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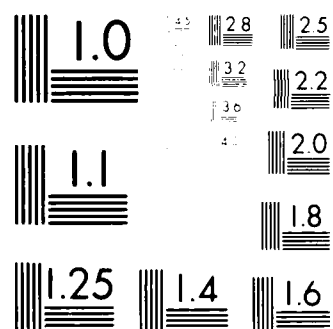
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NICAD BATTERY PACKAGES

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SCIENTIFIC REPORT NO. 3

February 1986

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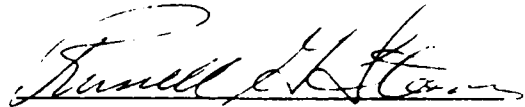
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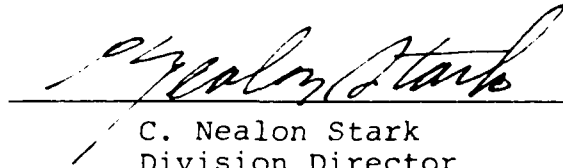


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## REPORT DOCUMENTATION PAGE

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|                                                                                                                                                                                                                                                                                                                                                     |       |                                              | batteries                                                                                         |                        |                      |
|                                                                                                                                                                                                                                                                                                                                                     |       |                                              | ampere hour (AH) rating                                                                           |                        |                      |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)<br>Presented is the development of a packaging concept for nickel-cadmium (nicad) cells used in sounding rocket payload under Contract F19628-81-C-0029. Included are design specifications, assembly procedures and test sequences four (4) types of nicad batteries. |       |                                              |                                                                                                   |                        |                      |
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## 1. INTRODUCTION

Problems encountered with purchased battery packages and increasing requirements for larger capacity cells in sounding rocket payloads led to the development of the battery packages in this report. Gell cells, lead acid batteries, silver cells and lithium batteries were considered along with nickel-cadmium (nicad) cells; however, nicads proved to be the most versatile. Several packaging concepts considering ease of assembly and servicing; minimization of weight and volume; and payload environmental requirements were evaluated.

## 2. CELL TESTING

Test fixtures were fabricated to cycle individual cells in groups of 24 (24 cells at 1.2 volts per cell for a nominal 28.8 volt battery). Two cycles of 14-hour charge at a C/10 rate, followed by a discharge at the 1C rate were used to evaluate the cells. Cells reading 1.0 volt under load after 60 minutes discharge are defined as acceptable and are assigned to battery packs. "C" is numerically equal to the rated ampere hour capacity of the cell. For the standard 1.2AH cell,  $C = 1.2$ . "C-rate" is a charge or discharge current (amperes), numerically equal to "C". For example, if  $C = 1.2$ , then 2C rate = 2.4 and a 2C discharge would be performed using a 2.4 ampere discharge current. Similarly, a C/10 charge on the same cell implies a 120 milliamperage charge current.

Characteristics of the cells included in this report are as follows:

| <u>Cell Type</u> | <u>AH Rating</u> | <u>Diameter</u> | <u>Length</u> | <u>Weight</u> |
|------------------|------------------|-----------------|---------------|---------------|
| C/2              | 1.2              | 1.012 in.       | 0.925 in.     | 1.10 oz.      |
| D/2              | 2.2              | 1.275 in.       | 1.448 in.     | 2.80 oz.      |
| D                | 4.0              | 1.275 in.       | 2.318 in.     | 4.6 oz.       |
| F                | 7.0              | 1.275 in.       | 3.508 in.     | 7.4 oz.       |

### 3. SEALED BATTERY BOXES

Figure 1 depicts a typical (28.8 volt at 1.2AH) sealed battery box in which the cells are encapsulated in a foam or silastic potting compound. This packaging concept proved suitable for normal operation of 1.2AH and 2.2AH systems; however, thermal problems became a concern if high rate charging or discharging is required. Furthermore, the recent trend to larger payloads with multiple experiments and longer flight times necessitates larger capacity batteries.

### 4. OPEN FRAME BATTERIES

In contrast to the sealed battery boxes the equivalent open frame unit in Figure 2 requires no potting material and has non-conducting top and bottom trays to hold the cells securely in place. Assembly is simplified since the cells are installed in the trays (observing proper polarity relationships) and can be wired in place. Temporary screws

are used in conjunction with the spacers to clamp the cells in place between the fiberglass trays which are counterbored to hold the cells securely and have 0.25 inch grooves machined to house the interconnecting links below the outside surface of the trays. Figure 3 depicts the top tray for a 1.2AH battery pack which is typical for all assemblies. Details of the counterbore, interconnecting link slots and the through slots for the exit wires are indicated.

Wiring of the sub-assembly, illustrated in Figure 4, is accomplished by soldering all of the interconnecting links on the bottom side, then inverting the sub-assembly to interconnect the top of the cells. Insulators are installed on all interconnecting links. The final wiring step is to attach wires to the cells through the top tray to the interface connector. A typical wiring schematic in Figure 4 shows a 28.8 volt battery with a center tap at 14.4 volts, a charging diode, and a monitor resistor. The diode and resistor are typically housed in the connector backshell which is then potted. Other wiring options or connectors can, of course, be specified. At this point the battery is mated to the battery charge/discharge console for evaluation.

The next step in the assembly procedure is to install the jam-nut receptacle (Bendix PT07A-10-6S for standard wiring) on the base mount, remove the temporary screws on the wiring sub-assembly and install the base mount using the seven (7) flathead socket screws indicated in Figure 5. Finally the

cover is installed using seven (7) binder head screws into the stand-offs and four (4) binder head screws into the tapped holes on the base mount. Two cycles of 14-hour charge at the C/10 rate followed by discharge at the 1C rate are then recorded as acceptance tests for each battery pack. When batteries are assigned to a project they are tested to the specific power profile and required environmental specifications.

##### 5. BATTERY TYPES

Three of the nicad cells used (2.2AH, 4.0AH and 7.0AH) have the same diameter and vary only in length, enabling the use of a common top tray, bottom tray and cover. Selecting the proper stand-off and base mount allows fabrication of any of the three batteries. Assembly Drawing #D-5061 (Figure 5) is tabulated to enable selection of the required hardware. A second assembly drawing (Figure 6) is dedicated to the 1.2AH batteries since the cell diameter is smaller.

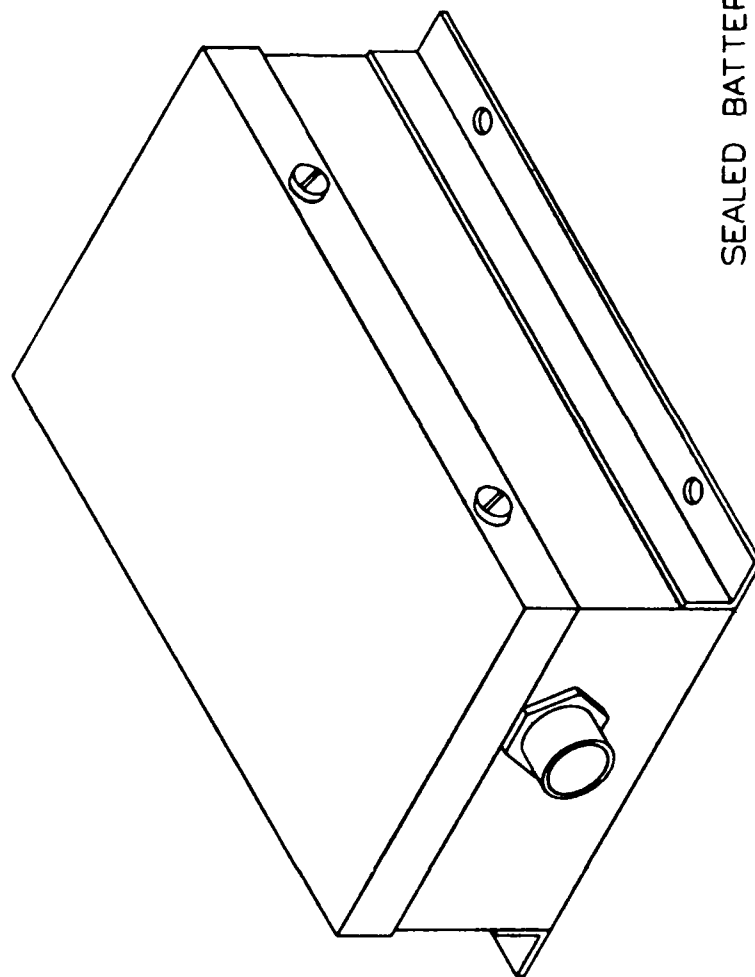
Physical characteristics of the four battery packages are as follows:

| <u>AH Rating</u> | <u>W</u> | <u>L</u> | <u>H</u> | <u>WT</u> |
|------------------|----------|----------|----------|-----------|
| 1.2              | 4.75 in. | 7.10 in. | 2.24 in. | 4.16 lb.  |
| 2.2              | 6.0 in.  | 9.25 in. | 2.19 in. | 6.75 lb.  |
| 4.0              | 6.0 in.  | 9.25 in. | 3.05 in. | 9.38 lb.  |
| 7.0              | 6.0 in.  | 9.25 in. | 4.26 in. | 13.75 lb. |

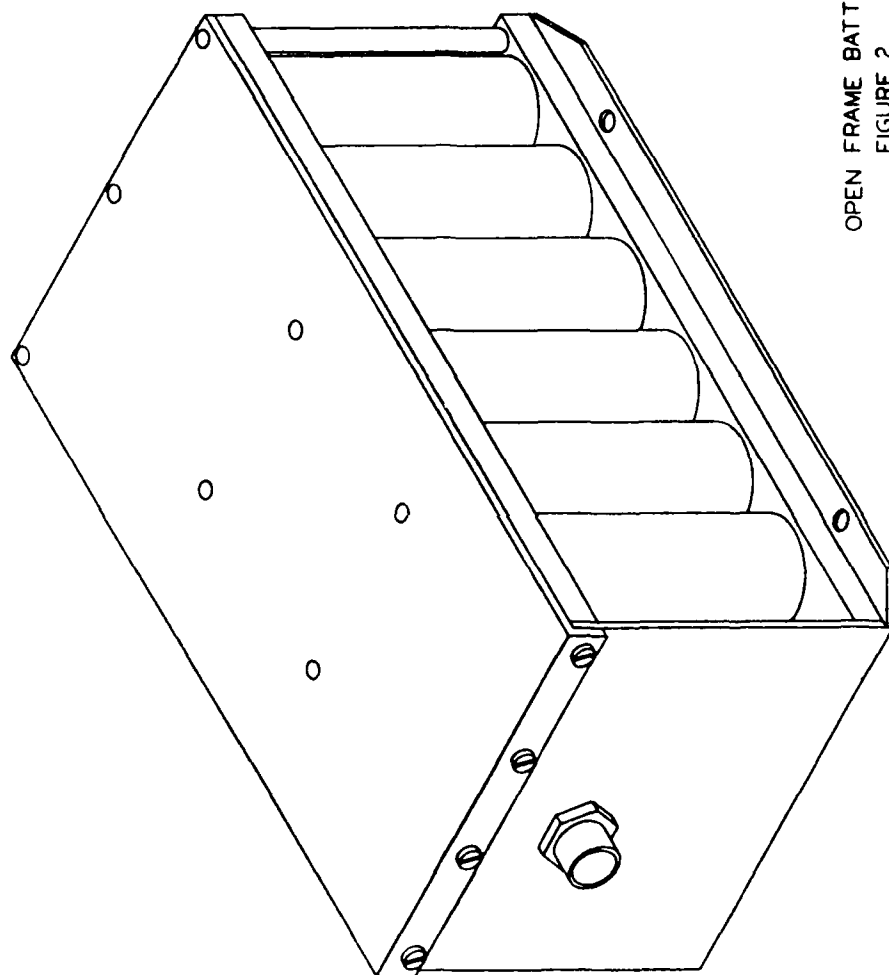
## 6. DOCUMENTATION

Tech Data Report #NU-183-3 "Battery Testing and Assembly Procedures" provides detailed fabrication information. The following drawings are also applicable.

|         |                                              |
|---------|----------------------------------------------|
| D-5061  | Assembly, Open Frame Battery Pack            |
| A-5056  | Stand-Off, Open Frame Battery Pack           |
| C-5057  | Cover, Open Frame Battery Pack               |
| C-5058  | Bottom Tray, Open Frame Battery Pack         |
| C-5059  | Top Tray, Open Frame Battery Pack            |
| D-5060  | Base Mount, Open Frame Battery Pack          |
| D-5061B | Assembly, Open Frame Battery Pack            |
| D-5063  | Wiring Sub-Assembly, Open Frame Battery Pack |
| D-5563  | Base Mount, Open Frame Battery Pack (1.2AH)  |
| C-5564  | Cover, Open Frame Battery Pack (1.2AH)       |
| C-5565  | Bottom Tray, Open Frame Battery Pack (1.2AH) |
| C-5560  | Top Tray, Open Frame Battery Pack (1.2AH)    |
| D-5568  | Assembly, Open Frame Battery Pack (1.2AH)    |



SEALED BATTERY BOX  
FIGURE 1



OPEN FRAME BATTERY  
FIGURE 2





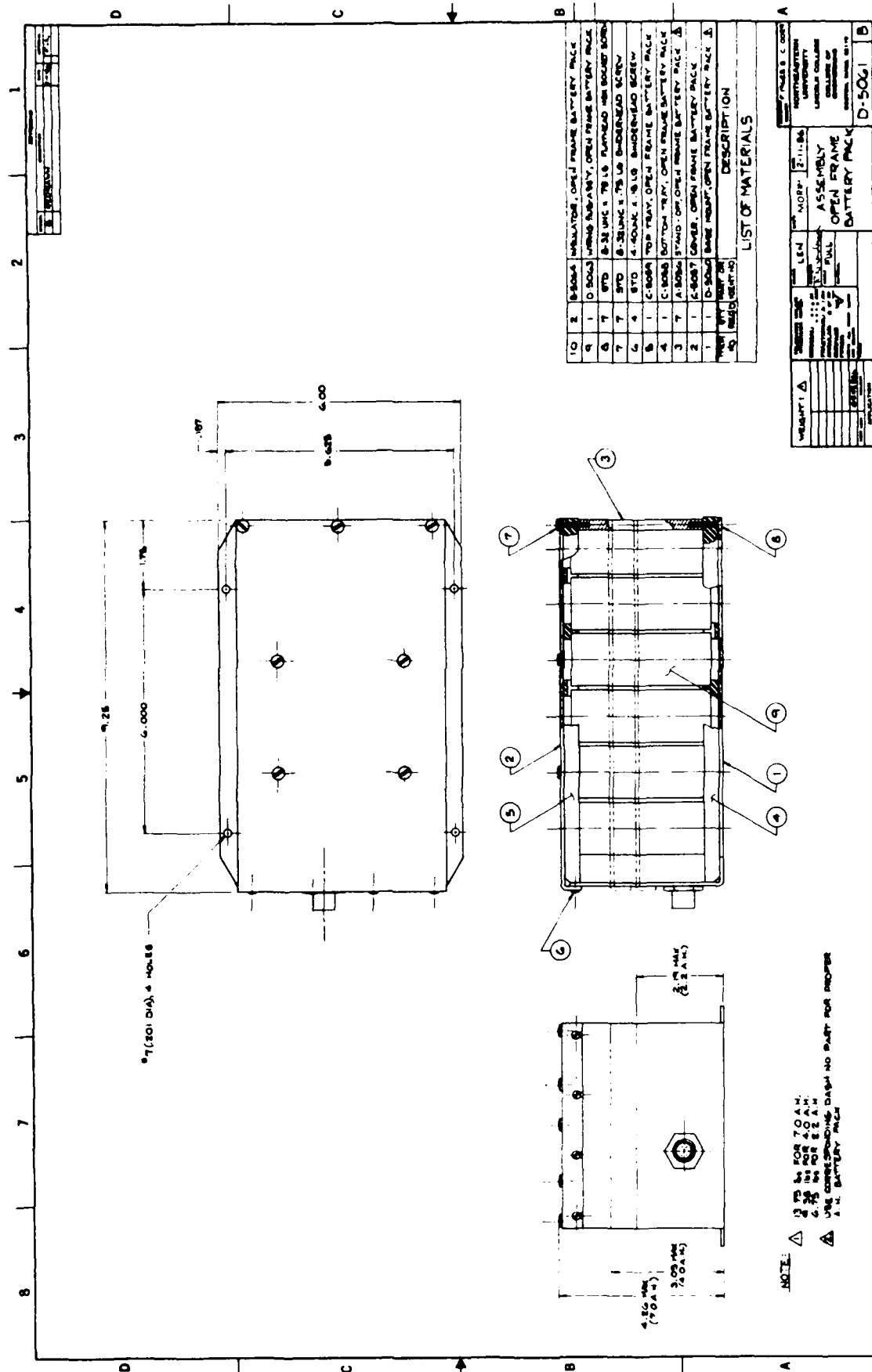


FIG. 5

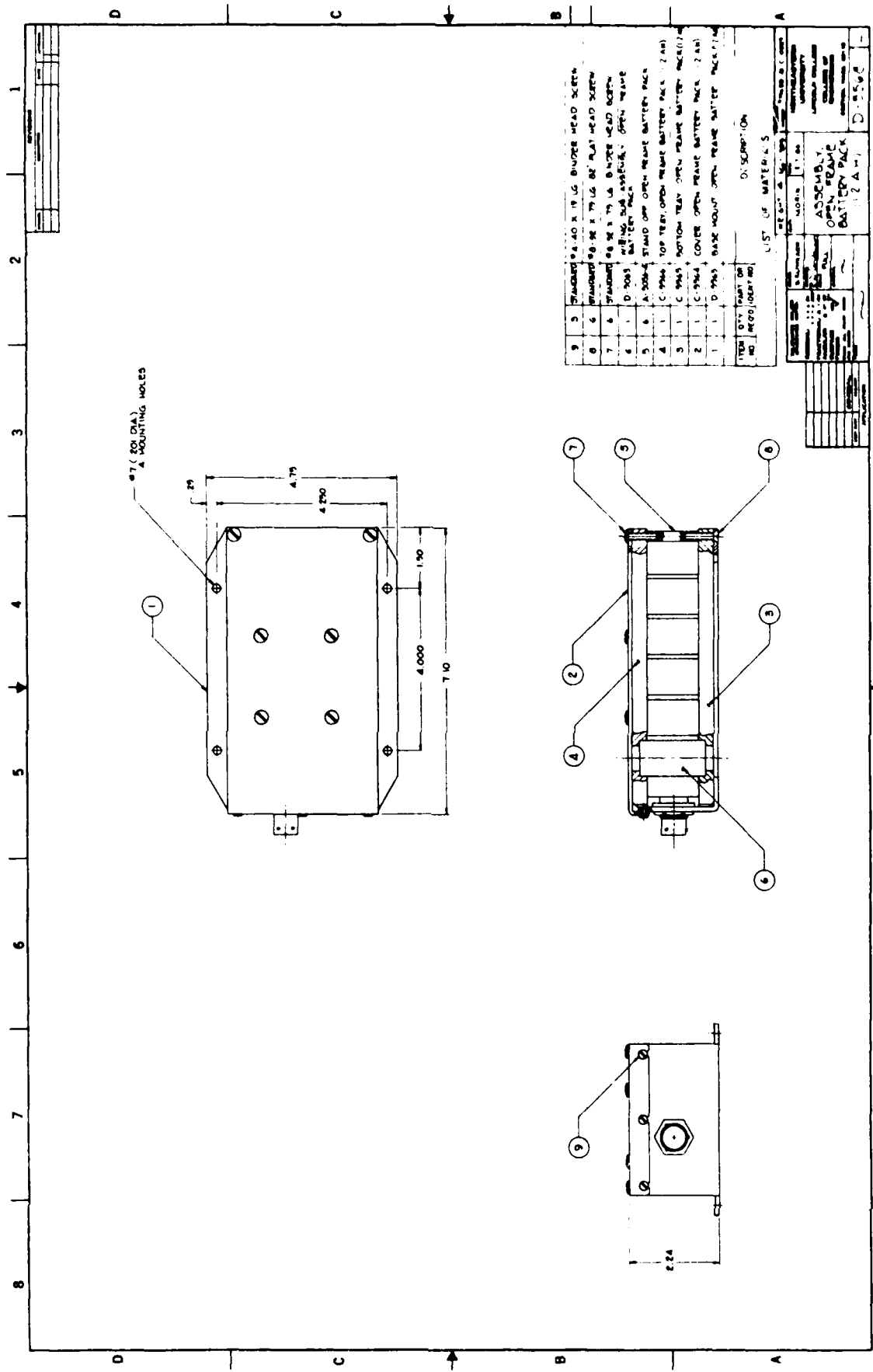


FIG. 6

## APPENDIX A

### Related Contracts and Report

Contract No. AF19628-81-C-0029      15 Feb. 1981 to present.

R.L. Morin and C.B. Sweeney, "Model 2480 Timer", Scientific Report No. 1, AFGL-TR-85-0112, November 1982. ADA165281.

R.D. Anderson and R.C. Eng, "Manacle Band Release Mechanism", Scientific Report No. 2, AFGL-TR-85-0116, May 1985.

## APPENDIX B

### Personnel

The following members of the Electronics Research Laboratory staff contributed to the work reported.

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|----------------------|------------------------------|
| Lawrence J. O'Connor | Principal Investigator       |
| Richard L. Morin     | Research Associate, Engineer |
| Robert D. Anderson   | Mechanical Designer          |
| Roger C. Eng         | Mechanical Designer          |
| Frederick J. Tracy   | Electronic Technician        |
| Harry M. Tweed, Jr.  | Electronic Technician        |

END

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