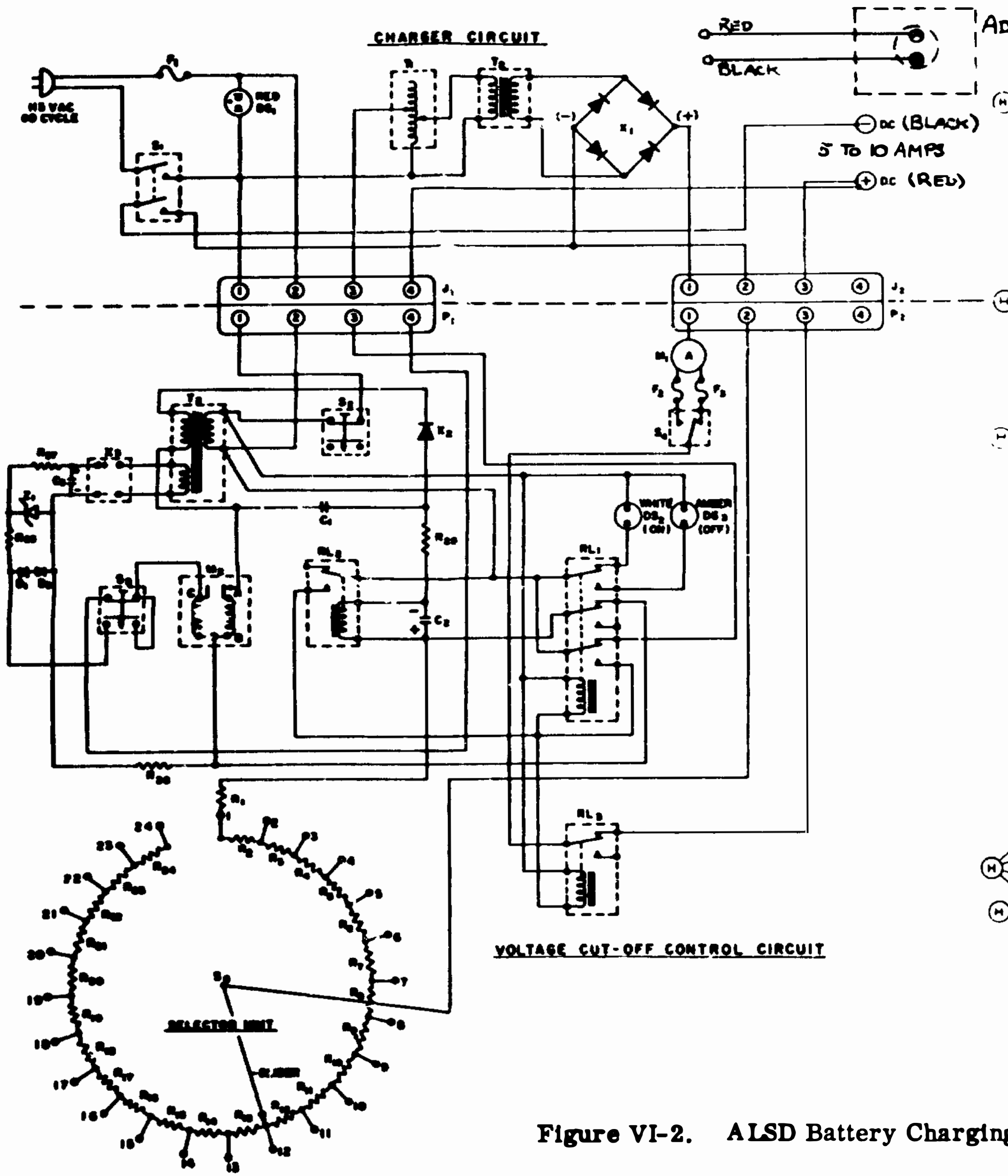
c. Freedom from contamination, such as corrosion products, scale, grease, etc.

d. Condition of connector pins and jacks.

2.6 Equipment Description - The ALSD Battery Charging Unit consists of a Yardney Electric Corporation SILVERCEL Charger, Model VC 24-10 and a battery adapter unit. The VC 24-10 charger employs a full wave AC-to-DC bridge rectifier and automatic control circuitry required for providing the ALSD battery charging current. The charging current is routed through a charging cable to the adapter unit, which contains the necessary electrical and mechanical hardware for interfacing with the ALSD battery assembly. A schematic of the unit is presented in Figure VI-2.

2.7 Performance Requirements

a. Adjust multimeter for R x 1 continuity test. Measure resistance between battery adapter unit red charging cable jack and pin A of receptacle. Multimeter shall read less than 0.2 ohms.



PARTS LIST	
SYMBOLS	DESCRIPTION
[illegible]	BATTERY-MERCURY CELL-MALLORY [illegible]
C_1 C_2	CAPACITOR - 4 MFD - 450WVDC - CORNELL DUBILIER BR-445
DS_1, DS_2, DS_3	PILOT LITE ASSEMBLY - DIALCO NO 95408H 931, 935, 933 (NE 51H NEON BULB)
F_1	FUSE 6-1/4A 250V LITTELFUSE - 3AG - 313625 & FUSEHOLDER 342001
F_2	FUSE - 1A - 250V - LITTELFUSE - 3AG - 313001 & FUSEHOLDER 342001
J_1	4 CONTACT SOCKET - CINCH JONES - S - 304 - RP
J_2	4 CONTACT SOCKET - CINCH JONES - S 2404 - 0B
M_1	AMMETER - 0-1AMP DC - 0-10AMP DC DUAL SCALE - SIMPSON MOD 1327C
M_2	CONTACT METER - 1MA DEFLECTION - MODEL 351C - ASSEMBLY PROD. CHESTERLAND, OHIO
P_1	4 CONTACT PLUG - CINCH JONES - P - 304 - CCT
P_2	4 CONTACT PLUG - CINCH JONES - P - 2404 - CCT
R_1 - R_{24}	RESISTOR (24) 2,000 OHMS - 1/2W - 1% - AEROVOX CP 1/2
R_{25}	RESISTOR - 10,000 OHMS - 1W - 10%
R_{26}	RESISTOR - 1,500 OHMS - 1/2W - 1% - AEROVOX - CP 1/2
RL_1	3 PDT 115VAC 60CYCLE RELAY - POTTER & BRUMFIELD KL 11A
RL_2	SPDT RELAY 40VDC 5000 OHMS COIL - POTTER & BRUMFIELD LB5
RL_3	SPDT RELAY 115VAC 60 CYCLE - POTTER & BRUMFIELD PR5AY
S_1	DPST TOGGLE SWITCH - SMITH NO 1760
S_2, S_3	SPDT PUSH BUTTON SWITCH - SMITH NO 580
S_4	SPDT ROTARY SWITCH - OHMITE - 111-2
S_5	SELECTOR UNIT - 24 POSITION ROTARY SWITCH - MALLORY 1324L
T_1	VARIABLE TRANSFORMER - SUPERIOR ELEC. CO. 1 OKVA - TYPE 116-U
T_2	ISOLATION STEPDOWN TRANSFORMER - 115/72VAC AT 10AMPS COIL CO OF AMERICA
T_3	ISOLATION TRANSFORMER - 1:1 - STANCOR PA8421
X_1	SELENIUM RECTIFIER - 90VAC INP 13.6A DC OUTPUT FULLWAVE SYNTRON CO.
X_2	SELENIUM RECTIFIER - 130VAC INP - 75MA. DC OUTPUT 1/2WAVE - FEDERAL 1003A
UPPER PANEL ASSEMBLY	PANEL - 19" WIDE - 7" HEIGHT - 1/8" THICK - STEEL PREMIER - RP-719 - GREY CHASSIS - 17" WIDE - 2" HEIGHT - 8" DEPTH - ZINC PLATED PREMIER CH-440 BRACKET - 6-1/2" HEIGHT - 8" DEPTH PREMIER CB-78
LOWER PANEL ASSEMBLY	PANEL - 19" WIDE - 10" HEIGHT - 1/8" THICK - STEEL PREMIER - RP - [illegible] - GREY CHASSIS - 17" WIDE - 2" HEIGHT - 13" DEPTH - ZINC PLATED PREMIER CH-422 BRACKETS - 6-1/2" HEIGHT - 13" DEPTH - PREMIER - CB-713
CABINET	13-1/4" HEIGHT - 21-3/4" WIDE - 15-1/4 DEPTH - PREMIER - OCR - 170 GREY
HEAVY POSTS	BIRNBACH - RED - 393A BIRNBACH - BLACK - 393A
LIGHT POSTS	SUPERIOR - DF - 30 - RED SUPERIOR - DF - 30 - BLACK
CLIPS LEADS (HEAVY)	CLIPS MUELLER NO 24C COVERS - MUELLER RED & BLACK - NO 25 PLUGS - BIRNBACH RED & BLACK - NO 382
CLIP LEADS (LIGHT)	CLIPS - MUELLER NO 48C COVERS - MUELLER RED & BLACK NO 49 PLUGS - E F JOHNSON NO 108-752-1 & 752-2 WIRE - NO 18 TEST LEAD WIRE - BELDEN 8899 RED & BLACK
SOLDER	KESTER RESIN CORE
DAMPER	ZILDEY PRODUCTS, N.Y.C
WIRE	3 CONDUCTOR CABLE - NO 16-3
WIRE	4 CONDUCTOR CABLE - BELDEN 8454
WIRE	HOOKUP (HEAVY) NO 14 - SOLID RED, WHITE, BLACK
WIRE	HOOKUP (LIGHT) NO 20 SOLID - ALPHA [illegible] - RED, BLACK, YELLOW, GREEN, WHITE, BROWN, ORANGE, BLUE
F_3	FUSE 10A - 250V LITTELFUSE - 3AG - 313010 & FUSEHOLDER 342001
R_{27}	RESISTOR - 10 OHMS - 1W - 5%
C_3	CAPACITOR - 1000 MFD - 12V - WVDC - SPRAGUE - TVA 1133
X_3	RECTIFIER ASSEMBLY - FWB - 1.5 AMPS - 50 V - PIV - MOTOROLA - MDA - 942-1
Z_1	ZENER DIODE - 6.8V 10W - MOTOROLA - 1M 6.8Z10
R_{28}	RESISTOR 1,000 OHMS - 1W - 5%
D_1, D_2	DIODE - 750 MA - 200 PIV - 1N 2069

NOTE

ALL STANDARD PARTS LISTED OR THEIR EQUIVALENTS ARE USED

Figure VI-2. ALSD Battery Charging Unit Schematic

b. Adjust multimeter for R x 1 continuity test. Measure resistance between battery adapter unit black charging cable and pin B of receptacle. Multimeter shall read less than 0.2 ohms.

c. Position switches of VC 24-10 charger as follows:

1) Power switch to Off.

2) Current control completely counterclockwise.

3) Cell selector switch to Position 16.

4) Ammeter selector switch to 0-10 position.

d. Connect resistor and ammeter in series across the 5-10 amps output jacks observing correct polarity.

e. Connect voltmeter across the 5-10 amps output jacks observing correct polarity.

f. Connect VC 24-10 charger power cable to 105-120 VAC, 60 cps power source.

g. Place Power switch On. Red Power On and Charging Current On indicators shall illuminate.

h. Depress Calibrate switch and adjust bottom screw on cut-off meter until indicator aligns with CAL mark. Release Calibrate switch.

i. Align red pointer on cut-off meter with the red line on the dial by adjustment of the small knob on the front of the cut-off meter.

j. Rotate current control slowly clockwise until ammeter indicates 2.0 amperes. VC 24-10 charger shall indicate 2.0 $\pm$ 0.2 amperes.

k. Rotate current control slowly clockwise until Charging Current On indicator goes out and Charging Current Off indicator illuminates. At switch-over, the voltmeter shall indicate 32 $\pm$ 0.65 VDC.

l. Depress Reset switch. Charging Current Off indicator shall go out. Release Reset switch.

m. Turn Power switch to Off. Disassemble test setup.

VII. ALSD INSPECTION AND SERVICE INSTRUCTIONS

1.0 INACTIVE BATTERY SUBSYSTEM VERIFICATION

1.1 Purpose - This procedure establishes the inspection and test requirements for the ALSD Battery (Inactive), (MMC P/N PS9403000014) and the ALSD Handle and Switch Actuator Assembly, (MMC P/N 467A8050013).

1.2 Time Interval - This procedure shall be performed in accordance with the following schedule:

a. Within the four (4) month period preceding launch date. (preferably at T-90 days)

Note: Service life of individual components is delineated in equipment data packages.

1.3 Test Equipment Requirements

a. Battery Charging Unit (MMC P/N 467A8080000-009)

b. Pressurization Unit (MMC P/N 467A8090000-009)

c. Gaseous Nitrogen source to conform with MIL-P-27401B, Type I.

d. Source regulator and gauge system capable of 0 - 100 (min.) psi range.

e. Source-to-Pressurization Unit hose capable of attaching to inlet port fitting, AN832-4D.

f. Multimeter, Simpson Model 260 or equivalent.

g. Torque wrench and sockets.

1.4 Failure/Malfunction Criteria - Failure of the Battery or Handle and Switch Actuator Assembly to meet the performance requirements specified herein shall constitute a malfunction. Each malfunction will require an investigation to determine cause.

1.5 Visual Examination - The units shall be visually examined for cleanliness. Particular attention shall be given to the following:

a. Condition of material finishes.

b. Satisfactory tightness of assembly bolts and screws.

c. Freedom from contamination, such as corrosion products, scale, grease, etc.

1.6 Equipment Description - The ALSD Battery consists of a pressurizable magnesium case (stainless steel for training units) with sixteen (16) silver-zinc cells, an electrical connector, power control switch and pressure relief valve. The Handle and Switch Actuator Assembly mechanically interfaces with the battery, and provides the means for electrically controlling the battery output power.

1.7 Electrical Performance Requirements

a. Install battery assembly on battery charging unit adapter box. Remove battery lid attachment nuts and cover. Install handle and actuator switch assembly on battery. (Remove switch hold-down from adapter box if necessary.)

(1) Insure that all cell interconnect straps and electrolyte fill caps are secure. Record under Item 2 of Table VII-2.

Note: When spare battery is being tested, handle assembly from any available ALSD may be employed.

b. Adjust multimeter for continuity check on the R x 1 scale. Connect meter leads between the red charging plug of the battery charging unit adapter box and the red battery power lead connected to the positive terminal cell.

(1) Meter shall indicate open circuit (infinite ohms). Record under Item 3 of Table VII-2.

c. Depress left side handle actuating switch.

(1) Meter shall indicate open circuit (infinite ohms). Record under Item 4 of Table VII-2.

d. Release left side and depress right side handle actuating switch.

(1) Meter shall indicate open circuit (infinite ohms). Record under Item 5 of Table VII-2.

e. Simultaneously depress left and right side handle actuating switches.

(1) Meter shall indicate continuity (less than 0.5 ohms). Record under Item 6 of Table VII-2.

f. Adjust multimeter for continuity check on the R x 1 scale. Connect meter leads between the black charging plug of the battery charging unit adapter and the black power lead connected to the negative terminal cell.

(1) Meter shall indicate continuity (less than 0.5 ohms). Record under Item 7 of Table VII-2.

g. Adjust multimeter for continuity check on the R x 1 scale. Depress both battery handle actuating switches. Sequentially connect meter leads between the battery charging unit red charging plug and battery electrical connector shell, and between the black charging plug and battery connector shell.

(1) Meter shall indicate open circuit (infinite ohms) between red charging plug and battery connector shell. Record under Item 8 of Table VII-2.

(2) Meter shall indicate open circuit (infinite ohms) between black charging plug and battery connector shell. Record under Item 9 of Table VII-2.

h. Remove handle assembly from battery. Replace battery lid, insuring the sealing gasket is properly installed and that there is no visual evidence of foreign particles. Tighten hex head nuts in increments of 4 to 6 inch-pounds to a torque of 12 to 16 inch-pounds unless Para. 1.8 is to be immediately performed.

Note: Hex head nuts should be tightened in a consecutive clockwise order; do not use the criss-cross method of tightening.

i. Remove battery from charging unit adapter.

1.8 Pressurization Performance Requirements (Flight Units Only)

a. Remove pressure relief valve from battery assembly. Assemble relief valve and pressurization unit components as illustrated in Figures VII-1 and VII-2. Loosen hex head nuts on battery assembly cover.

b. Disengage pressurization unit regulator valve by turning counterclockwise several turns. Close all remaining valves on pressurization unit.

c. Connect high pressure nitrogen tank to pressurization unit. Adjust nitrogen tank regulator to 60 ±20 psig. Open low pressure relief valve.

d. Open supply valve and isolation valve. Slowly adjust regulator valve for a gauge indication of 3 psig. Nitrogen gas shall escape around battery assembly lid. Allow battery assembly to purge for a minimum of five (5) minutes.

e. Adjust regulator to maintain 3 psig while retightening battery assembly cover nuts consecutively to 12-16 inch-pounds in 4-6 inch-pound increments.

f. Slowly adjust regulator (clockwise) until battery relief valve "cracks".

(1) Pressure gauge shall read 5.0 ±1.0 psi. Record under Item 10 of Table VII-2.

g. Adjust pressurization unit regulator for a gauge indication of 4.0 psi.

h. Slowly open manometer isolation valve. Close isolation valve and supply valve.

i. Allow pressure to stabilize for a minimum of ten (10) hours.

Note: If manometer indicates less than 7.0 in. Hg during the first 60 minutes, close manometer isolation valve, repeat steps g. and h., and continue with 10-hour leak test. A decrease in pressure below 5 in. Hg during the 10-hour period indicates a leak. Check for leaks using a liquid leak detector.

j. Record the following initial readings under Items 11 through 15 of Table VII-2.

(1) Starting time

(2) Ambient temperature

(3) Uncorrected barometric pressure

(4) Barometric temperature correction (if required) from Table VII-1.

(5) Manometer pressure reading (read crown of mercury column).

k. Allow a minimum of three (3) hours to elapse before documenting final readings. Record the following under Items 18 through 22 of Table VII-2.

(1) Completion time

(2) Ambient temperature

(3) Uncorrected barometric pressure

(4) Barometric temperature correction (if required) from Table VII-1.

(5) Manometer pressure reading (read crown of mercury column).

Compute leakage in accordance with the data sheet instructions to ensure that a maximum of 0.2 in. Hg is not exceeded.

Note: Ambient temperature range shall be between 60° and 90°F with variations not to exceed ±10° during performance of test.

l. Depressurize system by turning regulator counterclockwise and opening isolation valve.

m. Disassemble test setup and immediately screw relief valve into battery assembly and torque to 35 ±5 inch-pounds. Replace lock-wire.

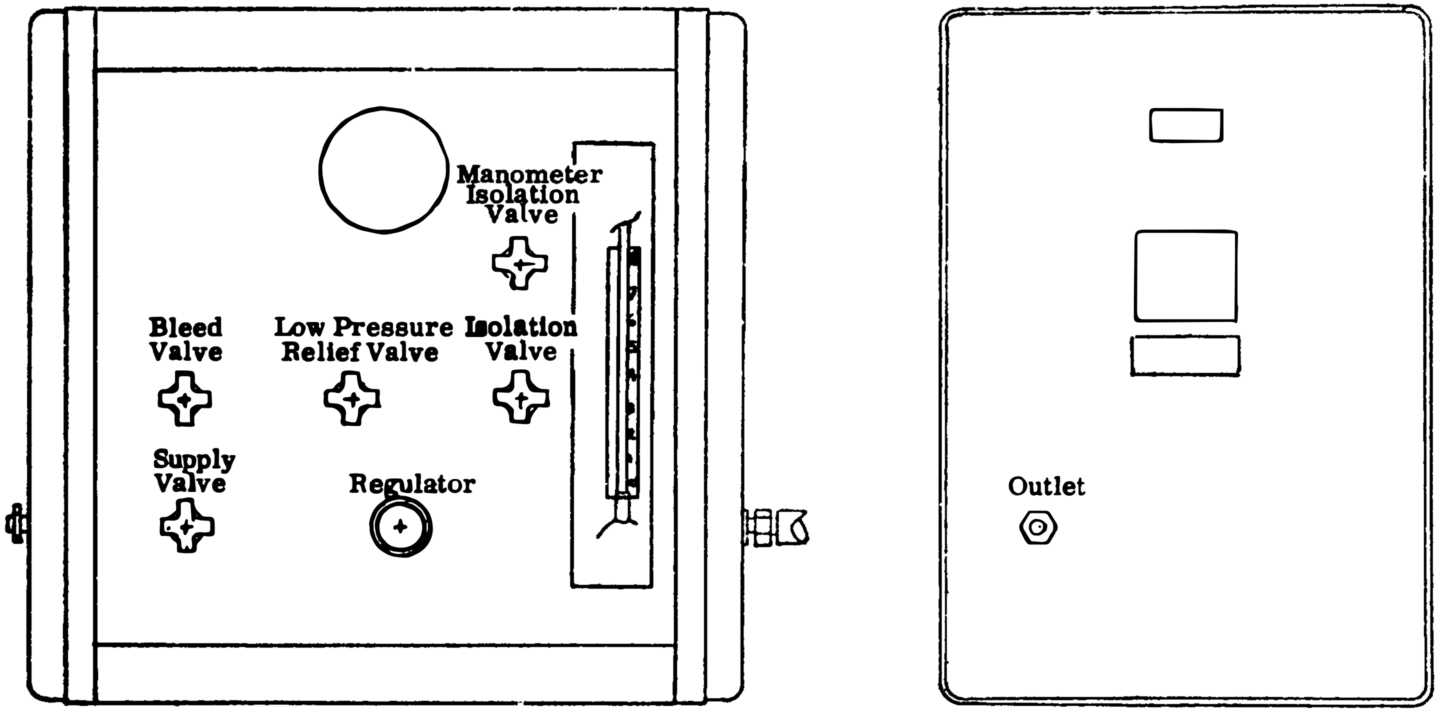


Figure VII-1. ALSD Pressurization Unit

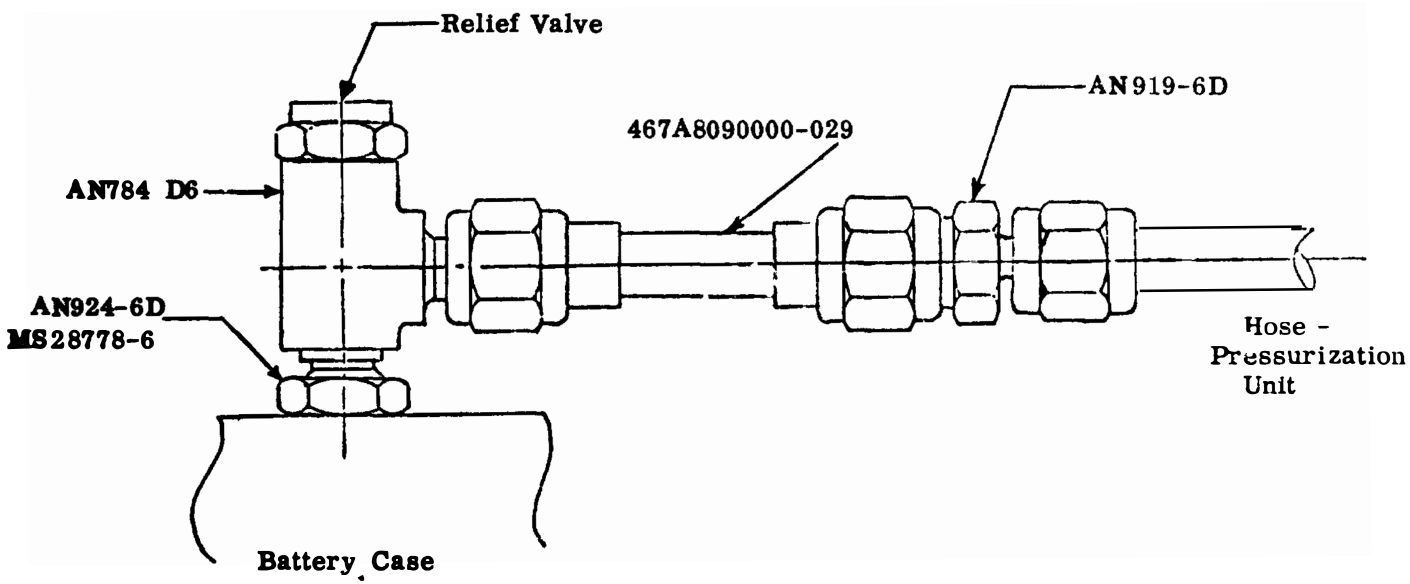


Figure VII-2. Battery Case/Pressurization Unit Interface

Table VII-1. Barometer Correction Chart (Sheet 1 of 2)

CORRECTION FOR BAROMETER OBSERVED HEIGHT IN INCHES																	
TEMP. °F.	27.5 IN.	27.75 IN.	28.0 IN.	28.25 IN.	28.5 IN.	28.75 IN.	29.0 IN.	29.25 IN.	29.5 IN.	29.75 IN.	30.0 IN.	30.25 IN.	30.5 IN.	30.75 IN.	31.0 IN.	31.25 IN.	31.5 IN.
60	.078	.079	.080	.0805	.081	.0815	.082	.083	.084	.0845	.085	.086	.087	.0875	.088	.089	.090
61	.080	.081	.082	.083	.0835	.084	.085	.086	.0865	.087	.088	.0885	.089	.090	.091	.092	.093
62	.083	.084	.085	.0855	.086	.087	.088	.0885	.089	.090	.091	.0915	.092	.093	.094	.0945	.095
63	.085	.086	.087	.088	.089	.0897	.090	.091	.092	.093	.0935	.094	.095	.096	.0965	.097	.098
64	.088	.089	.090	.091	.092	.0925	.093	.094	.095	.0955	.096	.097	.098	.0985	.099	.100	.101
65	.090	.091	.092	.093	.094	.095	.0955	.096	.097	.098	.0985	.099	.100	.101	.102	.103	.104
66	.093	.094	.095	.096	.097	.0975	.098	.099	.100	.1005	.101	.102	.103	.104	.105	.106	.107
67	.095	.096	.097	.098	.099	.100	.1005	.101	.102	.103	.104	.105	.106	.107	.108	.109	.110
68	.098	.099	.100	.101	.102	.1025	.103	.104	.105	.106	.107	.108	.109	.1095	.110	.111	.113
69	.100	.101	.102	.103	.104	.105	.106	.107	.108	.109	.110	.111	.112	.1125	.113	.114	.115
70	.103	.104	.105	.106	.107	.108	.109	.110	.111	.1115	.112	.113	.115	.1155	.116	.117	.118
71	.105	.106	.107	.108	.109	.110	.111	.112	.113	.114	.115	.116	.117	.118	.119	.120	.121
72	.108	.109	.110	.111	.112	.113	.114	.115	.116	.117	.118	.119	.120	.121	.122	.123	.124
73	.110	.111	.112	.113	.114	.115	.116	.117	.118	.119	.120	.121	.123	.124	.125	.126	.127
74	.113	.114	.115	.116	.117	.118	.119	.120	.121	.122	.123	.124	.126	.1265	.127	.128	.130

Table VII-1. Barometer Correction Chart (Sheet 2 of 2)

	CORRECTION FOR BAROMETER OBSERVED HEIGHT IN INCHES																
TEMP. °F.	27.5 IN.	27.75 IN.	28.0 IN.	28.25 IN.	28.5 IN.	28.75 IN.	29.0 IN.	29.25 IN.	29.5 IN.	29.75 IN.	30.0 IN.	30.25 IN.	30.5 IN.	30.75 IN.	31.0 IN.	31.25 IN.	31.5 IN.
75	.115	.116	.117	.118	.119	.120	.121	.122	.124	.1245	.125	.127	.128	.129	.130	.131	.132
76	.118	.119	.120	.121	.122	.123	.124	.125	.127	.1275	.128	.129	.131	.132	.133	.134	.135
77	.120	.121	.122	.123	.125	.126	.127	.128	.129	.130	.131	.132	.134	.135	.136	.137	.138
78	.123	.124	.125	.126	.128	.1285	.129	.130	.132	.133	.134	.135	.137	.1375	.138	.139	.141
79	.125	.126	.127	.129	.130	.131	.132	.133	.134	.135	.136	.138	.139	.140	.141	.142	.144
80	.128	.129	.130	.131	.133	.134	.135	.136	.137	.138	.139	.140	.142	.143	.144	.145	.147
81	.130	.131	.132	.134	.135	.136	.137	.138	.140	.141	.142	.143	.145	.146	.147	.148	.149
82	.133	.134	.135	.136	.138	.139	.140	.141	.143	.144	.145	.146	.148	.1485	.149	.150	.152
83	.135	.136	.137	.139	.140	.141	.142	.144	.145	.146	.147	.149	.150	.151	.152	.153	.155
84	.138	.139	.140	.141	.143	.144	.145	.146	.148	.149	.150	.151	.153	.154	.155	.156	.158
85	.140	.141	.142	.144	.145	.146	.147	.149	.150	.151	.152	.154	.156	.157	.158	.159	.161
86	.143	.144	.145	.146	.148	.149	.150	.151	.153	.154	.155	.157	.159	.160	.161	.162	.164
87	.145	.146	.147	.149	.150	.151	.152	.154	.156	.157	.158	.159	.161	.162	.163	.165	.166
88	.148	.149	.150	.151	.153	.154	.155	.157	.159	.160	.161	.162	.164	.165	.166	.167	.169
89	.150	.151	.152	.154	.155	.156	.158	.159	.161	.162	.163	.165	.167	.168	.169	.170	.172
90	.153	.154	.155	.156	.158	.159	.161	.162	.164	.165	.166	.168	.170	.171	.172	.173	.175

Table VII-2. Inactive Battery Subsystem Verification Data Sheet

ALSD Assembly Part No. 467A8060000 - ________________ Serial Number ________________

Battery Assembly Part No. PS940300014 - ________________ Serial Number ________________

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL		
					DATE	INSP.	CUST.
1		Status of calibration sensitive measuring & test equipment verified					
2	1.7.a(1)			Acceptable			
3	1.7.b(1)			Inf. Ohms			
4	1.7.c(1)			Inf. Ohms			
5	1.7.d(1)			Inf. Ohms			
6	1.7.e(1)			<0.5 Ohms			
7	1.7.f(1)			<0.5 Ohms			
8	1.7.g(1)			Inf. Ohms			
9	1.7.g(2)			Inf. Ohms			
10	1.8.f(1)			5 ±1.0 psi			
11	1.8.j(1)						
12	1.8.j(2)		°F				
13	1.8.j(3)		In. Hg.				
14	1.8.j(4)		In. Hg.				
15	1.8.j(5)		In. Hg.				

Table VII-2. Inactive Battery Subsystem Verification Data Sheet (Continued)

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL DATE	APPROVAL INSP.	APPROVAL CUST.
16		Subtract Item 14 from 13 to obtain temperature corrected barometric pressure.	in. Hg.				
17		Add Items 15 and 16 to obtain temperature corrected absolute pressure.	In. Hg.				
18	1. 8. k(1)						
19	1. 8. k(2)		°F				
20	1. 8. k(3)		In. Hg.				
21	1. 8. k(4)		In. Hg.				
22	1. 8. k(5)		In. Hg.				
23		Subtract Item 21 from Item 20 to obtain temperature corrected barometric pressure.	In. Hg.				
24		Add Items 22 and 23 to obtain temperature corrected absolute pressure.	In. Hg.				
25		Multiply Item 17 by $\frac{459.6 + \text{Item } 12}{459.6 + \text{Item } 19}$ to temperature-correct initial pressure.	In. Hg.				
26		Subtract Item 24 from Item 25 to obtain leakage.		<0.2 In. Hg.			

2.0 NONOPERATING POWER HEAD SUBSYSTEM VERIFICATION

2.1 Purpose - This procedure establishes the inspection and test requirements for the nonoperating ALSD Power Head, (MMC P/N PS955000002).

2.2 Time Interval - This procedure shall be performed in accordance with the following schedule:

a. Within the four (4) month period preceding launch date. (preferably at T-90 days)

Note: Service life of individual components delineated in equipment data packages.

2.3 Test Equipment Requirements

a. Pressurization Unit (MMC P/N 467A8090000-009).

b. Gaseous Nitrogen source to conform with MIL-P-27401B, Type I.

c. Source regulator and gauge system capable of 0-100 (min.) psi range.

d. Source-to-Pressurization Unit hose capable of attaching to inlet port fitting, AN832-4D.

e. Multimeter, Simpson Model 260 or equivalent.

2.4 Failure/Malfunction Criteria - Failure of the Power Head to meet the performance requirements specified herein shall constitute a malfunction. Each malfunction will require an investigation to determine cause.

2.5 Visual Examination - The units shall be visually examined for cleanliness. Particular attention shall be given to the following:

a. Condition of material finishes.

b. Satisfactory tightness of assembly bolts and screws.

c. Freedom from contamination, such as corrosion products, scale, grease, etc.

2.6 Equipment Description - The ALSD Power Head contains the electric motor, percussion and rotation systems required for powering the drill bit.

2.7 Electrical Performance Requirements

a. Adjust multimeter for continuity test on the R x 1 scale. Sequentially measure the resistance between the male pins of the electrical connector and each pin and the shell of the connector.

(1) Resistance between pins shall be less than 1.0 ohm. Record under Item 2 of Table VII-3.

(2) Resistance reading between each pin and the connector shell shall indicate open circuit (infinite ohms). Record under Item 3 of Table VII-3.

2.8 Pressurization Performance Requirements

a. Remove power head pressure relief valve and assemble with pressurization unit components as illustrated in Figures VII-1 and VII-3.

b. Disengage pressurization unit regulator valve by turning counterclockwise several turns. Close all remaining valves on pressurization unit.

c. Connect high pressure nitrogen tank to pressurization unit. Adjust nitrogen tank regulator to 60 $\pm$20 psig.

d. Remove power head oil filler screw. Slowly open the supply and isolation valves.

   (1) Pressurization gauge should indicate zero (0) pressure. Record under Item 4 of Table VII-3.

e. Open manometer isolation valve. Position power head so that oil port is vertical. Slowly close regulator valve while monitoring oil port for escaping nitrogen. Set regulator so that nitrogen escapes without ejecting oil (approximately 0.5 inch on manometer). Allow power head to purge for a minimum of five (5) minutes.

f. Remove oil residue which may have collected. Replace oil port screw and seal, and torque to 7 $\pm$1 inch-pounds. Close manometer isolation valve.

g. Slowly adjust regulator (clockwise) until power head relief valve "cracks".

   (1) Pressure gauge shall indicate 15 $\pm$2.0 psi. Record under Item 5 of Table VII-3.

h. Adjust pressurization unit regulator for a gauge indication of 10 psi. Close isolation valve and supply valve.

i. Allow power head pressure to stabilize for a minimum of two (2) hours.

   Note: A decrease in pressure below 8 psi indicates a leak. Check for leaks using a liquid leak detector.

j. Record the following initial readings under Items 6 through 10 of Table VII-3.

   (1) Starting time

   (2) Ambient temperature

   (3) Uncorrected barometric pressure

   (4) Barometric temperature correction (if required) from Table VII-1.

   (5) Pressure gauge reading.

k. Allow a minimum of fifteen (15) hours to elapse before taking final readings. Record the following under Items 14 through 18 in Table VII-3.

(1) Completion time

(2) Ambient temperature

(3) Uncorrected barometric pressure

(4) Barometric temperature correction (if required) from Table VII-1.

(5) Pressure gauge reading.

Compute leakage in accordance with the data sheet instructions to ensure that a maximum of 0.5 psig (1.02 in. Hg) is not exceeded.

Note: Ambient temperature range shall be between 60° and 90°F with variations not to exceed $\pm 10^{\circ}$ during performance of this test,

l. Depressurize system by turning regulator counterclockwise and opening isolation valve.

m. Disassemble test setup and immediately screw relief valve into power head and torque to 35 ± 5 inch-pounds.

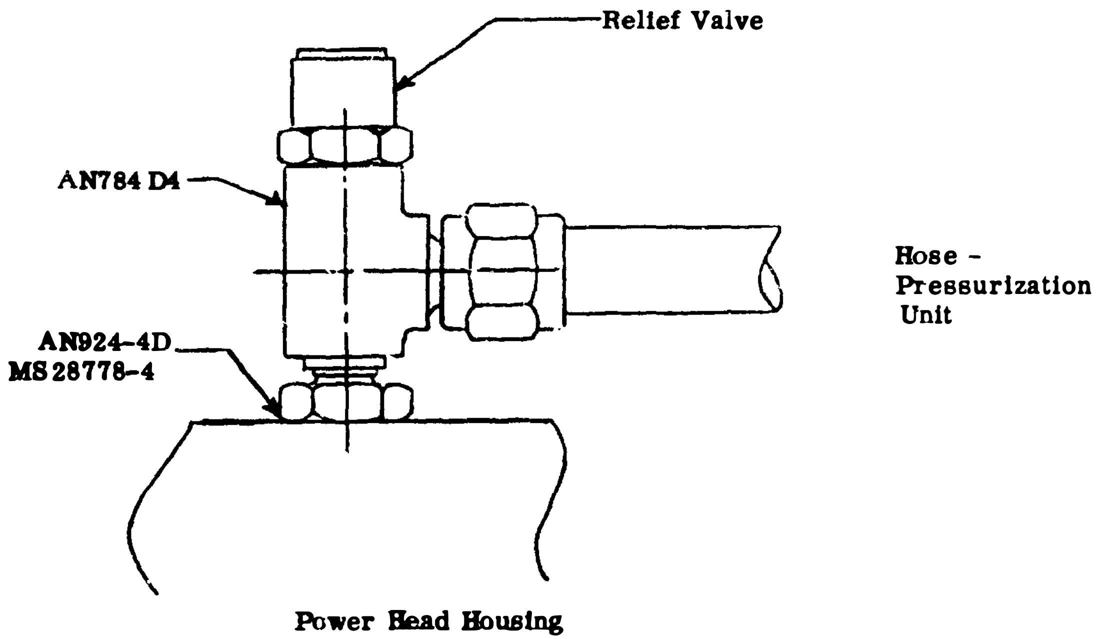


Figure VII-3. Power Head/Pressurization Unit Interface

Table VII-3. NONOPERATING Power Head Subsystem Verification Data Sheet

ALSD Assembly Part No. 467A8060000 - ________________ Serial No. ____________________

Power Head Part No. PS955000002 - ________________ Serial No. ____________________

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL DATE	INSP.	CUST.
1		Status of calibration sensitive measuring & test equipment verified					
2	2.7.a(1)			< 1.0 Ohm			
3	2.7.a(2)			Inf. Ohms			
4	2.8.d(1)			0 psig			
5	2.8.g(1)			15±2.0 psig			
6	2.8.j (1)						
7	2.8.j (2)		°F				
8	2.8.j (3)		In. Hg.				
9	2.8.j (4)		In. Hg.				
10	2.8.j (5)		psig				
11		Multiply Item 10 by 2.036 to obtain In. Hg.	In. Hg.				
12		Subtract Item 9 from Item 8 to obtain temperature corrected barometric pressure.	In. Hg.				
13		Add Items 11 and 12 to obtain temperature corrected absolute pressure.	In. Hg.				

Table VII-3. NONOPERATING Power Head Subsystem Verification Data Sheet (Continued)

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL		
					DATE	INSP.	CUST.
14	2.8.k(1)						
15	2.8.k(2)		°F				
16	2.8.k(3)		In. Hg.				
17	2.8.k(4)		In. Hg.				
18	2.8.k(5)		psig				
19		Multiply Item 18 by 2.036 to obtain In. Hg.	In. Hg.				
20		Subtract Item 17 from 16 to obtain temperature corrected barometric pressure.	In. Hg.				
21		Add Items 19 and 20 to obtain temperature corrected absolute pressure.	In. H. g				
22		Multiply Item 13 by $\frac{459.6 + \text{Item 7}}{459.6 + \text{Item 15}}$ to temperature-correct starting pressure.	In. Hg.				
23		Subtract Item 21 from 22 to obtain leakage.		$<$ 1.02 In. Hg.			

3.0 ALSD ASSEMBLY DEPLOYMENT VERIFICATION

3.1 Purpose - This procedure established the inspection and test requirements for the deployment of the ALSD.

3.2 Time Interval - This procedure shall be performed in accordance with the following schedule:

a. Within the four (4) month period preceding launch date. (preferably at T-90 days)

3.3 Test Equipment Requirement

a. 0 - 15 pound range spring scale.

3.4 Failure/Malfunction Criteria - Failure of the ALSD to meet the deployment performance requirements specified herein shall constitute a malfunction. Each malfunction will require an investigation to determine cause.

3.5 Visual Examination - The unit shall be visually examined for cleanliness. Particular attention shall be given to the following:

a. Condition of material finishes.

b. Satisfactory tightness of assembly bolts and screws.

c. Freedom from contamination, such as corrosion products, scale, grease, etc.

3.6 Equipment Description - The ALSD assembly consists of the integrated battery/power head, treadle and rack assemblies with their associated subassemblies.

3.7 Deployment Performance Requirements - Table VII-4 to be used for deployment verification entries.

Place ALSD in stowed configuration on a suitable work table with battery oriented to the right and the bottom of treadle on table top.

a. Hold ALSD steady with right hand.

(1) Remove bore stem retention pin by pulling upward on ring. (Figure V-10) Pin shall remove easily. Record under item 2.

(2) Remove rack support pin by pulling release ring horizontally to left (Figure V-11) Pin shall come out easily. Record under item 2.

b. Release rack camloc by turning counterclockwise 90 degrees (ref. Figure V-12). Lift bracket.

(1) Camloc shall release easily. Bracket shall rotate clear of power head without interference. Record under item 3.

c. Release battery camloc by turning counterclockwise 90 degrees. Lift camloc clear of treadle. Remove camloc and support pin by pulling release lanyard ring horizontally to the right (Figures V-13 and V-14).

(1) Camloc shall release easily. There shall be no interference between camloc and bore stem tray bulkhead. Record under item 4.

(2) The pin shall release easily. Record under item 5.

d. Restrain rack assembly. Attach spring scale to within 0.25 inch of the end of leg retained by clip. Apply force perpendicular to the leg in plane of motion.

(1) Release shall require 5 to 10 pounds. Record under item 6.

(2) Ensure that leg unfolds outward to locked position. Record under item 7.

(3) Check leg extension. Telescoping section shall start to extend without binding. Record under item 8.

e. Attach loop in a cord to extension leg (d). Attach spring scale to loop and pull parallel to leg axis until leg locks in fully extended position.

(1) Force shall not exceed 3 pounds. Record under item 9.

(2) Check orange color coding. Record under item 10.

(3) Ensure that leg is firmly locked by retainer springs. Record under item 11.

f. (1) Ensure that fixed leg will start to extend manually without binding. Record under item 12.

g. Repeat step (e) for this leg. Record under items 13, 14, and 15.

h. Restrain ALSD. Attach spring scale to within 0.25 inch of end of handle and switch actuator. Apply force perpendicular to the handle until it releases from stowage clip.

(1) Release is to occur between 5 and 10 pounds. Record under item 16.

i. Engage handle fixed lock pin into upper receptacle in battery. Attach spring scale to disengaged end of handle 2.5 $\pm$ .2 inches from lower receptacle in battery. Apply force 90 degrees to the handle in plane of lock pin until spring-loaded pin fully engages receptacle.

(1) Engagement force shall not exceed 10 pounds. Record under item 17.

j. Lift rack vertically to clear treadle and power head assembly.

(1) Ensure that no binding or interference occurs during removal. Record under item 18.

(2) Lower leg shall unfold downward to a locked position. Record under item 19.

(3) Ensure that leg will start to extend without binding. Record under item 20.

k. Repeat step (e) for this leg. Record under items 21, 22, and 23.

l. Place rack on surface. Rack shall be stable with no tendency to tip or lean when rocked. Record under item 24.

m. Delete

n. Remove bore stem cover.

(1) Cover shall disengage easily without binding. Record under item 26.

o. Pull bore stem retention strap release tab.

(1) Velcro shall separate easily. Strap shall fully deploy. Record under item 27.

p. Rotate adapter (in power head spindle) counterclockwise until retention spring clips reach detent at end of groove.

(1) Adapter shall turn easily. Spring-loaded key blocks shall release freely. Retention spring clips shall engage groove limit detent to preclude further adapter rotation without definite torque increase. Record under item 28.

q. Delete

r. Reset collet. Depress spring-loaded key blocks. Rotate clockwise until adapter is fully engaged.

(1) Collet shall reset without binding. Adapter shall engage without binding. Record under item 30.

s. Sequentially remove, inspect, and replace each bore stem.

(1) Bore stems to be free of any damage to taper joints and drill bits. Check for orange stripe on inside circumference of upper end of taper of drill bit stems. Paint to be clearly visible. Check yellow band on six stems. Ensure paint is clearly visible around entire circumference. Record under item 31.

t. Remove power head support bracket pin by pulling ring parallel to power head axis (ref. Figure V-23).

(1) Pin shall come out easily. Bracket shall rotate free of the thermal guard without interference. Record under item 32.

u. Lift power head and battery assembly from treadle and place on surface.

(1) Assembly shall lift easily with no interference. Record under item 33.

v. Lift treadle from table and fit to rack.

(1) There shall be no binding or interference. Record under item 34.

w. Remove thermal shroud by pulling release ring.

(1) Shroud latch shall release easily. Record under item 35.

x. Restrain rack. Attach spring scale to within 0.25 inch of the end of the wrench handle. Apply force perpendicular to wrench handle until handle releases from stowage clip.

(1) Release shall occur between 5 and 10 pounds. Record under item 36.

*y. Sequentially remove core stem caps (A through H) from the first retainer assembly and I through L from the second retainer assembly.

(1) Caps shall slide from stowage retainer easily.

(2) Replace caps in proper sequence. Record under item 37.

*z. Select a core stem as a check tool. Sequentially couple the male and female threads of remaining core stems to the check tool. Couple all male ends to the power head spindle.

(1) All threads are to smoothly and easily engage and disengage. Record under item 38.

aa. Reassemble ALSD into stowage mode in accordance with the following procedures.

a) Place ALSD components on a suitable work bench.

b) Place bore stems in rack. Ensure that bore stems with drill bit attached are placed over special plug in rack. Rotate stem until bit cutting blade engages slot. Stems with yellow band to be placed over plugs marked with "Y" in Figure III-19.

c) Reset adapter, remove treadle from rack, place treadle on table, stow velcro,

d) Overlap bore stem retention strap and engage velcro,

e) Hold bore stems in stowage position with one hand and replace bore stem cover with other hand,

f) Insert bore stem cover retention pin. Ensure pull ring is oriented to handle and wrench stowage side of rack,

g) Remove handle from power head and place in rack stowage clip. Ensure that rack pin engages hole in handle,

* To be performed in LRL at NASA-MSC by MMC personnel.

h) Restow wrench in rack clips. Ensure that rack pin engages hole in wrench handle,

i) Replace thermal shroud on battery. Pull ring to be at the corner of the battery where start switch is located,

j) Place power head and battery assembly on treadle with battery spring-loaded lock pin receptacle over battery camloc receptacle in treadle. Ensure that there is no interference between the thermal guard and the power head support fixture on treadle. Ensure that power head support ring engages slots in treadle support fixture,

k) Rotate power head support bracket to closed position and install power head support bracket retention pin. Ring toward spindle,

l) Release fixed leg lock spring and collapse extended section of leg,

m) Release adjoining leg lock spring and collapse extended section of leg,

n) Release #3 leg lock spring and collapse extended section of leg,

o) Lift rack, using handle, fold #3 leg inward,

p) Engage rack pin into treadle receptacle,

q) Insert rack support pin #1,

r) Rotate rack retention bracket to closed position and engage rack camloc (90° clockwise),

s) Fold #1 leg inward and engage stowage clip ensuring that #2 leg foot pad is restrained by #1 leg foot pad and that #1 leg foot pad is restrained by rack fixture,

t) Install battery camloc ,

u) Rotate ALSD assembly 90° toward operator,

v) Fully collapse extended section of leg #3 and ensure that foot pad is restrained by rack fixture; engage rack support pin #2,

w) Place end of bore stem retention strap velcro under leg #1,

x) Ensure bore stems positioned adjacent to leg #1 do not interfere with leg deployment,

y) Hold ALSD in vertical orientation with carrying handle. Place assembly into plastic bag,

z) Place assembly into bottom of shipping container (portion with handle attached) in the following orientation: carrying handle to the right, battery to the left, and the bore stems forward. Close and latch top. Lock container.

Verify correct assembly with Figures III-3, III-4, and III-5. Particular attention shall be given to camloc fasteners and the proper positioning of all release lanyards and pull pins in accordance with Figure III-14. Ensure that power head lanyard attach bracket is located such that lanyard is 30° - 45° to the power head spindle. Ensure that bore stem retention strap velcro is placed under rack leg #1. Ensure bore stems positioned adjacent to rack leg #1 do not interfere with leg deployment. Ensure leg hinges (2 each) are not over-centered when in stowed position. Ensure ALSD/ALSEP mounting receptacles are free of paint. Record under item 39.

Table VII-4. ALSD Assembly Deployment Verification

ALSD Assembly Part No. 467A8060000- ____________ Serial Number ____________

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL		
					DATE	INSP.	CUST.
1		Status of calibration sensitive measuring & test equipment verified.					
2	3.7 a(1) 3.7 a(2)			Acceptable Acceptable			
3	3.7.b(1)			Acceptable			
4	3.7.c(1)			Acceptable			
5	3.7 c(2)			Acceptable			
6	3.7 d(1)			5 to 10 lbs			
7	3.7 d(2)			Acceptable			
8	3.7 d(3)			Acceptable			
9	3.7 e(1)			< 3 lbs.			
10	3.7 e(2)			Acceptable			
11	3.7 e(3)			Acceptable			
12	3.7 f(1)			Acceptable			
13	3.7 g(1)			< 3 lbs.			
14	3.7 g(2)			Acceptable			
15	3.7 g(3)			Acceptable			

Table VII-4. ALSD Assembly Deployment Verification (Continued)

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL DATE	APPROVAL INSP.	APPROVAL CUST.
16	3.7 h(1)			5 to 10 lbs			
17	3.7 i(1)			$\leq$ 10 lbs			
18	3.7 j(1)			Acceptable			
19	3.7 j(2)			Acceptable			
20	3.7 j(3)			Acceptable			
21	3.7 k(1)			$<$ 3 lbs.			
22	3.7 k(2)			Acceptable			
23	3.7 k(3)			Acceptable			
24	3.7 1			Acceptable			
25	Delete						
26	3.7 n(1)			Acceptable			
27	3.7 o(1)			Acceptable			
28	3.7 p(1)			Acceptable			
29	Delete						
30	3.7 r(1)			Acceptable			
31	3.7 s(1)			Acceptable			
32	3.7 t(1)			Acceptable			

Table VII-4. ALSD Assembly Deployment Verification (Concluded)

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL DATE	APPROVAL INSP.	APPROVAL CUST.
33	3.7 u(1)			Acceptable			
34	3.7 v(1)			Acceptable			
35	3.7 w(1)			Acceptable			
36	3.7 x(1)			5 to 10 lbs			
37	3.7 y (2)			Acceptable			
38	3.7 z(1)			Acceptable			
39	3.7aa(1)			Acceptable			

4.0 ALSD BATTERY ACTIVATION PROCEDURES

4.1 Purpose - This procedure establishes the operating instructions for activating the dry charged ALSD Flight (PS9403000014-003) and Training (PS9403000014-001) Unit Battery Assemblies.

4.2 Activation Time Intervals - This procedure shall be performed in accordance with the following schedule.

a. Flight unit batteries shall be activated in accordance with the Apollo countdown schedule specified in another section of this manual.

b. Training unit batteries shall be activated at the beginning of ALSD operational training and when cell set replacements are required.

4.3 Test Equipment Requirements

a. Voltmeter, DC 0-50 Volts, Weston Model 901 or equivalent.

b. Voltmeter, DC 0-3 Volts, Weston Model 531 or equivalent.

c. Torque Wrench, 0-50 inch-pounds

d. Battery Filler Kit (Yardney Part No. 11294 for training models and No. 11310 for flight models).

e. Vacuum Chamber or Bell Jar capable of maintaining 5 In. Hg. (min.) pressure.

4.4 Failure/Malfunction Criteria - Failure of the unit to meet the performance requirements specified herein shall constitute a malfunction. Each malfunction will require an investigation to determine cause.

4.5 Visual Examination - This unit shall be visually examined for cleanliness. Particular attention shall be given to the following:

a. Condition of material finishes.

b. Freedom from contamination, such as corrosion products, scale, grease, etc.

c. Satisfactory tightness of assembly bolts and screws, electrical receptacle, relief valve and switch cover.

d. Condition of electrical connector pins.

4.6 Equipment Description - The ALSD Battery Assembly contains sixteen (16) silver-zinc cells, pressure relief valve, control switch with sealing boot, electrical receptacle, interconnecting wiring and mechanical hardware required to interface with the ALSD Power Head and Handle Assembly.

4.7 Precautions

a. Electrolyte Characteristics - The electrolyte (a strong solution of potassium hydroxide) is alkaline and corrosive, and should be handled with care. If neglected, the electrolyte will cause serious burns when it is permitted to come in contact with the eyes or skin. Alkali-proof apron, rubber gloves and splash-proof goggles or a face mask are recommended for personnel engaged in filling and servicing SILVERCEL batteries.

b. Antidotes, Internal - Give large quantities of water and a weak acid solution such as vinegar, lemon juice or orange juice. Follow with one of the following: white-of-egg, olive oil, starch water, mineral oil, or melted butter. Obtain medical attention at once.

c. Antidotes, External - For the skin: wash the affected area with large quantities of water. Neutralize with vinegar, lemon juice, or 5% acetic acid and wash with water. Obtain medical attention at once.
For the eyes: wash with saturated solution of boric acid or flood with water. Use this first aid treatment until medical attention can be obtained.

d. Washing Glassware - The electrolyte is somewhat corrosive to glass. All beakers and syringes used should be thoroughly washed with water following their contact with the electrolyte.

e. Carbon Dioxide Absorption - Store the electrolyte in closed alkali-resistant containers as it absorbs carbon dioxide from the air. Prolonged exposure to the air will impair the properties of the electrolyte.

<u>CAUTION</u>: Do not, under any circumstances, attempt to use any type of electrolyte other than the special electrolyte furnished with the SILVERCEL battery. Other types of electrolyte may damage or destroy the battery.

f. **Handling Precautions - This battery is capable of supplying unusually high currents if it is accidentally short circuited. A prolonged short circuit may cause serious burns to personnel and may destroy the battery. To avoid accidental short circuits, all tools used in connection with the battery or within close vicinity of the battery must be properly insulated with a double layer of electrical tape or varnish.**

<u>CAUTIONS:</u>

(1) The battery shall be kept in an upright position under normal handling and operating conditions.

(2) In fastening the battery cover to the case, tighten the 18 hex head nuts (in increments of 4-6 inch-pounds) to a total torque of 12-16 inch-pounds. The hex head nuts should be tightened in a consecutive clockwise order. Do not use the criss-cross method of tightening nuts.

4.8 Battery Activation Procedure

Note: Filler Kit Items - Each battery is furnished with a battery filler kit containing the items delineated in paragraph IV-3.0. Ensure that proper filling kit (YEC P/N 11310 for Flight Units and P/N 11294 for Training Units) is used for activation.

a. Remove the battery cover and rubber sealing gasket by removing the 18 hex head nuts and stowing in bag remote from area where activation is performed.

CAUTION: To prevent seal damage, do not pry cover up by using an instrument under cover edge.

b. Remove the cell screw valve from each cell of the battery. Check that the "O" ring between the flange and threads of each cell screw valve is not damaged. Retain the cell screw valves as they will be re-inserted after filling.

c. Check to ensure that metal portion of filler caps have snug fit with polyethylene caps. Remove cap from one electrolyte filler bottle. Hand tighten one of the polyethylene filler caps securely onto the electrolyte bottle.

CAUTION: Do not apply excessive torque since damage will result to the polyethylene filler cap. Do not squeeze electrolyte from the bottle during this assembly.

d. Place the battery on its bottom with the cover opening toward the operator. Tilt the battery forward approximately 45°.

e. Insert filler cap tip with "O"ring into cell vent threaded hole. While ensuring that proper thread alignment is maintained, hand-tighten the assembly clockwise using only the hexagon section of the filler cap until the filler cap tip is securely in position.

WARNING: Do not tighten the filler cap to the cell by holding the bottle, since this will result in discharge of electrolyte onto the battery.

f. Position the battery so that the cover face is upward.

g. Press the electrolyte bottle at its mid-section compressing it 1/4-inch maximum. Then release until air bubbles cease to rise in the bottle. Repeat this operation until all of the electrolyte has been transferred into the cell. This operation should be performed slowly. Repeat this operation several times after the bottle is empty in order to remove any electrolyte in the filler cap assembly. Allow assembly to stand in this attitude for at least five minutes.

h. After filling is completed, carefully remove the filler cap and bottle from the cell by turning only the hexagon section of the filler cap. Remove any excess electrolyte from the vent hole by using a vent cleaner. Insert vent cleaner up to the knot, into the cell vent hole and turn for one complete revolution.

WARNING: If electrolyte is spilled on the cells or the battery interior, cognizant engineering personnel shall be informed immediately and shall review the incident. Use of such a battery shall be authorized by Material Review procedures only.

i. Replace the cell screw valve in the cell vent hole after the removal of the excess electrolyte from the vent hole is completed. Tighten valve to a flush fit using a torque of 1-2 inch-pounds.

WARNING: It is recommended that the cell screw valves be positioned in the cell vent immediately after the filling of each cell in order to minimize the possibility of filling one cell twice.

j. After the filling operation of one cell has been conducted, remove the polyethylene filling cap from the empty bottle by holding the polyethylene section of the cap. Clean the passage of the filling tip to remove droplets by inserting a stainless steel wire.

k. Repeat the procedural steps of Paragraphs 4. 8. c through 4. 8. j until all sixteen (16) cells have been filled.

l. After filling of all cells is complete, remove the sixteen (16) cell screw valves and allow the battery to soak for a minimum of six hours before continuing test. Battery cover shall be temporarily installed (without nuts) to preclude entry of foreign debris.

4.9 Battery Degassing (Vacuum Activation) Procedure

Note: The following instructions listed under this paragraph are applicable only to Flight model batteries.

a. Remove cover from battery and ensure that all cell screw valves are removed.

b. Install battery in vacuum chamber or bell jar in an upright position.

c. Slowly decrease internal chamber pressure from ambient to 5 ± 1 in. Hg over a five-minute period. Maintain chamber pressure at 5 ± 1 in. Hg for approximately 15 seconds, and slowly return to ambient over a five-minute period.

d. Remove battery from vacuum chamber, ensure that cell tops are free of electrolyte, and continue with Paragraph 4. 10.

4.10 Battery Voltage Checks

a. Replace 16 cell screw valves and tighten each to a flush fit using a torque of 1-2 inch-pounds.

b. Using the Weston 531 voltmeter (or equivalent), measure the terminal voltage of each cell for 1. 85 $\pm$ 0. 03 VDC. Record cell voltages under Items 5 through 20 of Table VII-5 using Figure VII-4 as a reference for cell identification.

c. Depress Hexseal boot switch cover. Using the Weston 531 (or equivalent) voltmeter, sequentially measure the voltage between Pin A (farthest from relief valve) and case, and Pin B (nearest to relief valve) and case of electrical receptacle. Voltmeter shall read 0 volts. Record under Items 21 and 22 of Table VII-5.

d. Depress Hexseal boot switch cover. Using the Weston 901 (or equivalent) voltmeter, measure the voltage between Pins A and B of the electrical receptacle. Pin A shall be +29.6 ±0.5 VDC with respect to Pin B. Record under items 23 and 24 of Table VII-5.

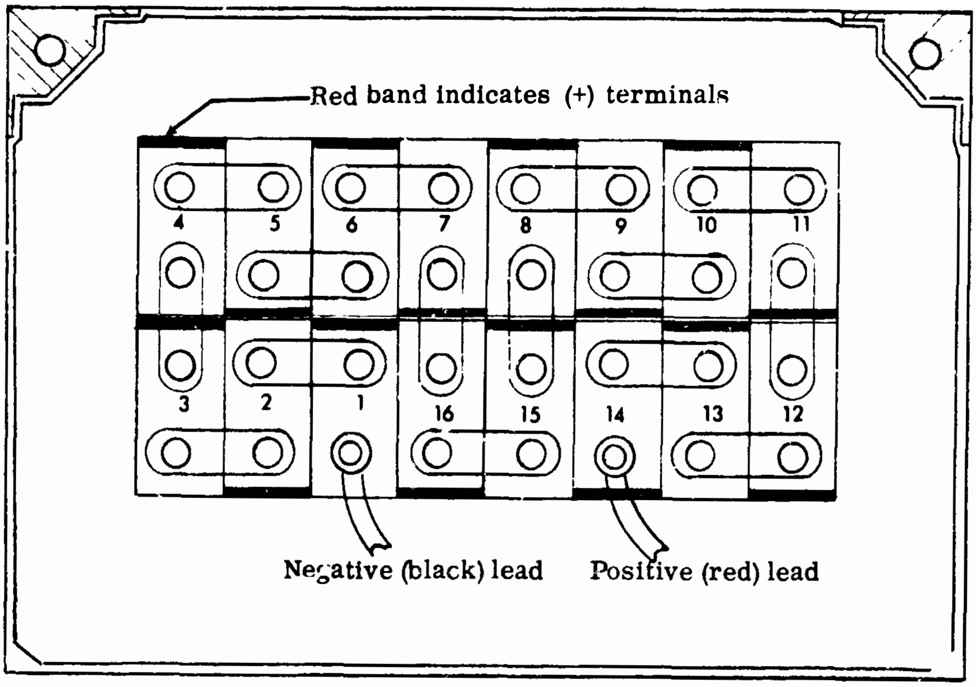
e. Visually inspect top of battery cells to ensure that cell cases and terminals are free of corrosion and electrolyte. Clean tops of cells if required.

Note: During re-inspection cycles of training unit batteries, vent holes and caps should be inspected to ensure that they are not clogged.

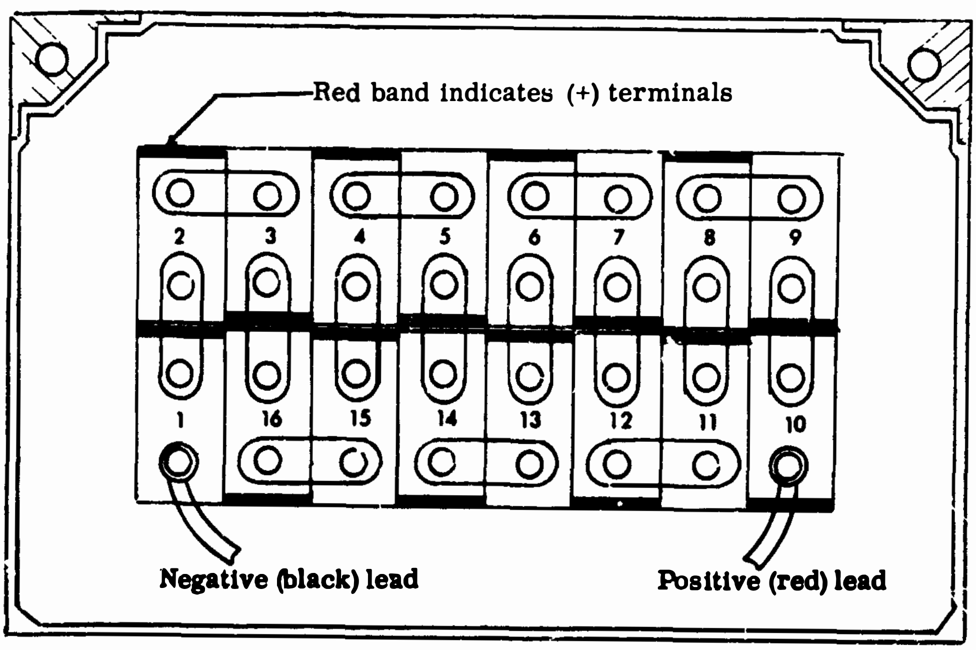
f. Replace the rubber sealing gasket and install two electrolyte trap assemblies (flight units only). Fasten cover to the case with the 18 hex head nuts previously removed, tightening them (in increments of 4-6 inch-pounds) to a torque of 12-16 inch-pounds. The hex head nuts should be tightened in a consecutive clockwise order. Do not use the criss-cross method of tightening nuts.

Notes: (1) Exercise extreme care during installation of electrolyte trap assemblies to ensure that the cell screw valves fit properly into the holes in the trap assembly. Ensure that the trap assembly lies flush with the cell tops after installation to preclude excessive loading by the battery case lid.

(2) Training unit (only) battery case pressure relief valves should be permanently removed to preclude accumulation of gas within the battery case during long term storage. Pressure relief valve is required only for operation of the ALSD system in a vacuum environment.



FLIGHT BATTERY



TRAINING BATTERY

Figure VII-4. Battery Cell Layout Diagram

Table VII-5. ALSD Battery Assembly Activation Data Sheet

ALSD Assembly Part No. 467A8060000 - ____________ Serial No. ____________

Battery Assembly Part No. PS940300014 - ____________ Serial No. ____________

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL		
					DATE	INSP.	CUST.
1		Status of calibration sensitive measuring & test equipment verified					
2	4.8.a - 1	Perform procedures		Completed			
3	4.9.a - d	Perform procedures		Completed			
4	4.10.a	Perform procedures		Completed			
5	4.10.b	Cell No. 1 Voltage		1.85 ± .03 VDC			
6	"	Cell No. 2 Voltage		"			
7	"	Cell No. 3 Voltage		"			
8	"	Cell No. 4 Voltage		"			
9	"	Cell No. 5 Voltage		"			
10	"	Cell No. 6 Voltage		"			
11	"	Cell No. 7 Voltage		"			
12	"	Cell No. 8 Voltage		"			
13	"	Cell No. 9 Voltage		"			
14	"	Cell No. 10 Voltage		"			

Table VII-5. ALSD Battery Assembly Activation Data Sheet (Continued)

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL		
					DATE	INSP.	CUST.
15	4.10.b	Cell No. 11 Voltage		1.85 ±.03 VDC			
16	"	Cell No. 12 Voltage		"			
17	"	Cell No. 13 Voltage		"			
18	"	Cell No. 14 Voltage		"			
19	"	Cell No. 15 Voltage		"			
20	"	Cell No. 16 Voltage		"			
21	4.10.c	Leakage Pin A to Case		0 VDC			
22	4.10.c	Leakage Pin B to Case		0 VDC			
23	4.10.d	Battery Terminal Voltage		29.6 ±0.5 VDC			
24	4.10.d	Pin A Positive		Yes			
25	4.10.e	Perform Procedure		Completed			
26	4.10.f	Perform Procedure		Completed			

5.0 POWER HEAD FUNCTIONAL CHECKOUT

5.1 Purpose - This procedure establishes the operating instructions for verifying proper functional operation of the ALSD Flight (PS955000002-007) and Training Unit No. 2 (PS955000002-005) Power Heads.

5.2 Time Interval - This procedure shall be performed in accordance with the following schedule.

a. Flight Unit No. 2 power head shall be verified in accordance with the BXA and KSC Prelaunch Operations Instructions.

b. Training unit power heads shall be verified in accordance with the ALSD Training Unit Service Checklist.

5.3 Test Equipment Requirements

a. Ammeter, DC 0 - 25 Amperes, Weston 901 or equivalent.

b. ALSD Battery Assembly (Activated).

5.4 Failure/Malfunction Criteria - Failure of the unit to meet the performance requirements specified herein shall constitute a malfunction. Each malfunction will require an investigation to determine cause.

5.5 Visual Examination - The units shall be visually examined for cleanliness.

5.6 Equipment Description - Refer to equipment descriptions in Paragraphs VII-1.6 and VII-2.6.

5.7 Performance Requirements

a. Install activated battery assembly on power head in accordance with the applicable service instructions.

b. Place battery/power head assembly on a clean rubber pad to preclude damage to thermal guard and paint finishes.

c. Remove the battery cover (and electrolyte trap assemblies on flight unit batteries) and temporarily stow with the 18 hex head nuts and rubber sealing gasket.

d. Using a "spin-tight" socket wrench, remove the two nuts and connecting bus strap between Cells 8 and 15 (Ref. Fig. VII-4) of the flight battery (Cells 6 and 13 for training batteries).

CAUTION: Avoid short circuits by using extreme care to ensure that tool or hardware do not contact other cell terminals.

e. For flight batteries, connect the positive lead of the ammeter (with appropriately fitting terminal lug) to the Cell 8 terminal and the negative lead to the Cell 15 terminal where the connecting bus strap was previously removed. Use the cell terminal nuts to secure the ammeter leads to the cell terminals.

Note: For training batteries, the positive ammeter lead is connected to Cell 6, and the negative lead to Cell 13.

f. Manually restrain the battery/power head assembly on the rubber pad, and depress the battery switch boot cover momentarily. Ammeter shall indicate 21 ±4 Amps. DC. Record under Item 7 of Table VII-6.

g. Carefully disconnect ammeter and replace cell bus strap and hardware.

h. Replace battery cover (and electrolyte trap assemblies on flight batteries) in accordance with the instructions in Paragraph VII-4. 10. f, tightening hex head nuts sequentially in a clockwise order in increments of 4-6 inch-pounds to a final torque of 12-16 inch-pounds.

Table VII-6. ALSD Power Head Functional Checkout Data Sheet

ALSD Assembly Part No. 467A8060000 - ____________ Serial No. ____________

Battery Assembly Part No. PS940300014 - ____________ Serial No. ____________

Power Head Assembly Part No. PS955000002 - ____________ Serial No. ____________

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	OLERANCE	APPROVAL		
					DATE	INSP.	CUST.
1		Status of calibration sensitive measuring & test equipment verified.					
2	5.7.a			Completed			
3	5.7.b			Completed			
4	5.7.c			Completed			
5	5.7.d			Completed			
6	5.7.e			Completed			
7	5.7.f			21 ± 4 Amps			
8	5.7.g			Completed			
9	5.7.h			Completed			

6.0 ALSD BATTERY CHARGING PROCEDURE

6.1 Purpose - This procedure establishes the operating procedures for charging the ALSD Flight (PS9403000014-003) and Training (PS9403000014-001) Unit Battery Assemblies.

6.2 Time Intervals - This procedure shall be performed in accordance with the following schedule.

a. Training unit No. 2 battery shall be recharged after each 16 minute operational discharge period.

b. Flight unit batteries shall not be recharged unless directed by the ALSEP countdown controller.

6.3 Test Equipment Requirements

a. ALSD Battery Charging Unit.

b. Power Source, 105 to 120 VAC, 60 cps, single phase.

c. Voltmeter, DC 0 - 50 Volts, Weston Model 901 or equivalent.

d. Voltmeter, DC 0 - 3 Volts, Weston Model 531 or equivalent.

6.4 Failure/Malfunction Criteria - Failure of the unit to meet the performance requirements specified herein shall constitute a malfunction. Each malfunction will require an investigation to determine cause.

6.5 Visual Examination - The ALSD battery shall be visually examined for cleanliness. Particular attention shall be given to the following:

a. Condition of material finishes.

b. Freedom from contamination, such as corrosion products, scale, grease, etc.

c. Satisfactory tightness of assembly bolts and screws, electrical receptacle, relief valve, and switch cover.

d. Condition of electrical connector pins.

6.6 Equipment Description - The ALSD Battery Charging Unit (described in Paragraph IV-2.0) shall be used to charge the Battery Assembly (described in Paragraph VII-1.0).

6.7 Battery Charging Unit Calibration

a. Position switches as follows:

1) Power switch to Off.

2) Current control knob completely counterclockwise.

3) Cell selector switch to Position 16.

4) Connect battery charging unit power cable to 105-120 VAC, 60 cps source.

5) Turn power switch to On. Red Power On indicator shall illuminate.

6) Depress Calibrate switch and adjust bottom screw on cutoff meter until indicator aligns with CAL mark. Release Calibrate switch.

7) Align red pointer on the cutoff meter with the red line on the dial by adjustment of the small knob on the front of the cutoff meter.

8) Turn power switch to Off Red Power On indicator shall go out.

6.8 Battery Charging

a. Install battery assembly (with cover removed) on battery charging unit adapter. Ensure careful engagement of mechanical alignment pins and electrical receptacle pins to prevent damage.

Note: For best results, all battery charging should be done at an ambient temperature of 65^{o} to 90^{o}F.

b. Connect battery charging unit adapter leads (red and black) to their respective 10-ampere output jacks on the battery charging unit.

c. Verify that current control knob is completely counterclockwise and cell selector switch is in Position 16.

d. Turn power switch to On. Depress Hexseal boot switch cover on battery assembly with adapter unit lock and tighten wing nut. Red Power On indicator and white Charging Current On indicator shall illuminate.

e. Slowly rotate current control knob clockwise until the following current level is indicated on the current meter:

1) Training battery initial charging current to be adjusted to 1.0 Amps.

2) Flight battery initial charging current to be adjusted to 2.0 Amps.

Note: When charging is complete (approximately 12 - 16 hours for a fully discharged battery), the current will automatically shut off. At this time, the white Charging Current On indicator shall go out and the amber Charging Current Off indicator shall illuminate.

f. Turn power switch to Off and remove battery assembly from battery charging unit adapter.

g. Using the Weston 531 voltmeter (or equivalent), measure the terminal voltage of each cell for 1.85 $\pm$0.03 VDC. Record cell voltages under Items 9 through 24 of Table VII-7 using Figure VII-4 as a reference for cell identification.

Note: Perform voltage measurements 6-10 hours after completion of charging to allow time for cell stabilization.

h. Depress Hexseal boot switch cover. Using the Weston 531 voltmeter (or equivalent), sequentially measure the voltage between Pin A (farthest from relief valve) and case, and Pin B (nearest to relief valve) and case of electrical receptacle. Voltmeter shall read 0 volts. Record under items 25 and 26 of Table VII-7.

i. Depress Hexseal boot switch cover. Using the Weston 901 voltmeter (or equivalent), measure the voltage between Pins A and B of the electrical receptacle. Pin A shall be +29.6 $\pm$ 0.5 VDC with respect to Pin B. Record under Items 27 and 28 of Table VII-7.

j. Visually inspect top of battery cells to ensure that cell cases and terminals are free of corrosion and electrolyte. Clean top of cells if required.

Note: During re-inspection cycles of training batteries, vent holes and caps should be inspected to assure that they are not clogged.

k. Replace the rubber sealing gasket and install two electrolyte trap assemblies (flight units only). Fasten cover to the case with the 18 hex head nuts previously removed, tightening them (in increments of 4-6 inch-pounds) to a torque of 12-16 inch-pounds. The hex head nuts should be tightened in a consecutive clockwise order. Do not use the criss-cross method of tightening nuts.

Notes: (1) Exercise extreme care during installation of electrolyte trap assemblies to ensure that the cell screw valves fit properly into the holes in the trap assembly. Ensure that the trap assembly lies flush with the cell tops after installation to preclude excessive loading by the battery case lid.

(2) Training battery (only) case pressure relief valve should be permanently removed to preclude accumulation of gas within the battery case during long term storage. Pressure relief valve is required only for operation of the ALSD system in a vacuum environment.

Table VII-7. ALSD Battery Charging Procedure Data Sheet

ALSD Assembly Part No. 467A806 0000 - ____________ Serial No. ____________

Battery Assembly Part No. PS940300014 - ____________ Serial No. ____________

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL		
					DATE	INSP.	CUST.
1		Status of calibration sensitive measuring & test equipment verified					
2	6.7.a			Completed			
3	6.8.a			Completed			
4	6.8.b			Completed			
5	6.8.c			Completed			
6	6.8.d			Completed			
7	6.8.e			Completed			
8	6.8.f			Completed			
9	6.8.g	Cell No. 1 Voltage		1.85 ± .03 VDC			
10	"	Cell No. 2 Voltage		"			
11	"	Cell No. 3 Voltage		"			
12	"	Cell No. 4 Voltage		"			
13	"	Cell No. 5 Voltage		"			
14	"	Cell No. 6 Voltage		"			
15	"	Cell No. 7 Voltage		"			

Table VII-7. ALSD Battery Charging Procedure Data Sheet (Continued)

ITEM NO.	PARA. REF.	COMPUTATIONS/INSTRUCTIONS	READING	TOLERANCE	APPROVAL		
					DATE	INSP.	CUST.
16	6.8.g	Cell No. 8 Voltage		1.85 $\pm$ .03 VDC			
17	"	Cell No. 9 Voltage		"			
18	"	Cell No. 10 Voltage		"			
19	"	Cell No. 11 Voltage		"			
20	"	Cell No. 12 Voltage		"			
21	"	Cell No. 13 Voltage		"			
22	"	Cell No. 14 Voltage		"			
23	"	Cell No. 15 Voltage		"			
24	"	Cell No. 16 Voltage		"			
25	6.8.h	Leakage from Pin A to Case		0 VDC			
26	6.8.h	Leakage from Pin B to Case		0 VDC			
27	6.8.i	Battery Terminal Voltage		29.6 $\pm$0.5 VDC			
28	2.8.i	Pin A Positive		Yes			
29	2.8.j			Completed			
30	2.8.k			Completed			

7.0 BATTERY SERVICE INSTRUCTIONS

7.1 Purpose - This procedure establishes the instructions necessary for field level maintenance of the ALSD Training Unit Battery, (Martin Marietta Corporation P/N PS 9403000014-001).

7.2 Time Interval - This procedure shall be performed in accordance with the following schedule:

a. Connector Inspection - Preceding each installation to ALSD Power Head.

b. Terminal Voltage - After activation as per paragraph VII-4.8, at the end of each partial or complete recharge cycle, and after 30 days storage.

c. Visual Cell Inspection - During activation, during each recharge cycle, or 30 days storage.

d. Electrical Circuit - After activation or cell replacement.

e. Cell Replacement

1) Replace complete cell set (16 cells) when the open circuit terminal voltage, after recharge of any one cell, reads less than 1.80 VDC.

2) Replace cells when cell distortion is severe, even though cell terminal voltage is above 1.80 VDC, or when excessive electrolyte seepage indicates a breakdown of cell envelope integrity of one or more cells.

3) When cells have been activated for 6 months.

7.3 Precautions

a. The battery is capable of supplying unusually high currents if it is accidentally short circuited. A prolonged short circuit may cause serious burns to personnel and may destroy the battery. To avoid accidental short circuits, all tools used in connection with the battery or within close vicinity of the battery must be properly insulated with a double layer of electrical tape or varnish.

b. The battery shall be kept in an upright position whenever practical during normal handling and operating conditions.

c. The electrolyte (a strong solution of potassium hydroxide) is alkaline and corrosive, and should be handled with care. Alkali-proof apron, rubber gloves and splash-proof goggles or a face mask are recommended for personnel engaged in servicing SILVERCEL batteries.

d. Thoroughly clean all tools after use in servicing SILVERCEL batteries with a warm solution of soapy water.

e. Do not store battery in discharged condition for prolonged periods.

f. Never completely discharge battery during use.

g. Battery relief valve should be permanently removed to preclude accumulation of gas within the battery case during long term stowage.

7.4 Servicing Equipment

a. Voltmeter, DC 0 - 50 volts, Weston Model 901 or equivalent.

b. Voltmeter, DC 0 - 3 volts, Weston Model 531 or equivalent.

c. Torque Wrench, 0 - 50 inch-pounds.

d. Miscellaneous hand tools.

e. Alkali proof mask, gloves, and apron.

7.5 Battery Disassembly

a. Cell Removal - Remove battery from power head as per disassembly instructions, paragraph VII-8.0. Remove battery cover and rubber sealing gasket by removing the 18 hex head nuts. Remove all battery terminal nuts and battery terminal straps one at a time. Grip cell number sixteen (Ref. Figure VII-4) with pliers on terminal and pull cell up. Move cell 15 over to vacancy left by cell 16 and remove in same manner. Repeat for remaining cells.

b. Switch Removal - Do not attempt to remove switch assembly in the field.

c. Connector Removal - Do not attempt to replace connector in the field.

7.6 Cleaning

a. **Internal - After battery cells are removed, clean battery case internally with Freon TF solvent and a clean cloth or brush. Blow out residue with shop air.**

b. **External - Clean externally with Freon TF solvent and a clean cloth.**

7.7 Cell Installation - Replace cells using reverse procedure of cell removal except do not use pliers on terminals. Press and slide battery in place. Replace wire lugs and terminal straps as shown in Figure VII-4. Torque terminal nuts to 25 inch-pounds.

7.8 Activation and Checkout - Perform activation and checkout of battery as per activation instructions VII-4.0.

8.0 ALSD POWER HEAD SERVICE INSTRUCTIONS

8.1 Purpose - This procedure establishes the field level inspection and service instructions for the ALSD Flight (PS955000002-007) and Training (PS955000002-005) Unit Power Heads.

8.2 General - Refer to Table VII-8 and Figure VII-5 for ALSD Power Head part numbers. For brevity, dash numbers without prefixes are used for descriptions throughout this procedure.

8.3 Time Intervals (Training Units) - This procedure shall be performed in accordance with the following schedule.

a. Percussor cam lubrication through external port shall be accomplished after each 0.5 hour of operation.

b. Minor internal lubrication and inspection shall be accomplished after each 2.0 hours of operation, or after any operating period which is to be followed by non-operating storage for a period exceeding one month.

c. Major internal lubrication and inspection shall be accomplished after 10 hours of operation.

d. Power head to be returned for factory inspection and checkout after each 15 hours of operation.

8.4 Time Intervals (Flight Units) - This procedure shall be performed in accordance with the following schedule.

a. Internal lubrication and inspection shall be accomplished during Apollo flight countdown as described in another section of this manual.

8.5 Precautions

a. No Load Operation - Operation of the power head with no load on the output spindle should be minimized. Continued "no load" operation can greatly shorten the life of the power head.

b. Storage - The power head and battery assembly should not be stored on the battery end for prolonged periods.

c. Polarity - Operation of the power head in the reverse direction can cause jamming. Closely observe polarity of all electrical connections disturbed during maintenance.

d. Jamming - De-energize power switch immediately if internal jamming occurs.

e. Heating - Avoid operating unit beyond 150°F case temperature for prolonged periods.

TABLE VII-8

ALSD Power Head Part Numbers

Pc. No.	Name	Qty.
12062-1	End Plate (Flight)	1
12062-1D	End Plate (Training)	1
12062-2	Outer Housing	1
12062-3	Gear Case Cover	1
12062-4	Ring, Field	1
12062-5	Magnet Segment	2
12062-6	Armature	1
12062-13	Holder, Brush (Lower)	1
12062-14B	Brush Assembly	2
12062-15	S.A. Magnet	1
12062-16	Nut Brg. Ret.	1
12062-17	Fan S.A.	1
12062-18	Gear, Cam	1
12062-19	Pinion, Inter.	1
12062-20	Gear, Rotary Drive	1
12062-21	Ring, Clamp	1
12062-22	Clutch, Overtorque	1
12062-23	Spring, Clutch	3
12062-24	Pin, Pinion Brg.	1
12062-25B	Nut, Dr. Tube Stop	1
12062-26	S.A. Brush Holder	1
12062-27	Tube, Output Drive	1
12062-28	Washer, Output Dr. Stop	1
12062-29	Nut, Dynamic Seal	1
12062-30	Ram Head	1
12062-31	Nut, Ram	1
12062-32	Sleeve, Ram	1
12062-33	Spring, Energy	1
12062-34	Retainer, Spring	1
12062-38	Washer, Insulator (Flight Unit)	5
12062-39	Housing, Percusser	1
12062-41	Washer, Clip CL (SM. I.D.)	1
12062-42	Follower, Cam	1
12062-44	Dowel Pin	2
12062-46	Ring, Brush Holder	1
12062-47	Bracket, Mag Ret.	2
12062-48	Clip, Spring	2
12062-49	Fan Hub	1
12062-50	Pin. Brush Spring	2
12062-51R	Spring Brush (R. H.)	2
12062-53	Cup, Spring Ret.	1
12062-54	Spring, Brg. Plug	1
12062-55	Ring, Thr. Brg. Sup.	1
12062-57	Fan Blade	1
12062-59	Rivet	4
12062-60	Nut, Ret.	1
12062-61	Shoulder Screw	2
12062-62	Washer Sl. Cl. (Lrg. I. D.)	1
12062-63	Holder, Brush (Upper)	1
12062-64	Cup, Brg.	1
12062-70A	Washer Ram Head	1
12062-71	Washer, Flat	5
12062-72	Sleeve, Brg. Lock	1
12062-73	Cap, Comm. End	1
12062-76	Lead Wire (Long)	2
12062-77	S.A. Connector & Lead Wire	1
12062-79	S.A. Rot. Dr. Gear	1
12062-80	S.A. Ram Sleeve	1
12062-82	Insert, Brg.	1
12062-83	Insert, Brg.	1
12062-84	Retainer, Wiper	1
12062-85	S.A. Connector Comp.	1
12062-86	S.A. Outer Housing	1
12062-89	Cup Washer	2
12062-90	Shield, Wrapper	1
12062-91	Shield, Disc	1
12062-94	Shield, Connector	1
12062-95	Spring, Suppression	3
12062-96	Button, Suppression	3
12062-101	Bearing, MRC R-4-AF-4-ST	1
12062-102	Bearing, MRC R-8-F-ST	1
12062-103	Bearing, TORR #NTA-2031	1
12062-104	Washer, Thrust TORR #TRA-2031	1
12062-107	Bearing, TORR B228	1
12062-108	Bearing, MRC MB-542-ST	1
12062-109	Bearing, MRC R-4-A-4 ST	1
12062-110	Bearing, TORR B45	1
12062-111	Bearing, MRC 5202 SB-ST Full Type	1
12062-112	3/16 Dia. Ball, M50 Steel	12

TABLE VII-8 (Cont.)

Pc. No.	Name	Qty.	Pc. No.	Name	Qty.
12062-113	Valve Pressure Relief	1	12062-143	#8 Lockwasher	3
12062-114	Receptacle, Battery Intercom	1	12062-144	#4-40x1/4 Bd. Hd. (Br.) M.S.	4
12062-117	Seal, Quad Ring Viton	1	12062-145	"O" Ring	1
12062-118	Seal, Dynamic Bellows	1	12062-146C	Quad. Ring	1
12062-123	Lock Ring, Waldes Koh. N-5001-137H	1	12062-148	"O" Ring	1
12062-124	"E" Ring, Waldes Koh. 5133-12-H	2	12062-150	Name Plate	1
12062-125	1/8 D. Ball M-50	1	12062-151	Wire, Name Plate	1
12062-126	Perma-Nut	4	12062-155	Roll Pin	2
12062-127	Seal, "O" Ring	1	12062-156	Insulator	1
12062-130	#6-32x1/4 Seel Screw	1	12062-157	End Plate Percussor	1
12062-133	#8-32x5/8 Soc. Hd. Cap Scr.	3	12062-158	Rod, Shock Absorber	1
12062-134	Wiper	1	12062-159	Spacer, Shock Absorb.	2
12062-135	Bushing, Thermal Ins.	5	12062-160	Tube, Shock Absorb.	1
12062-136	#10-32x7/8 Soc. Hd. Cap Sc.	15	12062-161	7/16-20x3/16 Soc. Hdl. S.S.	1
12062-137	#1204-00 Int. Shake L.W.	4	12062-162	#6-32x1/2 Seel Screw	1
12062-138	Quad Ring	2	12062-163	S. A. Rod, Shock Abs.	1
12062-140	Term. Clip	2	12062-165	Spacer	1
12062-142	#1210-06 Int. Shake L.W.	17	12062-166	Nut, Relief Valve	1
			12062-167	Washer, Insulating	15
			12062-168	Washer, Flat	5
			12062-169	Washer, Insulating	5
			12062-170	Washer, Insulating	10
			12062-171	Spring Ring	1

8.6 Maintenance Equipment

Torque Wrench - 1/4 drive 0-50 in.-lbs., adaptable to:
- 5/8 in. nut
- 1/2 in. nut
- 3/8 in. nut
- 5/32 in. nut
- 9/64 in. cap screw hex
- 5/32 in. cap screw hex
- 6/32 in. screw slot

Allen Wrench 5/32 in.
Drift Punch 5/32 in.
Drift Punch 1/8 in.
Drift Punch 1/16 in.
Screwdriver, Standard 4 in.
Screwdriver, Standard 6 in.
Screwdriver, Phillips 4 in.
Screwdriver, Phillips 6 in.
Pliers, Needle Nose
Wrench, End 1/4 in.
Wrench, Spanner
Hammer 1-2 lb.
Mallet 1-2 lb.
Inspection Mirror
Brush, Cleaning 1 in.
Vessel, Cleaning 6x6x2 in.
Steel Pin, 1/8 round x 1/2 long
Air Nozzle
Shop Air, 50-100 psi
Grease, DuPont 240AC Krytox Fluorinated (supplied in lube kit)
Oil, DuPont 143AC Krytox Fluorinated (supplied in lube kit)
Oil Filler Cap (supplied in lube kit)
Fluid, Cleaning Freon T. F. Solvent

8.7 Lubrication

a. External Port - Remove lubrication port screw (-162). Assemble oil filler cap to Krytox 143 AC oil bottle. Apply five (5) drops of oil through lubrication port to cam lubrication pad (-134).

b. Minor Internal - Remove battery, thermal guard and front end assem[illegible] as per paragraphs 8.10.a through 8.10.c. Apply a generous supply of K[illegible] grease to cam follower bearing (Ref. Fig. VII-21), cam gear ramp (-18), [illegible] bearing (-110), all accessible gearing, and lubrication pad (-134). Reass[illegible] as per paragraph 8.11.

c. Major Internal - Lubrication after complete disassembly and cleaning (paragraph 8.8 and 8.10) is explained in the Assembly Procedures, paragraph 8.11.

8.8 Cleaning

a. Minor External - Clean external surfaces with Freon T. F. solvent and a soft brush or a clean cloth.

b. Minor Internal - Use a clean cloth to wipe away excess grease deposits or other foreign materials from housing walls. Cloth can be dampened with Freon TF Solvent if necessary to remove crusted deposits.

c. Major Internal - All parts and [illegible] except the center housing, should be submerged in Freon TF solvent and cleaned with a soft brush while parts are submerged. Clean the center housing by brushing with solvent being careful to avoid getting solvent into the percussor mechanism. Grease lost to solvent in the percussor assembly cannot be replaced in the field. Use shop air to remove final residue after cleaning. If metallic particles were present on disassembly, repeat the cleaning process using new solvent.

8.9 Inspection

a. External - Examine power head visually for cleanliness, condition of material finishes, contamination, corrosion, scale, grease, tightness of bolts and screws, electrical receptacle, relief valve, and electrical connector pins. Check housing carefully for signs of fatigue failures, distortion of housings. etc.

b. Internal - Inspect all bearings for wear and smoothness of operation. Check all gear teeth for damage or excessive wear. Inspect housing internally and externally for cracks. Inspect brushes, brush springs, and wiring for defects. Check armature commutator for smoothness and commutator slots for foreign particles. Check electrical connector pins and connector for tightness. Check cam gear (-18) [illegible] for smoothness. Inspect all hardware for defects. Replace all defective components.

8.10 Disassembly Instructions

a. Battery - Set unit on bench with battery end down. Remove the five cap screws (-136) (Ref. Figure VII-6). Hold battery rigid while slightly rocking and pulling up vertically on power head. Lay power head down, and remove laminated mylar insulation and retainer assembly together with the connector shield (-94) from the battery (Ref. Figure VII-7). Temporarily stow (flight units only) thermal washers (-38).

b. Power Head Thermal Guard - Remove all lock nuts holding the thermal guard together and the thermal guard to the power head. Temporarily stow all loose screws and washers. Remove remaining cap screws from power head housing flanges. Carefully lift thermal guard clear of power head. Temporarily stow all loose hardware (Ref. Figure VII-8).

c. Forward Housing (Partial) - Grasp spindle and pull assembly axially from center housing (Ref. Figure VII-9). Remove housing quad ring seal (-138) and cam gear bearing spring (-54).

d. <u>Forward Housing (Complete)</u> - Insert 5/32 drift punch into hole in retainer nut (-60) and use to turn nut counterclockwise (viewing from center housing end). If retainer nut cannot be loosened in this manner, tap drift punch with hammer close to retainer nut (Ref. Figure VII-10). Repeat above procedure to loosen the spindle stop assembly (-[illegible]). Completely unscrew (LH thread) spindle stop assembly and slide off end of spindle being careful not to loose spring-loaded electrostatic brushes (-96) and springs (-95). Use 1/16-inch drift punch to drive roll pin (-155) clear of hole. Use 1/8 inch drift punch to unscrew (RH thread) dynamic seal nut (-29) from rotary drive gear shaft (-20) (Ref. Figure VII-11). Slide dynamic seal nut and spindle (-27) out of rotary drive gear cavity. (Temporarily stow loose roll pin (-155) and the six bearings (-112). Use a mallet to tap the rotary drive gear upward until gear contacts the cam gear bearing support (-55). Cam pinion bearing (-82) can be removed from the forward housing by pulling on cam gear and clutch assembly (-18) Remove cap screws (-133) from cam gear bearing support (-55) and remove cam gear bearing support from forward housing. Push rotary drive gear (-20) from forward housing.

e. <u>Rear Housing</u> - Pull rear housing and armature clear of center housing. Remove spacer (-165) located inside housing below connector. Unscrew (RH thread) armature end cap (-73) using a screwdriver and protruding tabs for leverage. Use 1/2-inch socket to remove armature shaft nut (-16). Remove armature assembly from rear housing (-1). Remove quad ring seal (-138) from center housing. Push bearing (-101) and spacer (-72) out of housing. (Ref. Figure VII-12).

f. <u>Center Housing</u> - The permanent magnet field assembly (-15) is removed by sliding it out of the center housing (Ref. Figure VII-13). If a finger grasp is not sufficient for removal, invert the housing and tap housing lightly with a non-metallic mallet around quad ring seal groove. Remove lubrication pad (-134) using a screwdriver to work pad out of housing.

g. <u>Seals</u> - (Ref. Figure VII-14) - Armature end cap (-73) seal (-145), quad ring seals (-138) on each end of center housing, rotary drive seal (-143C), and spindle stop assembly seals (-117 and -127) are free for removal if disassembly instructions 8.10.a through 8.10.e have been followed. Oil port seal screws (-130 and -132) are removed with a screwdriver. The spindle shaft dynamic bellows seal (-118) is removed from dynamic seal nut (-29) by pressing around seal periphery with finger. Access to the relief valve seal (-148) is achieved by unscrewing the relief valve assembly (-113).

8.11 <u>Assembly Instructions</u>

a. <u>General</u> - Ensure that all parts have been thoroughly cleaned, inspected, and defective parts replaced before proceding with the assembly of the power head. Assembly of components, with the exception of a press fit on bearings, should assemble easily. Difficulty in assembly indicates a problem and should be thoroughly investigated.

b. Lubrication - Apply a generous supply of Krytox grease on all bearings (Ref. Figure VII-21). Turn bearings by hand to work grease into bearing races. Coat all seals with Krytox grease before and after installation. Prevent grease from contacting brushes or armature commutator. Lubricate all gears and friction surfaces.

c. Center Housing (-2) - Check to ensure that no ferrous particles have been attracted to the field magnet assembly (-15). Align the field magnet key with the slot in the center housing and slide the field assembly into housing. Use an inspection mirror to ensure that the key is seated properly in the housing slot. Tap field assembly lightly with a nonmetallic mallet to seat fully. Work a generous supply of grease into lubrication pad (-134) and install into pad housing. Lightly lubricate relief valve seal (-148). install on relief valve (-113) and install relief valve into housing. Torque to 35 inch pounds. Install seal screw (-162) and torque to 7 inch pounds.

d. Rear Housing (-1, -1D)

1. Brushes (-14B) - Remove and replace one brush at a time. Ensure that new leads are correct length (dress if necessary) and are positioned out of the way of the armature commutator area once lead attachment screws (-144) are tight. Torque screws to 6 inch pounds. Ensure that brushes slide freely in brush holder (-63).

2. Armature (-6) - Spread brushes and insert armature into housing. Insert bearing (-101), shield side toward armature, over armature shaft and into housing. Screw nut (-16) onto armature shaft and tighten to 30 inch pounds. Insert spacer (-72) into housing on top of bearing (-101). Slip seal (-145) over spacer. Screw cap (-73) onto housing being careful not to disturb seal and tighten cap until it bottoms against spacer (-72).

3. Installation - Install seal (-138), well lubricated with Krytox grease, in seal groove on aft end of center housing. Invert aft housing and place shim (-165) into rear housing (Ref. Figure VII-15). Set center housing over armature and slowly bring housings together. If spacing exists between the mating flanges, separate assemblies and recheck the field assembly for a shift of position. After mating is correct, hold together temporarily with two cap screws (-136), one on each side of power head. Seat commutator brushes as per paragraph 8.13.

e. Forward Housing (-3)

1. Major - Install well lubricated seal (-146C) into housing seal groove. Ensure that seal is not twisted. Press rotary drive gear (-20) through rotary drive bearing (-107) until it bottoms against bearing. Install cam gear bearing support (-55) and cap screws (-133) with lock washers (-143). Torque to 11 inch pounds. Insert bearing race and the cam bearing (-103) in cam gear bearing support (-55). Install cam gear (Ref. Figure VII-16) clutch, and bearing assembly into cam bearing support until pinion bearing (-109) is seated. Note: Lift rotary drive gear up as necessary to permit pinion bearing (-109) to be inserted into housing. Use mallet to tap rotary drive gear (-20) shoulder tight against rotary drive bearing (-107). Insert bellows seal (-118) into dynamic seal nut (-29). Work

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bellows seal with fingers until in position (Ref. Figure VII-17). Slide dynamic seal nut and bellows seal assembly carefully over small diameter end of spindle (-27) and down until assembly bottoms out on spindle flange. Apply grease to spindle axial bearings (-108) and axial bearing grooves in spindle. Press bearings (six) into spindle grooves, align spindle grooves with rotary drive gear shift (-20) grooves, and axially insert spindle into forward end of housing (Ref. Figure VII-18). Hold spindle in and carefully screw dynamic seal nut (-29) clockwise onto protruding end of rotary drive gear shaft (-20). Important: If dynamic seal nut (-29) will not screw up fully by hand, remove nut and spindle and repeat above procedure. Use drift punch to turn dynamic seal nut (-29) until roll pin (-155) holes are aligned. Install roll pin (-155) and drive flush with hammer. Install rotary seals (-127 and -117) into respective seal grooves in spindle stop tube. Partially screw spindle stop lock nut (-60) onto spindle stop tube. Install electrostatic brushes (-96) and springs (-95) into spindle stop assembly. Hold brushes in while sliding spindle stop assembly (Ref. Figure VII-19) over female end of spindle and screw counterclockwise until hand tight. Use drift punch and hammer to tighten spindle stop assembly. Tighten spindle stop lock nut (-60) in same manner. Move spindle in and out by hand. Operation should be smooth with a travel of approximately 1/4-inch. Check the electrostatic brushes visually for proper installation. Install seal screw (-130) and torque to 7 inch pounds.

2. Minor - Lubricate cam gear bearing spring (-54) and insert into cam pinion cup (-53). Install quad ring seal (-138) into seal groove on forward end of center housing. Align cam gear (-18) so ramp will not interfere with cam follower (-30). Gently press forward housing assembly into center housing and temporarily install two cap screws (-136), one on each side of power head.

f. Thermal Guard

1. Training Unit No.2 - Remove two cap screws (-136) on side of power head opposite relief valve (-113). Position thermal guard in place and re-install two screws (-136), lock washers (-142), and thermal washers (467A8050030-027) as shown in Figure VII-20. Bottom, but do not tighten screws. Repeat above procedure for opposite side of power head. Ensure that thermal guard overlaps are interfaced properly. Install remaining hardware as shown in Figure VII-22. Note: If thermal washers (-170) vary in thickness, separate those that vary from the rest for use between the thermal guard and insert washer (-135). Match washers according to thickness to fit gaps between thermal guard and insert washer (-135). Tighten the ten cap screws holding the power head housings together and tighten in incremental steps to 30 inch pounds. Install the two rectangular insulator strips (467A8050030-025) between the power head and thermal guard clamp. Ensure that insulator strips do not overlap and are aligned properly with thermal guard. Install flat washer (AN960C10L) over short cap screw (MS 1696-10) and insert assembly through hole (armature side) in thermal guard clamp. Attach lock nut (MS 21043). Repeat for opposite side of clamp except install lanyard

assembly (467A8050030-069) under washer on nut end of cap screw. Keep lanyard parallel with spindle (Ref. Figure VII-22) and tighten cap screws until thermal guard clamp is tight around spindle stop assembly. Insert cap screws (MS-51957-14) through two remaining holes at forward-most end of thermal guard. Attach flat washers (AN 960 C4) and lock nuts (MS-21043-04) and tighten.

2. Flight Units - Thermal guard installation procedures for flight units are the same for training units except that flight units require additional washers (-71, -167-168, -169, -170) and are installed as shown in Figure VII-5.

g. Battery - Lay battery on bench, top down, and install laminated mylar assembly with retainer plate on top (Ref. Figure VII-23). Ensure that connector shield bottom is contacting battery case and that large slots in connector shield are up. Lay thermal washers (-38) (Flight Units only) over battery cap screw holes. Align slots for proper interface with stress ribs on power head when installed. Check battery and power head connector pins for straightness, and vertically lower power head on battery while visually aligning guide pins. After guide pins and connector pins have engaged, tap spindle lightly to bottom power head against battery. Press cap screws down and turn with Allen wrench to engage threads. Tighten cap screws incrementally to 30 inch pounds.

8.12 Clutch Adjustment - Disassemble power head as per paragraphs 8.10.1 through 8.10.4. Clamp cam gear (-18) in vise with pinion gear (-19) up. Insert a 1/8-inch pin approximately 1/2-inch long into valley between two gear teeth. Hold in place and insert a 1/2-inch socket down over pinion gear and pin. Use socket wrench handle to hold pinion gear, while breaking staking of retainer nut (-21) by turning counterclockwise with a spanner wrench. Tighten nut (-21) and replace socket handle with torque wrench. Incrementally tighten nut (-21) with spanner until rotation of the torque wrench gives a reading of 28 $\pm$ 2 inch pounds. Stake retainer nut (-21) in two places. Reassemble power head as per assembly instructions.

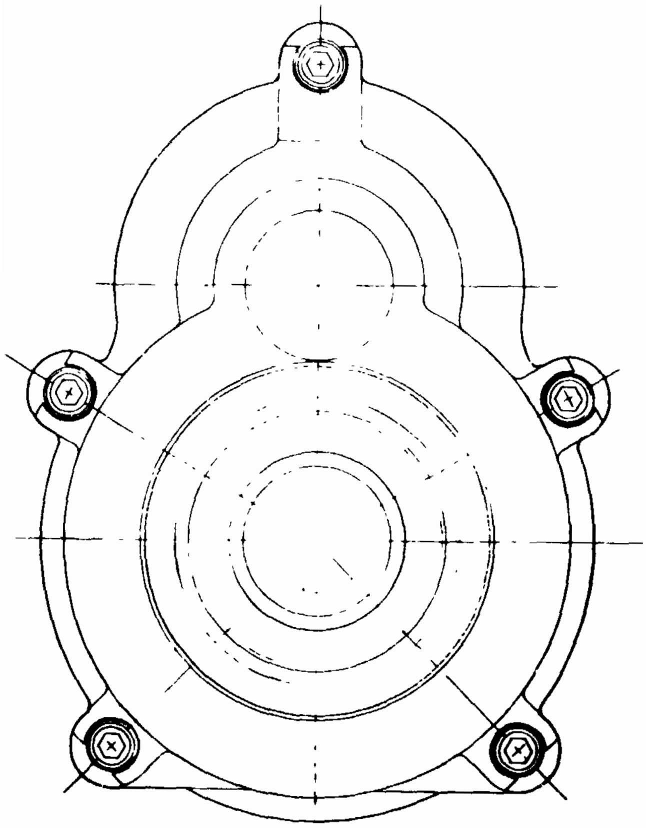
8.13 Brush Seating - If commutator brushes have been disturbed or replaced during maintenance, before installing forward housing and thermal guard, set power head in place on battery (Ref. Figure VII-24), depress battery switch and allow armature to run for 3 to 5 minutes to seat brushes.

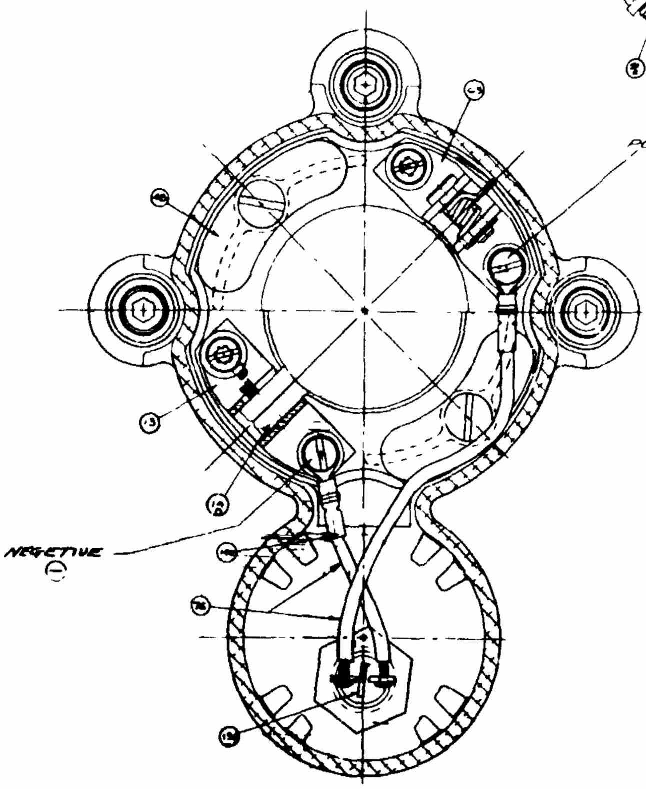
TABLE VII-9

Malfunction Localization Chart
ALSD Power Head

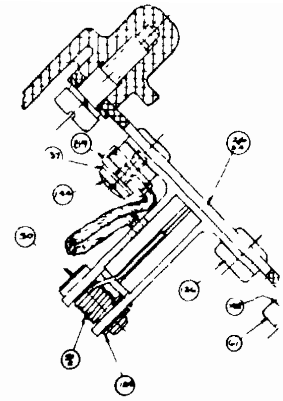
Symptom	Probable Cause In Descending Order	Action
Unit will not operate.	1. Battery discharged	Charge or replace battery
	2. Battery switch	Replace battery
	3. Battery connector defective Power Head connector defective	Replace battery
	4. Short circuit in battery	Replace battery
	5. Short circuit in Power Head	Replace armature or rear housing
	6. Broken wire in Power Head	Replace rear housing
	7. Brushes defective	Replace brushes
Unit attempts to turn over but will not run.	1. Battery discharged	Charge or replace battery
	2. Polarity wrong	Correct wiring
	3. Gearing jammed	Replace defective gearing
	4. Field magnets broken	Replace field assy.
	5. Galled bearing	Replace defective bearing
	6. Percussor jammed	Replace center housing
Battery discharge rate high.	1. Defective battery	Replace battery
	2. Partial short circuit	Check wiring
	3. Lack of lubrication	Perform major lubrication
	4. Armature rubbing fields	Replace fields
	5. Faulty bearing/s	Replace bearing/s
	6. Faulty Percussor Assembly	Replace center housing
	7. Shorted armature	Replace armature
Spindle rotates with no percussor	Broken percussor spring	Replace center housing
Percussion with no rotation	1. Defective gear/s	Replace defective gear/s
	2. Clutch too loose	Adjust clutch
Motor runs with no spindle rotation or percussion	Faulty gear train	Replace defective gear/s
Intermittent operation	1. Defective switch	Replace battery
	2. Bad brushes	Replace brushes
	3. Defective wiring	Check wiring
	4. Defective connector	Replace battery or rear housing
	5. Defective armature	Replace armature

FOLDOUT FRAME 1





SECT. B-B



FOLDOUT FRAME 2

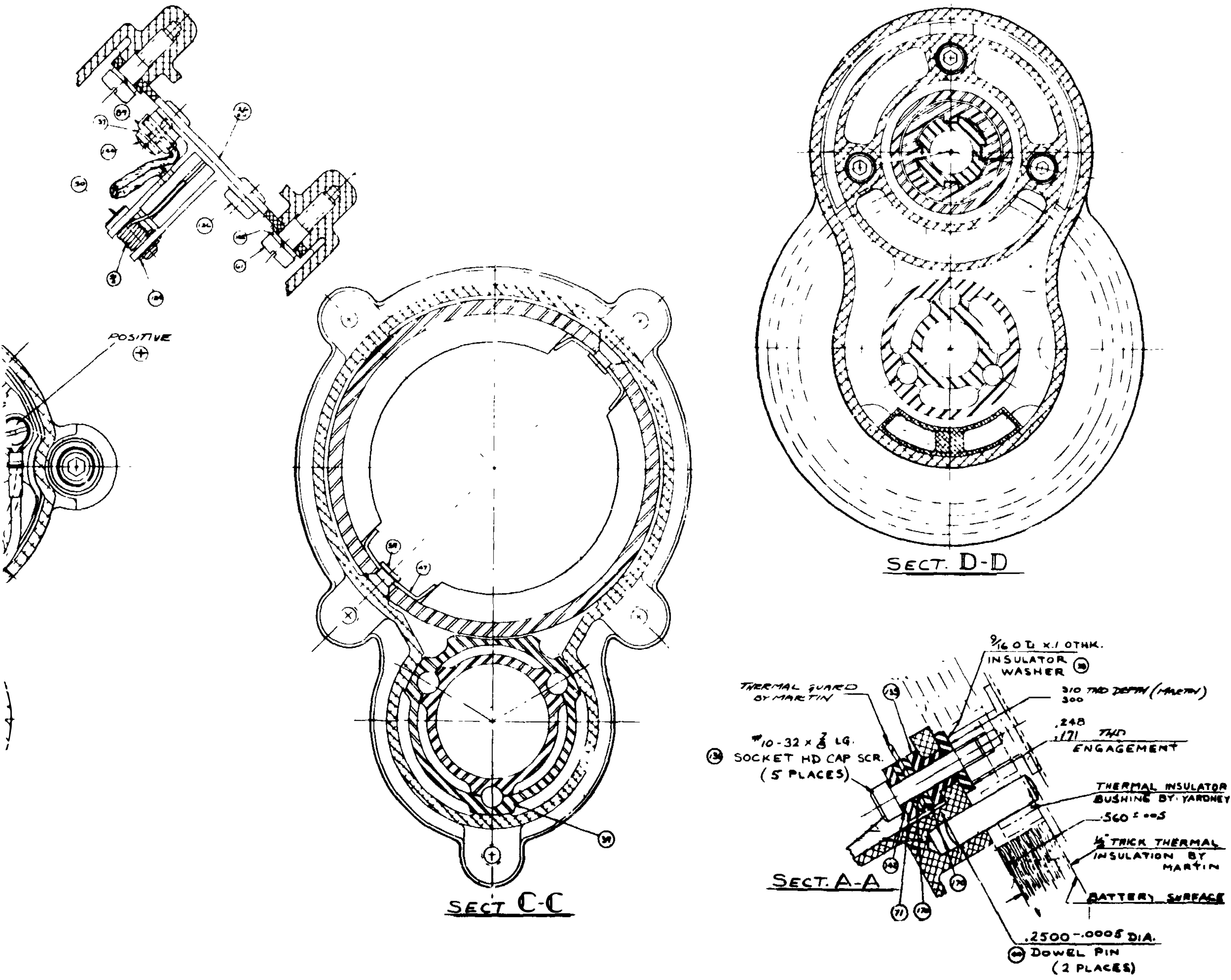
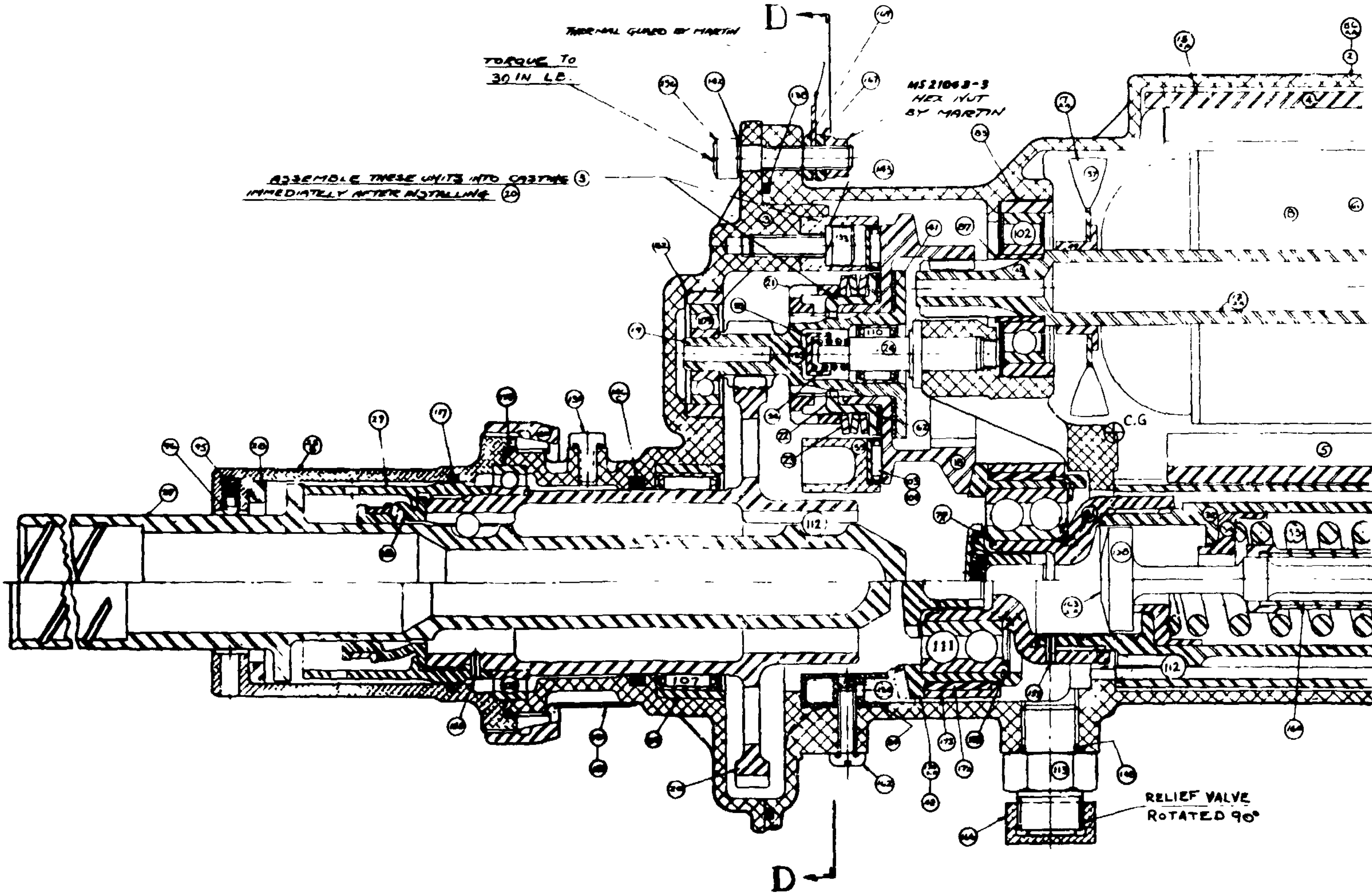


Figure VII-5. ALSD Power Head Assembly

FOLDOUT FRAME



FOLDOUT FRAME 2

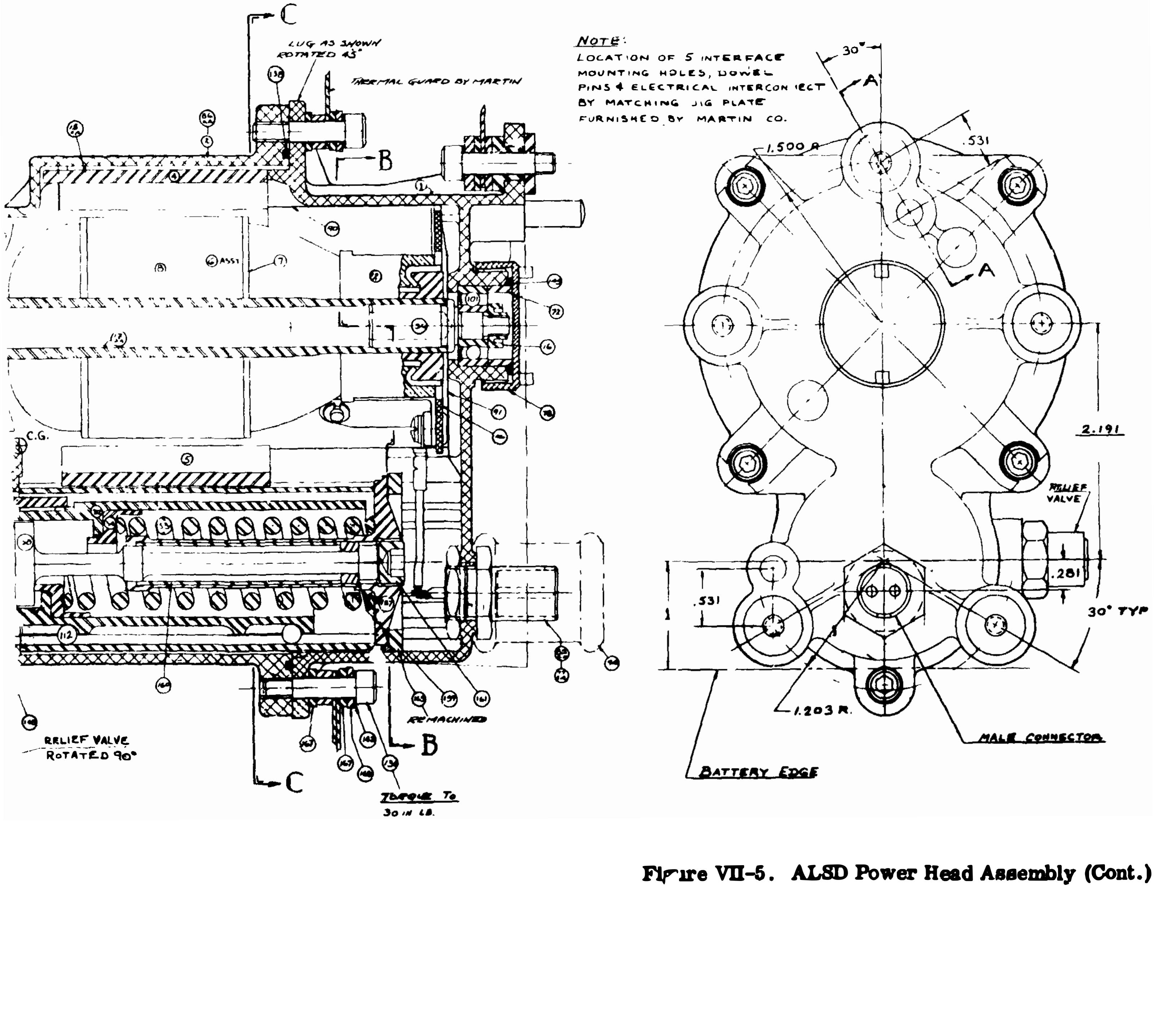


Figure VII-5. ALSD Power Head Assembly (Cont.)

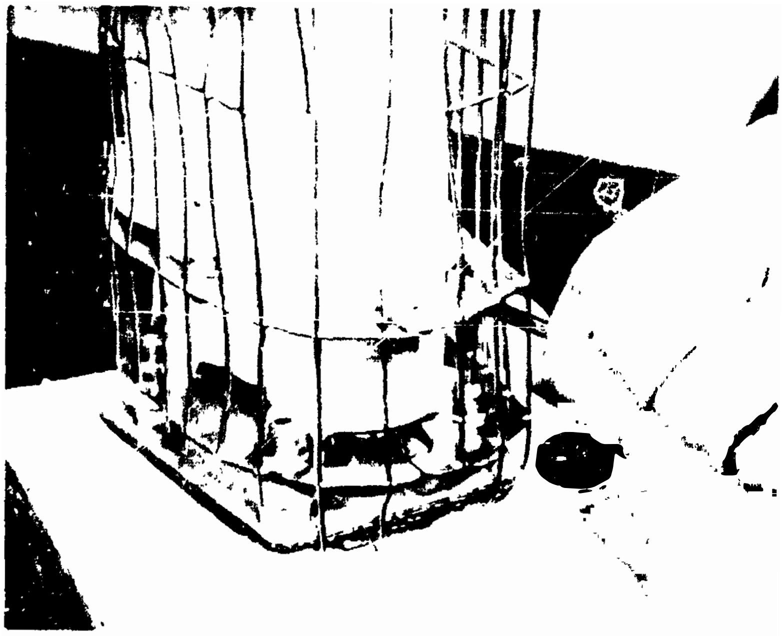


Figure VII-6. Battery Removal

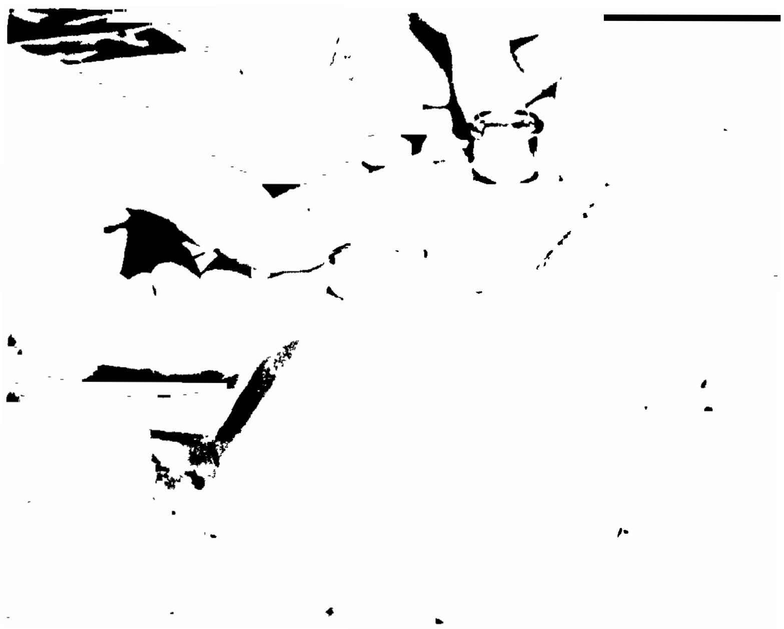


Figure VII-7. Thermal Shield Assembly Removal

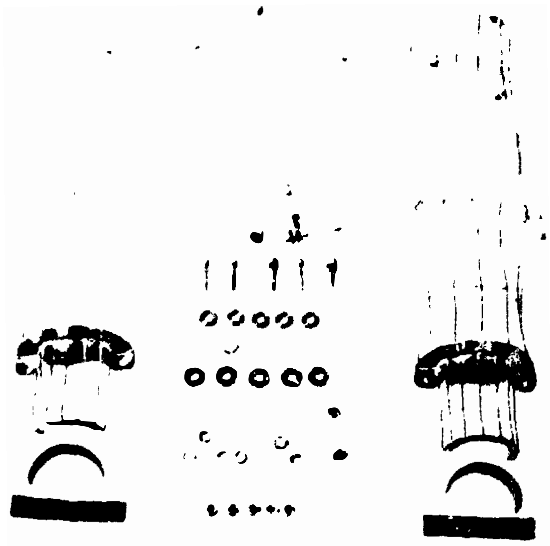


Figure VII-8. Thermal Guard Disassembled

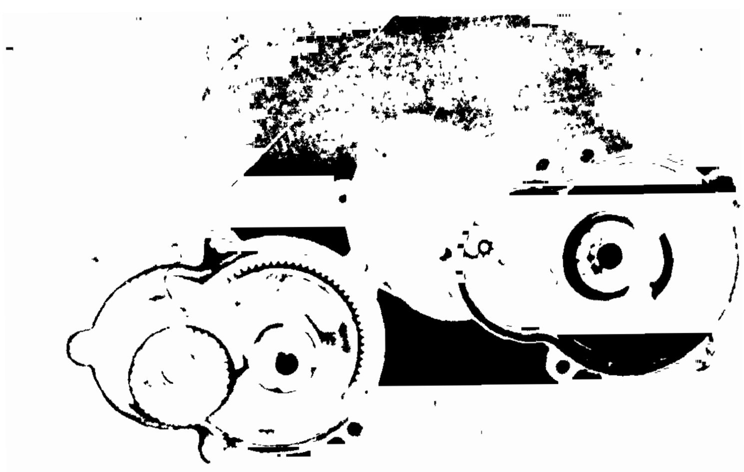


Figure VII-9. Power Head Forward Housing Removed

Figure VII-10. Spindle Stop Lock Ring Removal

Figure VII-11. Bellows Seal Nut Removal

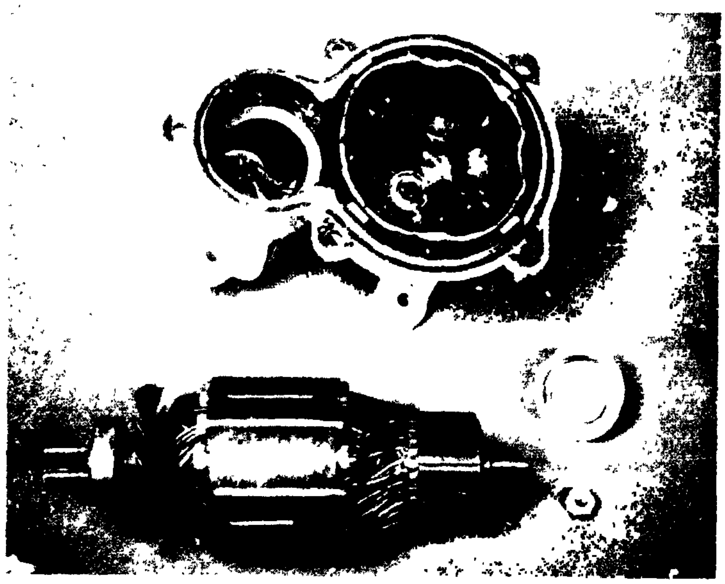


Figure VII-12. Rear Housing Disassembled

Figure VII-13. Field Assembly Removal

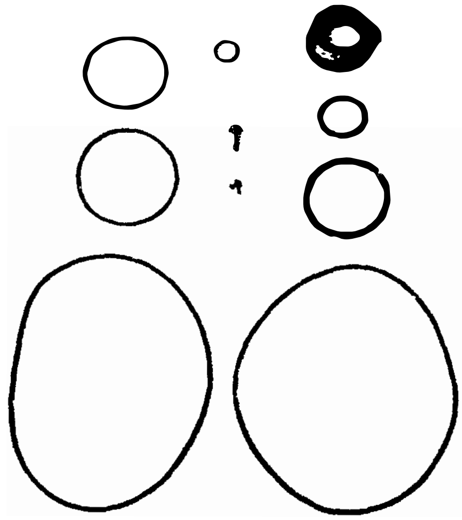


Figure VII-14. Power Head Seals Removed

Figure VII-15. Rear Housing Before Installation Into Center Housing

Figure VII-16. Installation of Cam Gear & Clutch Assy.

Figure VII-17. Installed Bellows Seal

Figure VII-18. Insertion of Spindle Assembly

Figure VII-19. Installation of Spindle Stop Assy.

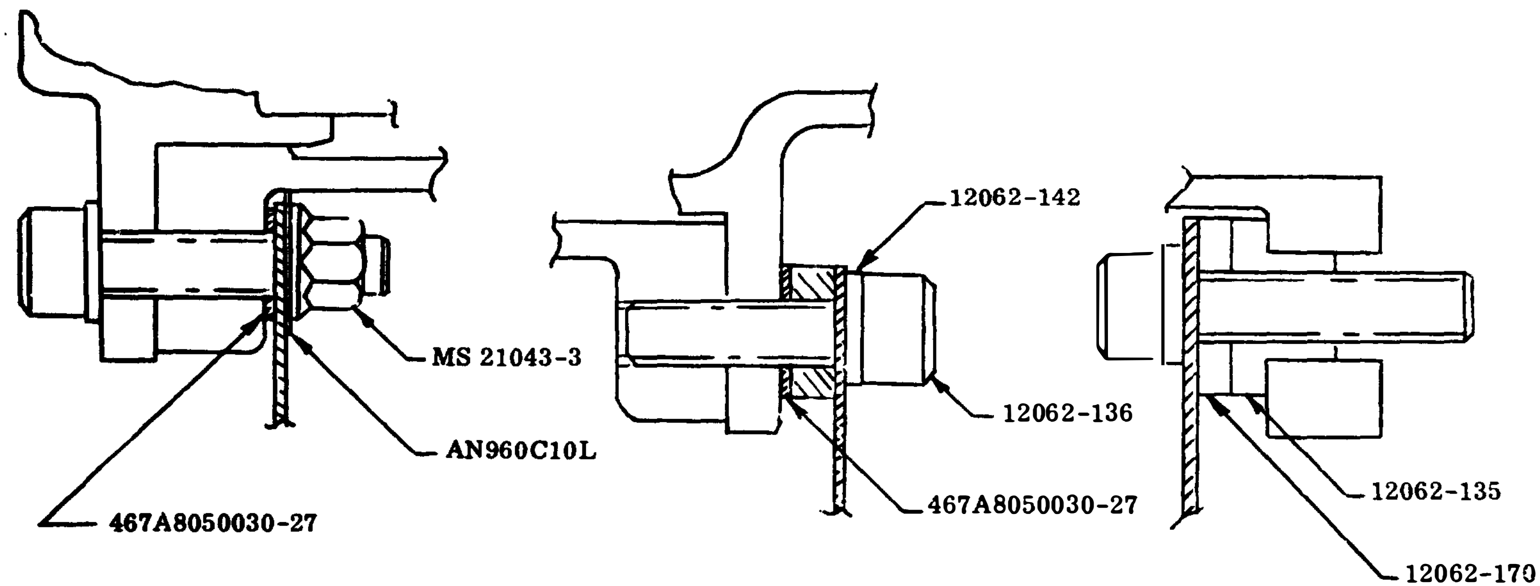


Figure VII-20. Thermal Guard Installation Training Unit No. 2

Figure VII-21. Lubrication of Cam Follower Bearing

Figure VII-22. Installation of Thermal Guard Lanyard

Figure VII-23. Insulation and Connector Shield Installed on Battery

Figure VII-24. Brush Run-In Mode

NASA — MSC
MSC 5254-70

VIII. ALSD/ALSEP INTEGRATION, PRELAUNCH AND POST LAUNCH OPERATIONS

1.0 INTRODUCTION

A tabulation of ALSD/ALSEP integration and prelaunch operations requirements are presented in Table VIII-1. These procedures, at the discretion of the ALSEP prime contractor, may be performed at BXA or KSC within the recommended time restrictions. The procedures have been developed to interface the ALSD requirements with the final ALSEP flight acceptance tests in accordance with the information available at the time of release of this manual. It is recommended that wherever possible, Martin Marietta Corporation technical assistance be provided when performing these operations.

TABLE VIII-1

ALSD/ALSEP Integration and Prelaunch Operations

Time	Procedure	Para. Ref.
Receipt of equip. in field (KSC)	1) Perform GSE operational readiness verification procedures on all units.	VI.1.0 & 2.0
T-(90-120) days	1) Perform GSE operational readiness verification procedures on all units.	VI.1.0 & 2.0
	2) Perform inactive battery subsystem verification procedures on all battery assemblies (4 units). Batteries attached to flight unit power heads to be removed and reinstalled in accordance with applicable procedures.	VII.1.0
	3) Perform nonoperating power head subsystem verification procedures on all power heads (2 units). Power heads to be removed and reinstalled on batteries in accordance with applicable procedures.	VII.2.0
	4) Perform ALSD assembly deployment verification on all ALSDs (2 units).	VII.3.0
	5) Sequentially install all ALSDs on ALSEP.	BXA Procedure
T-10 days	Remove battery and power head from designated flight unit ALSD and perform nonoperating battery and power head subsystem verification.	VII.1.0 & 2.0

TABLE VIII-1 (Cont.)

Time	Procedure	Para. Ref.
T-6 days	Perform ALSD battery activation procedure.	VII.4.0
T-5 days	1) Install activated battery on designated flight unit and perform power head functional checkout procedures.	VII.5.0
	2) Remove battery from power head and perform paragraphs VII.1.8.a through f, 1, and m to purge battery case. Perform paragraphs VII.4.10.c and d to ensure proper battery voltage.	VII.1.8
	3) Assemble activated battery and power head and perform ALSD assembly deployment verification.	VII.3.0
	NOTES: 1) After performance of paragraph VII.3.7.u lift ALSD assembly and momentarily depress both handle actuating switches to verify power head operation.	
	2) Performance of paragraphs VII.3.7.y and z to be performed at MSC LRL just prior to sealing SRC.	
T-4 days	1) Remove 5 temporary identification tags (power head tag from thermal guard, battery tag and 3 lanyard tags).	N/A
	2) Perform the following final checks:	N/A
	a) Verify that the four lanyard pull pins (Ref. Fig. III-14) are properly and completely engaged on treadle and rack.	
	b) Verify that the battery thermal shroud (Ref. Fig. III-6) release latch is secure.	
	c) Verify that the rack-to-treadle and battery-to-treadle camlocs (Ref. Fig. V-12; V-13) are secure.	

TABLE VIII-1 (Cont.)

Time	Procedure	Para. Ref.
	3) Carefully install ALSD assembly on board ALSEP/LM.	BXA Proced.
T + 5 days	Astronaut scientist to perform 3-hole lunar drilling mission.	V.3.0
	NOTES: Drilling mission should be performed within 15 days of battery activation to ensure full power output capacity of the ALSD battery.	

IX. TRAINING UNIT SERVICE CHECKLIST

1.0 PURPOSE

The purpose of this checklist is to provide an easy reference for the training unit inspection and maintenance requirements of the training battery and power head.

Procedure	Time	Para. Ref.
Activate Cells	1 day before use	VII. 4.0
Recharge	Within one day of partial or full discharge (power head will not percuss)	VII. 6.0
Inspect Cells	Every month or every recharge	VII. 4.10, e.
Check Cell Voltages	After every recharge cycle	VII. 4.10, b, c, d.
Visual Inspection	Prior to installing battery on power head	VII. 4.5
Check wiring	After cell replacement	VII. 4.5, c.,d.
Replace Cells	Cell voltage low after charge Cells leaking Cells distorted After 6 months activation	VII. 7.0
Internal Cleaning	Before installing new cells	VII. 7.6
Lubricate		
External Port	.5 hrs. of operation	VII. 8.7, a.
Minor Internal	2 hrs. of operation To be stored in excess of 30 days after use.	VII. 8.7, b.
Major Internal	10 hrs. of operation	VII. 8.7, c.
Clean		
Minor External	As required	VII. 8.8, a.
Minor Internal	2 hrs. of operation Unscheduled minor maintenance	VII. 8.8, b.
Major Internal	10 hrs. of operation Unscheduled major maintenance Seal replacement	VII. 8.8, c.
Check Power Head Current	RPM low Abnormal heating Connector pins burned After 2 hrs. of operation	VII. 5.7

Replace Seals	Seals damaged	VII. 8.0
Inspect		
External	.5 hrs. of operation	VII. 8.9, a.
Internal	2 hrs. of operation To be stored in excess of 30 days after use 10 hours of operation	VII. 8.9, b
Unscheduled Maintenance	As required	VII. 8.0

X. ALSD SPARE PARTS DISTRIBUTION

1.0 INTRODUCTION

1.1 ALSD Flight Units - Primary flight spares support is attained by the availability of two (2) identical ALSD flight units (Part Number 467A8060000-069). The current mission requirement for the ALSD has been reduced from two flights to one, providing one (1) complete backup unit to support the single flight. In addition, a total of two (2) spare battery assemblies (Part Number PS940300014-003) are provided in the event that launch schedule slippages require the activation of replacement batteries.

A summary list of additional flight spare components and subassemblies provided under the terms of the ALSD contract is presented in Table X-1, and a detailed list is presented in Table X-2. It is anticipated that these spares may eventually become available to support the ALSD training program.

1.2 ALSD Training Units - The ALSD training units will be subjected to considerable use, and a larger inventory of spare parts has been provided to support the anticipated maintenance requirements. A summary list of components and subassemblies is presented in Table X-1, and a detailed list is presented in Table X-3.

1.3 Ground Support Equipment (GSE) - The major elements of GSE required to service the ALSD include the Pressurization Unit (Part Number 467A8090000-009) and the Battery Charging Unit (Part Number 467A8080000-009). A total of two each of these units have been provided for prelaunch operations, with one set serving as a backup for the primary equipment. Availability of two pressurization units also provides the capability of simultaneous checkout of the battery and power head pressurization systems.

A total of three (3) battery charging units have been provided to support the training requirements at a variety of locations. Pressurization units are not required for support of the ALSD training units.

In addition to the above, a pressurization unit and battery charging unit will be released to the GSE inventory after completion of all ALSD acceptance testing at the Martin Marietta Corporation.

Table X-1. ALSD Spare Parts Summary *

Nomenclature	Total Quantity	Training Units #1	Training Units #2	Flight Units
Drill Bits	30 ea.	8	22	
Drill Bit Extension Tube Sets	3 ea.	1	2	
Hole Casing Set (6 Pieces) without Adapters	11 ea.	2	9	
Batteries (Flight)	4 ea.			4
Secondary Cell Set (for Training Battery)	6 ea.	3	3	
Percussor Assembly	1 ea.		1	
Motor Assembly	1 ea.		1	
Power Train Assembly	1 ea.		1	
Seal Refurbishment Kit	7 ea.		4	3
Castings	2 ea.		1	1
Cam	1 ea.		1	
Bearing Set	2 ea.		2	
Gear Set	1 ea.		1	
Motor Brush Set	4 ea.		4	
Motor Armature	3 ea.		2	1
Percussor Spring	1 ea.		1	
Electrical Connector	4 ea.		3	1
Purge & Relief Valve	2 ea.			2
Permanent Magnet Set	1 ea.		1	
Electrical Switch	2 ea.		1	1
Accessory Group (not including Battery Shroud and Power Head Guard)	1 ea.		1	
Thermal Guard (Power Head)	2 ea.		2	
Battery Shroud	2 ea.		2	
Adapter (Hole Casing/Power Head)	3 ea.	1	2	

Note: A total of two (2) each additional spare Drill Bits and one (1) each Training Battery are to be furnished with ALSD Training Units.

* Delivered under Contract NAS9-6587.

Table X-2. ALSD Flight Unit Spares and Material Samples*

Nomenclature	Part Number	Quantity
Battery (Flight)	PS9403000014-003	4
Battery Filler Kit	11310 (Yardney Electric)	4
Seal Refurbishment Kit	12062-211 (Black & Decker)	3
Castings	12062-214 (Black & Decker)	1 (Set)
Motor Armature	12062-6 (Black & Decker)	1
Electrical Connector (Power Head)	PS8133000001-005	1
Purge & Relief Valve	12062-113 (Black & Decker)	2
Electrical Switch	BA-3ST (Microswitch)	1
<u>Material Samples</u>		
Drill Bit	PS600100023-011	3/Flt.Unit
Extension Tube	PS600100022-005	1/Flt.Unit
Cap	467A8050016-013	3/Flt.Unit
Drill String Wrench	467A8050014-039	1/Flt.Unit

Notes:

1) Finish Requirements - The spare batteries and power head castings shall be painted in the same manner and areas as the comparable flight units as depicted on Drawing 467A8050000. No additional finish is required for the balance of parts listed above in excess of that defined on the applicable detail or assembly drawings.

2) Cleaning Requirements - The spare batteries and material samples shall be cleaned and bagged in accordance with Drawing 467A8050034.

3) Preservation and Packaging - Preservation and packaging of the above shall be in accordance with MIL-P-116 and MIL-STD-794 (WP) Level "A". Packing and shipping containers shall be in accordance with MIL-STD-794 (WP) Level "B".

   Battery Filler Kits shall be packaged and shipped separately from other spare parts, using containers in which the components were received from Yardney Electric (or equivalent). Components of these filler kits must be protected from contamination by cushioning material.

4) Material samples under Contract NAS9-9462:

   Stem caps Part Number 467A8060003 - 3 Each

   Cap retainer (anodized aluminum)

* Delivered under Contract NAS9-6587.

Table X-3. ALSD Training Unit Spares (Sheet 1 of 6) *

Part Number	Nomenclature	Quantity	Notes
Martin Marietta Hardware			
PS600100023-007	Drill Bit	8	
467A8050000-011	Drill Bit	22	
467A8050030-089	Thermal Guard (Power Head)	2	
467A8050029-049	Thermal Shroud (Battery)	2	
467A8050036-009	Adapter (Casing/Power Head)	2	
BA-3ST (Microswitch)	Electrical Switch	1	
	One (1) Drill Bit Extension Tube Set, consisting of		
PS600100022-001	Extension Tube - Standard	7/Set	
PS600100022-003	Extension Tube - Bit	1/Set	
	Two (2) Drill Bit Extension Tube Sets, consisting of		
PS600100022-005	Extension Tube - Standard	7/Set	(1)
PS600100022-007	Extension Tube - Bit	1/Set	(1)
Note (1)	Including canadizing, cleaning, sandblasting and anodizing in accordance with Note 20 on Drawing 467A8050000 Sheet 3.		
	Nine (9) Hole Casing Sets (w/o adapters), consisting of		
467A8050006-019	Hole Casing - Standard (long section w/o color)	4/Set	
467A8050006-039	Hole Casing - (long section, black internal band)	1/Set	
467A8050006-089	Hole Casing - Tip (closed end section)	1/Set	
	Three (3) Hole Casing Sets (w/o adapters), consisting of		
467A8050006-019	Hole Casing - Standard (long section w/o color)	4/Set	
467A8050006-039	Hole Casing - (long section, black internal band)	1/Set	
467A8050006-049	Hole Casing - Tip (closed end section)	1/Set	
	One (1) Accessory Group, consisting of		
467A8050001-039	Treadle Assembly	1	(2)
467A8050001-019	Camloc Assembly	1	(2)
12R1-1BB	Receptacle, Camloc	1	(2)
MS20426-AD2	Rivet	2	(2)
467A8050009-029	Lock Pin Assembly	1	(2)
467A8050012-007	Clamp	1	(2)

* Delivered under Contract NAS9-6587.

Table X-3. ALSD Training Unit Spares (Sheet 2 of 6)

Part Number	Nomenclature	Quantity	Notes
467A8050012-021	Yoke	1	(2)
467A8050012-023	Yoke	1	(2)
MS20470B5	Rivet	8	(2)
MS16535-159	Rivet, Tubular	1	(2)
467A8050000-001	Pad	1	(2)
467A8050000-003	Nameplate	1	(2), (3)
467A8050000-005	Pad	1	(2)
467A8050000-007	Pad	1	(2)
66-60-6B	Insignia	1	(2)
66-28-1	Mod Plate	1	(2)
MS20470B3	Rivet	6	(2)

Note (2) These parts shall be attached to the Treadle Assembly. Parts shall be fit checked and assembled using Training Unit No. 2 Power Head, Thermal Guard, Battery and Thermal Shroud for coordination purposes.

Note (3) The Nameplate shall be marked as follows:
Die stamp in .094" high characters,
Nomenclature: "ALSD Training Unit No. 2 Spare"
Die stamp in .062" high characters,
Part Number: "467A8050000-079"
Contract No.: "NAS 9-6587"
Serial Number: (leave blank)

Part Number	Nomenclature	Quantity	Notes
467A8050013-099	Handle and Switch Assembly	1	
467A8050028-029	Rack Assembly	1	
467A8050014-039	Wrench	1	
	One (1) Hole Casing Set, consisting of		
467A8050006-089	Hole Casing - Tip (closed end section)	1/Set	
467A8050006-019	Hole Casing - Standard (long section w/o color)	4/Set	
467A8050006-039	Hole Casing - (long section, black internal band)	1/Set	
	One (1) Hole Casing Set, consisting of		
467A8050006-089	Hole Casing - Tip (closed end section)	1/Set	
467A8050006-019	Hole Casing - Standard (long section w/o color)	4/Set	
467A8050006-029	Hole Casing - Short	1/Set	
467A8050036-009	Adapter (Casing/Power Head)	1/Set	
467A8050027-019	Retainer - 4 Female - 4 Male Caps	1	
467A8050027-009	Retainer - 4 Male, 3 Female, 1 Bit Cap	1	
	Three (3) Electrical Connectors, consisting of		
PS813300001-007	Connector, ALSD (Female)	2	(4)
PS813300001-005	Connector, ALSD (Male)	1	(4), (5)

Note (4) Quantities are total. Two female and one male comprise the total requirement for three electrical connectors.

Note (5) This part physically installed in Black & Decker Connector Assy. P/N 12062-85 listed below as part of a Motor Assy.

Table X-3. ALSD Training Unit Spares (Sheet 3 of 6)

Part Number	Nomenclature	Quantity	Notes
Subcontractor Hardware			
Yardney Electric			
	Six (6) Secondary Cell Sets, consisting of		
HR 5 DC	Battery Cells	16/Set	
11218	Silvercel Filling Kit	1/Set	
Black and Decker			
	One (1) Percussor Assembly, consisting of		
	One (1) Cam Follower S/A, consisting of		
12062-30	Ram Head	1	(6)
12062-31	Nut Ram	1	(6)
12062-42	Follower, Cam	1	(6)
12062-70A	Washer, Ram Head	1	
12062-111	Bearing, MRC 5202 SB-ST	1	
12062-123	Lock Ring	1	
12062-32	Sleeve, Ram	1	(6)
12062-33	Spring, Energy	1	
12062-34	Retainer, Spring	1	(6)
12062-39	Housing Percussor	1	(6)
12062-147	Shim	1	(6)
	One (1) Shock Absorber S/A, consisting of		
12062-157	End Plate, Percussor	1	
12062-158	Rod, Shock Absorber	1	
12062-159	Spacer, Shock Absorber	1	
12062-160	Tube, Shock Absorber	1	
12062-161	Screw, Socket Head	1	
	One (1) Motor Assembly, consisting of		
12062-6	Armature	1	
12062-14B	Brush Assembly	2	
12062-15	Magnet Assembly	1	
12062-16	Nut, Bearing Retainer	1	
12062-26	Brush Holder Assembly	1	
12062-48	Clip, Spring	1	
12062-61	Shoulder Screw	2	
12062-85	Connector Assembly	1	
12062-89	Cup Washer	2	
12062-94	Shield, Connector	1	
12062-137	Lock Washer, Internal Shake	4	
12062-144	Screw, Round Head (Br)	4	

Table X-3. ALSD Training Unit Spares (Sheet 4 of 6)

Part Number	Nomenclature	Quantity	Notes
	One (1) Power Train Assembly, consisting of		
	One (1) Clutch Assembly, consisting of		
12062-18	Gear Cam	1	(6)
12062-19	Pinion, Inter.	1	(6)
12062-21	Ring, Clamp	1	(6)
12062-22	Clutch, Overtorque	1	(6)
12062-23	Spring, Clutch	3	
12062-41	Washer	1	
12062-62	Washer	1	
12062-20	Gear, Rotary Drive	1	(6)
12062-27	Tube, Output Drive	1	(6)
12062-28	Washer, Output Drive Stop	1	
12062-29	Nut, Dynamic Seal	1	
12062-53	Cup, Spring Retainer	1	
12062-54	Spring, Bearing Plug	1	
12062-55	Ring, Thrust Bearing Support	1	
12062-101	Bearing, MRC R-4-AF-4-ST	1	
12062-103	Bearing, TORR #NTA-2031	1	(6)
12062-104	Washer, Thrust TORR #TRA 2031	1	(6)
12062-107	Bearing, TORR #B228	1	(6)
12062-108	Bearing, MRC MB-542-ST	1	
12062-109	Bearing, MRC R-4-A-4-ST	1	
12062-110	Bearing, TORR #B45	1	(6)
12062-112	Ball, M50 Steel	12	
12062-117	Seal, Quad Ring Viton	1	
12062-118	Seal, Dynamic Bellows	1	
12062-125	Ball, M50 Steel	1	
12062-155	Roll Pin	2	
12062-146C	Quad Ring	1	
	Four (4) Seal Refurbishment Kits, P/N 12062-211, consisting of		
12062-117	Seal, Quad Ring Viton	1/Kit	
12062-118	Seal, Dynamic Bellows	1/Kit	
12062-127	Seal, "O" Ring	1/Kit	
12062-130	Screw, Steel	1/Kit	
12062-138	Quad Ring	2/Kit	
12062-145	"O" Ring	1/Kit	
12062-146C	Quad Ring	1/Kit	
12062-148	"O" Ring	1/Kit	
12062-162	Screw, Steel	1/Kit	
N/A	2 oz. Tube Krytox 240AC	1/Kit	
N/A	1 fl. oz. Krytox 140AC Fluorinated Oil	1/Kit	
	One (1) Casting Set, consisting of		
12062-1D	End Plate Assembly (Casting), including	1	
12062-44	Dowel Pin (2)		
12062-90	Shield - EMI (1)		
12062-91	Shield - EMI (1)		

Table X-3. ALSD Training Unit Spares (Sheet 5 of 6)

Part Number	Nomenclature	Quantity	Notes
12062-2D	Outer Housing S/A, including	1	
12062-24	Pin Pinion Bearing (1)		
12062-83	Insert Bearing (1)		
12062-162	Steel Screw (1)		
12062-3	Gear Case Cover, including	1	
12062-64	Cup Bearing (1)		
12062-82	Insert Bearing (1)		
12062-25B	Nut, Drive Tube Stop	1	
12062-60	Nut, Retainer	1	
12062-71	Washer, Flat	5	(6)
12062-72	Sleeve, Bearing Lock	1	
12062-73	Cap, Commutator End	1	
12062-95	Spring, Suppression	3	
12062-96	Button, Suppression	3	
12062-113	Valve, Pressure Relief	1	
12062-127	Seal, "O" Ring	1	
12062-130	Steel Screw	1	
12062-133	Socket Head Cap Screw	3	
12062-134	Wiper	1	
12062-135	Bushing, Thermal Insulator	5	
12062-136	Socket Head Cap Screw	5	
12062-138	Quad Ring	2	
12062-142	Lock Washer, Internal Shake	17	
12062-143	Lock Washer	3	
12062-145	"O" Ring	1	
12062-148	"O" Ring	1	
12062-164	Socket Head Screw	10	
	One (1) Cam & Cam Follower, P/N 12062-210, consisting of		
12062-18	Cam	1	(6)
	One (1) Cam Follower S/A, consisting of		
12062-30	Ram Head	1	(6)
12062-31	Nut Ram	1	(6)
12062-42	Follower, Cam	1	(6)
12062-70A	Washer, Ram Head	1	
12062-111	Bearing, MRC 5202 SB-ST	1	
12062-123	Lock Ring	1	
	Two (2) Bearing Sets, P/N 12062-212, consisting of		
12062-101	Bearing, MRC R-4-AF-4-ST	1/Set	
12062-102	Bearing, MRC R-8-F-ST	1/Set	
12062-103	Bearing, TORR #NTA-2031	1/Set	(6)
12062-104	Washer, Thrust TORR #TRA 2031	1/Set	(6)
12062-107	Bearing, TORR #B228	1/Set	(6)
12062-108	Bearing, MRC MB-542-ST	1/Set	
12062-109	Bearing, MRC R-4-A-4-ST	1/Set	
12062-110	Bearing, TORR #B45	1/Set	(6)
12062-111	Bearing, MRC 5202 B2-ST	1/Set	

Table X-3. ALSD Training Unit Spares (Sheet 6 of 6)

Part Number	Nomenclature	Quantity	Notes
	One (1) Gear Set, Bit Rotation, P/N 12062-215, consisting of		
12062-19	Pinion, Inter.	1	(6)
12062-20	Gear, Rotary Drive	1	(6)
12062-27	Tube, Output Drive	1	(6)
	Four (4) Motor Brush Sets, P/N 12062-213, consisting of		
12062-14B	Brush Assembly	2/Set	
	One (1) Motor Armature, consisting of		
12062-6	Motor Armature	1/Set	
	One (1) Percussor Spring, consisting of		
12062-33	Percussor Spring	1/Set	
	One (1) Permanent Magnet Set, consisting of		
12062-15	Permanent Magnet Set	1	

Note (6) These parts shall have a light film of Krytox 143AC Fluorinated Oil, DuPont Co., brush application. Parts shall then be individually packaged in polyethylene bags and heat sealed.

Special Notes:

1. Finish Requirements - All Martin Marietta fabricated spare parts shall be finished in the same manner and areas as the comparable flight unit parts as depicted on Drawing 467A8050000 or other applicable drawings. The Power Head castings and Battery Case shall also be finished like the flight unit items. All other subcontractor spare hardware requires no additional finish other than the protective oil coating, indicated in Note (6).

2. Identification and Marking - Identification and marking shall be the same as provided for the flight unit items. Spare identification tags shall be provided with each spare item.

3. Preservation and Packaging - Preservation and packaging of the above shall be in accordance with MIL-P-116 and MIL-STD-794 (WP) Level "A". Packing and shipping containers shall be in accordance with MIL-STD-794(WP) Level "B". Marking of packages and shipping containers shall meet the requirements of MIL-STD-129.

Battery Filler Kits shall be packaged and shipped separately from other spare parts, using containers in which the components were received from Yardney Electric (or equivalent). Components of these filler kits must be protected from contamination by cushioning material.

XI. ALSD TRANSPORTATION AND STORAGE REQUIREMENTS

1.0 GENERAL EQUIPMENT DESCRIPTION

1.1 Apollo Lunar Surface Drill - The ALSD flight equipment consists of the following major items:

Part Number	Nomenclature	Item Description
467A8060000-069	ALSD	Consists of entire ALSD in ALSEP stowage mode, less battery filling kit and accessory details kit (core stems and caps). Item is stowed in aluminum shipping container (Part No. 467A8050003-009) with rubber padding to prevent transportation damage.
467A8060000-079	Accessory Details Kit	Consists of core bit, core stems and caps.

1.2 Ground Support Equipment - The ALSD ground support equipment consists of the following major items:

Part Number	Nomenclature	Item Description
467A8080000-009	Battery Charging Unit	Consists of a SILVERCEL charger and adapter unit required for charging the ALSD battery.
467A8090000-009	Pressurization Unit	Consists of the equipment required for pressure testing the ALSD battery and power head.
Yardney P/N 11310	Silvercel Filling Kit	Consists of electrolyte, pads and filling equipment required for preflight battery activation.

1.3 Flight Spares - The ALSD flight spares consist of the following major items:

Part Number	Nomenclature	Item Description
PS940300014-003	Battery	Consists of ALSD battery replacement.
--	Miscellaneous Spares	Consists of miscellaneous spare parts for support and servicing of ALSD power head and battery assembly.

2.0 PRESERVATION AND PACKING

2.1 Flight Unit ALSD - The ALSD shall be packaged by the contractor in aluminum shipping containers with padding to preclude transportation damage. The ALSD within the container shall be placed in a sealable contamination control bag to maintain cleanliness of the unit. Accessory details (core stems and caps) shall be placed in sealable contamination control bags to maintain cleanliness, and packaged separately from the ALSD assembly. No special environmental control devices or environment recording equipment shall be required for the shipping containers. Over-packing of the flight unit equipment shall be provided as required to ensure safe delivery by air transportation.

2.2 Ground Support Equipment and Flight Spares - Equipment shall be packaged by the contractor to the extent required to ensure safe air transport to the delivery destination. No special environmental control devices or environment recording equipment shall be required for the GSE.

3.0 TRANSPORTATION

3.1 Flight Unit ALSD - The ALSD flight units shall be hand-carried by air transportation from the contractor's facility to the destination designated by NASA. Temperature extremes during ALSD transport shall not exceed -2[illegible] to +100°F.

3.2 Ground Support Equipment and Flight Spares - GSE and flight spares shall be packaged for normal commercial air transportation. Temperature extremes during equipment transport shall not exceed -20° to +100°F.

4.0 STORAGE

4.1 Temperature and Humidity - The ALSD and GSE shall be stored in an area where the temperature is maintained within the range of 30° to 90°F, with occasional excursions in the range of 0° to 120°F allowed. The relative humidity shall be maintained within the range of 20 to 80 percent with occasional excursions up to 95 percent allowable.

5.0 INSPECTION

5.1 General - The ALSD and GSE shall be visually inspected for transportation damage upon receipt at the destination as delineated below. Functional checkout of the equipment shall be performed in accordance with the requirements of this manual.

5.2 Flight Unit ALSD - The over-packing shall be removed from the ALSD aluminum shipping containers. The shipping container shall be externally inspected for evidence of transportation damage. The container shall be opened for visual examination of the ALSD contamination control bags. The Accessory Details Kit (core stems and caps) shall be inspected for damage to the contamination control bags.

5.3 Ground Support Equipment and Flight Spares - The over-packing shall be removed from the Battery Charging Unit and the Pressurization Unit. The units shall be inspected for evidence of transportation damage. Functional checkout of the equipment shall be performed in accordance with the requirements of this manual. No inspection of the battery filling kits or flight spares is required.