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SNAP 7 PROGRAM

QUARTERLY PROGRESS REPORT NO. 5

Task 8--Strontium-90 Fueled Thermoelectric Generator Development

November 1, 1961 to January 31, 1962

MND-P-2483-5

MARTIN NUCLEAR DIVISION

BALTIMORE 3, MARYLAND

SNAP 7 PROGRAM

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Nuclear Division,
Martin Marietta Corporation, Baltimore, Md

Prepared by

W. A. McDonald
W. A. McDonald
Ass't. Project Engineer

Approved by

W. L. Kershaw
W. L. Kershaw
Project Engineer

LEGAL NOTICE

FOREWORD

This quarterly report covers the period from November 1, 1961 through January 31, 1962. It has been prepared by the Martin Company according to the requirements of Contract AT(30-3)-217, Task 8, with the U. S. Atomic Energy Commission.

DISTRIBUTION

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CONTENTS

I. INTRODUCTION AND SUMMARY

The SNAP 7 program is being conducted by the Martin Company for the purpose of developing four radioisotope-fueled thermoelectric power generation systems. The current program in its entirety covers:

(1) Design, fabrication, test and delivery of four radioisotope-fueled thermoelectric generator systems. These systems are to be designed to meet the rigorous environmental requirements of field use by the U. S. Coast Guard and the U. S. Navy.

(2) Fabrication of the Strontium-90 fuel for one of the aforementioned generators.

The four generator systems as specified under the contract are as follows:

(1) A 5-watt electric generation system for U. S. Coast Guard light buoy. The system is referred to as SNAP 7A. This phase of the overall program is identified as Subtask 8. 1.

(2) A 30-watt electric generation system for U. S. Coast Guard fixed light station. The system is referred to as SNAP 7B. This phase of the overall program is identified as Subtask 8. 2.

(3) A 5-watt electric generation system for U. S. Navy weather station. The system is referred to as SNAP 7C. This phase of the overall program is identified as Subtask 8. 3.

(4) A 30-watt electric generation system for U. S. Navy boat-type weather station. The system is referred to as SNAP 7D. This phase of the overall program is identified as Subtask 8. 4.

Fuel processing for the four systems is identified as a separate subtask, Subtask 8.5, to permit a more detailed surveillance of this aspect of the program.

This report has been divided into three major sections: Section II, the SNAP 7A and SNAP 7C efforts; Section III, the SNAP 7B and SNAP 7D efforts; and Section IV, the fuel processing effort.

The drafts of the final technical reports for the SNAP 7A and SNAP 7C systems were released for publication early in January 1962. Published copies of the reports are now being distributed.

A. SNAP 7A AND SNAP 7C

During this report period, the SNAP 7A battery and converter were subjected to the required shock, vibration and temperature tests. The generator was fueled, postfueling radiation levels were checked and the generator was integrated into the complete SNAP 7A system. After the completion of acceptance tests, the SNAP 7A system was delivered to the Coast Guard at Curtis Bay Station and there installed in a buoy which, in turn, was anchored in the bay where it will be subjected to further evaluation.

The SNAP 7C generator was shipped to Davisville, Rhode Island, on October 23, 1962 for transport to Antarctica by the USS Arneb. The generating system is to be installed on the Ross Ice Shelf early in February 1962. The generator will power a five-watt U. S. Navy Remote Weather Station.

B. SNAP 7B AND SNAP 7D

During this report period, tests were conducted to determine the operational characteristics of SNAP 7B and 7D thermoelectric couples. Also, the reliability model of the generator has been operated at high temperature for 23 days to date. The electrical, converter and battery specifications for the SNAP 7D system were completed and released.

C. FUEL PROCESSING

The primary effort in the fuel processing phase of the program has been to provide the necessary liaison with the personnel installing the processing equipment. Maintenance and checkout guides have been written to assure satisfactory installation and continued performance throughout the fuel processing span. An operation procedure guide has been written to describe the engineering concept of the fuel processing operation. The guide was written for the personnel who will be conducting the fuel processing operation.

II. SNAP 7A AND 7C FIVE-WATT ELECTRIC GENERATION SYSTEMS--SUBTASKS 8.1 AND 8.3

A. OBJECTIVES

The objectives of Subtasks 8.1 and 8.3 for this report period were:

(1) To prepare the SNAP 7A and SNAP 7C final technical reports (Refs. 1 and 2) for publication.

(2) To perform shock, vibration, and environmental temperature tests on the SNAP 7A battery and converter.

(3) To fuel the SNAP 7A generator.

(4) To integrate the SNAP 7A fueled generator and electric generation system to assure compatibility.

(5) To deliver the SNAP 7A system to the Coast Guard at the Curtis Bay Station.

(6) To continue testing the reliability model for SNAP 7A and SNAP 7C.

(7) To evaluate hydrocatylators for conservation of battery water.

B. ACHIEVEMENTS AND DISCUSSION

The SNAP 7A and SNAP 7C final technical reports were written, published and distributed. The reports include a physical description; a thermoelectric analysis; a thermal analysis; the fuel form and shielding requirements; a description of the generator assembly and the electrical assembly; a review of the operational testing and the environmental testing; the shielding requirements; and a listing of the engineering drawings.

The environmental testing of the SNAP 7A generator was accomplished with the third 10-watt generator as reported in the preceding quarterly progress report (Ref. 3).

The shock and vibration tests and the temperature tests for the SNAP 7A battery and converter were conducted in accordance with the Statement of Work (Ref. 4). The battery and converter successfully withstood the environments with no resultant mechanical or electrical defects.

Figure 1 shows the reference axes used during the shock and vibration testing of the battery and converter. Figure 2 shows the instrumentation circuitry used during the tests.

1. Test Requirement and Test Method

a. Vibration--SNAP 7A battery and converter

The battery and converter were mounted to a flat fixture plate and tested simultaneously as follows:

(1) Dwell at 5 to 33 cps in discrete frequency intervals of 1 cps; dwell for 3 minutes at each frequency (3-g level or 0.060 ± 0.006 inch displacement, whichever is less).

(2) Repeat (1) for the two remaining principal orthogonal axes.

(3) Dwell at the most severe resonant condition, at the input level consistent with the frequency, for a period of 2 hours.

Figure 3 shows the mounting arrangement for the vibration test in the longitudinal direction.

b. Shock test--SNAP 7A battery and converter

A Barry medium impact shock machine was used for the shock tests which were as follows: The specimen was subjected to two 6-g shocks of 6-millisecond half sinewave pulse in each of the three principal orthogonal axes.

Figure 4 shows the mounting arrangement for the shock test in the lateral direction.

c. Temperature--SNAP 7A battery and converter

The battery and converter were positioned in a small temperature chamber, as shown in Fig. 5, and subjected to the following ambient temperatures:

(1) +90° F--sea level pressure.

(2) +60° F--sea level pressure.

(3) 0° F--sea level pressure.

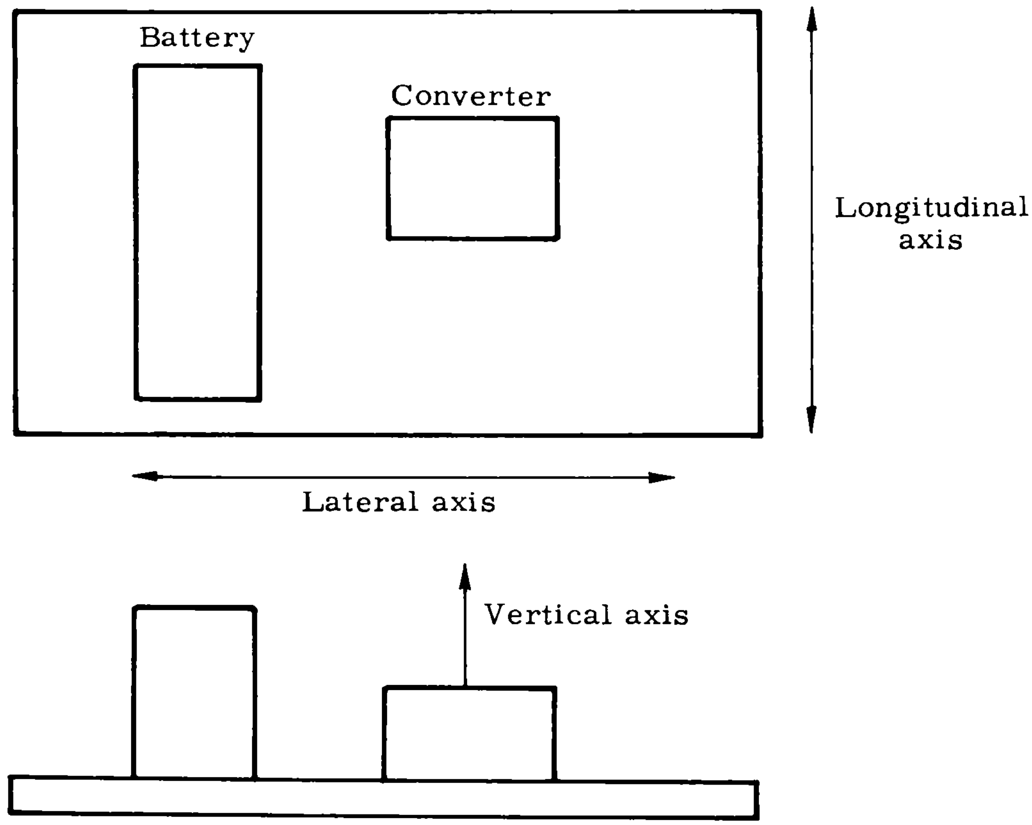


Fig. 1. Reference Axes for Vibration and Shock Testing of SNAP 7A Battery and Converter

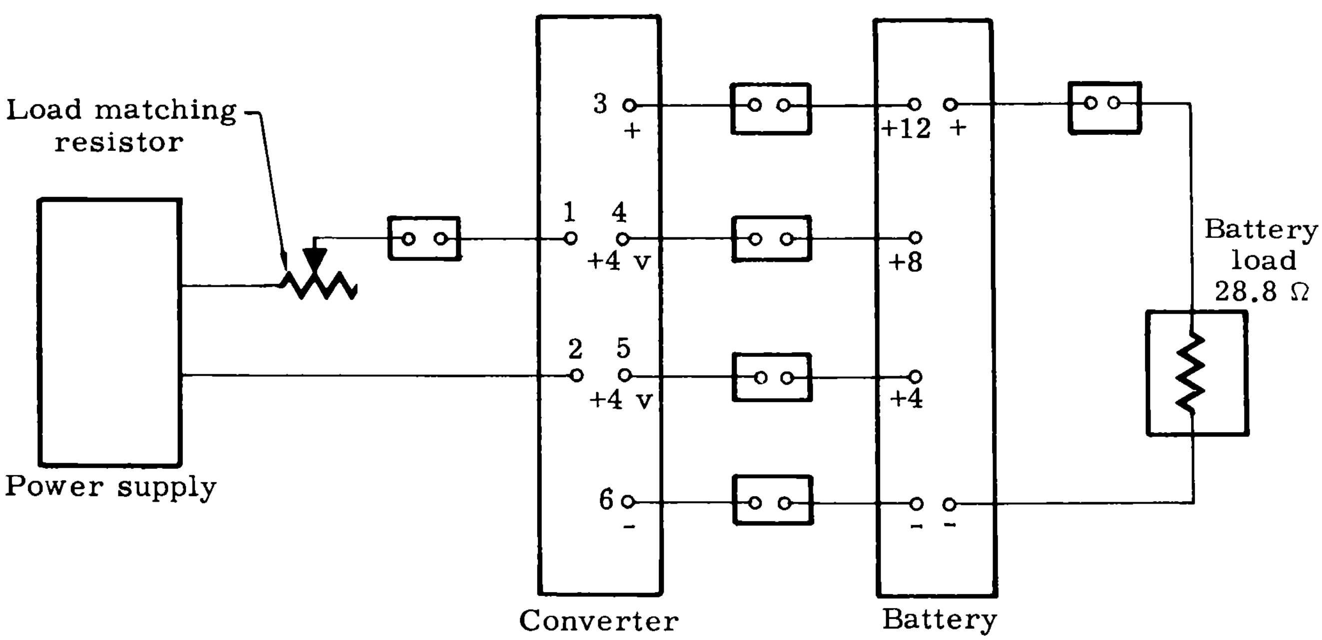


Fig. 2. SNAP 7A Battery and Converter Test Instrumentation Circuitry

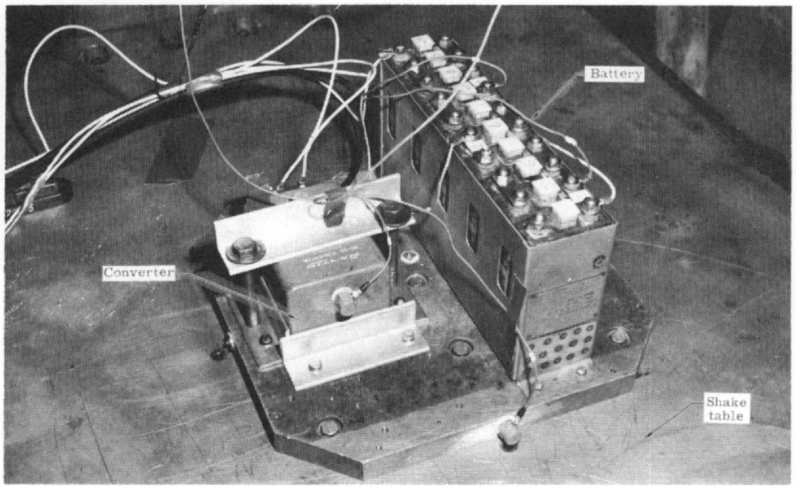
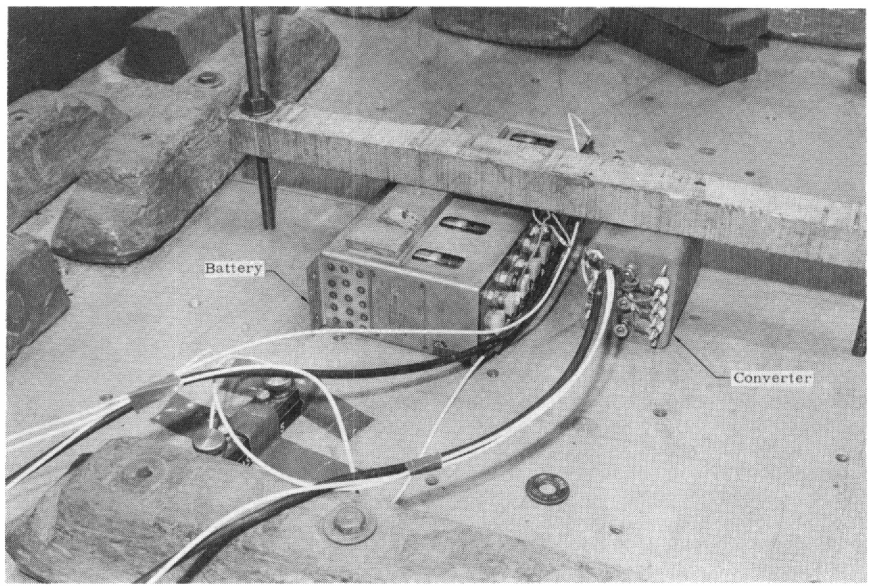


Fig. 3. SNAP 7A Battery and Converter Positioned on the Vibration Slide Table for Excitation in the Longitudinal Axis

Fig. 4. SNAP 7A Battery and Converter Positioned on the Barry Medium Impact Shock Machine for Longitudinal Shock Tests



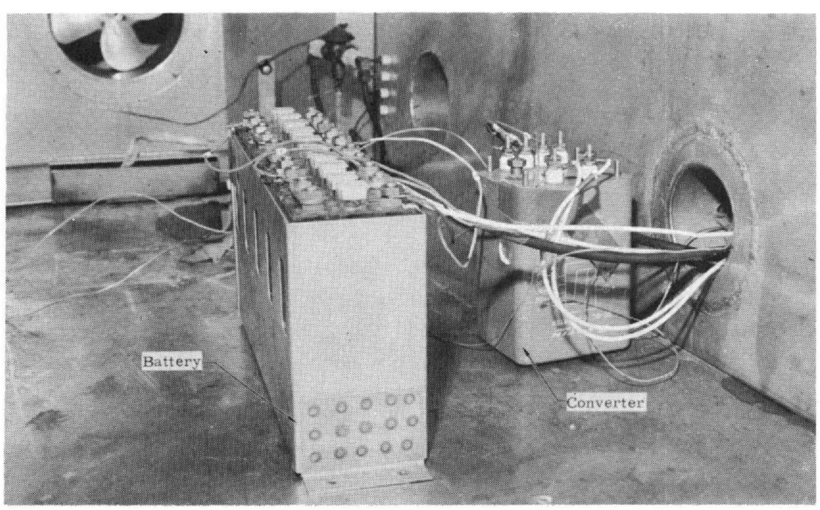


Fig. 5. SNAP 7A Battery and Converter Positioned in Temperature Chamber and Subjected to Various Ambient Temperatures

2. Results of 7A Converter and Battery Tests

a. Vibration

No major vibration resonance was detected. As indicated by functional checks prior to and after all tests, there were no adverse effects in the specimens subjected to the 2-hour 33-cps vibration test. Table I is a tabulation of the functional data obtained in conjunction with the vibration tests.

b. Shock

The battery and converter functional checks and visual inspections made before and after each plane of shock showed no structural damage or effects on the operation of either unit. Table II is a tabulation of the data obtained in conjunction with the shock tests.

c. Temperature

Satisfactory performance of the battery and of the converter at the temperature extremes, 0° and +90° F, and at a midpoint, +60° F, was verified. The data obtained are presented in Table III.

d. Performance check*

Pre-environmental and postenvironmental performances were substantiated.

The parametric data for the SNAP 7A generator were reported in the preceding quarterly report (Ref. 3).

The preliminary SNAP 7A generator tests were terminated on 15 November 1961, and the generator was prepared for fueling. This consisted of removing the electric heaters and extra thermocouples and installing a new MIN-K insulating cover plate. Two thermocouples were left in the generator to measure the fuel block and iron shoe temperatures at the thermoelectric hot junction.

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*Performance monitoring during environmental test was utilized for determination of electrical failure only, and does not necessarily reflect the operation characteristics of the battery or converter. Stabilized conditions were not obtained prior to exposure to each of the mechanical environments; therefore, these conditions are reflected by slight indications of change in performance.

TABLE I

Vibration Test Data--SNAP 7A Battery and Converter

Item	Before Vertical Vibration	After Vertical Vibration	Before Longitudinal Vibration	After Longitudinal Vibration	Before Lateral Vibration	After Lateral Vibration	Before 33-cps Vibration Dwell	After 33-cps Vibration Dwell
Battery cell								
Voltage	1.32 v	1.32 v	1.32 v	1.32 v	1.32 v	1.32 v	1.32 v	1.32 v
Converter input								
Voltage	6.05 v	6.32 v	6.28 v	6.40 v	6.20 v	5.30 v	6.27 v	6.35 v
Current	1.96 a	2.02 a	2.02 a	2.03 a	2.02 a	2.03 a	2.02 a	2.02 a
Converter output								
Section No. 1								
Voltage	12.23 v	12.21 v	12.24 v	12.22 v	12.25 v	12.23 v	12.16 v	12.16 v
Current	336 ma	370 ma	373 ma	373 ma	372 ma	372 ma	405 ma	405 ma
Section No. 2								
Voltage	8.16 v	8.14 v	8.16 v	8.15 v	8.16 v	8.15 v	8.11 v	8.10 v
Current	24 ma	14 ma	10 ma	12 ma	6 ma	9 ma	14 ma	15 ma
Section No. 3								
Voltage	4.09 v	4.06 v	4.08 v	4.07 v	4.08 v	4.07 v	4.05 v	4.04 v
Current	-18 ma	-9 ma	-8 ma	-9 ma	-4 ma	-9 ma	-11 ma	-10 ma
Battery output								
Voltage	11.99 v	11.97 v	12.0 v	11.99 v	12.0 v	11.99 v	11.90 v	11.89 v
Current							405 ma	400 ma

TABLE II

Shock Test Data--SNAP 7A Battery and Converter

Item	Before Vertical Shock	After Vertical Shock	Before Lateral Shock	After Lateral Shock	Before Longitudinal Shock	After Longitudinal Shock
Battery cell voltage	1.32 v	1.32 v	1.32 v	1.32 v	1.32 v	1.32 v
Converter input						
Voltage	5.88 v	5.92 v	5.92 v	5.93 v	5.93 v	5.93 v
Current	1.90 a	1.92 a	1.92 a	1.92 a	1.92 a	1.92 a
Converter output						
Section No. 1						
Voltage	12.11 v	12.11 v	12.11 v	12.10 v	12.10 v	12.10 v
Current	411 ma	413 ma	413 ma	411 ma	411 ma	410 ma
Section No. 2						
Voltage	8.07 v	8,07 v	8.07 v	8.07 v	8.07 v	8.07 v
Current	15 ma	15 ma	15 ma	15 ma	15 ma	15 ma
Section No. 3						
Voltage	4.02 v	4.02 v	4.02 v	4.03 v	4.03 v	4.02 v
Current	-14 ma	-13 ma	-13 ma	-11 ma	-11 ma	-11 ma
Battery output						
Voltage	11.84 v	11.84 v	11.84 v	11.83 v	11.83 v	11.82 v
Current	408 ma	405 ma	405 ma	408 ma	408 ma	403 ma

TABLE III

Temperature Test Data--SNAP 7A Battery and Converter

Ambient temperature	Room temp	+60° F	+90° F	0° F	80° F
Converter case temperature	--	+67° F	+96° F	+5° F	86° F
Converter input					
Voltage	5.87 v	5.93 v	6.03 v	5.73 v	5.86 v
Current	1.86 v	1.91 a	1.92 a	1.96 a	1.90 a
Converter output					
Section No. 1					
Voltage	12.12 v	12.17 v	12.09 v	12.08 v	12.13 v
Current	413 ma	417 ma	414 ma	411 ma	412 ma
Section No. 2					
Voltage	8.08 v	8.12 v	8.06 v	8.06 v	8.10 v
Current	34 ma	11 ma	17 ma	4 ma	9 ma
Section No. 3					
Voltage	4.03 v	4.05 v	4.02 v	4.01 v	4.04 v
Current	-28 ma	-9 ma	-13 ma	-2 ma	-6 ma
Battery output					
Voltage	11.82 v	11.87 v	11.79 v	11.78 v	11.82 v
Current	408 ma	408 ma	403 ma	402 ma	406 ma

The generator was then shipped to Quehanna where it was assembled with the biological shield. The biological shield had been used previously as a shipping cask to transport the Strontium-90 fuel capsules from Oak Ridge to the Martin Quehanna facility. The generator was next moved into a hot cell and was made ready for fueling as shown in Fig. 6. The fuel capsules, a capsule retaining plate, a Min-K insulation plate, and the shield plug were installed by remote operations. At this point the final closure cover was manually bolted in place, and a radiation check was made to verify compliance with shielding requirements. The generator was fueled with 40,800 curies of radioactive Strontium-90. The measured dosage rates in milliroentgens per hour were:

At one meter from center of source	Top--2.5 Side--1.0
At the surface	Top--30 Side--15

These values are well within the ICC regulations for unescorted shipments (10 mr/hr maximum at one meter and 200 mr/hr maximum at the surface). The fueling was accomplished on November 21, 1961. Approximately 30 minutes were required to install the capsules and close the generator. During the fueling, an argon purge was used. After sealing the generator, it was purged with hydrogen and filled with helium to assure the desired thermal conductivity through the insulation for the first two years of operation.

After checking the generator for satisfactory electrical performance it was returned to the Baltimore plant where it was integrated into the overall system. Prior to this time the system had been assembled and operated using a d-c power supply. The load used was a buoy lantern consisting of a flasher, lamp changer and light bulb rated at 12 volts, 3.05. The flasher cycle was 4 seconds, 3.6 seconds with the light off and 0.4 second with the light on. Upon completion of the generator testing, to verify proper performance, the closure was welded to the housing. Access to the inner generator may only be accomplished by cutting away the generator closure. This provision prevents any unauthorized opening of the generator-biological shield assembly.

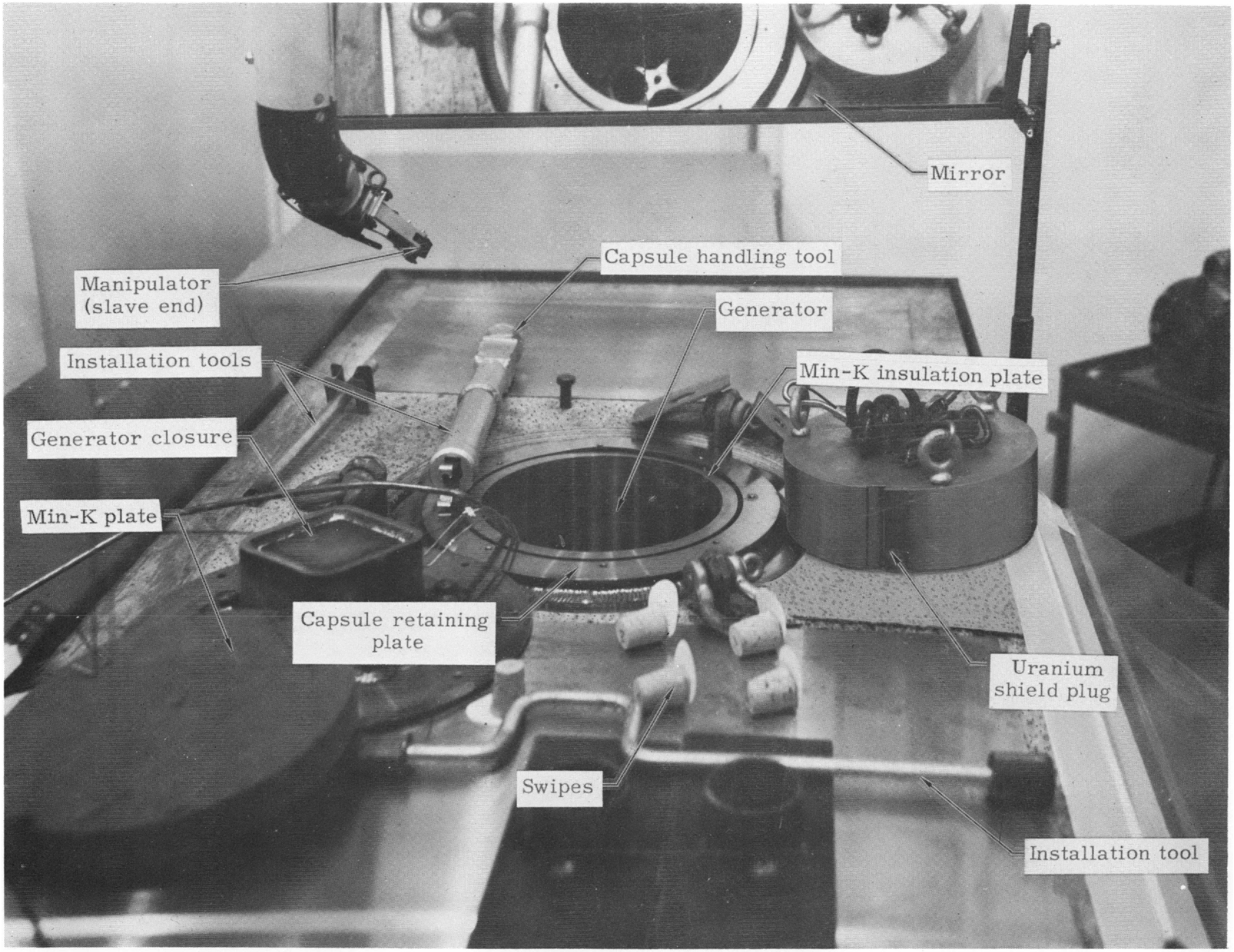


Fig. 6. Fueling of SNAP 7A Generator in Hot Cell at Martin Quehanna Facility

During the preceding tests on the system, voltage spread problems occurred. A three-section converter was substituted into the system in place of the single-section converter. Each section controls the voltage across three battery cells. With this arrangement it is possible to hold each of the nine cells used within the desired range of 1.33 to 1.38 volts per cell. The three-section converter proved adequate for voltage control, and displayed excellent stability under temperature variations. The converter had a maximum efficiency of 66%, which is available at the end-of-life condition for the generator. The converter schematic is shown in Fig. 7, and the corresponding parts list is included as Table IV.

The SNAP 7A system acceptance test was conducted at Martin Marietta in Baltimore on December 12, 1961. The system was delivered to the Coast Guard at the Curtis Bay Station on December 15, 1961. Figure 8 shows the generator on its shipping pallet as it arrived at the Curtis Bay Station. It was installed in an 8 x 26E buoy as shown in Fig. 9. The relative locations of the components in the buoy are shown in Fig. 10. Figure 11 shows the buoy as it is installed in the bay at the Curtis Bay Station. A subsequent reading taken on December 22, 1961 verified that the system was functioning properly. The readings were:

Fuel block	932° F
Hot junction	897° F
Generator	1.724 amp 10.52 watts

The reliability model (for the SNAP 7A and SNAP 7C programs) as assembled with new thermoelectric modules has operated in excess of 2000 hours (as of January 31, 1962). During this period it was operated for 9 days with a hot junction temperature of 800. F and a power output of 2 watts. The remainder of the time it has been operated with a hot junction temperature of 900° F and a power output of 2.52 watts. The reliability model simulates one-quarter of the actual generator.

Figure 12 shows the arrangement of the couples and the locations of the thermocouples in the reliability model. The center thermoelectric module, No. 46, was completely instrumented before assembly. Iron wire voltage taps were installed directly above the bonded hot junction on the "P" and "N" elements of all five couples. Voltage taps on couples Nos. 2, 4 and 5 and thermocouples on couples Nos. 1 and 3 were attached to the center of the hot shoe. Thermocouples were also

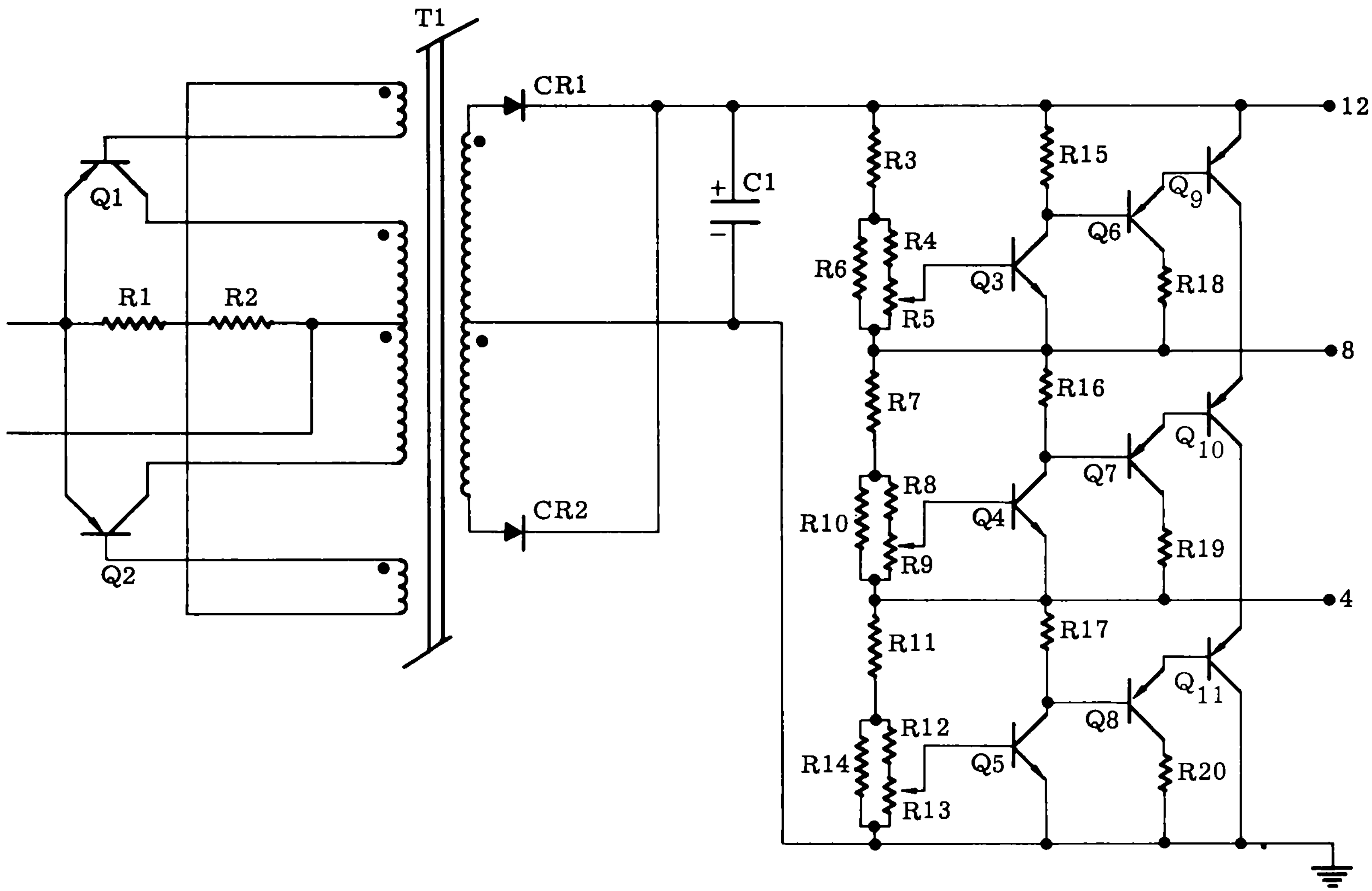


Fig. 7. Schematic of SNAP 7A Converter P/N SIG11119 DC -to- DC Converter (3 outputs)

TABLE IV

Parts List--SNAP 7A Converter (3 outputs)
P/N S1611119

Schematic Part No.	Manufacturer's Part No.	Description
Q_1, Q_2, Q_9, Q_{10} Q_{11}	2N 1360	Transistor PNP
Q_6, Q_7, Q_8	2N 526	Transistor PNP
Q_3, Q_4, Q_5	2N 358	Transistor NPN
R_1		68-ohm 1/2-watt resistor 5%
R_2		330-ohm 1/2-watt resistor 5%
R_3, R_4, R_7, R_8 R_{11}, R_{12}		50-ohm wire-wound No. 38 wire
R_5, R_9, R_{13}		0- to 100-ohm 2-watt carbon pot
R_5, R_{10}, R_{14}		39-ohm 1/2-watt resistor 5%
R_{15}, R_{16}, R_{17}		220-ohm 1/2-watt resistor 5%
CR_1, CR_2	IN 538	Rectifier diode
C_1		100-μf capacitor (tantalum)
T_1	SLT 611125	Transformer

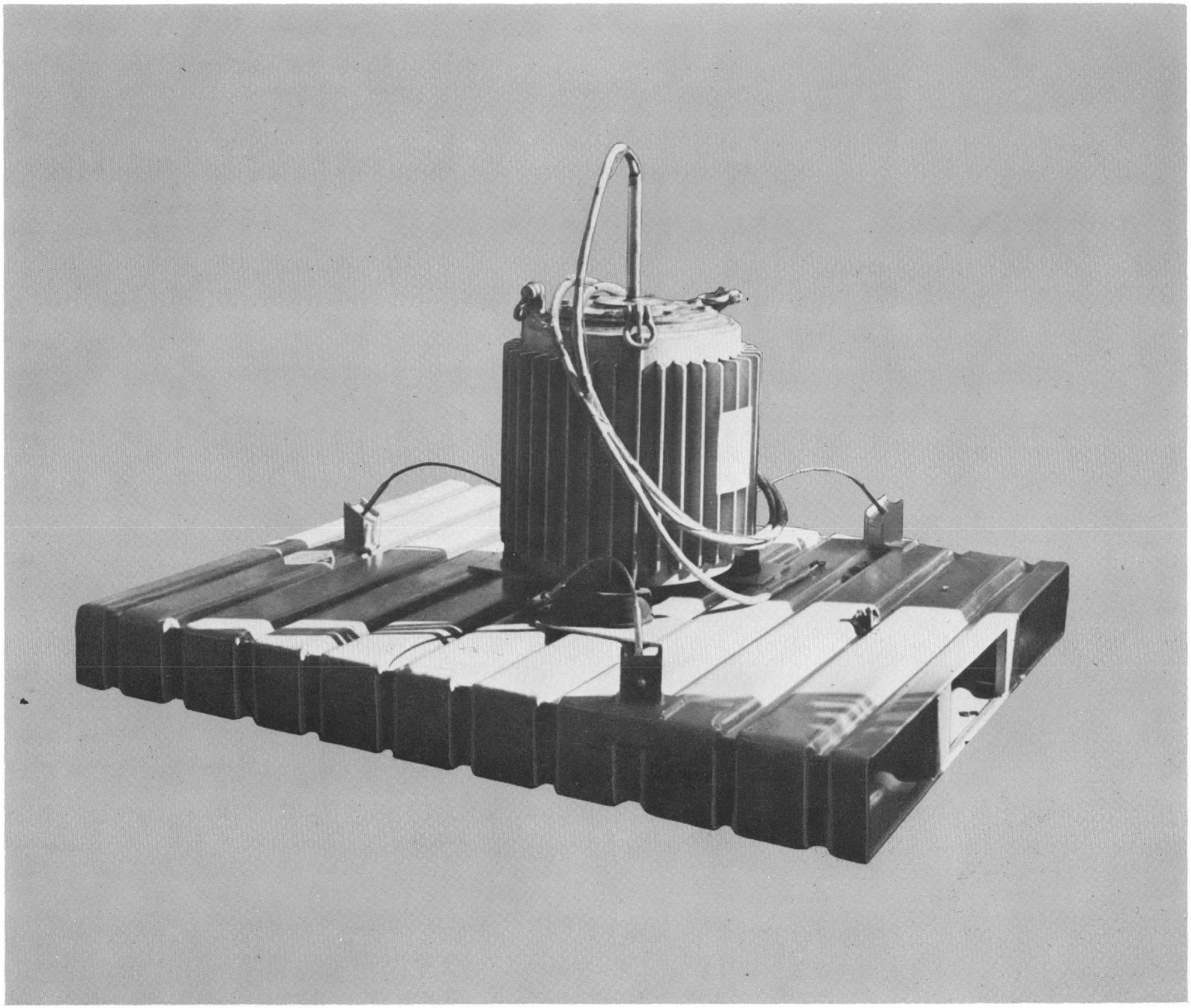


Fig. 8. SNAP 7A Generator

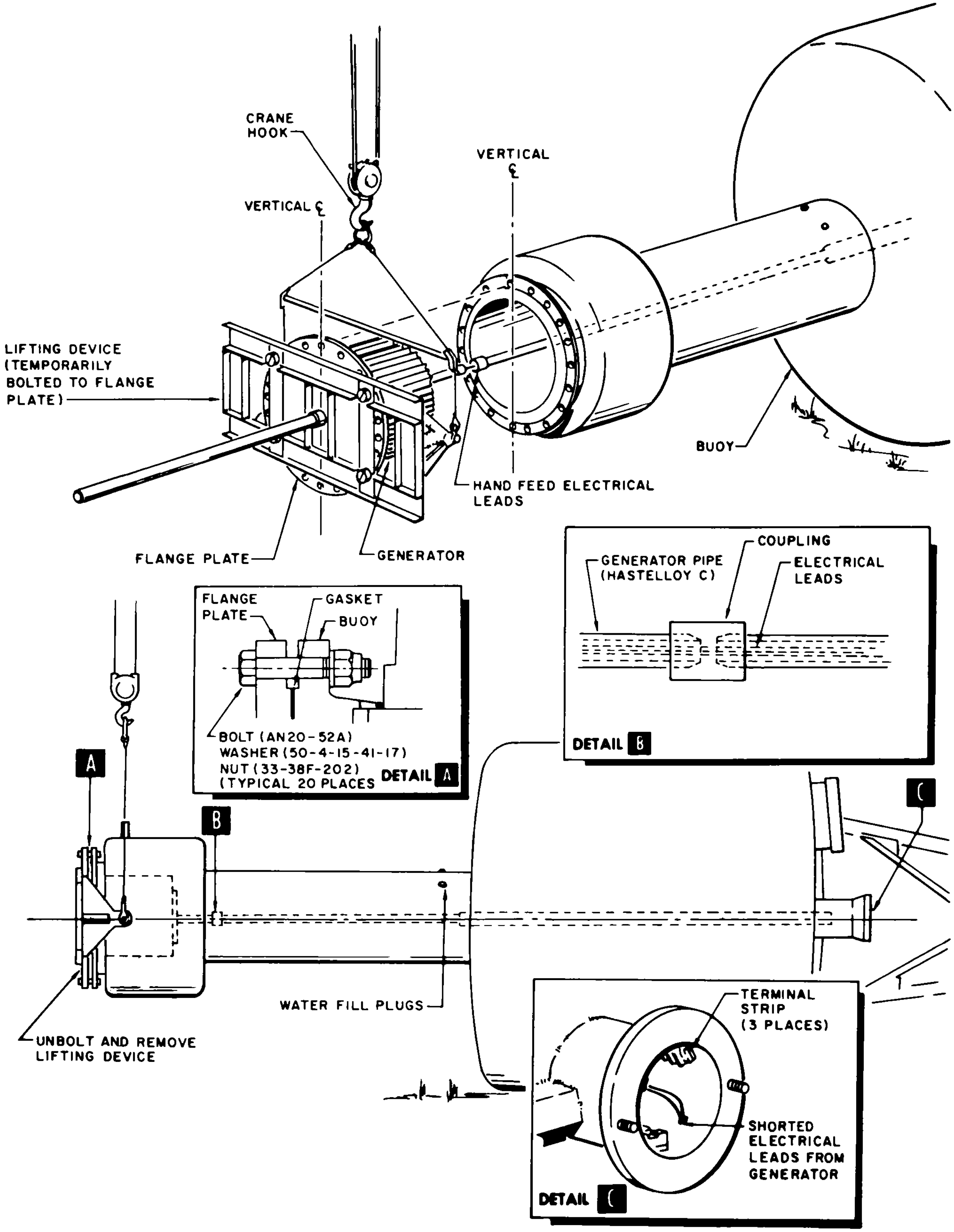


Fig. 9. Generator Installation Details SNAP 7A

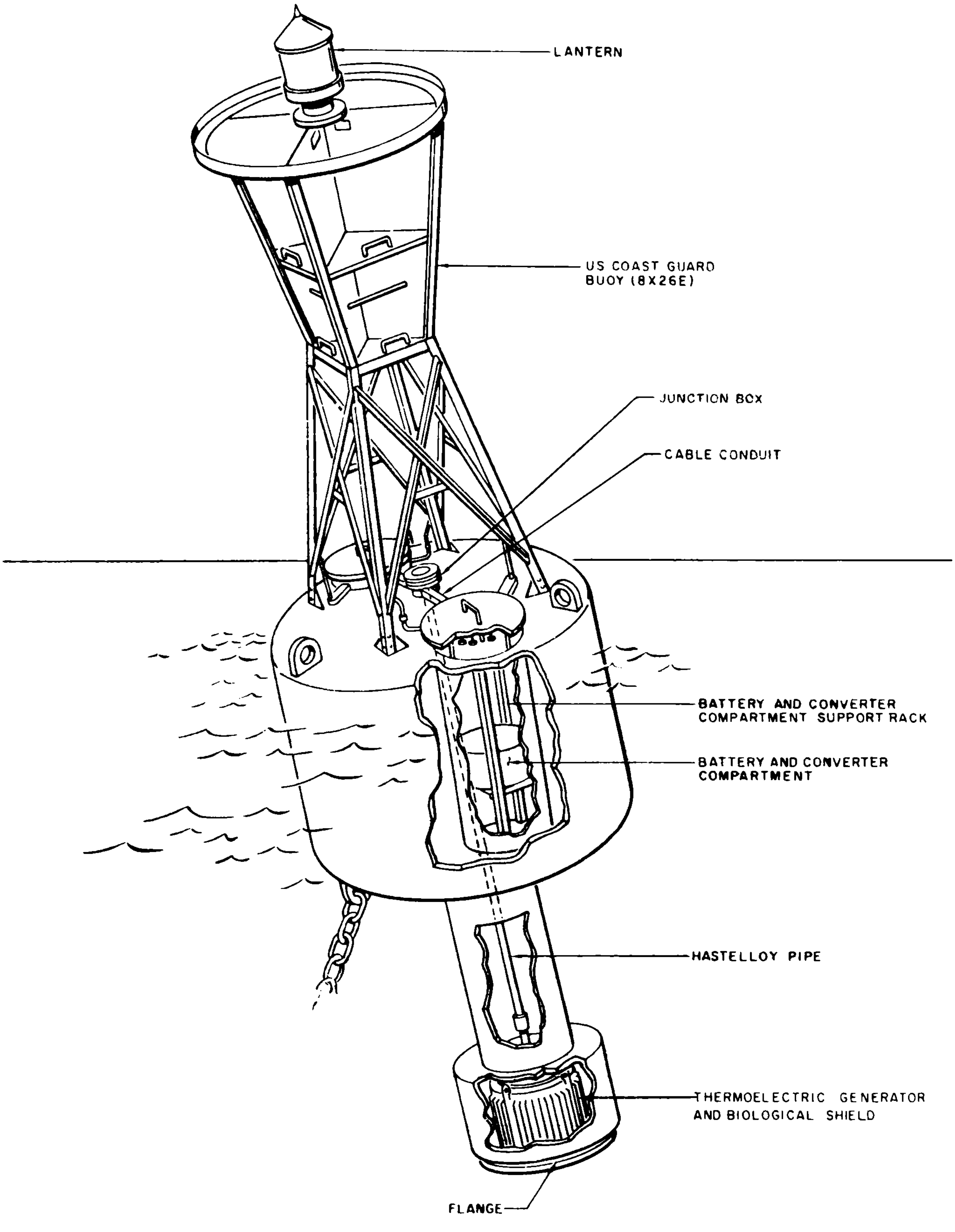
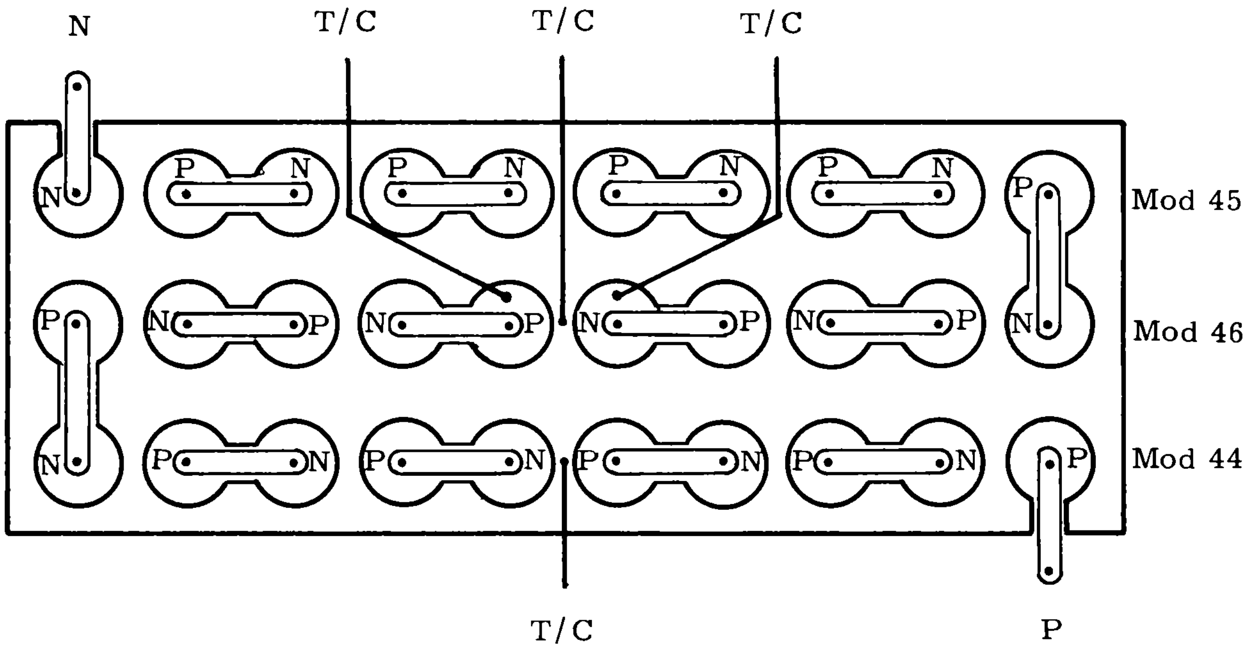
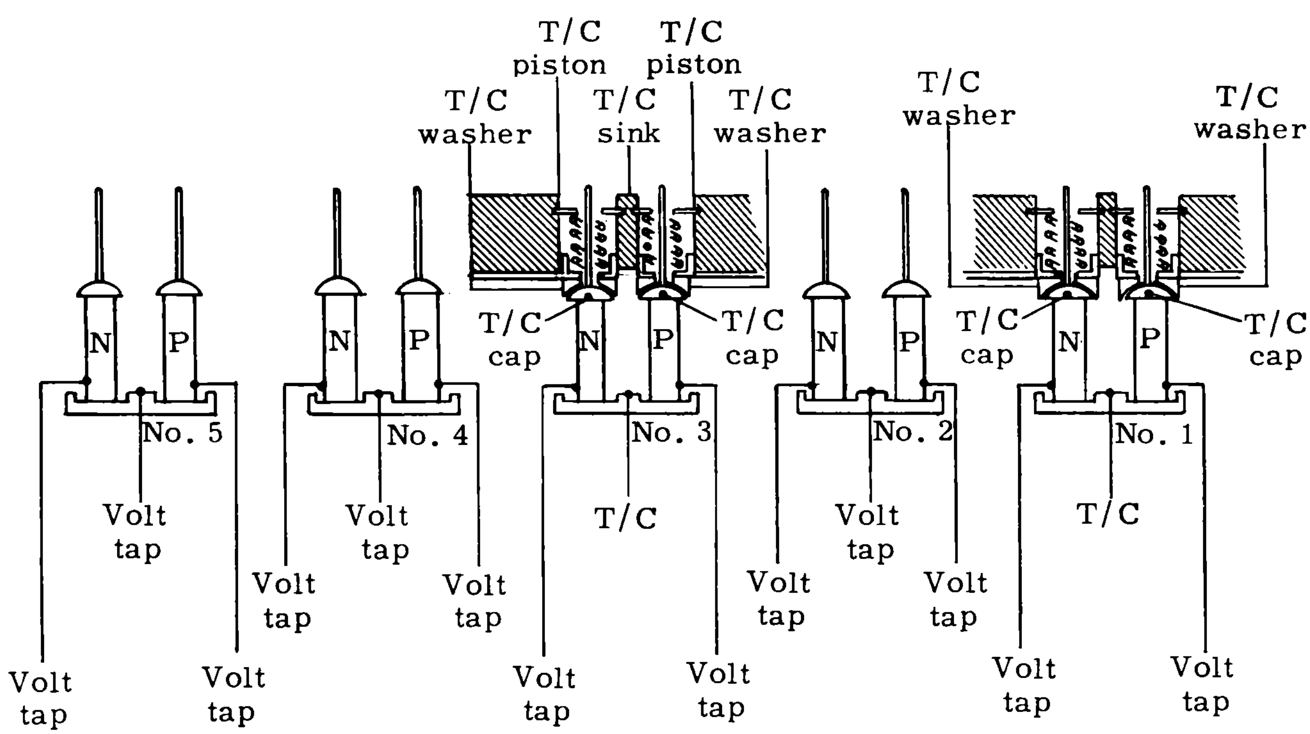


Fig. 10. SNAP 7A Installation

Fig. 11. SNAP 7A Light Buoy



10-Watt Reliability Model Thermocouple and Voltage Tap Location



Module No. 46

Fig. 12. Arrangement of the Thermoelectric Couples and the Locations of the Thermocouples in the Reliability Model

attached to the cold caps, pistons, and heat sink bar of couple No. 3. The terminal straps of all three thermoelectric modules were provided with voltage taps.

Hydrocatylators were purchased and were tested in conjunction with the SNAP 7A batteries. The purpose of these devices is to recombine into water the hydrogen and oxygen given off by the cells and thus decrease water losses and consequently permit greater voltage fluctuation without damage to the battery. The tests are not conclusive at this point, but indications are that they do not retard the water loss sufficiently to permit a wider tolerance on the voltage.

Based on the final SNAP 7A system tests using the actual components with the three-section converter, the hydrocatylators are not required. Since the three-section converter has been able to hold the individual cell voltages within the desired limits, outgassing is no longer a serious problem. The water loss measured over a six-day period averaged 0.079 gram per cell at design operating conditions. If extrapolated for one year, this would mean a loss of 4.8 grams. The cells contain approximately 30 grams of water; therefore, the battery should easily operate for a two-year maintenance-free period.

III. SNAP 7B AND 7D 30-WATT ELECTRIC GENERATION SYSTEMS--SUBTASKS 8.2 AND 8.4

A. OBJECTIVES

The major engineering objectives of Subtasks 8.2 and 8.4 for the current report period were:

(1) To initiate thermoelectric couple tests for the SNAP 7B and 7D systems.

(2) To assemble the reliability model for the SNAP 7B and 7D systems.

(3) To establish electrical design, converter, and battery specifications for the SNAP 7D system.

(4) To complete the revised conceptual installation drawings for the SNAP 7B and 7D systems.

B. ACHIEVEMENTS AND DISCUSSION

Ten thermoelectric couples of the SNAP 7B and 7D design were tested using hot junction temperatures of 800° and 900° F. These couples consisted of a Martin-manufactured "N" element and a Minnesota Mining and Manufacturing Company (3M) "P" element. The performance of these couples indicates that the required generator output of 60 watts can be readily obtained. Two of the 10 couples have been placed under life test, there has been no noticable change in their performance or characteristics.

During the fabrication of the thermoelectric couples in which the 3M "P" element was used, considerable breakage of the "P" elements was experienced. The Materials Section of the Martin Company had been working with "P" element material which showed considerable promise both in performance and in structural properties. It was therefore decided to try several thermoelectric couples in which Martin-manufactured "P" and "N" elements were utilized. Four couples were fabricated and tested under the same conditions as the other ten couples. The indications are that these materials are superior to those initially tested. The improved couple performance is attributed to lower overall resistances after bonding, and to higher Seebeck voltages. The structural properties are definitely superior.

Based on these data it was decided that the operating model and the SNAP 7B and 7D generators would be assembled with the Martin-made elements. The reliability model has been assembled with the previous elements, but will be reassembled with the new elements as soon as the change can be made without a schedule delay to the SNAP 7B and 7D generator program.

The SNAP 7B and 7D reliability model was completed, and went into operation on January 5, 1962. During the initial warm-up period, one of the power input leads developed an open circuit and the tests were interrupted for repair. The reliability model has operated at high temperature for a period of 23 days. The power outputs for hot junction temperatures of 800°, 850°, 900°, and 950° F are 8.3, 9.8, 11.1, and 12.24 watts, respectively. The output is expected to increase when the new couples are installed. The reliability model represents one-sixth of the SNAP 7B and 7D generator. The arrangement and instrumentation of the reliability model is shown in Fig. 13.

The SNAP 7D Battery Specification has been written and released. The battery is to consist of three sections containing three cells each. Each battery section is to have provisions for independent mounting. The battery is to be capable of containing 1800 watt-hours of energy throughout a two-year life with a nominal charging cycle. Further, it shall be capable of a continuous charge of 6.5 amps during a two-year period without loss of electrolyte to the extent that such loss affects battery performance. The battery (three sections) is not to exceed a total weight of 200 pounds.

The overall electrical specifications (Ref. 5) show an equivalent continuous energy requirement of 13.51 watts for normal operation. For abnormal loads (transmission every hour instead of every 6 hours) the equivalent continuous energy requirement is 56.85 watts. It is expected that the abnormal operation would not exceed 72 successive transmissions at one-hour intervals and that the condition would not occur more often than once every three weeks.

The electrical system is to be provided with a current-sensing device. When the current from the generator drops below 3.5 amps, the sensor will activate a switching arrangement to transfer the flashing beacon to an emergency set of batteries. These batteries are to be provided by the customer, and they will not be connected to the generator. The transmitter will continue to operate off the battery tied into the generator system until the reserve energy falls below the required operating levels. A manual reset will permit returning the system to its normal circuit once the trouble has been remedied.

The Preliminary Electrical Design and Test Specification of the SNAP 7D dc-to-dc converter (Ref. 6) calls for a preliminary breadboard converter to be used for evaluation purposes. This specification requires satisfactory operation with inputs of 9.6 volts at 5.5 to 9 amps, and a single output delivering 12 ± 0.5 volts with a 9.6-volt input.

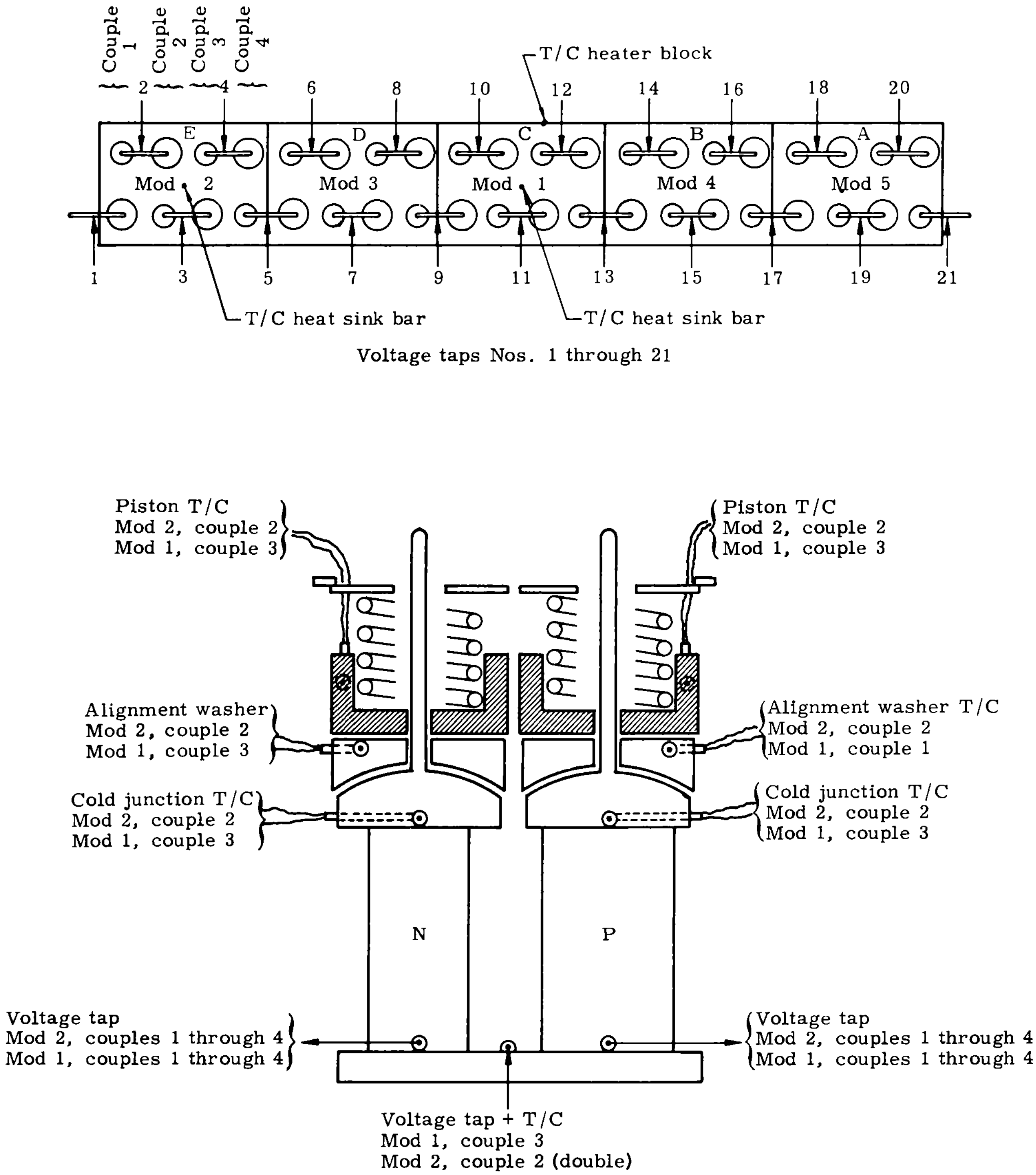


Fig. 13. 60-Watt SNAP 7B and 7D Reliability Model Thermocouple and Voltage Tap Locations

The efficiency is to exceed 80%. The maximum root mean square voltage ripple shall not exceed 2.5% of the output voltage with batteries attached. Environmental data are to be in accordance with the Statement of Work (Ref. 4). The testing requirements have been superseded by the Test Specification for SNAP 7D Breadboard Converter (Ref. 7). The regulation, end of life, beginning of life, and the reliability tests are set forth in detail.

The SNAP 7B generator housing cannot maintain the desired cold junction temperature in still air on a warm day by normal air cooling during operation. The generator may be short-circuited for shipment which will keep the temperatures down during shipment. To keep the generator cooled during operation, an aluminum tank was designed; tank design data were presented in the previous quarterly progress report (Ref. 3). The fins have since been extended from 6 to 9 inches long. This extension of the fin reduces the temperature differential to approximately 15° F between the generator surface and the surface of the tank.

An alternate solution to the cooling problem is to mount the generator on an underwater slab. This would eliminate the need for the tank and would provide an infinite heat sink. The actual installation is to be resolved during the next quarter, after discussion with the receiving agency.

The SNAP 7D generator is to be installed as shown in Fig. 14 in a Nomad-class weather buoy. This represents a revision in the installation plan presented in the previous quarterly progress report. The conceptual installation shown requires an extension of the center wall between watertight bulkheads Nos. 3 and 4 and the construction of an inner deck. Approximately 540 gallons of oil are required to fill the compartment to a height of 4 inches over the top of the generator. The heat from the generator is transferred through the oil to the hull and on to the water surrounding the buoy. The inner deck prevents the oil from sloshing, and also serves as a battery compartment. The batteries are to be mounted directly to the inner deck by means of a mounting plate. This permits dissipation of battery heat through the buoy structure. The remainder of the electrical equipment is to be mounted to bulkhead No. 4.

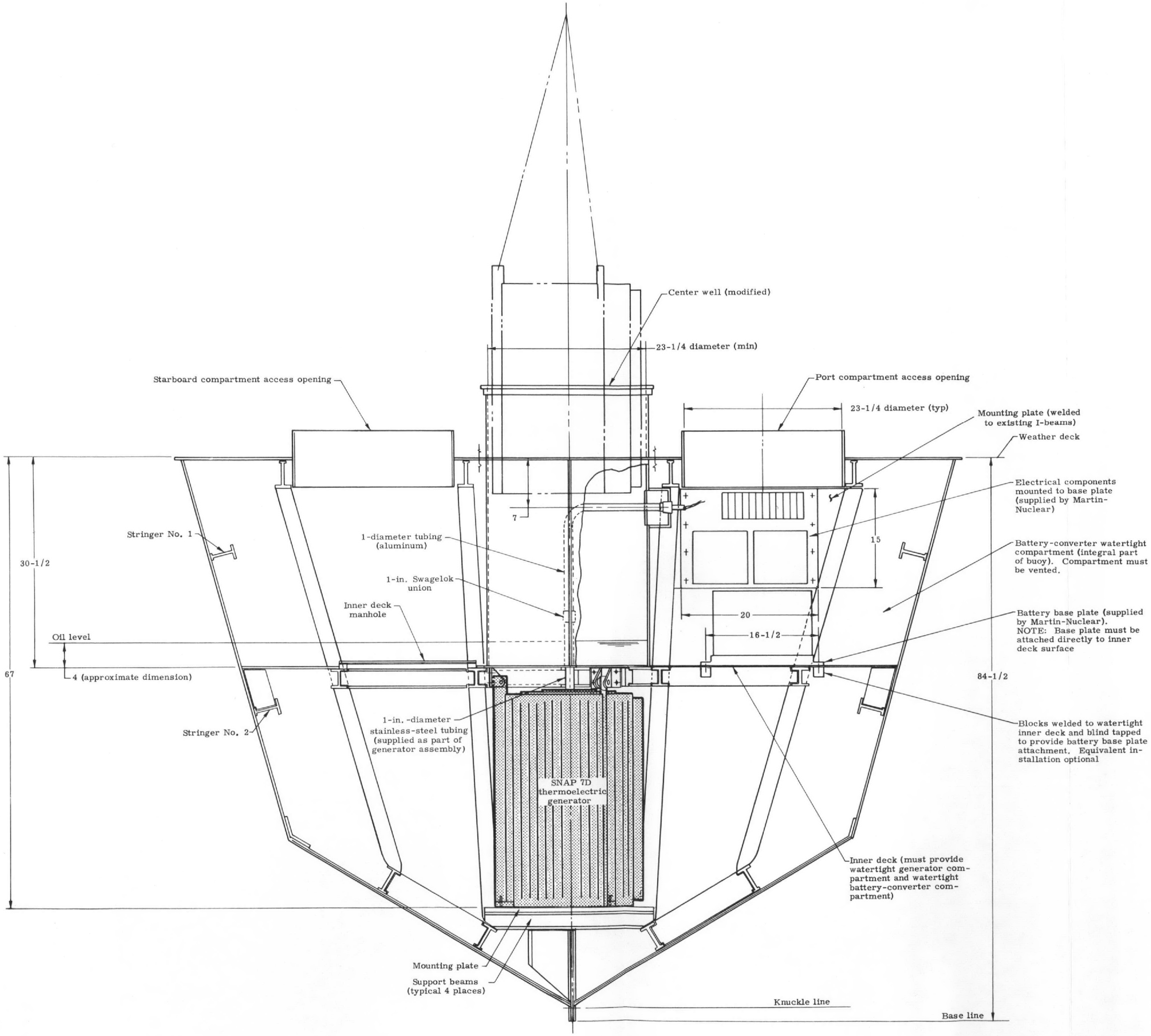


Fig. 14. SNAP 7D Generator Installed in Nomad-class Weather Buoy

IV. FUEL PROCESSING FOR THE SNAP 7B GENERATOR--SUBTASK 8.5

A. OBJECTIVES

The major engineering objectives of Subtask 8.5 for the current report period were:

(1) To provide Quehanna personnel with engineering support during both the installation and the checking out of the fuel processing equipment at Quehanna.

(2) To provide maintenance instructions in regard to the processing equipment.

(3) To write and publish an operation procedure guide.

B. ACHIEVEMENTS AND DISCUSSION

The Engineering Section has maintained close liaison with the personnel who are installing and who will be operating the fuel processing equipment. Changes have been made only where such changes facilitate the operation or increase the reliability of the equipment. These changes have included relocating the inlet air filter, modifying the ball mill to permit easier remote handling (to be used in the back-up process if the Waring blender does not work satisfactorily during the dry runs), relocating the locking handles on the welding fixture, and others. The calorimeter to be used in the fuel processing containment box has been completed and delivered to Quehanna. The calorimeter to be used in the generator loading cell will be delivered during the next progress report period.

Each piece of process equipment has been reviewed and maintenance instructions have been written where required. Vendors were consulted for maintenance recommendations on all purchased equipment.

Check-out procedures have been written for the more complex items such as the overhead transfer box, the electric furnace, the hydraulic press and the welding fixture. These procedures supplement normal quality control, and give assurance that the units will work properly after they are installed.

An operation procedure guide has been written by members of the Engineering Section for the benefit of personnel operating the equipment. The procedure, as presented in the guide, should be used when setting up the dry runs. During the dry runs, revisions to the procedure will most likely be required. The operator will know the intended engineering concept, and should follow the engineered process as closely as possible to ensure the maximum utilization of the equipment.

A final operation procedure, established with the mutual concurrence of the Engineering, the Nuclear Chemistry and the Health Physics Sections, will be determined before the actual process operation begins.

During this report period, the emphasis at Quehanna has been on the testing of all the phases in the reconstruction program and the acceptance of certain portions of this program. In addition, considerable effort was expended by the Quehanna staff on other phases of this improvement program, such as:

(1) All manipulators available at this time are repaired. The last two manipulators remaining in Baltimore will be sent to the facility at Quehanna for repair and alteration.

(2) Since the electrical requirement for the program has developed into such a large problem, three technicians from the Martin Nuclear Instrument Department will assist the Quehanna group. During the present report period, installation of the following items was 90% completed:

  (a) A 14-circuit breaker panel and conduit which will supply additional 110-volt a-c power to the front of the cells.

  (b) A 440-volt emergency power outlet to the front of the cells for the containment box lighting systems.

(3) Cable has been installed in all the conduits in Cell Nos. 1 and 2. The electrical installation of these two cells is approximately 90% complete at this time.

(4) All process lines in Cell No. 1 have been installed with the exception of the waste disposal lines, and additional work has been performed on the vacuum pump systems. There have been difficulties with the proper operation of these pumps in that the vacuum in the system pulls oil out of the pumps much more rapidly than has been experienced with other types of pumps. Upon the arrival of the cupola, the ventilating system to this apparatus will be installed. The piping in Cell No. 1 was leak tested with 5 lb of hydrostatic pressure and also 20 in. of vacuum. Plastic sleeves have not been placed around the hot joints at this time. This will be done during the dry run procedure.

(5) The individual procedures that were written for the strontium process are, for example, a cooling procedure, a dissolving procedure and a metering procedure. Each procedure is accompanied by a sketch showing that portion of the process which is relevant. In this way, the operation may proceed on a batch basis, and confusing valves and lines will not be apparent. A large color line drawing will also be available in the operating area to personnel who are operating the equipment.

(6) The containment box for Cell No. 2 was lowered into the cell. Preliminary checks indicate that all dimensions are satisfactory. Lights have been installed in addition to running all other cabling necessary inside the box. The alpha can transfer mechanism will be installed in the near future.

(7) Considerable effort is being expended on the control and standarization of the Marshall furnace. It was necessary to replace the polyethylene tubing with copper and metal convoluted tubing, polyethylene tubing leaked or softened enough to fall against the hot areas around the door.

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The Martin Company
Nuclear Division, Baltimore 3, Maryland

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Upper Atmosphere Re-Entry Study--High Altitude Burnup
MND-P-2699 (Two Volumes)
C. R. Fink and W. C. Reed
February 1962 UNCLASSIFIED

This report was prepared in compliance with the requirements of AEC Contract AT(30-3)-217, Task 7, Sub-subtask 7.3.4. Volume I presents the results and conclusions of the High Altitude Burnup Study, and Volume II contains in detail the work upon which these results and conclusions are based.

The principal objectives of the study were to evaluate experimental methods for determining the fate of radioactive fuels reentering the atmosphere after space missions, and to recommend experimental programs to determine: (1) the size distribution of particulate matter resulting from burnup of the re-entering fuel, and (2) the subsequent dispersion, residence time and area of deposition of the fuel particulate. Studies of ablation, particulate movement, fuel materials and sampling techniques led to the conclusion that (1) controlled laboratory experiments and (2) world-wide sampling for test materials injected into the atmosphere would be required in a test program to determine fuel fate. The recommended experimental programs are the "particulate characteristics" experiments, designed to provide data necessary for analytical prediction of fuel particulate properties, and the "particulate fate" experiments, designed to provide data permitting analytical prediction of residence time, dispersion and deposition area of the fuel particulate as functions of particulate characteristics, spatial origin and season of injection. Included in Volume II are the technical contributions of several companies whose specialized capabilities would implement a High Altitude Burnup Experimental Program.

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