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N66-18409
NASA-CR-70589

# DEVELOPMENT OF A TYPICAL MARS LANDING CAPSULE STERILIZATION CONTAINER

Second Quarterly
TECHNICAL PROGRESS REPORT

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RAD-SR-66-14
NASA Contract NAS 8-20502
15 January 1966

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
Huntsville, Alabama

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# INTRODUCTION

This Second Quarterly Progress Report on the "Development of a Typical Mars Landing Capsule Sterilization Container" program, Contract NAS 8-20502, covers the work performed from 1 October 1965 to 1 January 1966, for NASA's George C. Marshall Space Flight Center. Mr. Ronald G. Crawford is the technical monitor.

During this period design efforts were completed and fabrication of test hardware was initiated. Basic fabrication of major assemblies are complete; final machining and finishing operations remain to be performed. Conventional manufacturing techniques were adequate for fabricating the sterilization container and model probe. All purchased items, except the "V" band clamp and electrical heaters for the simulated component boxes, have been received.

Thermal and structural mathematical models were developed and performance predictions were finalized. These are presented in the body of this report. They indicate low thermal stresses induced by the heat sterilization cycles and are not expected to induce permanent distortions. Minor permanent distortions are expected to occur as a result of relieving machining stresses.

The test plan outlined in the first quarterly report remains unchanged. Test fixtures were designed and their fabrication initiated.

Instrumentation types and locations were established. Data recording and reduction procedures were reviewed.

At this time no significant problems exist that would delay completion of this program as scheduled.

## 1. DESIGN

The design of the sterilization container and model probe assembly was completed in the second quarter. A thorough description of the design details was presented in the first quarterly progress report (RAD-SR-65-264). Figure 1 (A through H) represents the detailed layout (Avco Drawing 7676) to which the container and probe assembly is being manufactured. Current military standards were used to specify detail design features and fabrication techniques.

Minor departure from detailed layout drawings have been made to the configuration for manufacturing convenience and to minimize cost as fabrication progresses. No compromises that will affect the performance of the assembly are being made.

Design engineering is continually reviewing the fabrication status with shop personnel and all variations will be documented.

All purchased items have been ordered and are in shop stores awaiting final assembly. At the present time the only major items yet to be received are the "V" band clamp and the electrical heating blankets. These items have been promised for the end of January and should not delay the test program.

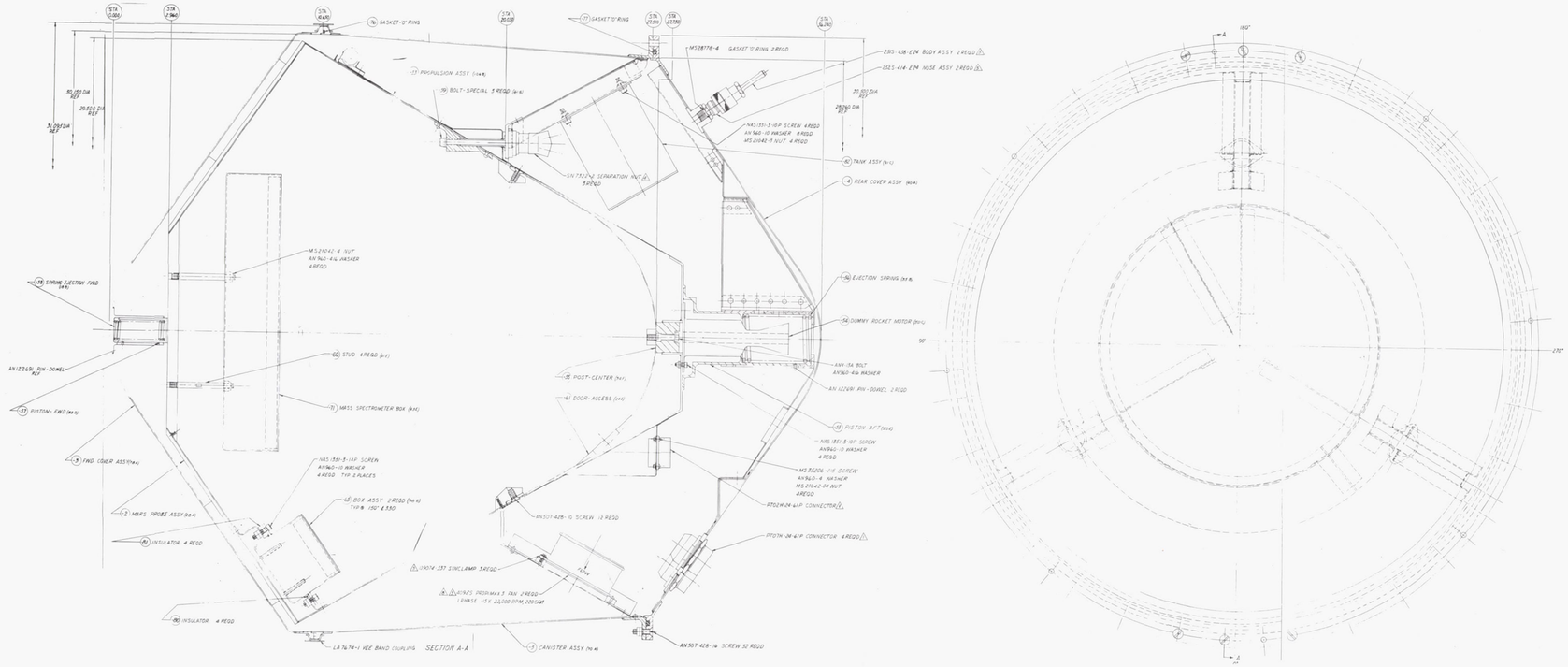
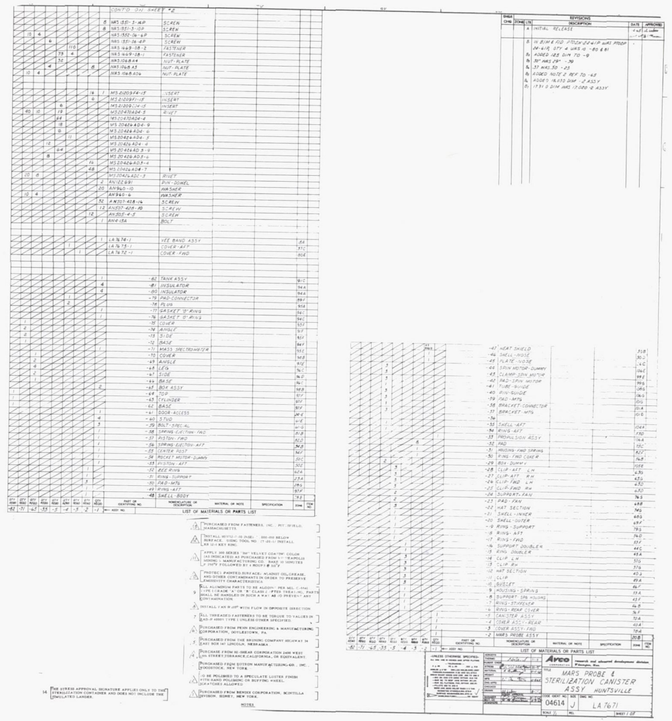



Figure 1 MARS PROBE AND STERILIZATION CANISTER ASSEMBLY



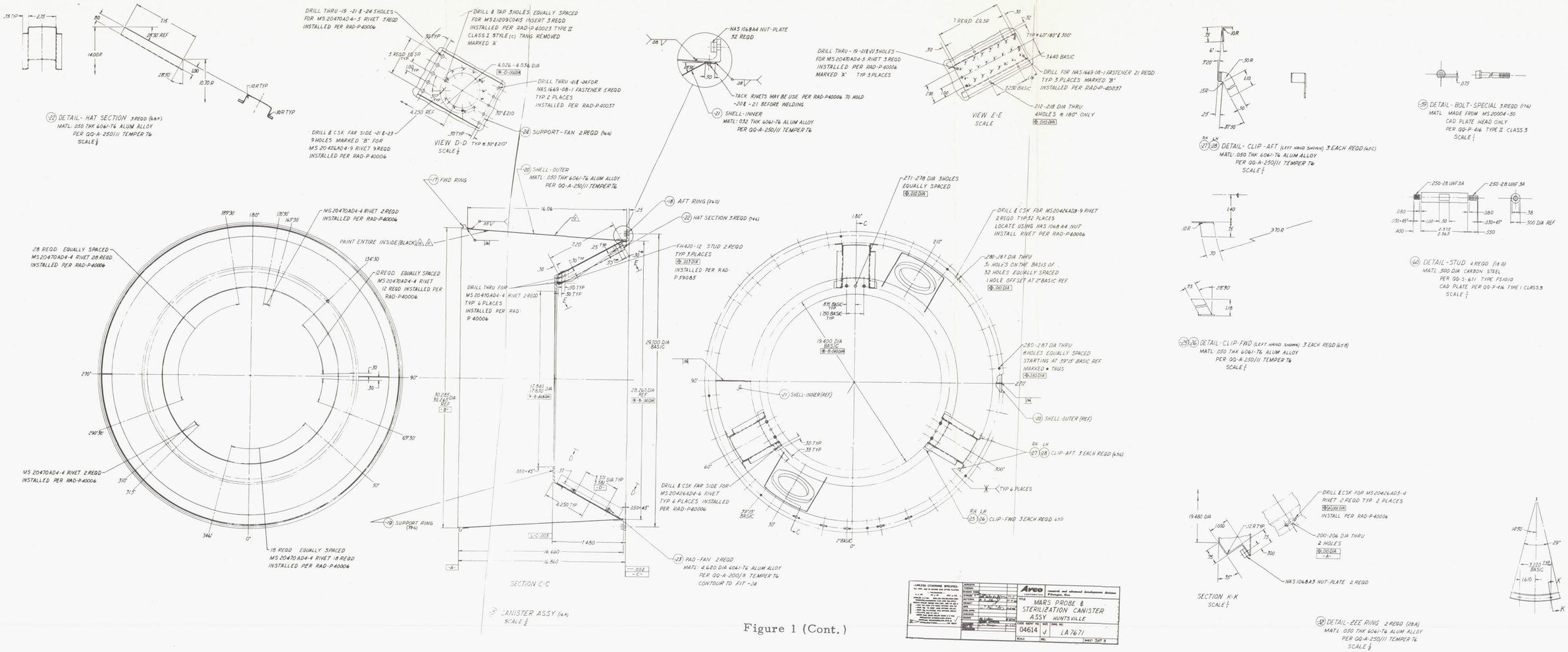



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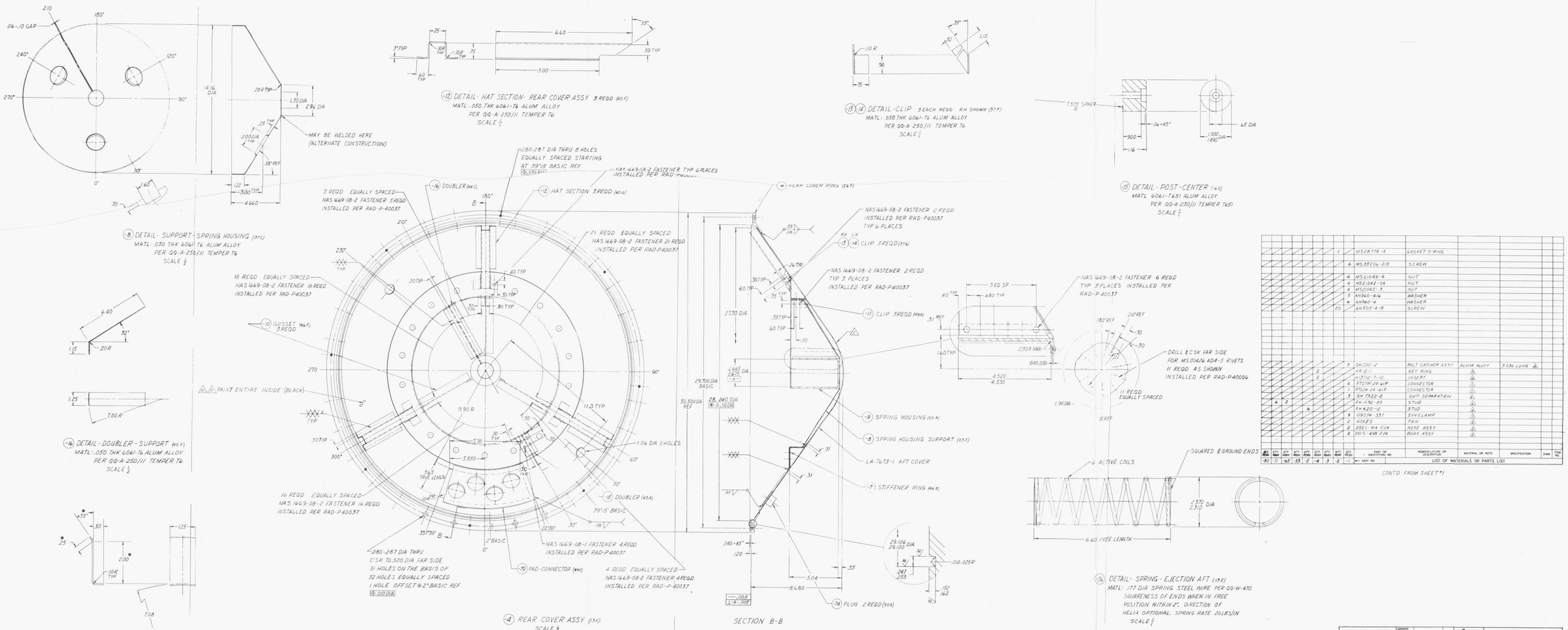



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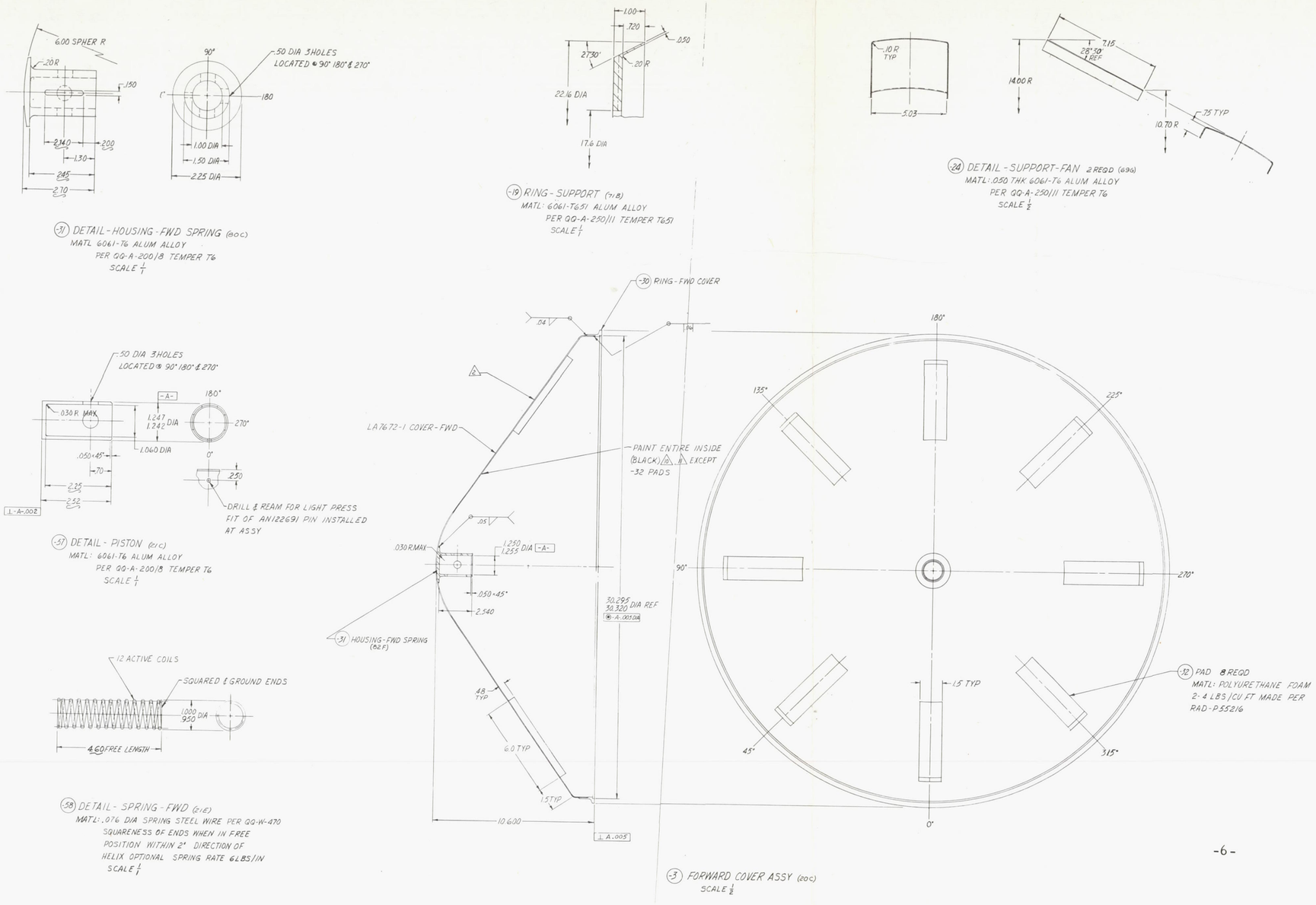





Figure 1 (Cont.)

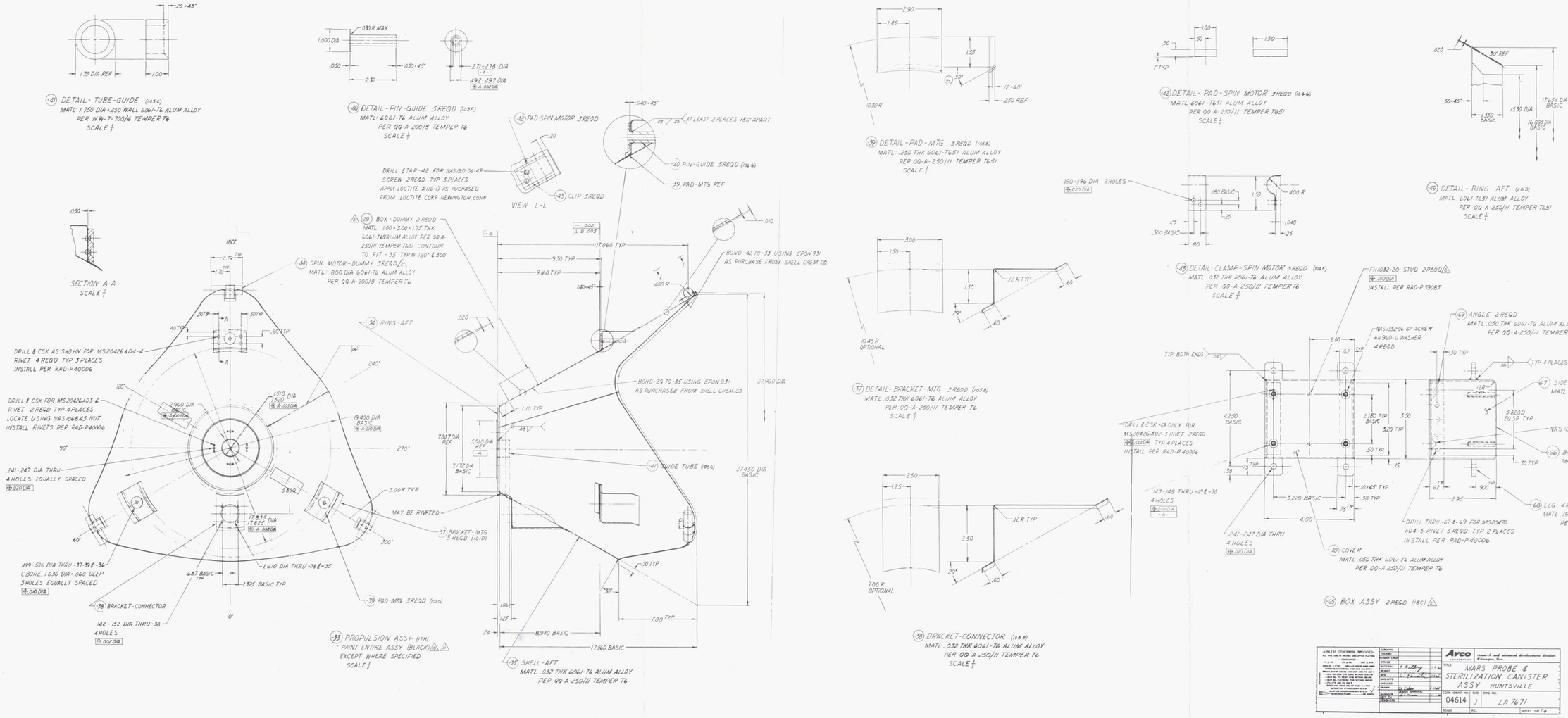



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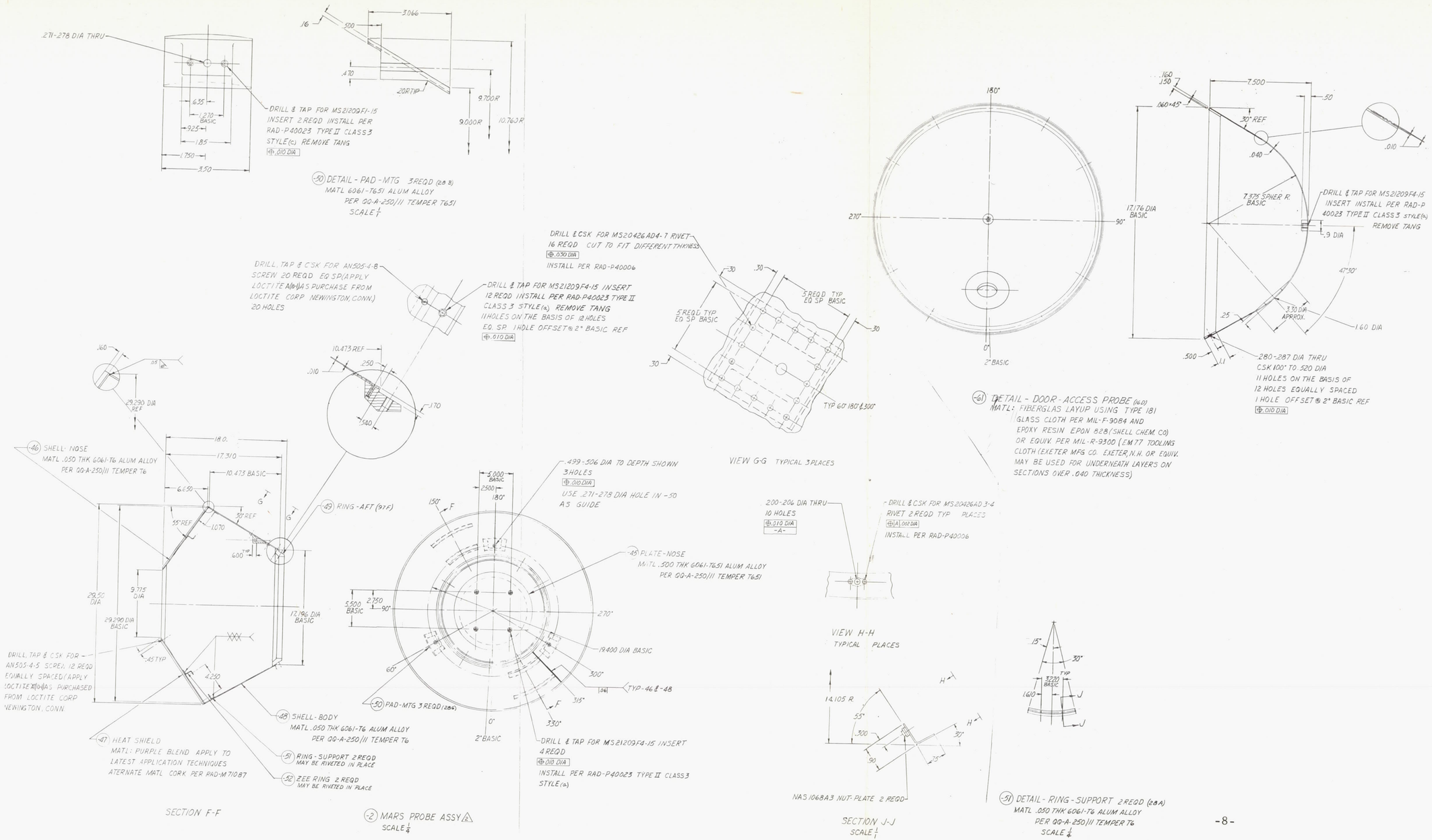
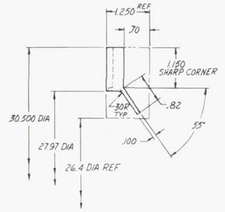
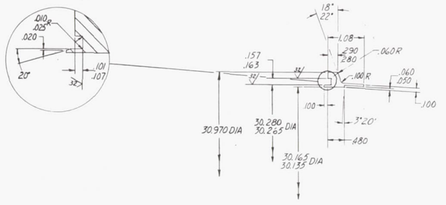


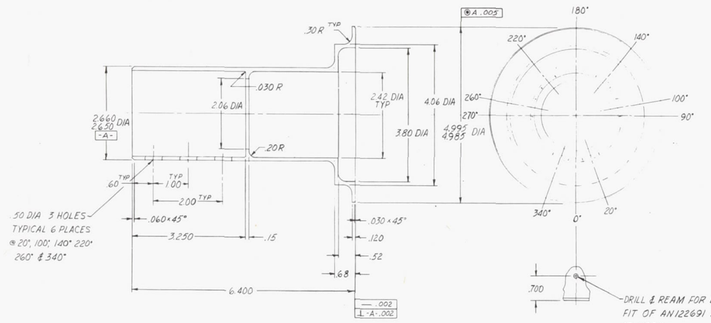

Figure 1 (Cont.)



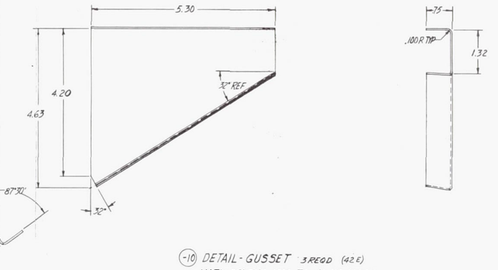

(-6) DETAIL - RING - REAR COVER (58F)
MATL: 1.250 THK 6061-T651 ALUM ALLOY
PER QQ-A-250/11 TEMPER T651
SCALE 1/1



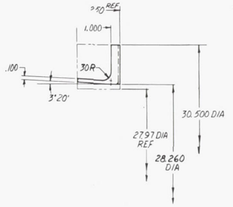

(-17) DETAIL - RING - FWD - CANISTER ASSY (10F)
MATL: 6061-T651 ALUM ALLOY
PER QQ-A-250/11 TEMPER T651
SCALE 1/1



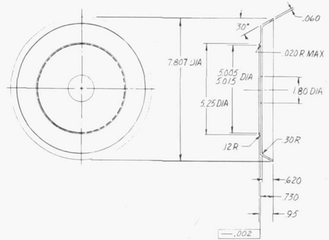

(-33) DETAIL - PISTON - SPRING HOUSING ASSY (13C)
MATL: 6061-T6 ALUM ALLOY
PER QQ-A-200/8 TEMPER T6
SCALE 1/1



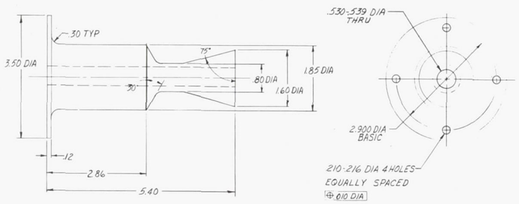

(-10) DETAIL - GUSSET 3 REQD (42E)
MATL: .050 THK 6061-T6 ALUM ALLOY
PER QQ-A-250/11 TEMPER T6
SCALE 1/1



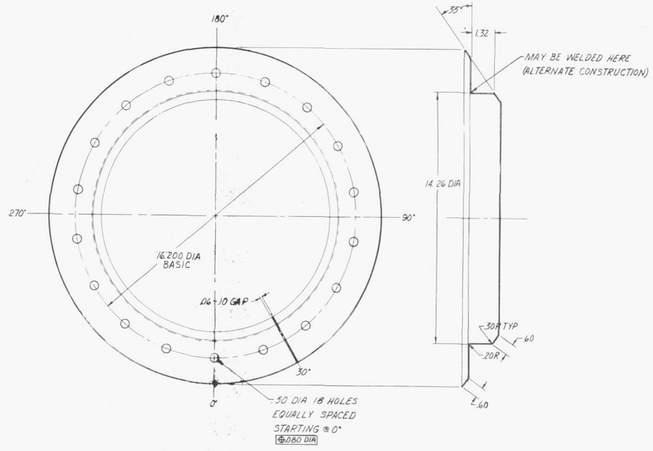

(-18) DETAIL - RING, AFT - CANISTER ASSY (66F)
MATL: 1.250 THK 6061-T651 ALUM ALLOY
PER QQ-A-250/11 TEMPER T651
SCALE 1/1



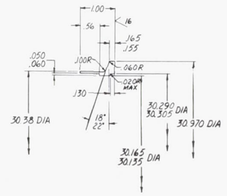

(34) DETAIL - RING - AFT - PROPULSION ASSY (10 S.E)
MATL: 1.000 THK 6061-T651 ALUM ALLOY
PER QQ-A-250/11 TEMPER T651
SCALE 1/2



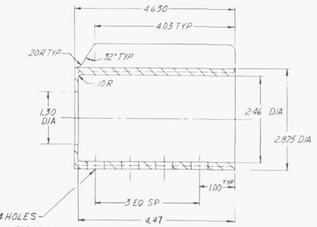

(34) DETAIL - ROCKET MOTOR - DUMMY (13E)
MATL: C 1018 COLD DRAWN STEEL
CAD PLATE PER QQ-P-416 TYPE I CLASS 3
SCALE 1/1



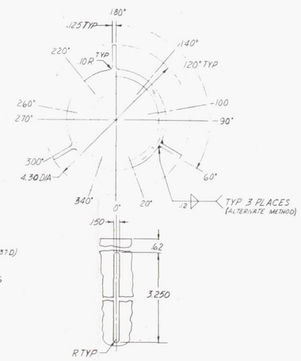

(-7) DETAIL - RING - STIFFENER (37C)
MATL: .050 THK 6061-T6 ALUM ALLOY
PER QQ-A-250/11 TEMPER T6
SCALE 1/2

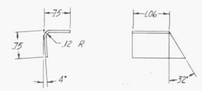



(30) DETAIL - RING - FWD COVER (78F)
MATL: 6061-T651 ALUM ALLOY
PER QQ-A-250/11 TEMPER T651
SCALE 1/1




(-9) DETAIL - HOUSING - SPRING (37D)
MATL: 6061-T6 ALUM ALLOY
PER QQ-A-200/8 TEMPER T6
WELDING MAY BE USE AS
ALTERNATE METHOD OF
FABRICATION
SCALE 1/1

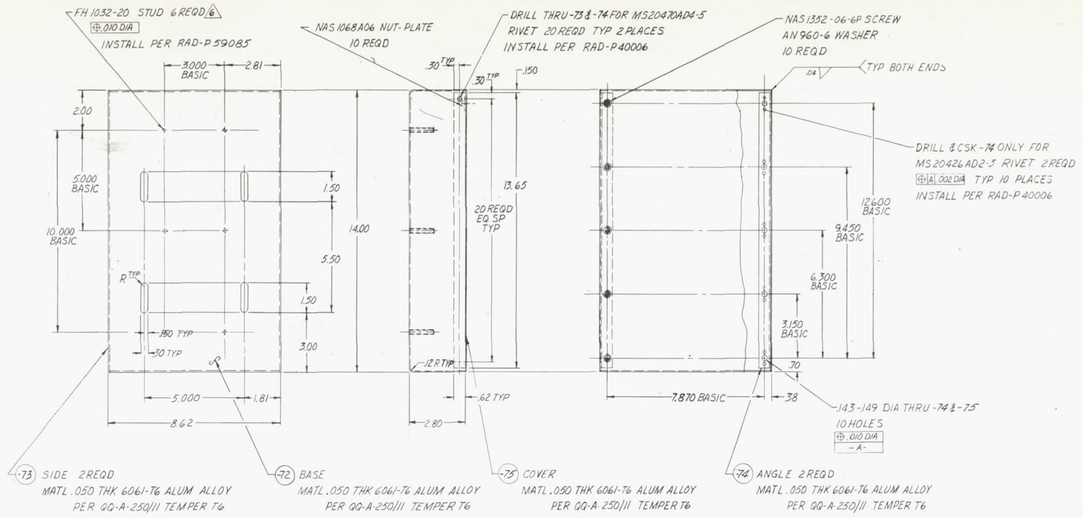


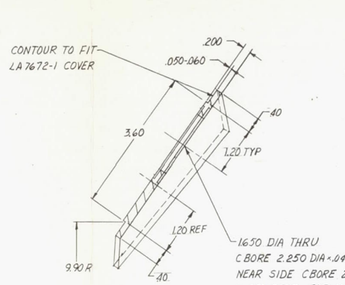



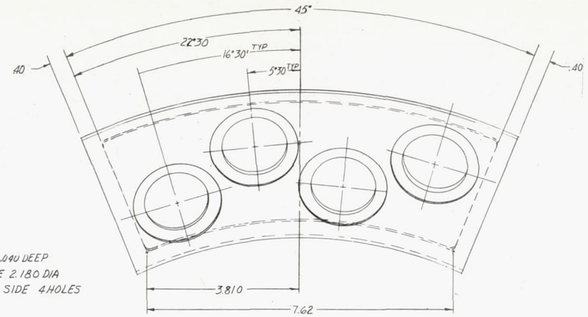

(-11) DETAIL - CLIP 3 REQD (37E)
MATL: .050 THK 6061-T6 ALUM ALLOY
PER QQ-A-250/11 TEMPER T6
SCALE 1/1

| | | | | | |
|---|---|---|---|---|---|
| -UNLESS OTHERWISE SPECIFIED- | AERODYN | | | Avco CORPORATION research and advanced development division Wilmington, Mass. | |
| | THERMO | | | | |
| | STRESS ENGR | | | | |
| | MATERIAL | K. Ritz | 11-5-62 | TITLE MARS PROBE & STERILIZATION CANISTER ASSY HUNTSVILLE | |
| | WEIGHT | | | | |
| | MFR | L. E. Sutton | 11-5-62 | | |
| | ENG APPD | | | | |
| | CHECKED | | | | |
| | DRAWN | W. Hall | 9-27-62 | | |
| | DESIGNED | Robert Gilbertson | 7-3-62 | CODE IDENT NO. 04614 | SIZE J |
| | RELEASED FOR PUBLICATION | | | SCALE | REL |
| | | | | DWG NO. LA 7671 | SHEET 8 of 6 |

Figure 1 (Cont.)

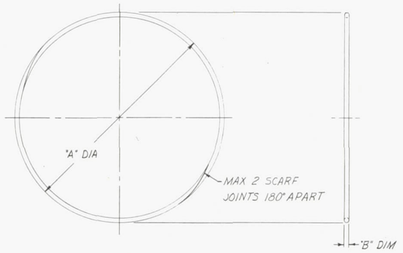


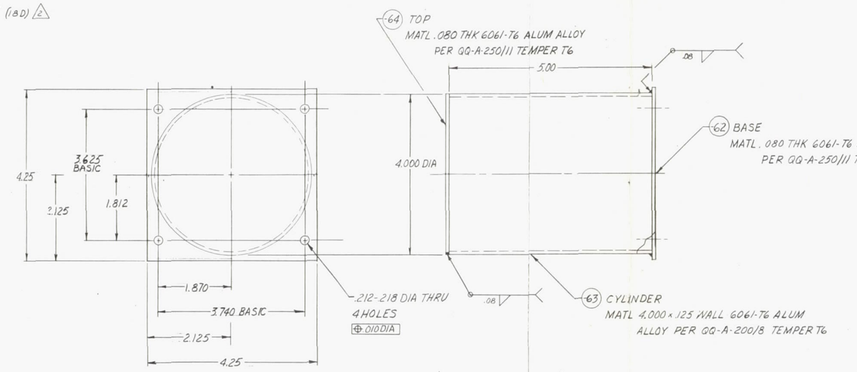

(-79) DETAIL - PAD-CONNECTOR (4.0 R)
MATL 6061-T651 ALUM ALLOY
PER QQ-A-250/11 TEMPER T651
SCALE 1/1

(-71) MASS SPECTROMETER BOX (18D) △2
SCALE 1/2

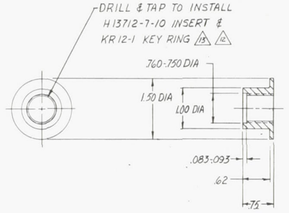



| PART NO | "A" DIA | "B" DIM |
|---|---|---|
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| -77 | 28.100<br>28.020 | .205/.215 |

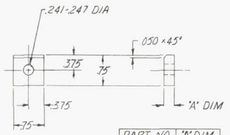
(-76)(-77) DETAIL - GASKET "O" RING
MATL VITON AS PURCHASED FROM
PRECISION RUBBER PROD. CORP.
DAYTON, OHIO COMPOUND # 17107A
OR EQUIV.




(-82) TANK ASSY (13G) △2
SCALE 1/1




(-78) DETAIL - PLUG 2 REQD (37B)
MATL 6061-T6 ALUM ALLOY
PER QQ-A-250/11 TEMPER T6
SCALE 1/1




| PART NO | "A" DIM. |
|---|---|
| -80 | .100 |
| -81 | .250 |

(-80)(-81) DETAIL - INSULATOR 4 EACH REQD
MATL FIBER GLASS PER
MIL-P 25515 TYPE I CLASS 2
SCALE 1/1

Figure 1 (Concl'd)

| | | | |
|---|---|---|---|
| -UNLESS OTHERWISE SPECIFIED- | AERODYN. | Avco CORPORATION | research and advanced development division Wilmington, Mass. |
| | THERMO | TITLE | MARS PROBE & STERILIZATION CANISTER ASSY HUNTSVILLE |
| | HUMAN ENGR | | |
| | STRESS | | |
| | MATERIAL | | |
| | WEIGHT | | |
| | MFG | | |
| | DWG APPD | | |
| | CHECKED | | |
| | DRAWN | CODE IDENT NO. 04614 | SIZE J |
| | MANAGER REL. ENG. DESIGNER | DWG NO. LA 7671 | |
| | | SCALE | REL |
| | | SHEET 3 OF 6 | |

## 2. THERMAL ANALYSIS

### 2.1 GENERAL DISCUSSION

The analytical approach to the thermal analysis is thoroughly discussed in the first quarterly progress report (RAD-SR-65-264, dated 15 October 1965). This analytical procedure was used to determine the thermal behavior of the final design configuration of the sterilization container and dummy probe assembly. The mathematical model of the system is shown in figure 2. This investigation was more detailed than that carried out during the preliminary design phase. It included the effects of the ejection spring areas, the fiberglass R.F. window, and the propulsion system on the assembly.

In predicting the behavior of the final design, a heat cycle with oven rise and cool-down times between room temperature to 145°C for 1 hour was used. The analysis includes heating inputs of 10 watts per pound of component to remote components of the probe.

The measurement of emissivity on actual hardware surfaces, between 0.1 and 0.14, is in close agreement with values used in the analysis. Other surfaces that require a high emissivity will be painted.

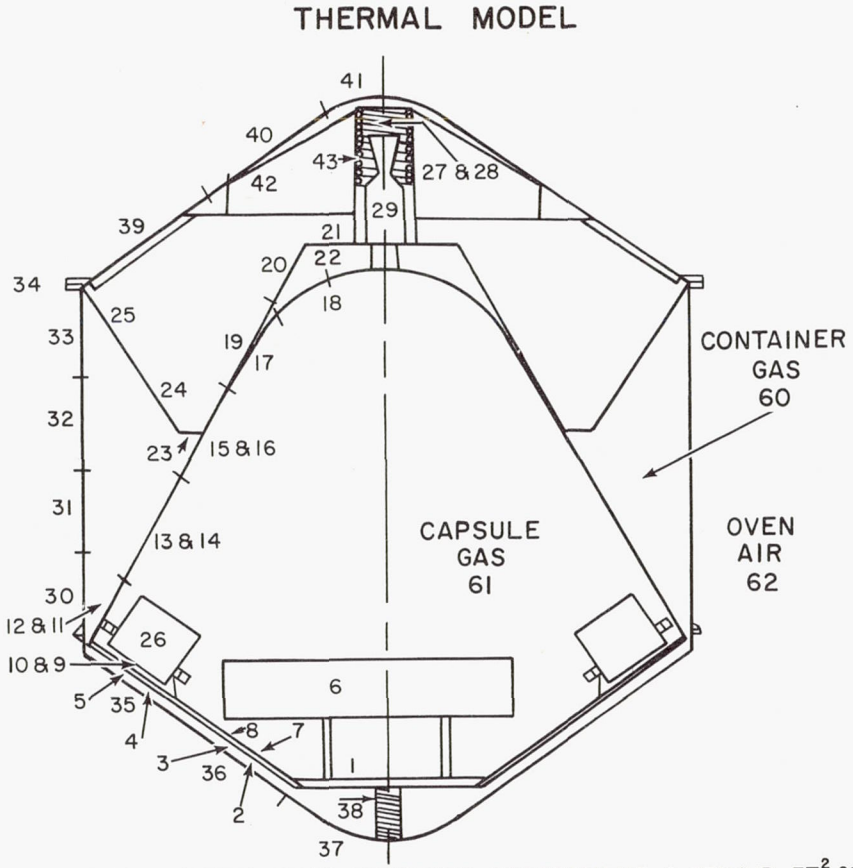
### 2.2 THERMAL PERFORMANCE PREDICTION

The analysis predicting performance includes the thermal response effect of nitrogen and helium inside the container under both free and forced convection conditions.

#### 2.2.1 Heating Phase

Under free convection with nitrogen inside the internal heat transfer coefficient is 0.9 Btu/hr-ft$^2$°F. The response of the more significant components are shown in figure 3. The slowest response component (item 22) requires 6.3 hours to reach soak temperature. Item 26, a component which contains a heating pad, did not reach soak temperature in the time period investigated because the analysis assumed the heating pad cutoff too soon. This has a minor effect on overall system heat balance and time to achieve soak temperature.

A condition in which nitrogen was used with internal forced convection was next investigated. The forced convection heat transfer coefficient in this case was 4.6 Btu/hr-ft$^2$°F. Component response for this




| | |
|---|---|
| 1 | FORWARD END OF PROBE |
| 2 & 3 | HEAT SHIELD |
| 4 & 5 | HEAT SHIELD |
| 6 | INSTRUMENT IN CENTER |
| 7 & 8 | SUBSTRUCTURE FOR HEAT SHIELD |
| 9 & 10 | SUBSTRUCTURE FOR HEAT SHIELD |
| 11 & 12 | SIDE OF REAR BODY |
| 13 & 14 | SIDE OF REAR BODY |
| 15 & 16 | SIDE OF REAR BODY |
| 17 | LOWER PART OF R.F. WINDOW |
| 18 | UPPER PART OF R.F. WINDOW |
| 19 | LOWER PART OF PROPULSION ASSEMBLY |
| 20 | UPPER PART OF PROPULSION ASSEMBLY |
| 21 | FLAT PART OF PROPULSION ASSEMBLY |
| 22 | BATTERY OR SEQUENCER |
| 23 | PROBE MOUNTING RING |
| 24 | SIDE OF CONICAL SUPPORT |
| 25 | SIDE OF CONICAL SUPPORT |
| 26 | INSTRUMENT PACKAGE IN INTERIOR |
| 27 & 28 | SPRING ASSEMBLY |
| 29 | ROCKET MOTOR |
| 30, 31, 32, 33 | CYLINDRICAL SIDE OF STERILIZATION CONTAINER |
| 34 | MOUNTING FLANGE |
| 35, 36, 37 | CONTAINER LID |
| 38 | SPRING ASSEMBLY |
| 39, 40, 41 | AFT CLOSURE |
| 42 | SIDE PLATE FOR SPRING HOLDER |
| 43 | SPRING HOUSING |
| 60 | GAS BETWEEN PROBE AND CONTAINER |
| 61 | GAS INSIDE PROBE |
| 62 | OVEN AIR OUTSIDE CONTAINER |

76-0008P

Figure 2 THERMAL ANALYTICAL MODEL

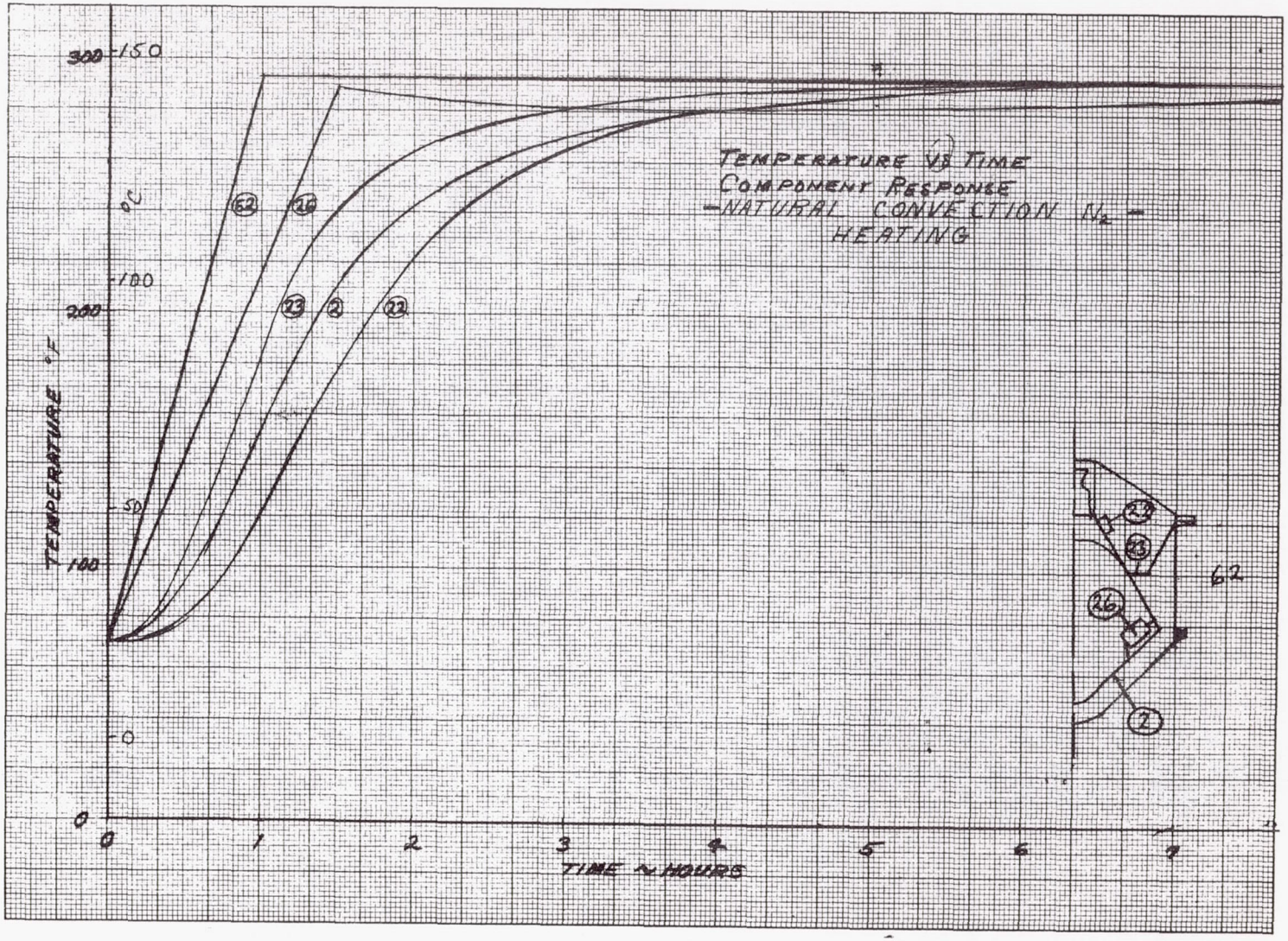



Figure 3 TEMPERATURE VERSUS TIME COMPONENT RESPONSE NATURAL CONVECTION $N_2$ HEATING

condition is shown in figure 4. Heat-up time of the slowest element is approximately 3 hours. Item 26 exceeded 145°C indicating in this instance that the heating pad was left on too long.

The third condition with helium in the sterilization container as the pressurizing gas, under free convection, results in a heat transfer coefficient of 1.85 Btu/hr-ft$^2$ °F. The component response is shown in figure 5. The slowest response element requires approximately 4.5 hours to reach soak temperature.

The fourth case, with helium under forced convection, has a heat transfer coefficient of 4.6 Btu/hr-ft$^2$ °F. Component response is shown in figure 6. Heat-up time of the slowest element is approximately 3 hours. Item 26 exceeded 145°C indicating in this instance that the heating pad was left on too long.

### 2.2.2 Cooling Phase

With nitrogen inside the sterilization container and free convection the thermal response of the system was calculated. The response of a few of the more significant components is shown in figure 7. Since item 26 is thermally insulated from the rest of the system, the response is quite slow. Figure 8 presents the thermal response of the system using nitrogen pressurizing gas under forced convection. Figure 9 shows the thermal response of the system using helium pressurizing gas under free convection. Figure 10 predicts the thermal response of the system using helium pressurizing gas under forced convection.

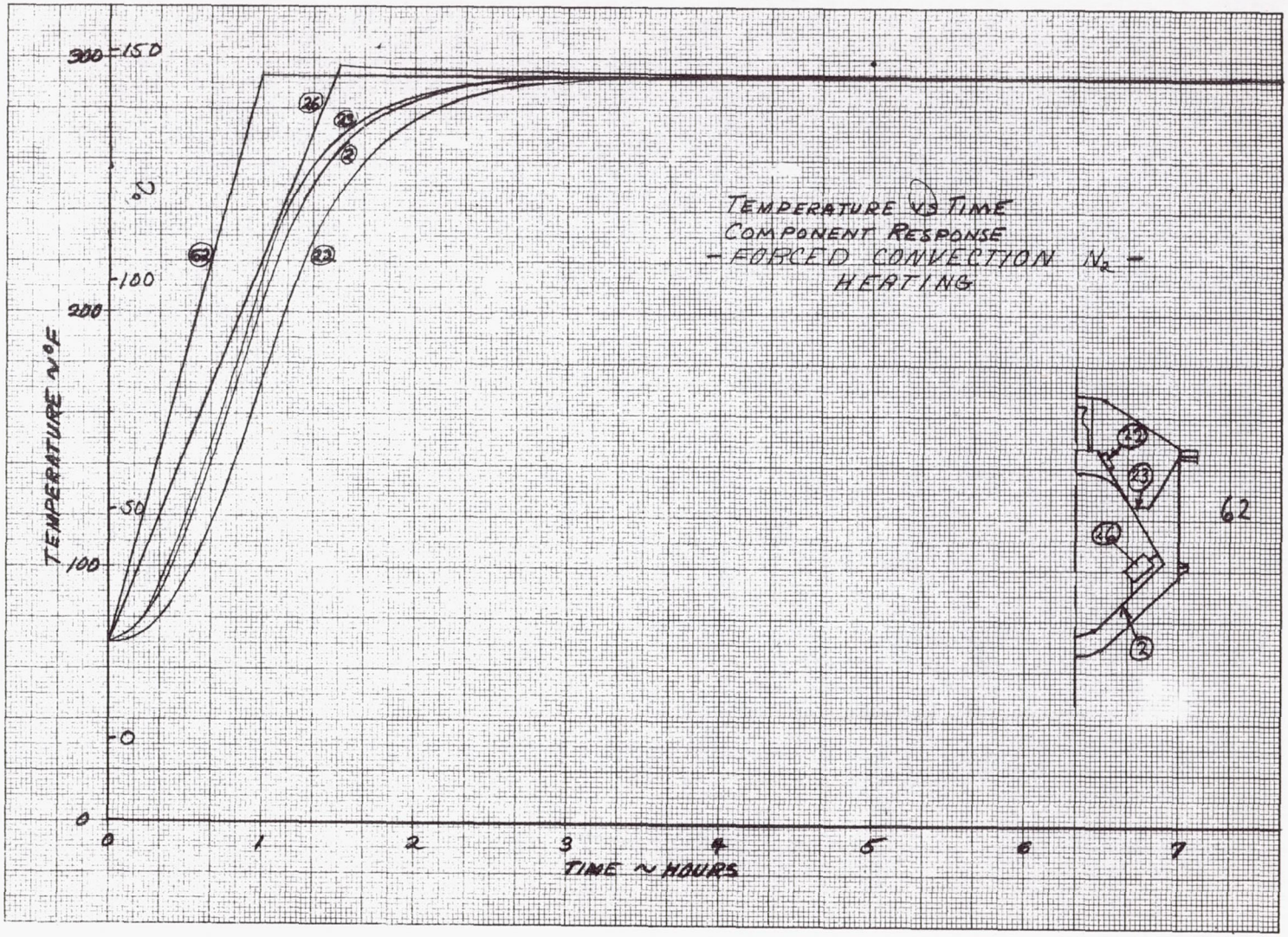



Figure 4 TEMPERATURE VERSUS TIME COMPONENT RESPONSE FORCED CONVECTION $N_2$ HEATING

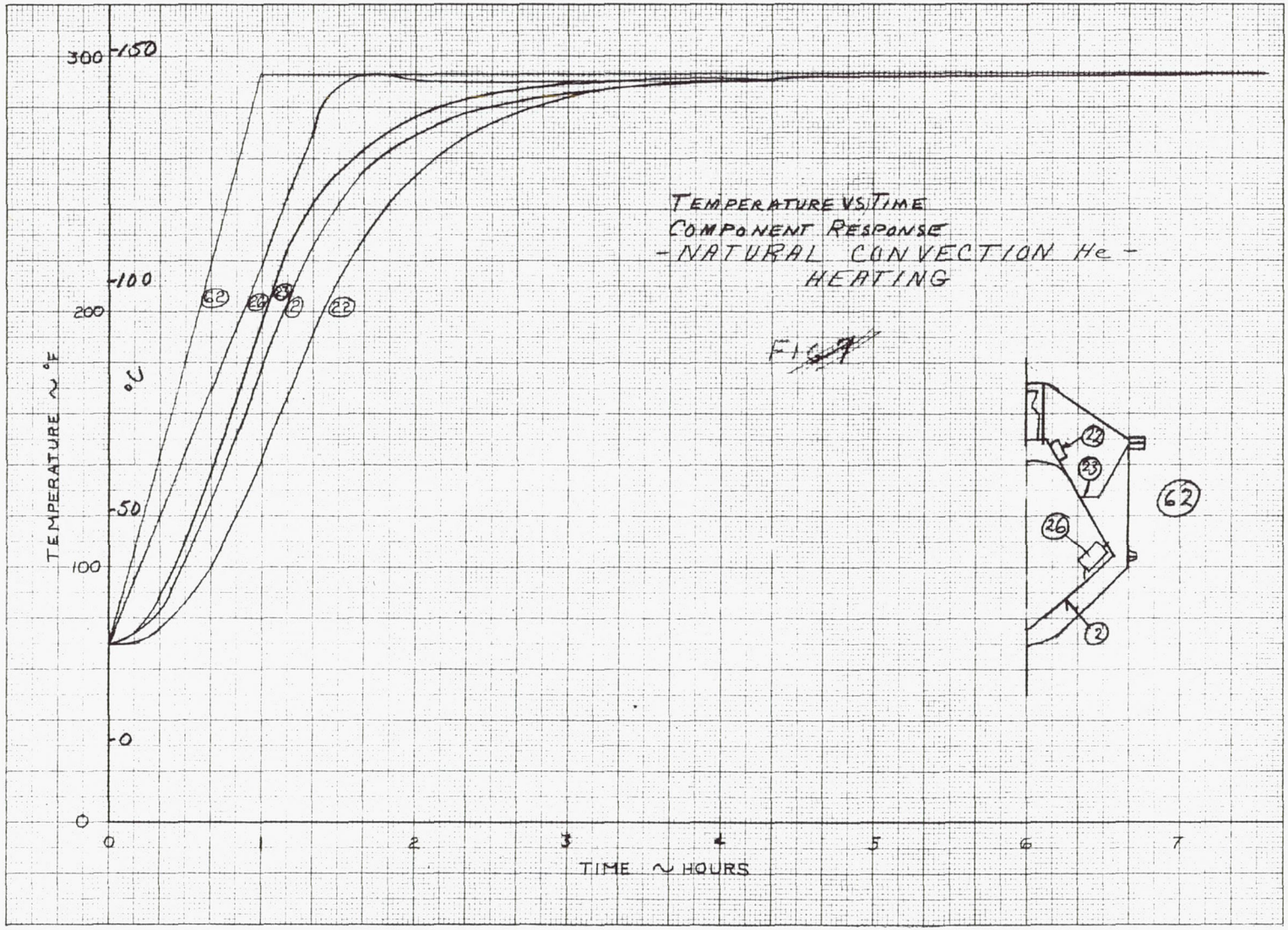



Figure 5 TEMPERATURE VERSUS TIME COMPONENT RESPONSE NATURAL CONVECTION $H_e$ HEATING

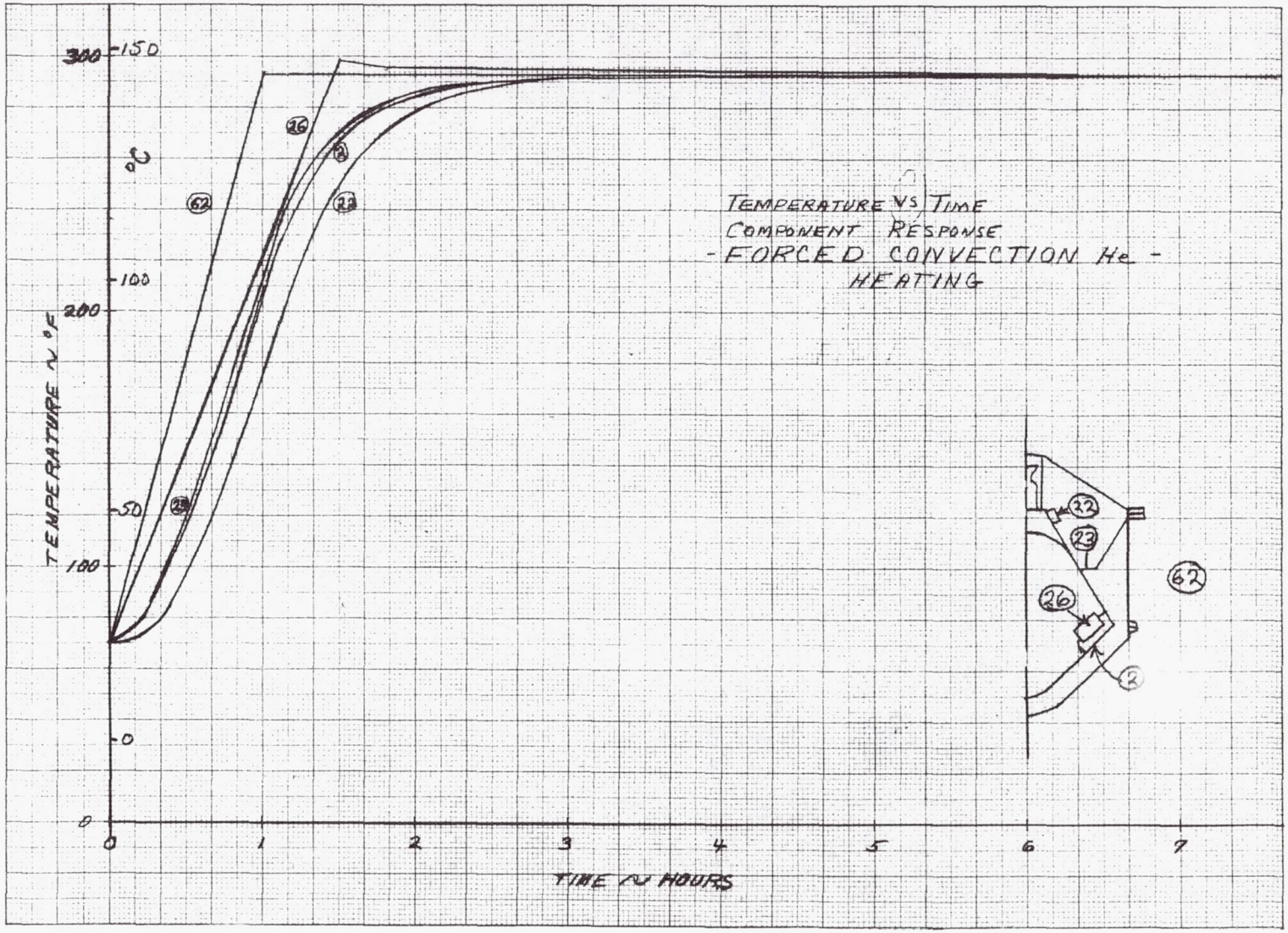



Figure 6 TEMPERATURE VERSUS TIME COMPONENT RESPONSE FORCED CONVECTION $H_e$ HEATING

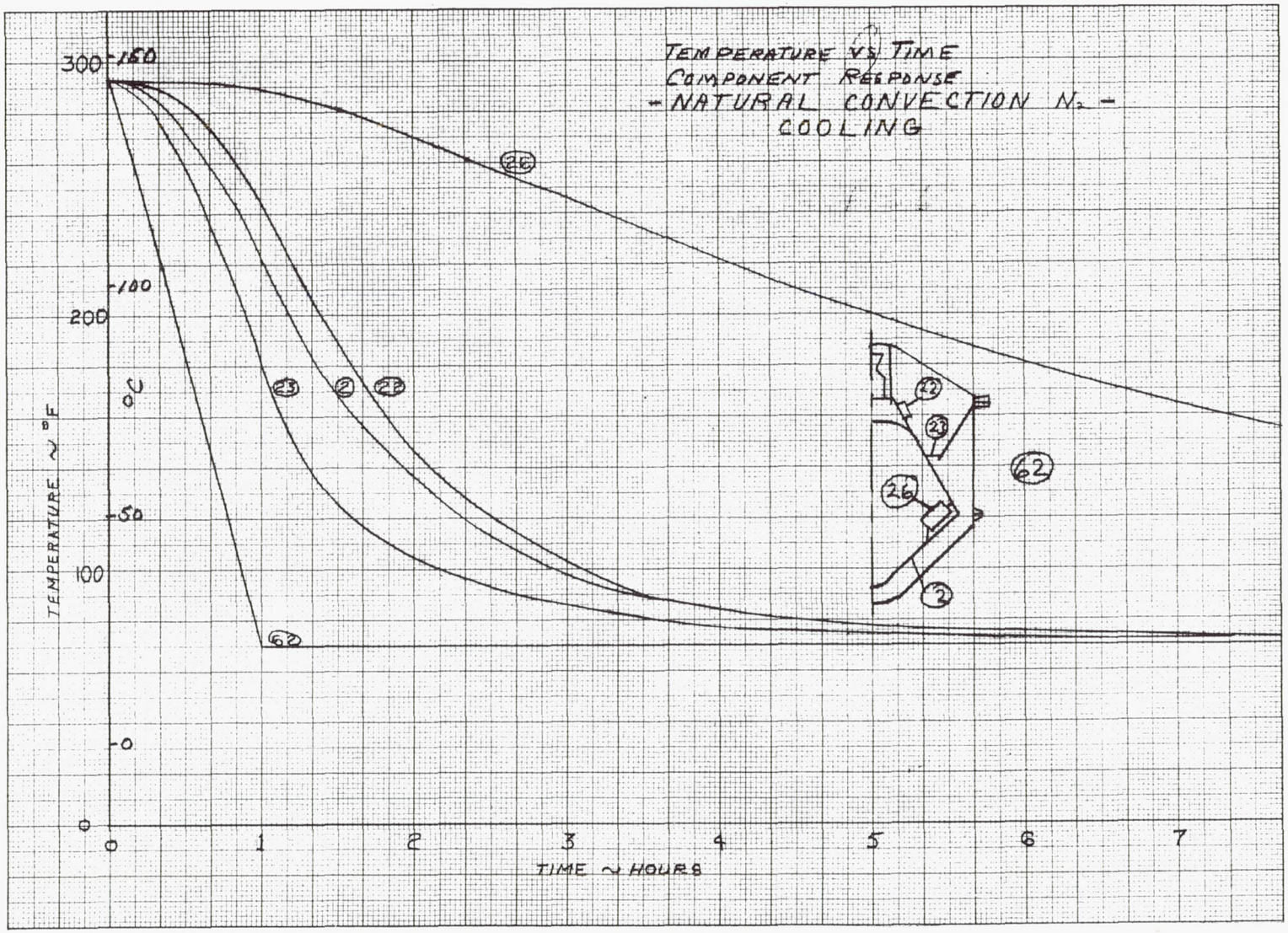



Figure 7 TEMPERAUTRE VERSUS TIME COMPONENT RESPONSE NATURAL CONVECTION $N_2$ COOLING

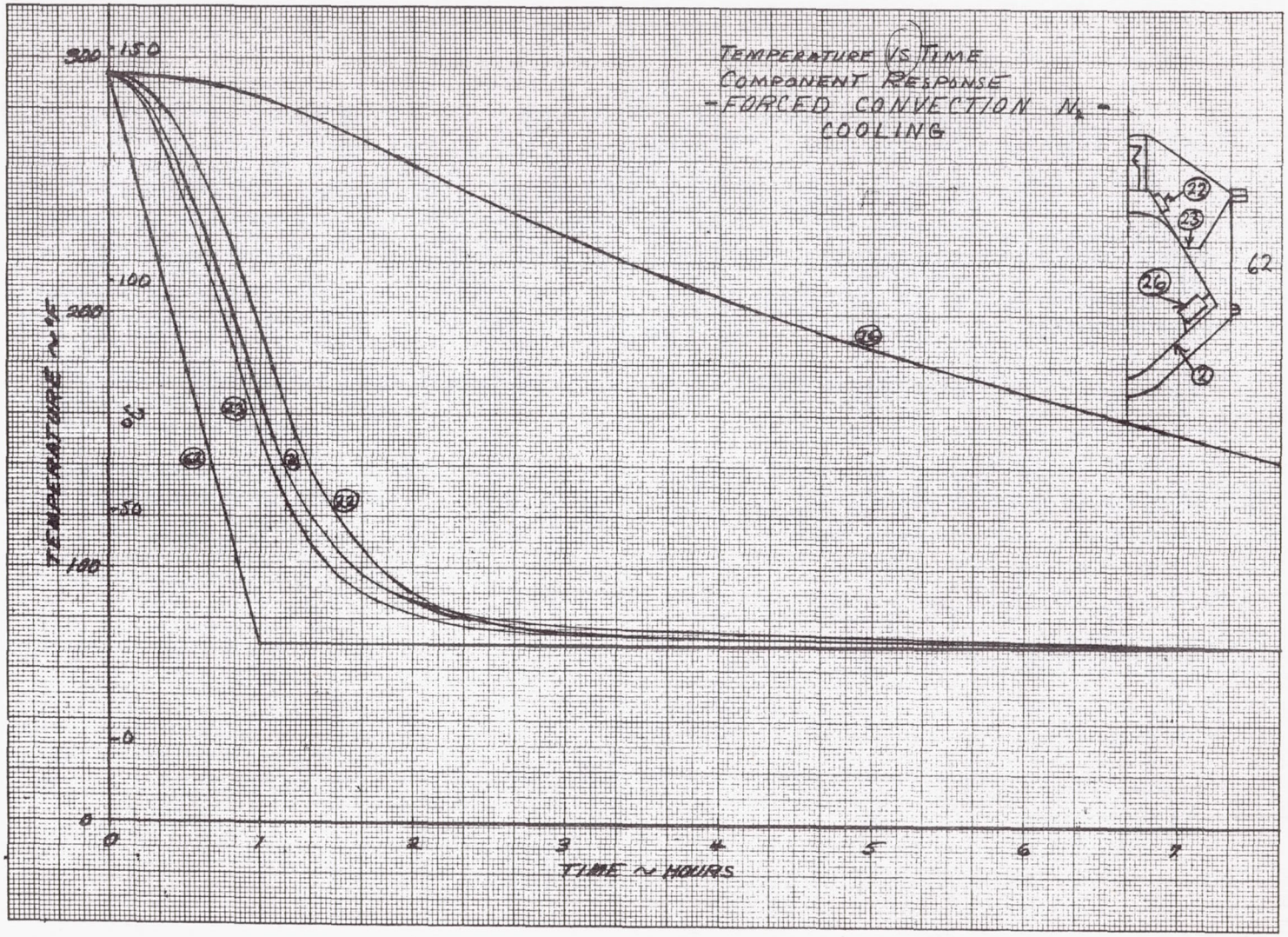



Figure 8 TEMPERATURE VERSUS TIME COMPONENT RESPONSE FORCED CONVECTION $N_2$ COOLING

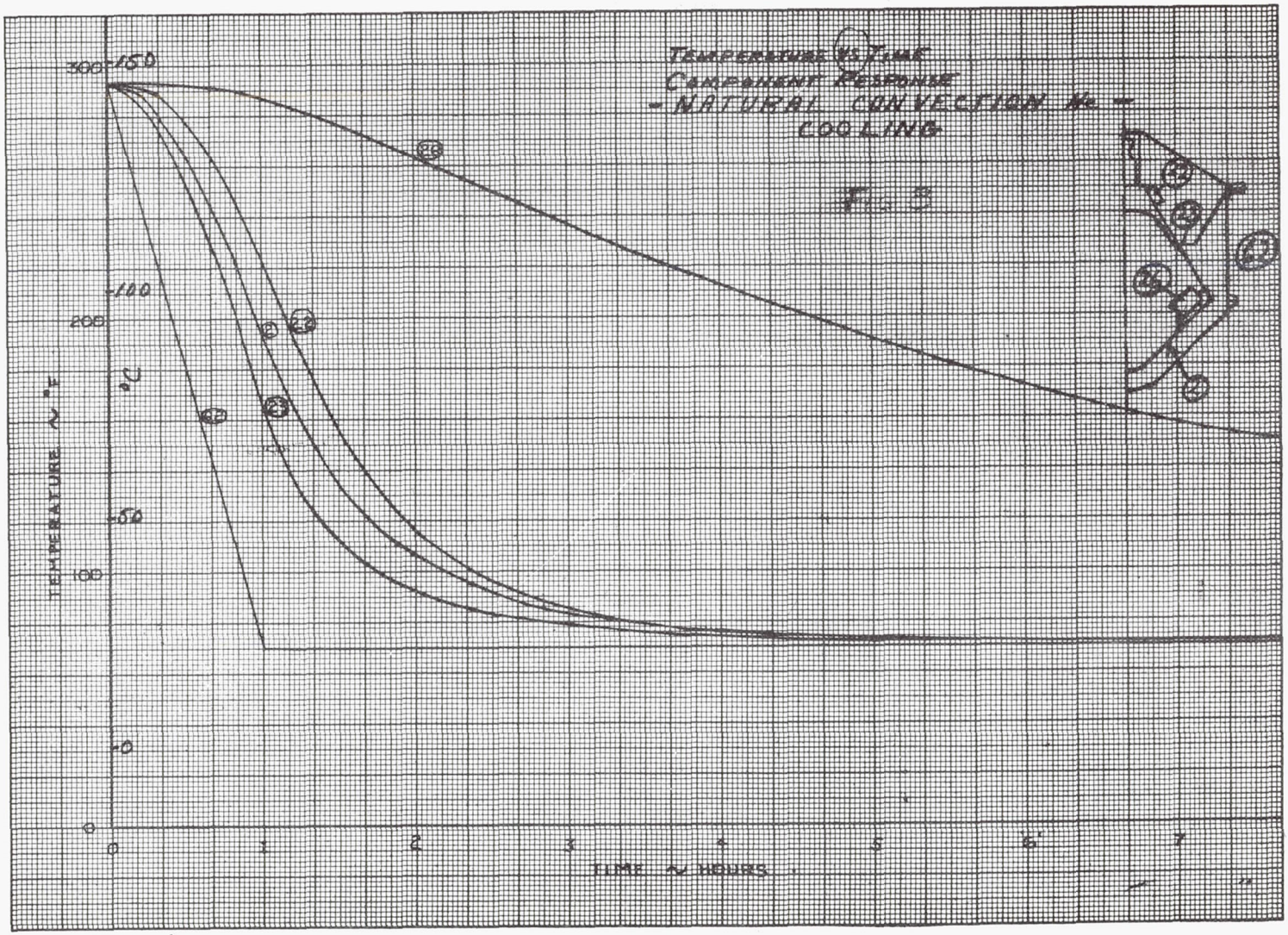



Figure 9 TEMPERAUTRE VERSUS TIME COMPONENT RESPONSE NATURAL CONVECTION $H_e$ COOLING

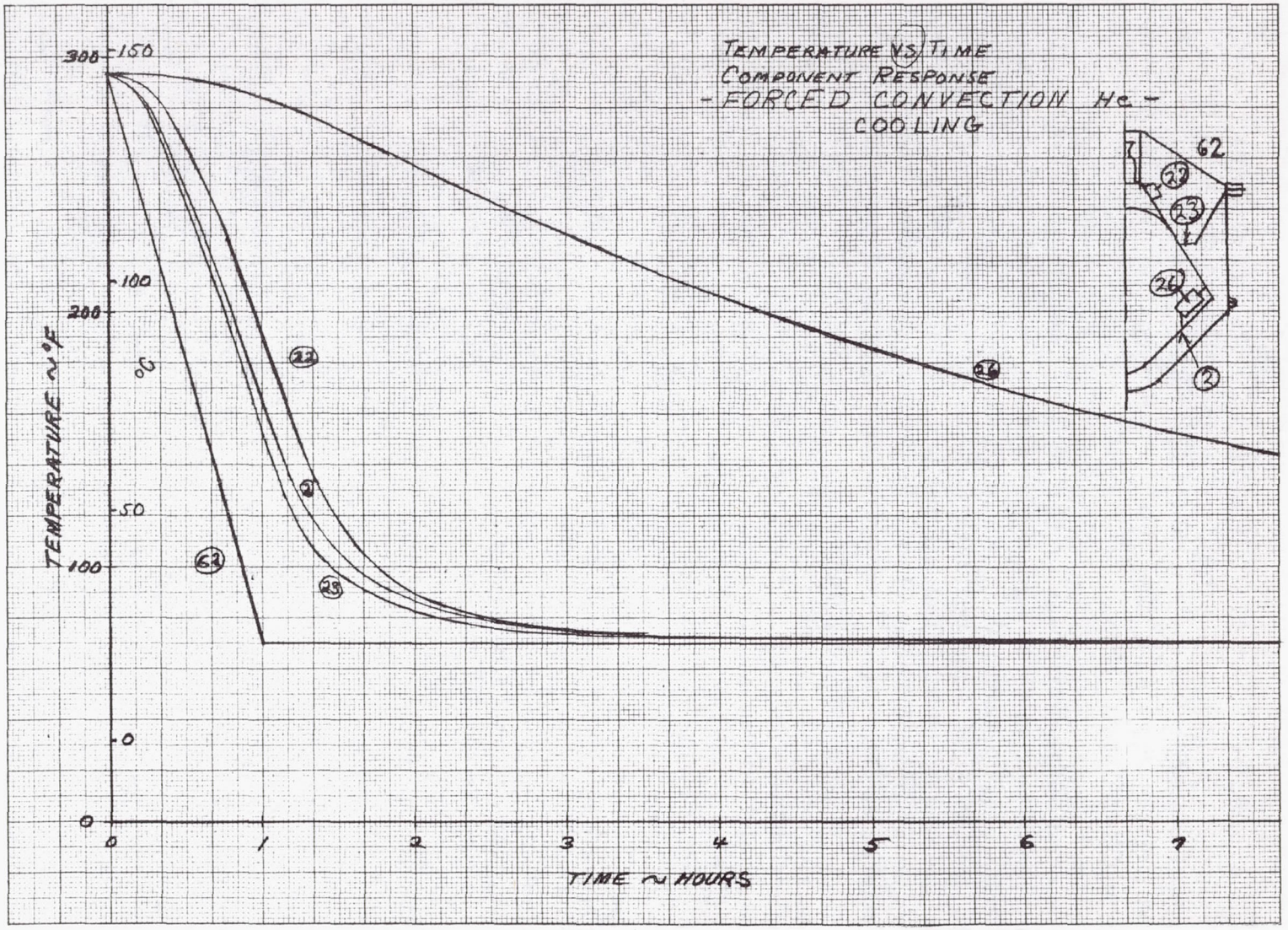



Figure 10 TEMPERATURE VERSUS TIME COMPONENT RESPONSE FORCED CONVECTION $H_e$ COOLING

## 2.3 CONTROLLED OVEN OVERSHOOT

A controlled overshoot heat sterilization cycle analysis was made. Temperature levels in certain areas were allowed to exceed the specified sterilization temperature level [145°C (293°F)] in order to investigate the possibility of shortening the heat-up time of the slower responding items.

The oven temperature was increased from room temperature to 171°C in 1 hour, held at 171°C for 1 hour and then decreased to 145°C in 0.5 hour. Separate heat inputs were applied to the insulated components. The results of this temperature cycle are shown in figure 11. The slowest response item (item 22) stabilized in 4.5 hours with nitrogen pressurizing gas under free convection in the sterilization container. Under the same conditions, but with no oven overshoot, this item required 6.3 hours to reach the stabilization temperature. Only the exterior metallic surfaces and support structure exceeded the 145°C heat sterilization cycle. It is believed that this overshoot will have little effect on performance of the assembly. Although little cycle time reduction is realized when internal heaters are used in components, greater advantage is expected where the use of electrical heaters is limited and a physically larger system is involved.

Figure 12 compares the more significant heating conditions with the controlled overshoot cycle. The response of item 22 (slowest responding element) is plotted for all conditions. The controlled overshoot condition using nitrogen pressurizing gas and free convection shows the temperature rise time is similar to a condition of a normal heat cycle using helium pressurizing gas with free convection. This is an improvement over the nitrogen free convection condition using the design thermal cycle of 1.8 hours.

## 2.4 CONCLUSIONS

There is no particular advantage in the forced convection condition of helium over nitrogen. The response time of the system is identical with either. The time required for the slowest responding element to reach stabilization is approximately 3 hours. Using helium with free convection stabilization can be achieved in approximately 4.5 hours. Using nitrogen with free convection stabilization occurs in approximately 6.3 hours.

The time required to cool to room temperature is quite lengthy for all conditions since little can be done to accelerate heat dissipation of the insulated components.

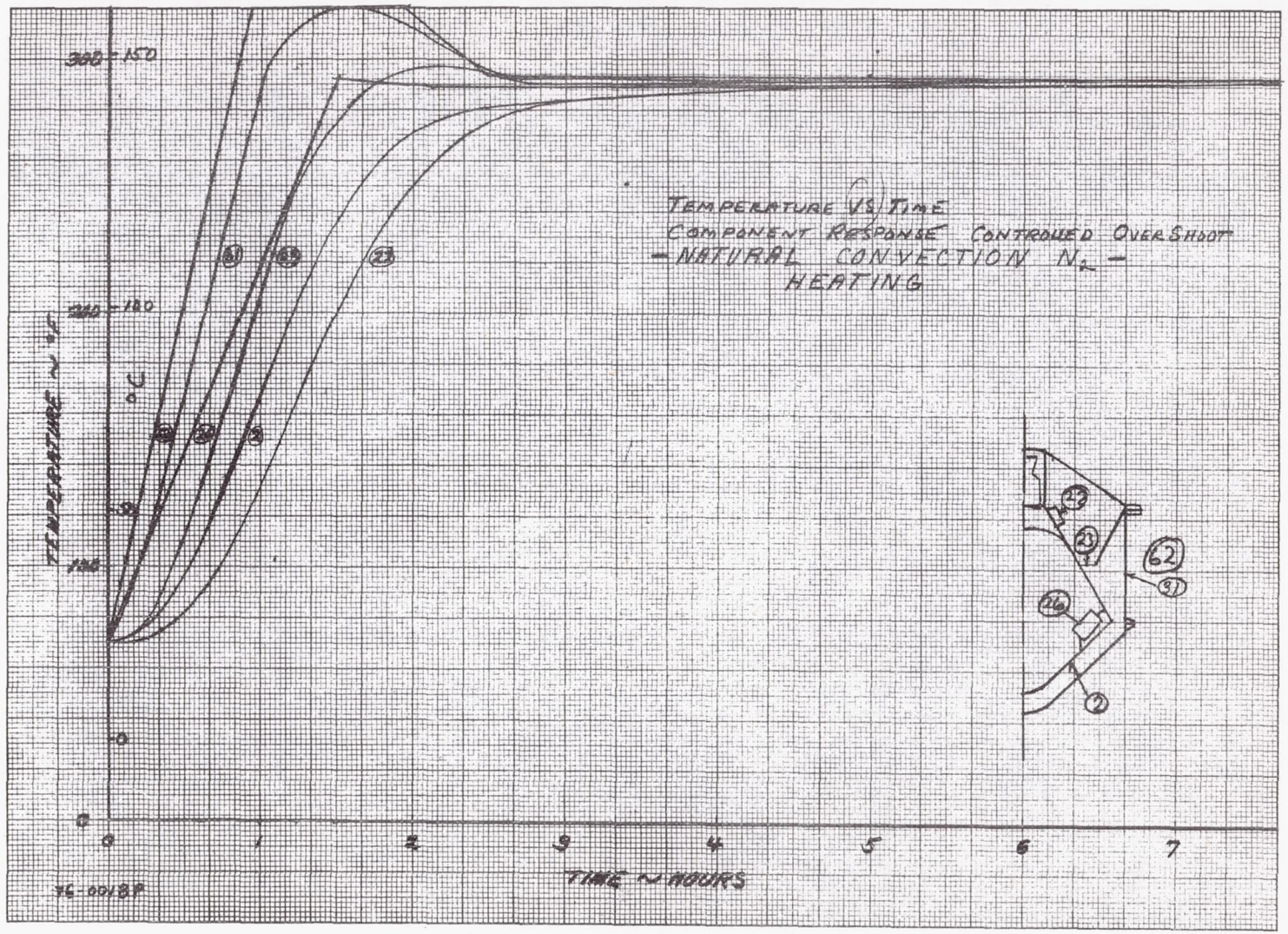



Figure 11 TEMPERATURE VERSUS TIME COMPONENT RESPONSE CONTROLLED OVERSHOOT NATURAL CONVECTION $N_2$ HEATING

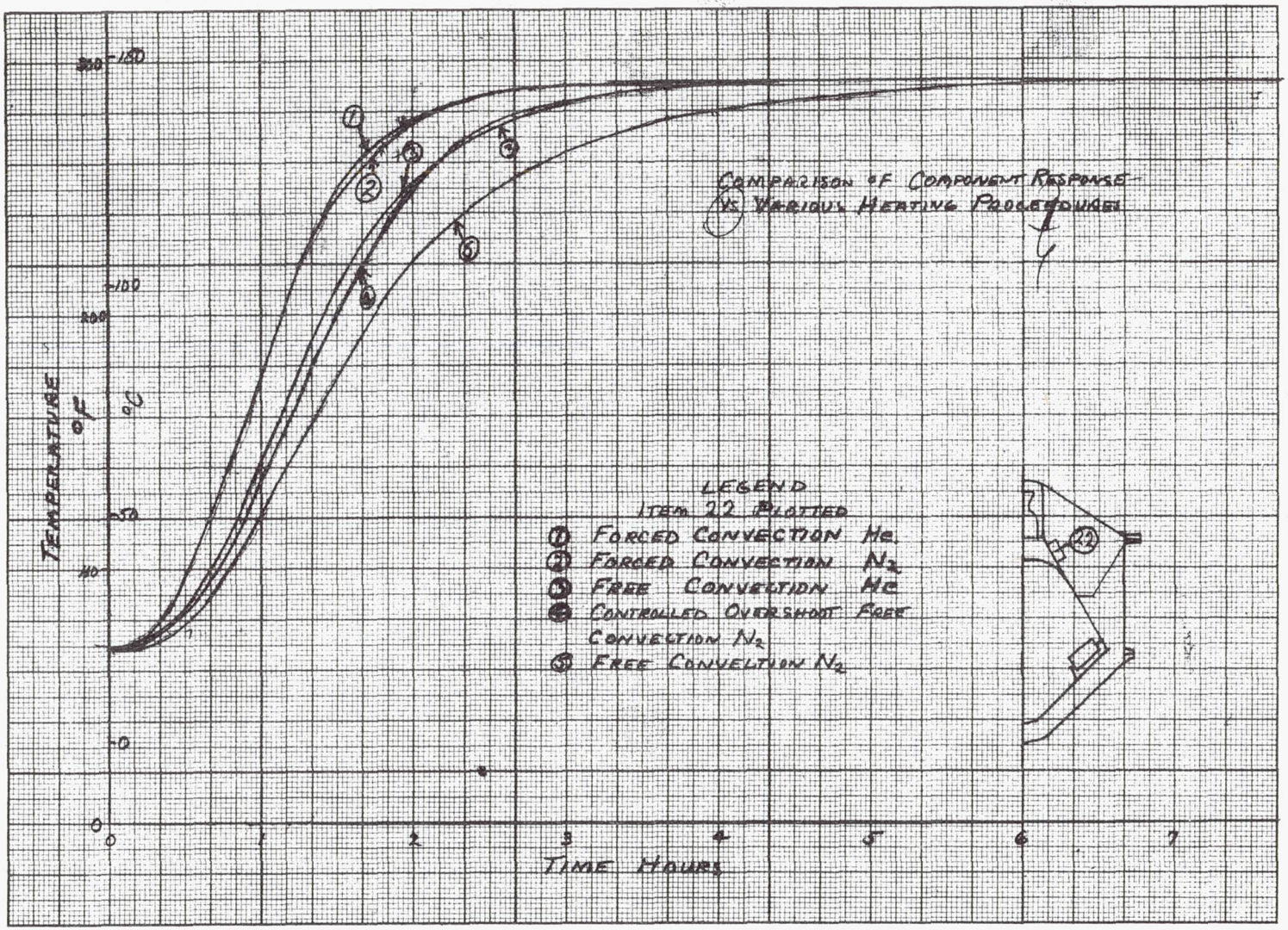



Figure 12 COMPARISON OF COMPONENT RESPONSE FOR VARIOUS HEATING PROCEDURES

# 3. STRUCTURAL ANALYSIS

## 3.1 GENERAL DISCUSSION

Structural performance predictions of the system were completed in the second quarter. The stress analysis was performed at a time 1 hour after initiation of the heating cycle and 1 hour after initiation of the cooling cycle. Previous analysis performed on the preliminary design indicated that the structure would pass through the maximum stresses due to the thermal heat cycle at those times. Nitrogen pressurizing gas, with free and forced convection conditions inside the sterilization container, produces the extreme stress limits the assembly encounters as a result of the thermal cycle. The mathematical model used in the analysis is shown in figure 13. The method of analysis used was described in the first quarterly progress report (RAD-SR-65-264, dated 15 October 1965). Results indicate that stresses well below allowable will develop during thermal cycling and no permanent distortions are expected.

## 3.2 STRUCTURAL PERFORMANCE PREDICTION

### 3.2.1 Nitrogen-Free Convection Heating

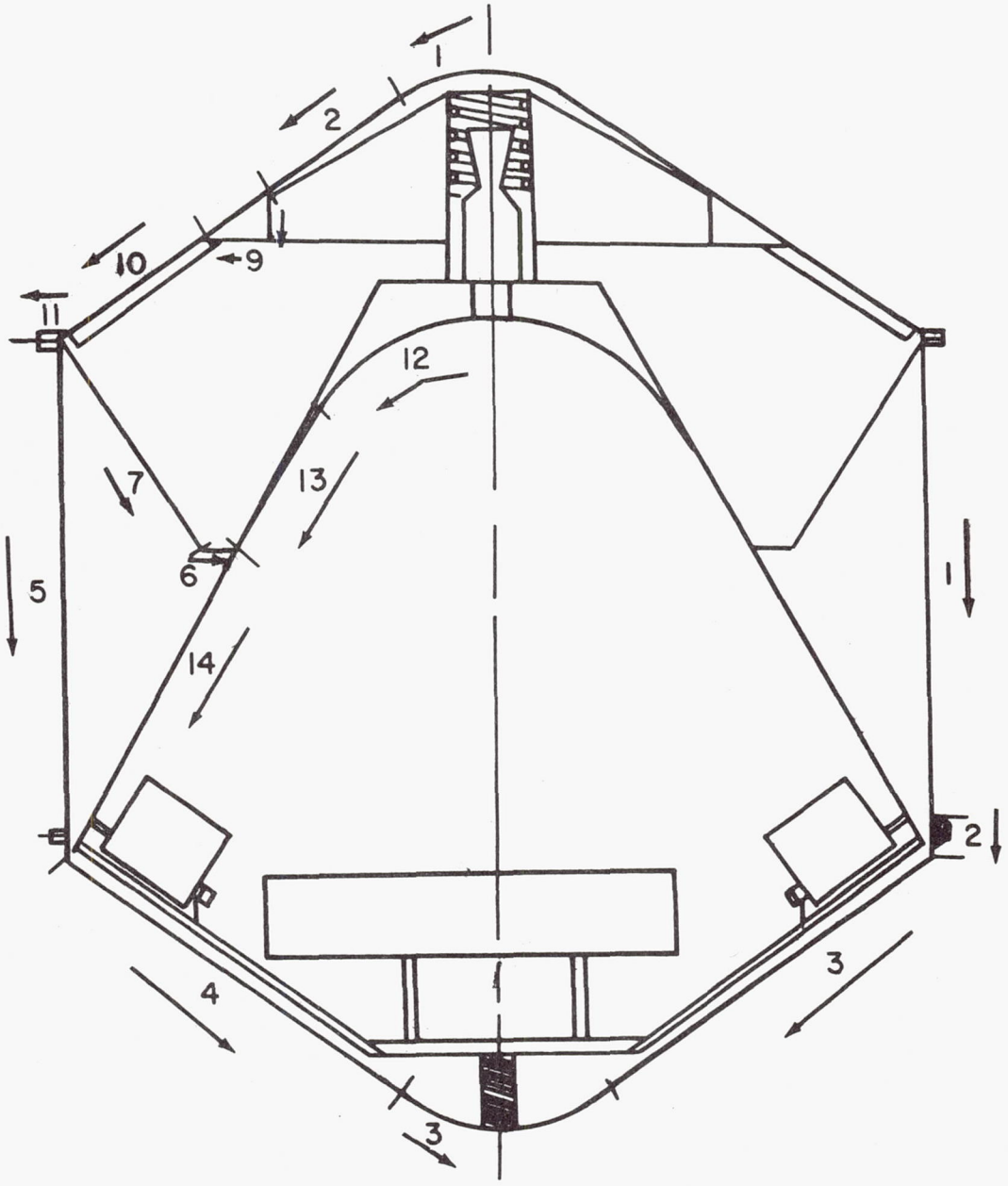
The thermal gradients for the condition using nitrogen gas in the sterilization container, under free convection heating, at a period of 1 hour after initiation of the heating phase, is shown in figure 14. Figures 15 and 16 are plots of the internal and external meridional and circumferential stresses in the sterilization container. The maximum stresses calculated were on the order of 3500 psi and are well within the allowable stress range of the material.

### 3.2.2 Nitrogen-free Convection Cooling

The thermal gradients for the condition using nitrogen gas in the sterilization container, under free convection cooling, at a period of 1 hour after initiation of the cooling phase, are shown in figure 17. Figures 18 and 19 are plots of the internal and external meridional and circumferential stresses in the sterilization container. The maximum stresses calculated are on the order of 1400 psi.

### 3.2.3 Nitrogen-Forced Convection Heating

Figure 20 shows the thermal gradient in the sterilization container at a time of 1 hour after initiation of the heating phase. Nitrogen




76-0004P

Figure 13 STRUCTURAL ANALYTICAL MODEL

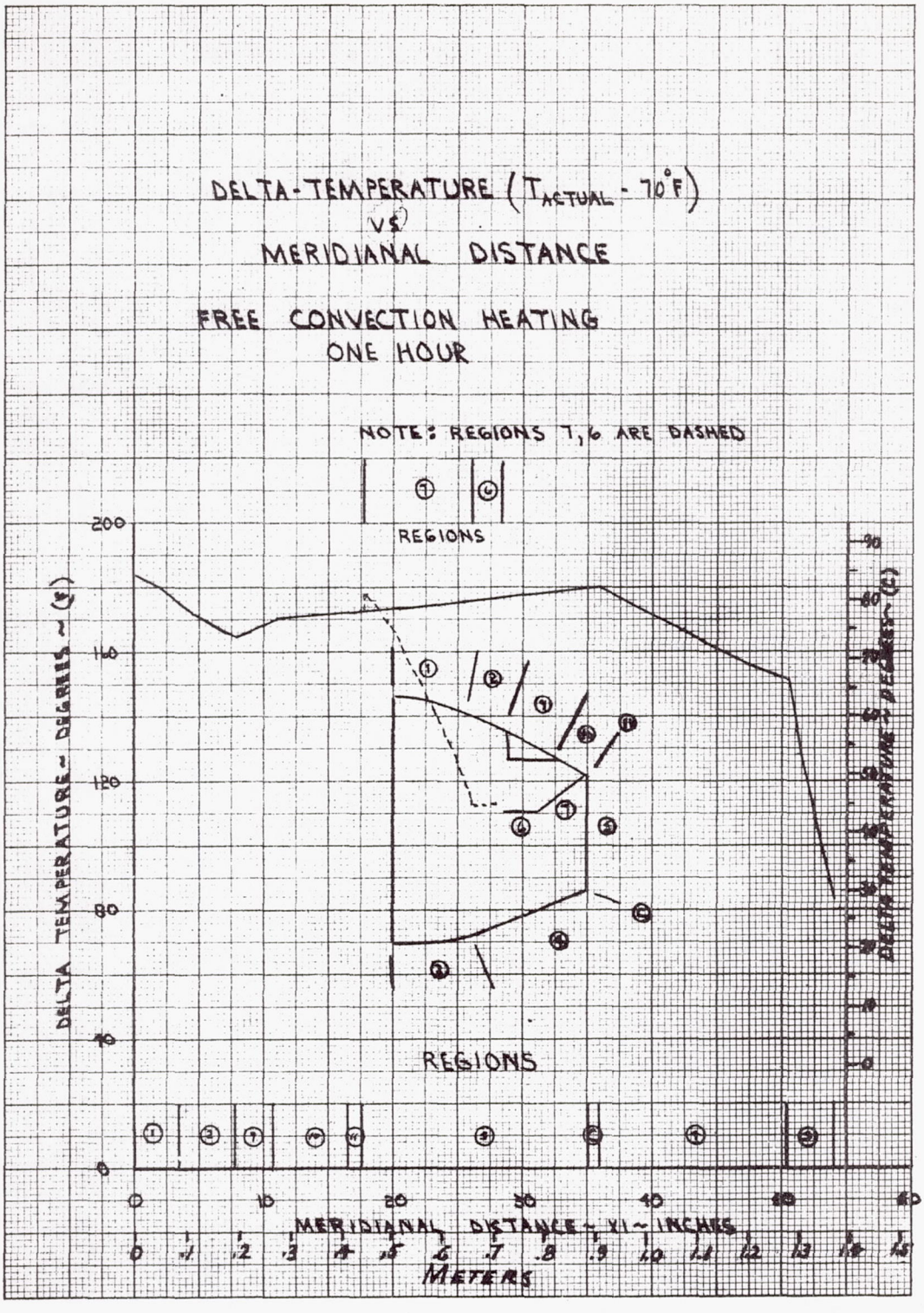



Figure 14 DELTA-TEMPERATURE ($T_{actual}$ -70°F) VERSUS MERIDIONAL DISTANCE
FREE CONVECTION HEATING ONE HOUR

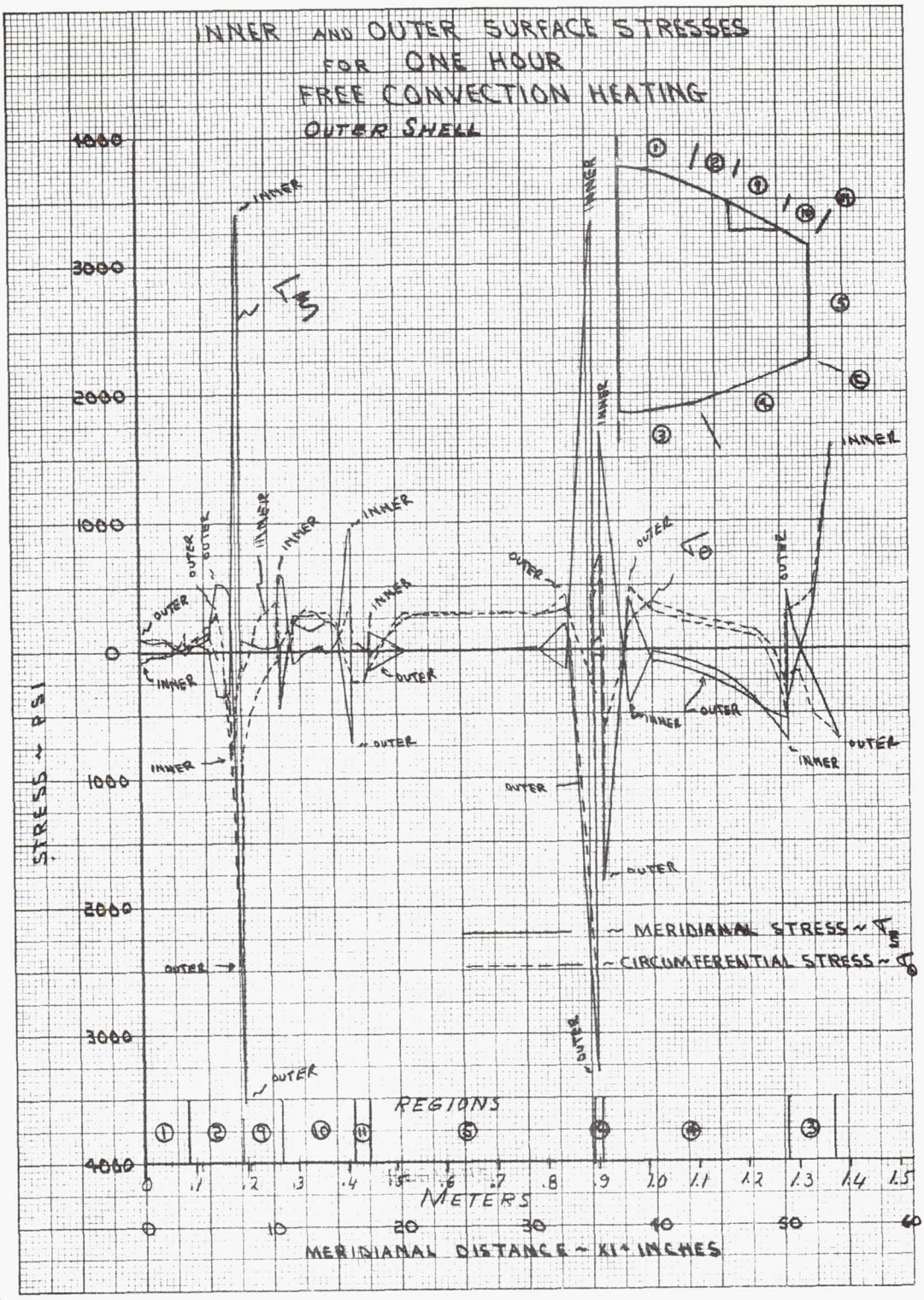



Figure 15 INNER AND OUTER SURFACE STRESSES FOR ONE HOUR FREE CONVECTION HEATING OUTER SHELL

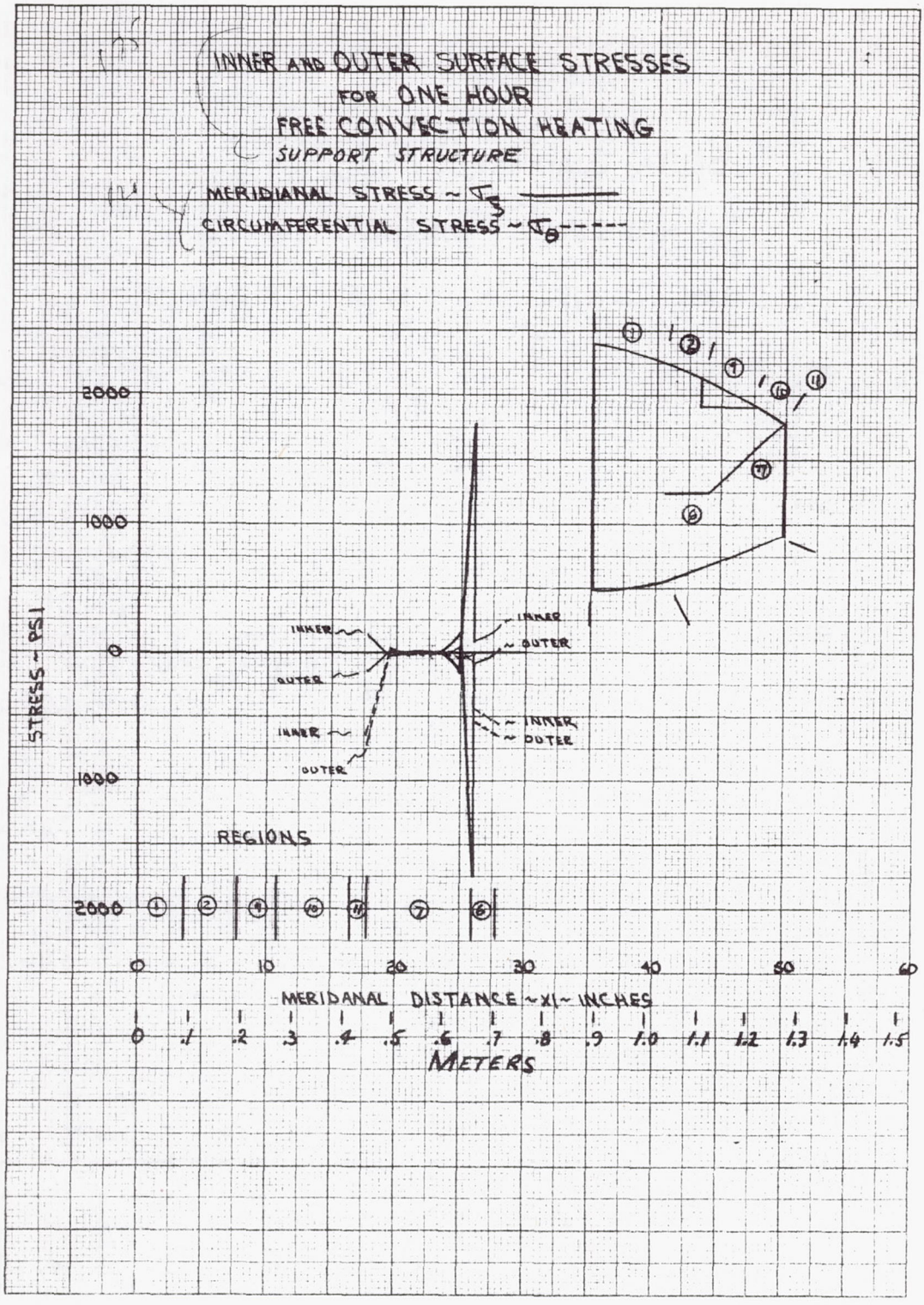



Figure 16 INNER AND OUTER SURFACE STRESSES FOR ONE HOUR FREE CONVECTION HEATING SUPPORT STRUCTURES

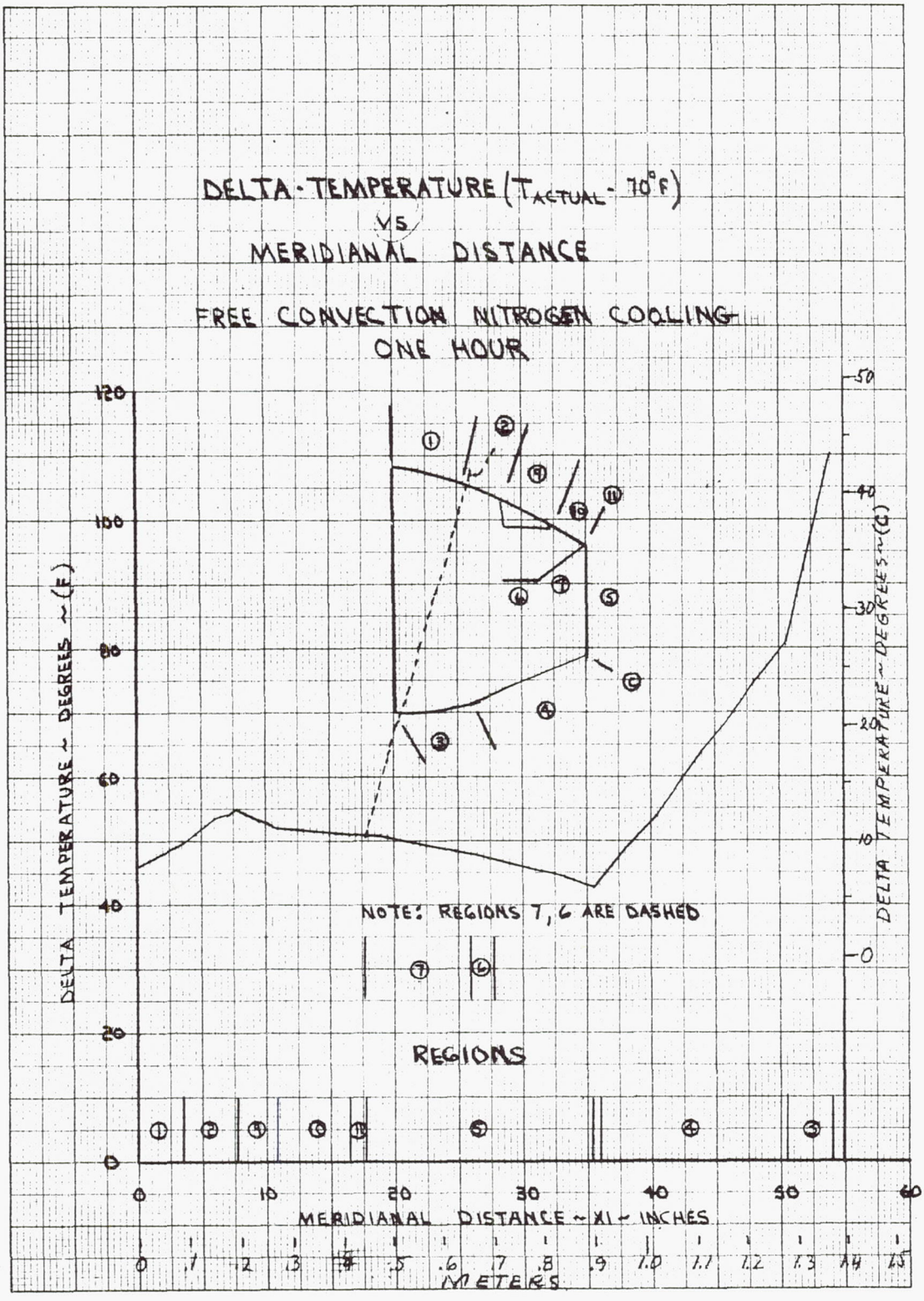



Figure 17 DELTA-TEMPERATURE ($T_{actual}$ -70°F) VERSUS MERIDIONAL AND DISTANCE
FREE CONVECTION NITROGEN COOLING ONE HOUR

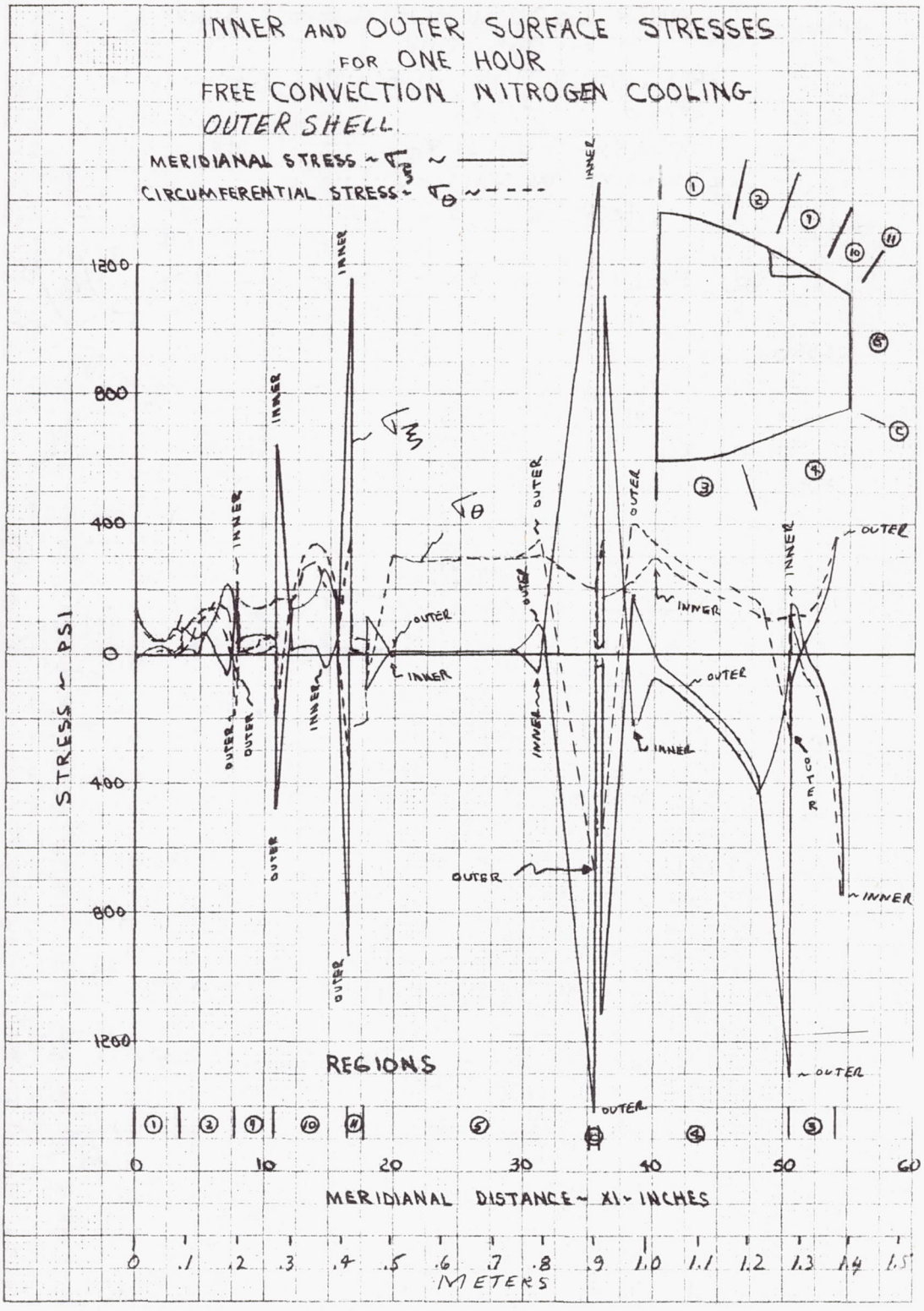



Figure 18 INNER AND OUTER SURFACE STRESSES FOR ONE HOUR FREE CONVECTION NITROGEN COOLING OUTER SHELL

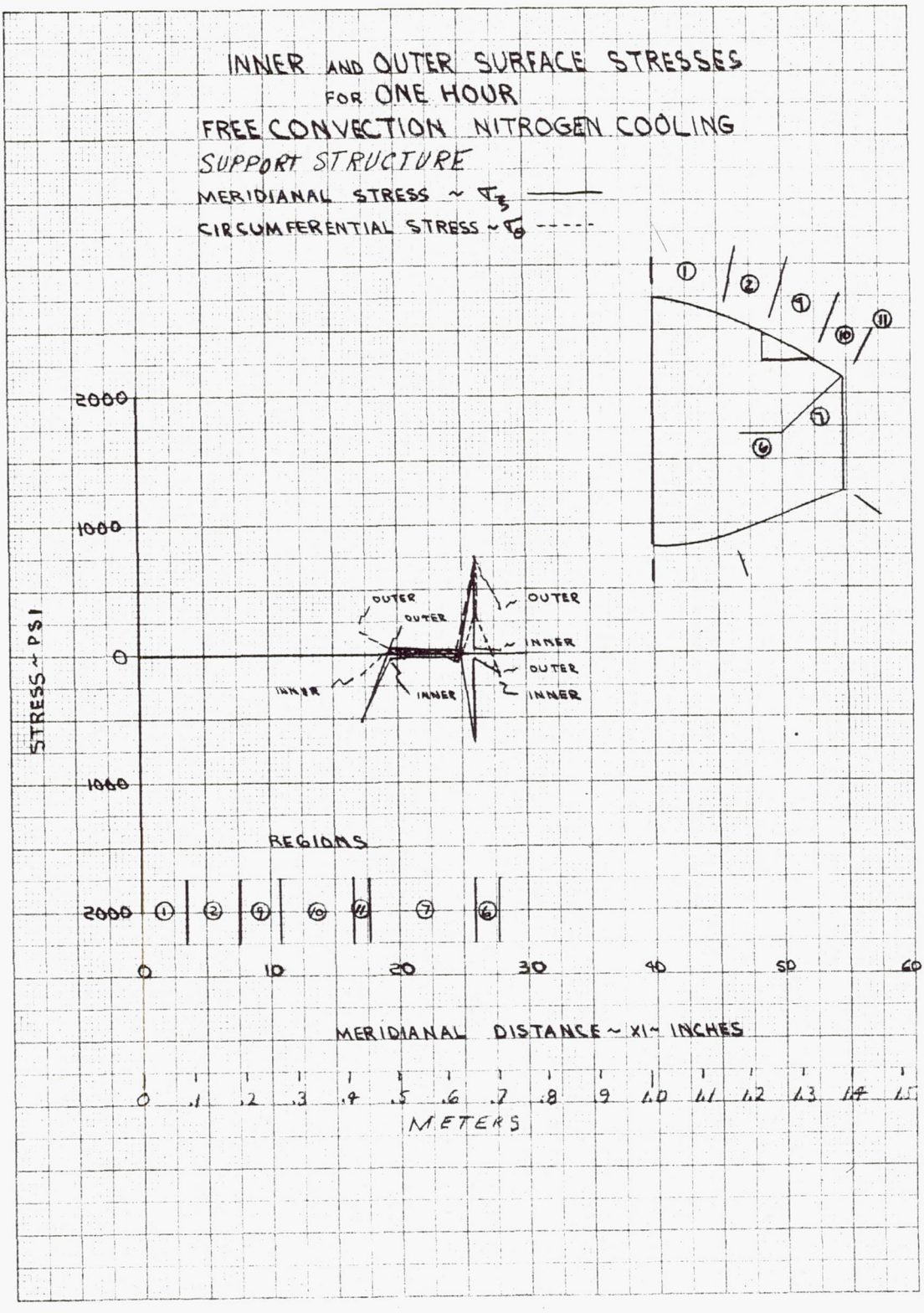



Figure 19 INNER AND OUTER SURFACE STRESSES FOR ONE HOUR FREE CONVECTION NITROGEN COOLING OUTER SHELL

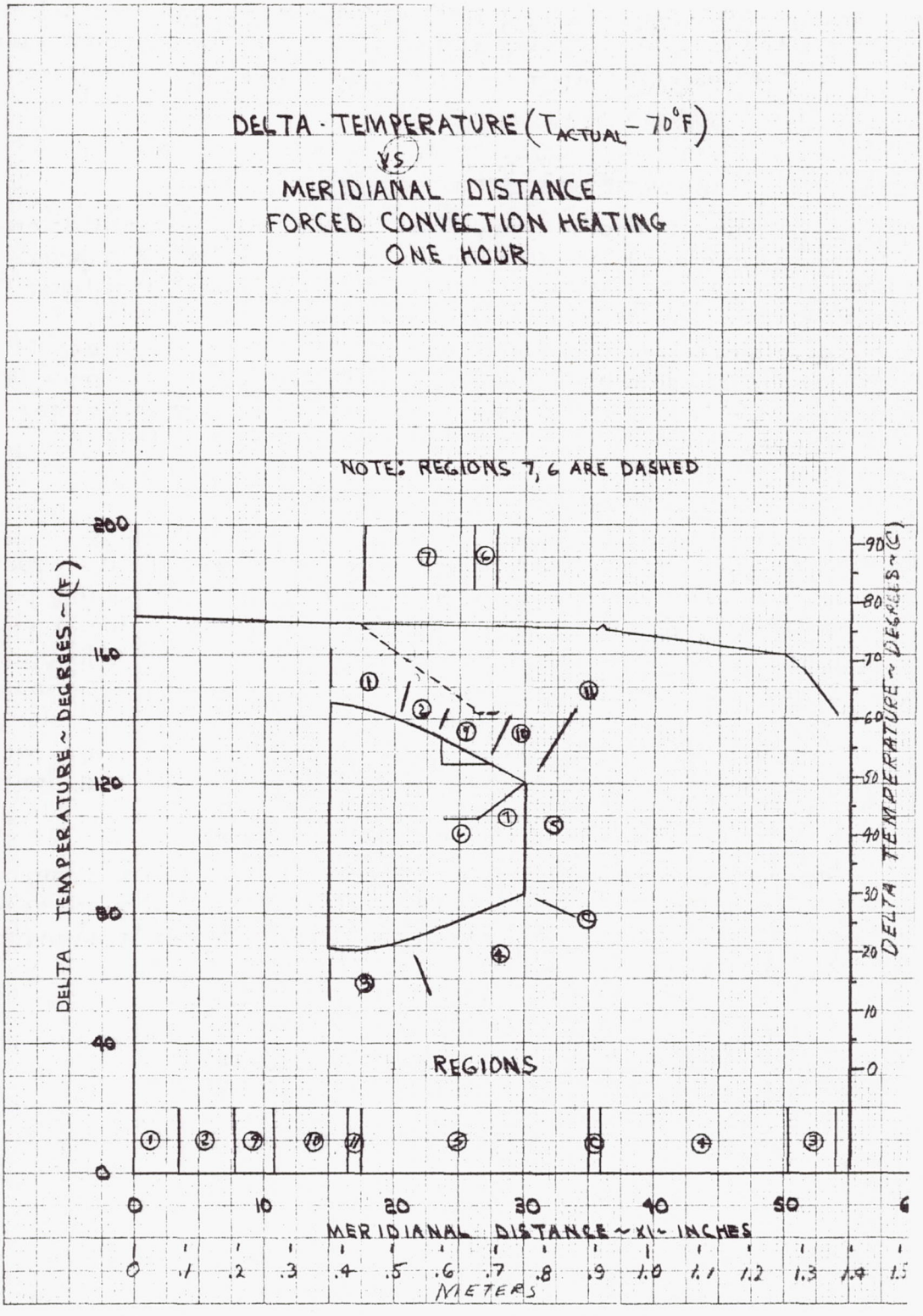



Figure 20 DELTA-TEMPERATURE ($T_{actual}$-70°F) VERSUS MERIDIONAL DISTANCE
FORCED CONVECTION HEATING ONE HOUR

gas was in the sterilization container under forced convection. Figures 21 and 22 are plots of the internal and external meridional and circumferential stresses in the sterilization container. The maximum stresses calculated under the above-mentioned conditions are 3500 psi.

### 3.2.4 Nitrogen-Forced Convection Cooling

Figure 23 shows the thermal gradient in the sterilization container a time of 1 hour after the initiation of the cooling phase. Nitrogen gas was in the stterilization container under forced convection.

Figures 24 and 25 are plots of the internal and external meridional and circumferential stresses in the sterilization container. The maximum stresses calculated under the above-mentioned conditions are 2100 psi.

## 3.3 CONCLUSIONS

The highest stress levels encountered by the sterilization container occur 1 hour after initiation of both the heating and cooling portions of the heat cycle. In the free convection heating condition, the stress level in the meridional direction approaches 3500 psi at the junction of elements 2 and 9 in figure 13, and also at element C ("V" band clamp flange). The forced convection heating condition has similar peaks at element C but indicated meridional stress levels approaching 1400 psi between elements 2 and 9. Both free and forced-convection conditions indicate meridional stress levels approaching 2000 psi at the intersection of elements 6 and 7.

Stresses as a result of heat-sterilization-cycle-induced thermal gradients are not great enough to cause permanent distortion of the assembly. Permanent distortion may occur as a result of relieving machining stresses during the thermal cycles.

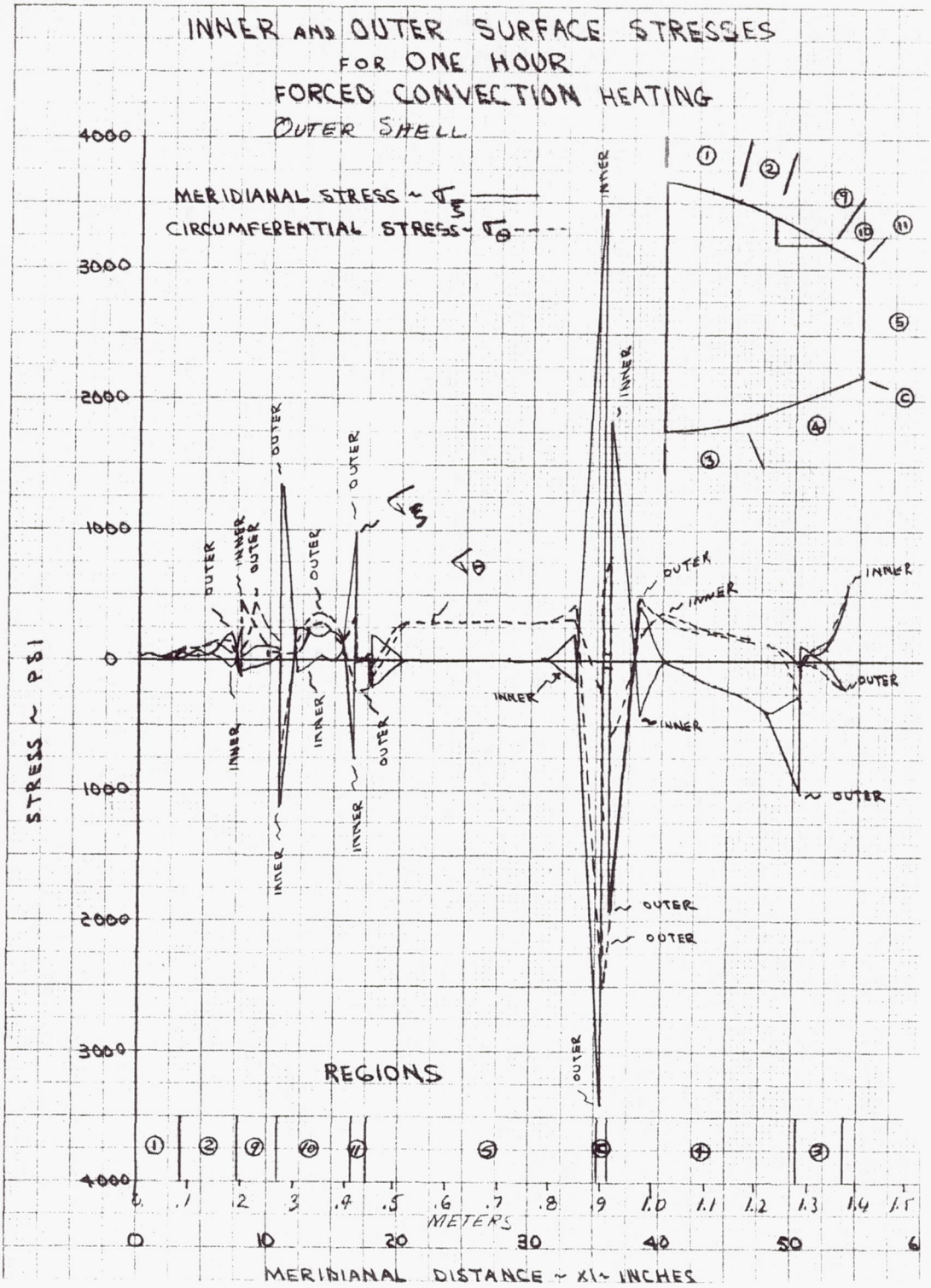



Figure 21 INNER AND OUTER SURFACE STRESSES FOR ONE HOUR FREE CONVECTION HEATING OUTER SHELL

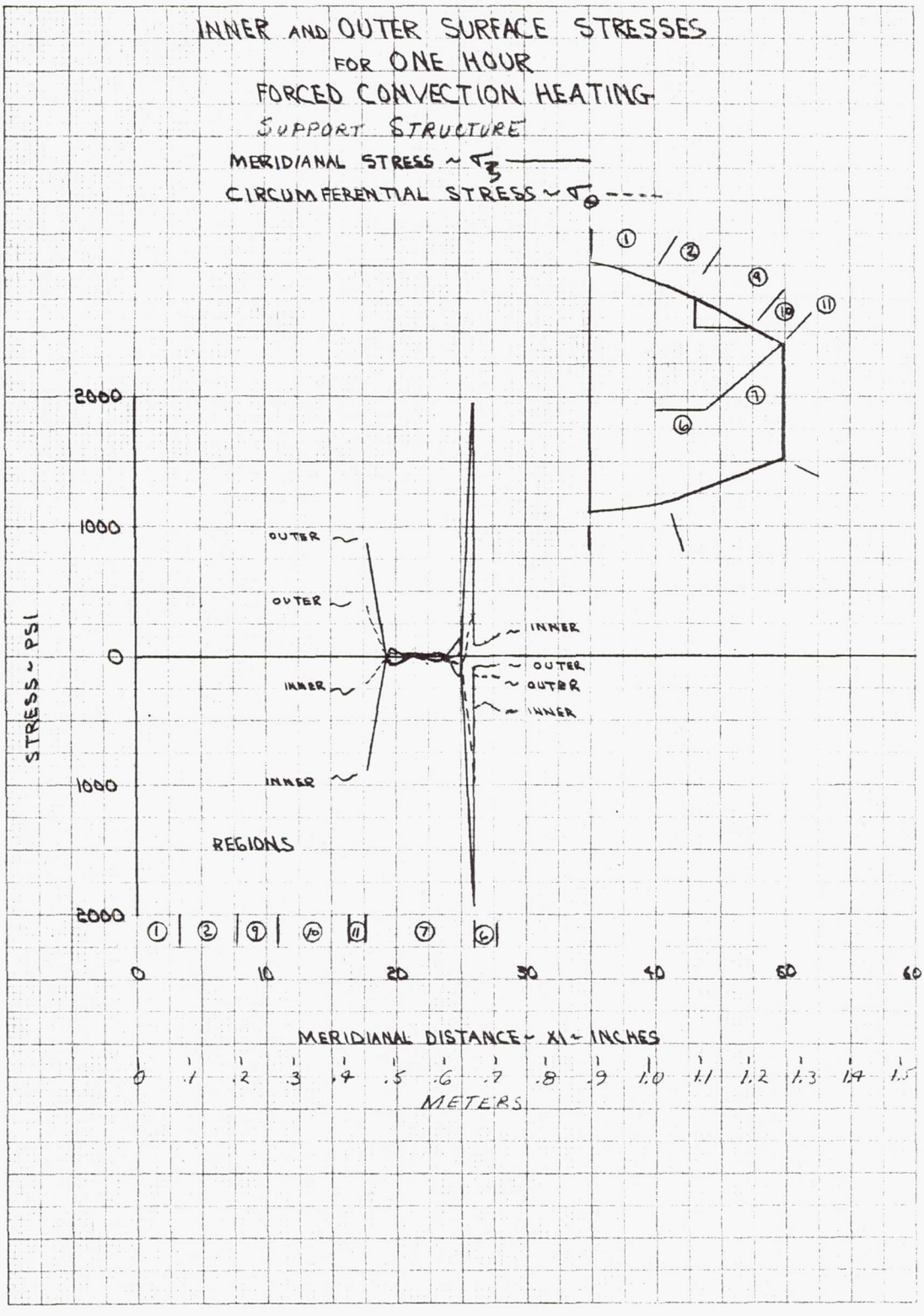



Figure 22 INNER AND OUTER SURFACE STRESSES FOR ONE HOUR FORCED CONVECTION HEATING SUPPORT STRUCTURE

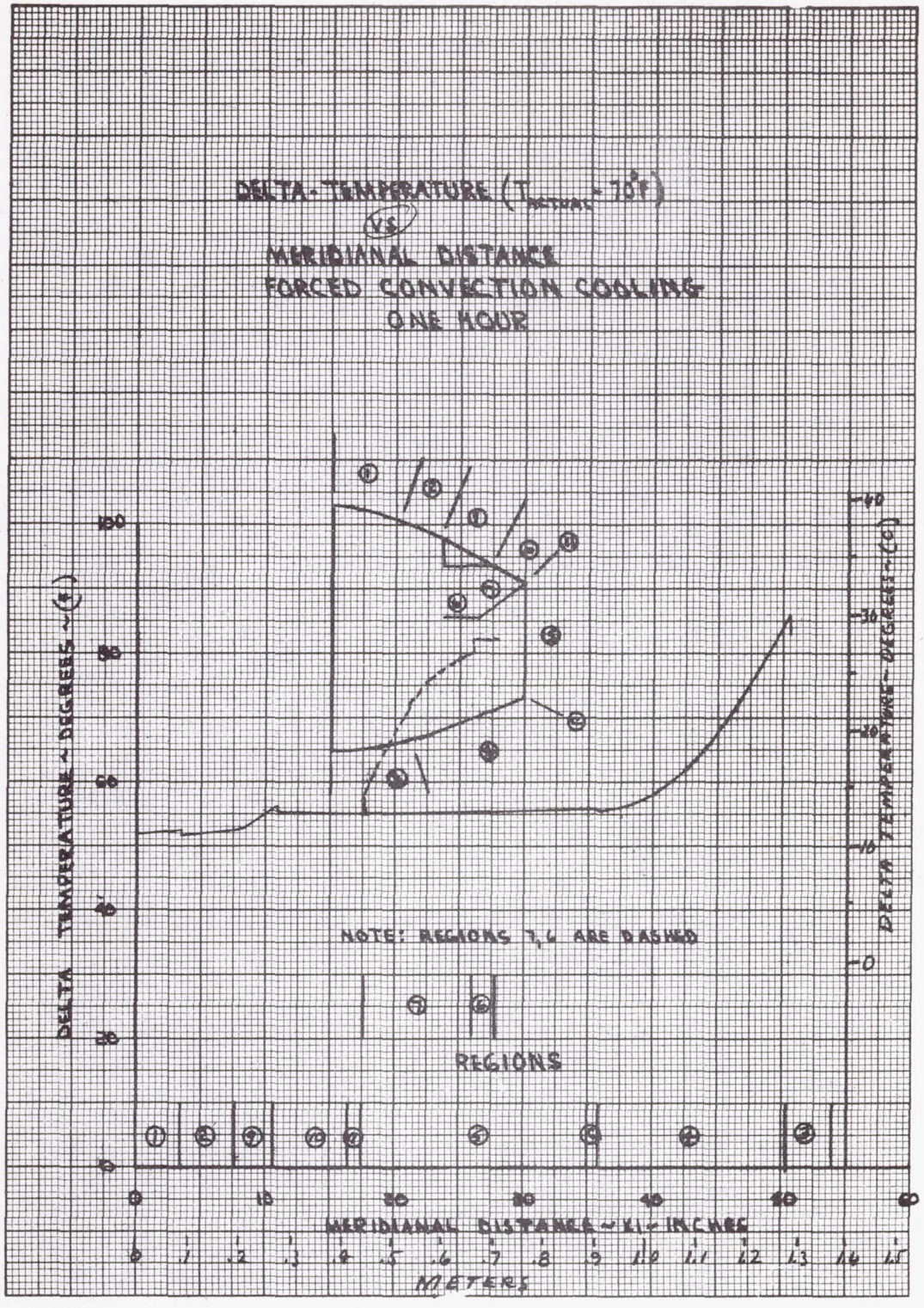



Figure 23 DELTA-TEMPERATURE ($T_{actual}$-70°F) VERSUS MERIDIONAL DISTANCE
FORCED CONVECTION COOLING ONE HOUR

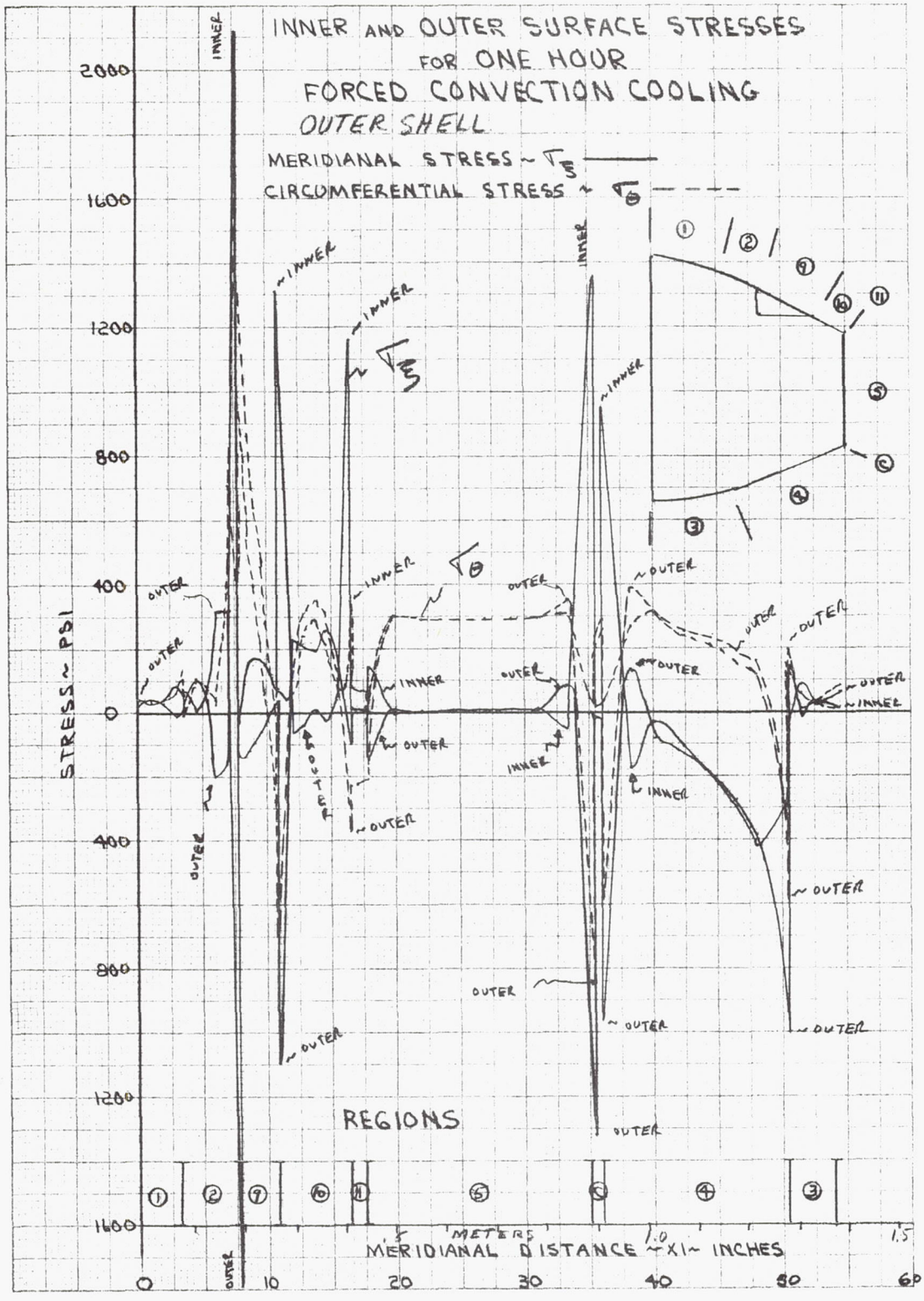



Figure 24 INNER AND OUTER SURFACE STRESSES FOR ONE HOUR FORCED CONVECTION COOLING OUTER SHELL

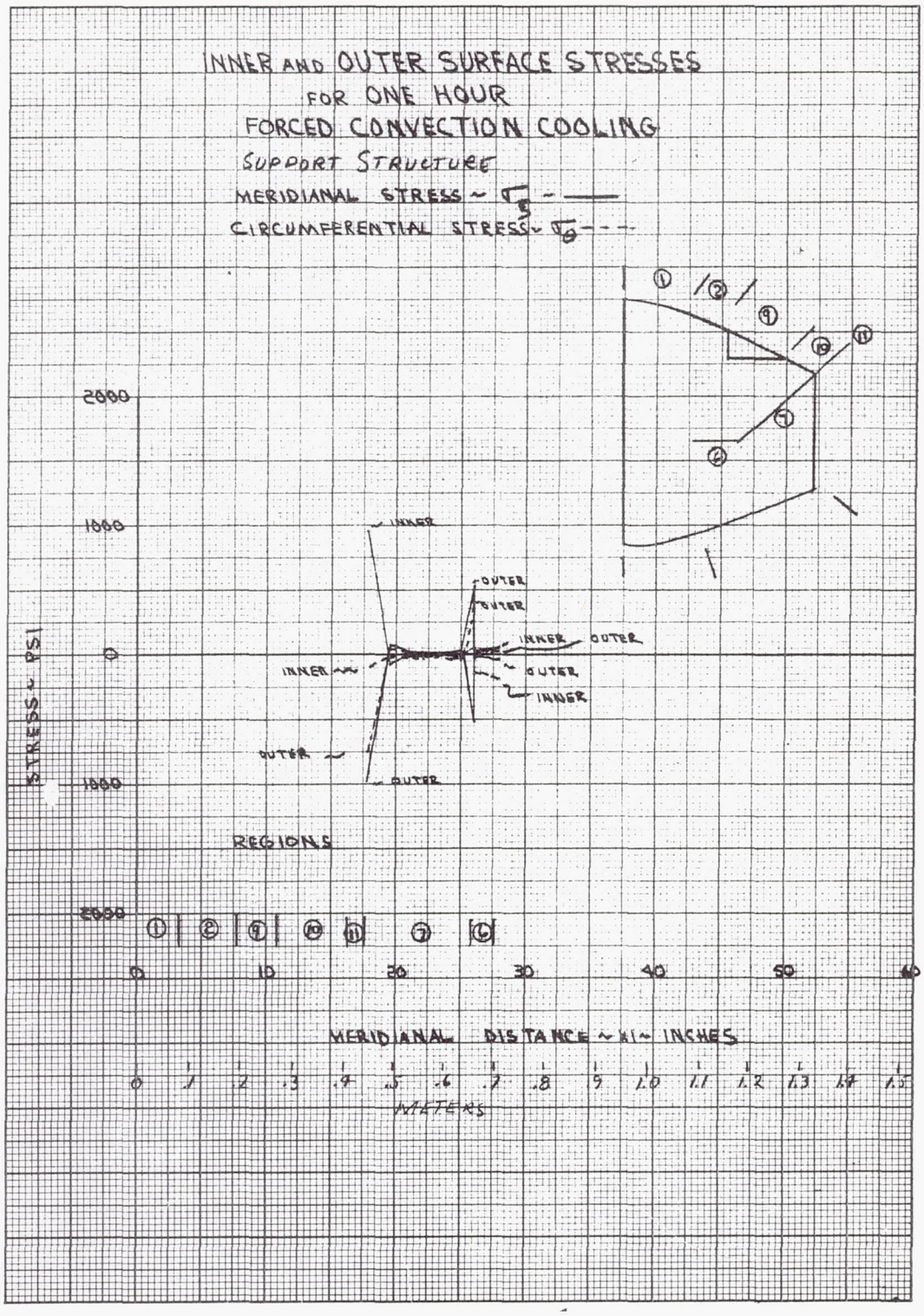



Figure 25 INNER AND OUTER SURFACE STRESSES FOR ONE HOUR FORCED CONVECTION COOLING OUTER SHELL

# 4. MANUFACTURING

## 4.1 GENERAL DISCUSSION

The fabrication of the sterilization container and model probe assembly is proceeding as scheduled. All major subassemblies are completed with the exception of final machining and finishing operations. Fabrication of all tooling has proceeded on an "as required" basis. Minor modifications were made to the original design to facilitate fabrication.

## 4.2 TOOLING APPROACH

As mentioned in preceding reports, all tooling is of a temporary nature since only one unit is being fabricated. Fixtures and tools are being constructed on an "as required" basis. Tools used as restraining fixtures to locate and hold container parts during welding are also being used for stress-relieving operations.

## 4.3 FABRICATION STATUS

All major components have been fabricated;only final machining and finishing operations remain to be performed. All purchase items have been received, except heating blankets for the simulated instrumentation packages and the "V" band clamps. These items are expected to be delivered by 24 January 1966.

### 4.3.1 Propulsion Assembly

The propulsion assembly structure (figure 26) is complete and in final inspection. This assembly is ejected from the sterilization container with the probe. It serves as the amount for the $\Delta V$ and spin rocket motors.

### 4.3.2 Mars Probe Assembly

The main instrumentation package of the dummy probe is complete and ready for instrumentation and final assembly. Figure 27 shows the application of a silicone primer to the model probe prior to the application of the modified purple blend. The purple blend heat shield material was then applied by a spraying operation. Figure 28 shows the vacuum bag molding of the heat shield. With the vacuum bag still in place, the heat shield was then oven cured. Figure 29 shows the final machining stage of the heat shield material and figure 30 shows the assembly after machining.

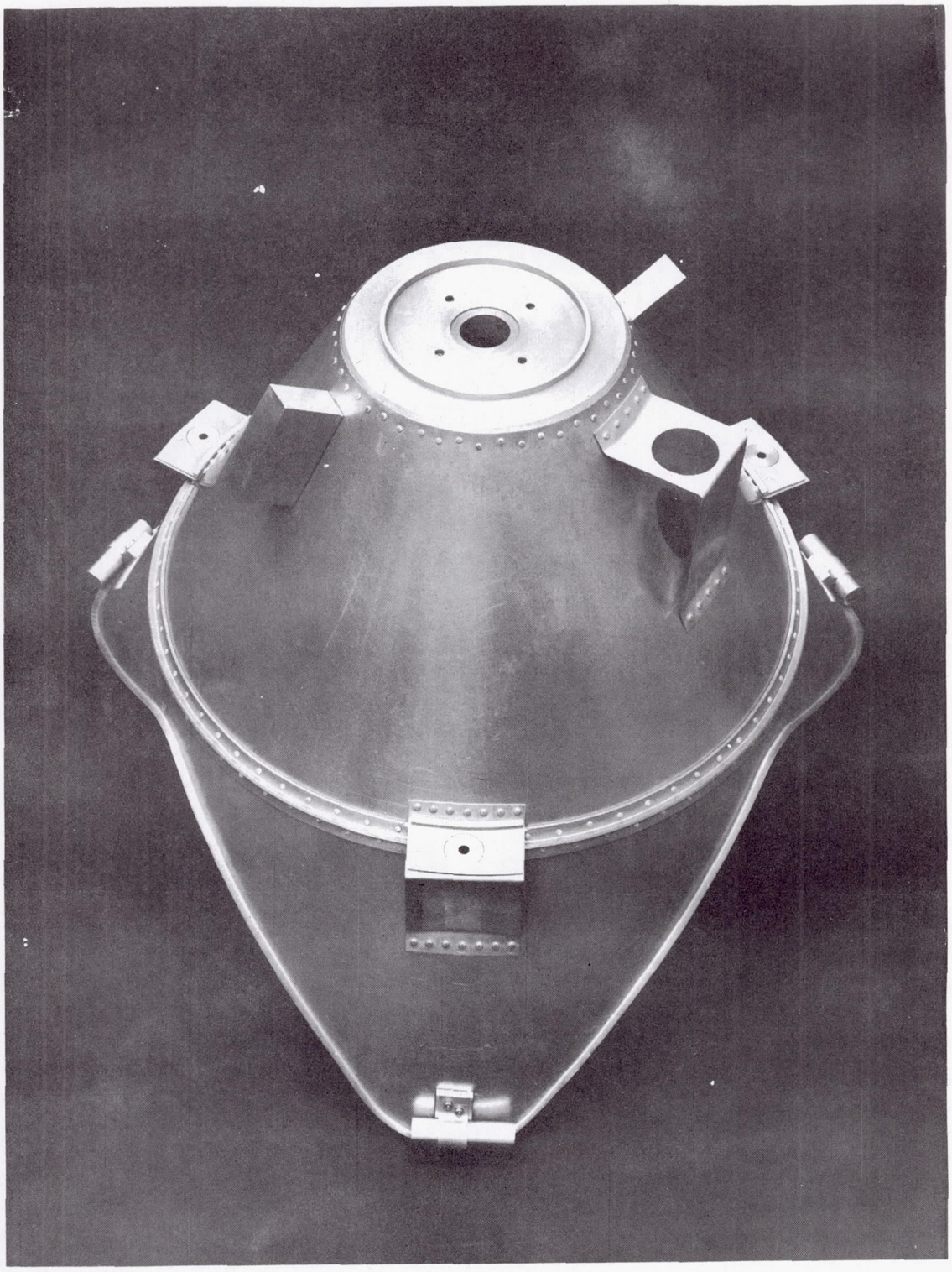


Figure 26 PROPULSION ASSEMBLY
PI4228B




Figure 27 APPLICATION OF SILICONE PRIMER TO PROBE ASSEMBLY
P16027C

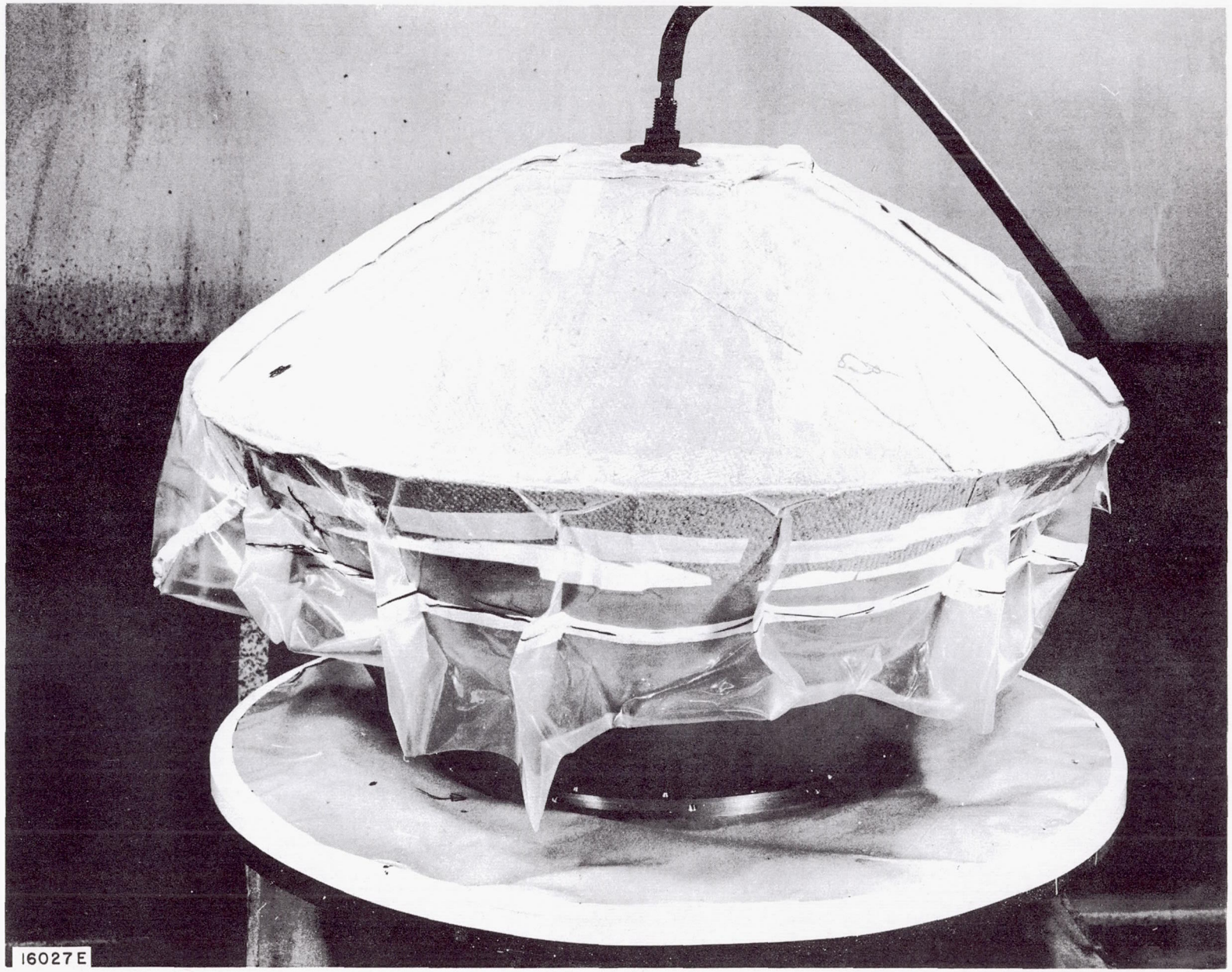



Figure 28 BAG MOLDING HEAT SHIELD MATERIAL
PI6027E

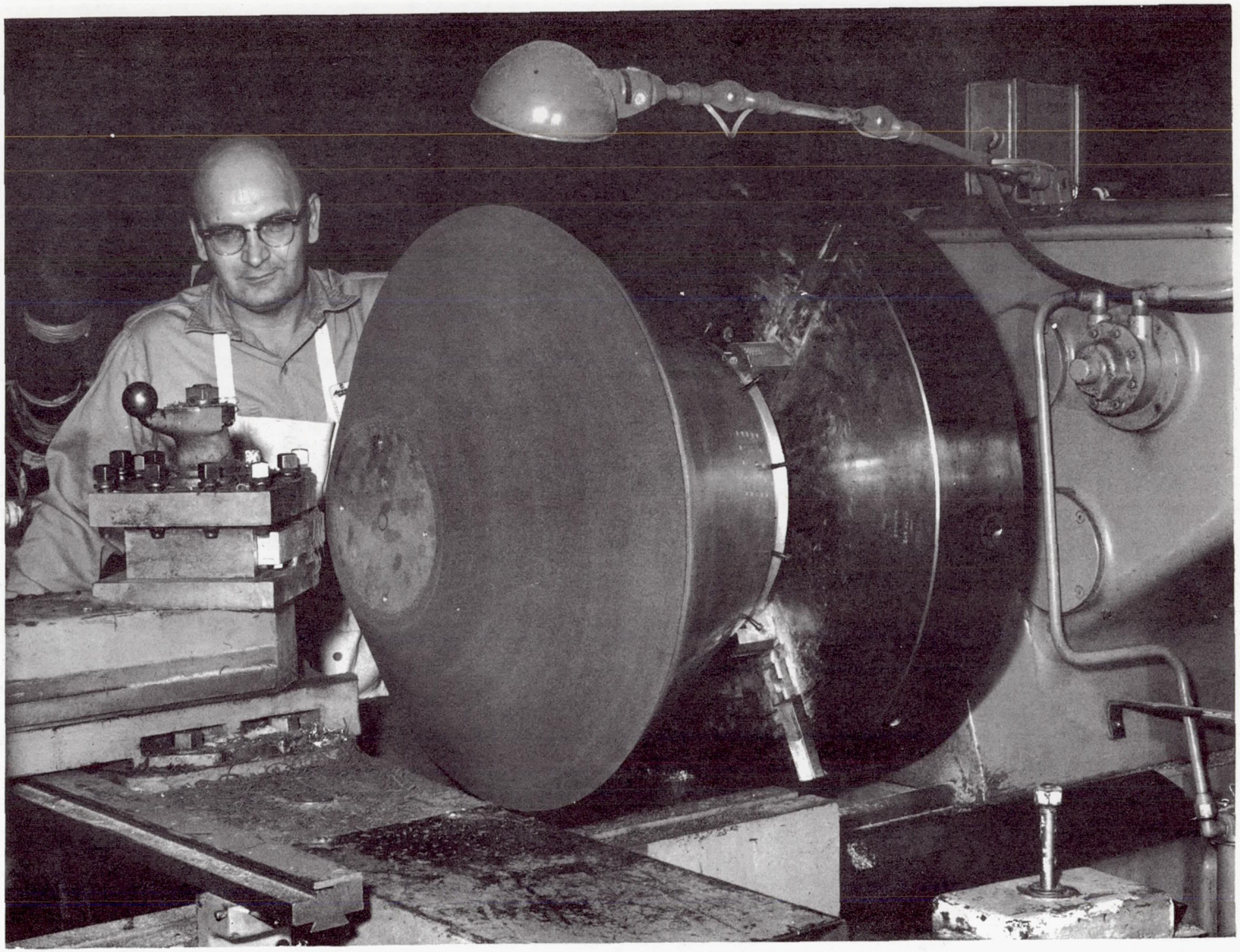


Figure 29 MACHINING PURPLE BLEND HEAT SHIELD
PI4228D



Figure 30 MODEL PROBE ASSEMBLY
PI4228C

### 4.3.3 Front Cover Assembly

The front cover is in the welded assembly stage and is ready for final machining and finishing. Figure 31 is a view with the cover ejection spring housing welded in place.

### 4.3.4 Rear Cover Assembly

The rear cover has been assembled and is ready for final machining and finishing. Figure 32 shows the welded and rivited assembly including the probe ejection spring housing.

### 4.3.5 Container Assembly

The center section of the container (container assembly) is in the final machining stage. Figure 33 shows this section installed in a lathe prior to final machining.

## 4.4 CONCLUSIONS AND RECOMMENDATIONS

The development of new fabrication techniques are not required for the fabrication of future sterilization containers. However, it is recommended that electronic beam welding be considered for the welding of rings to individual parts in future assemblies. Although tooling may be more expensive, parts could be prefinished and welded with little or no distortion.

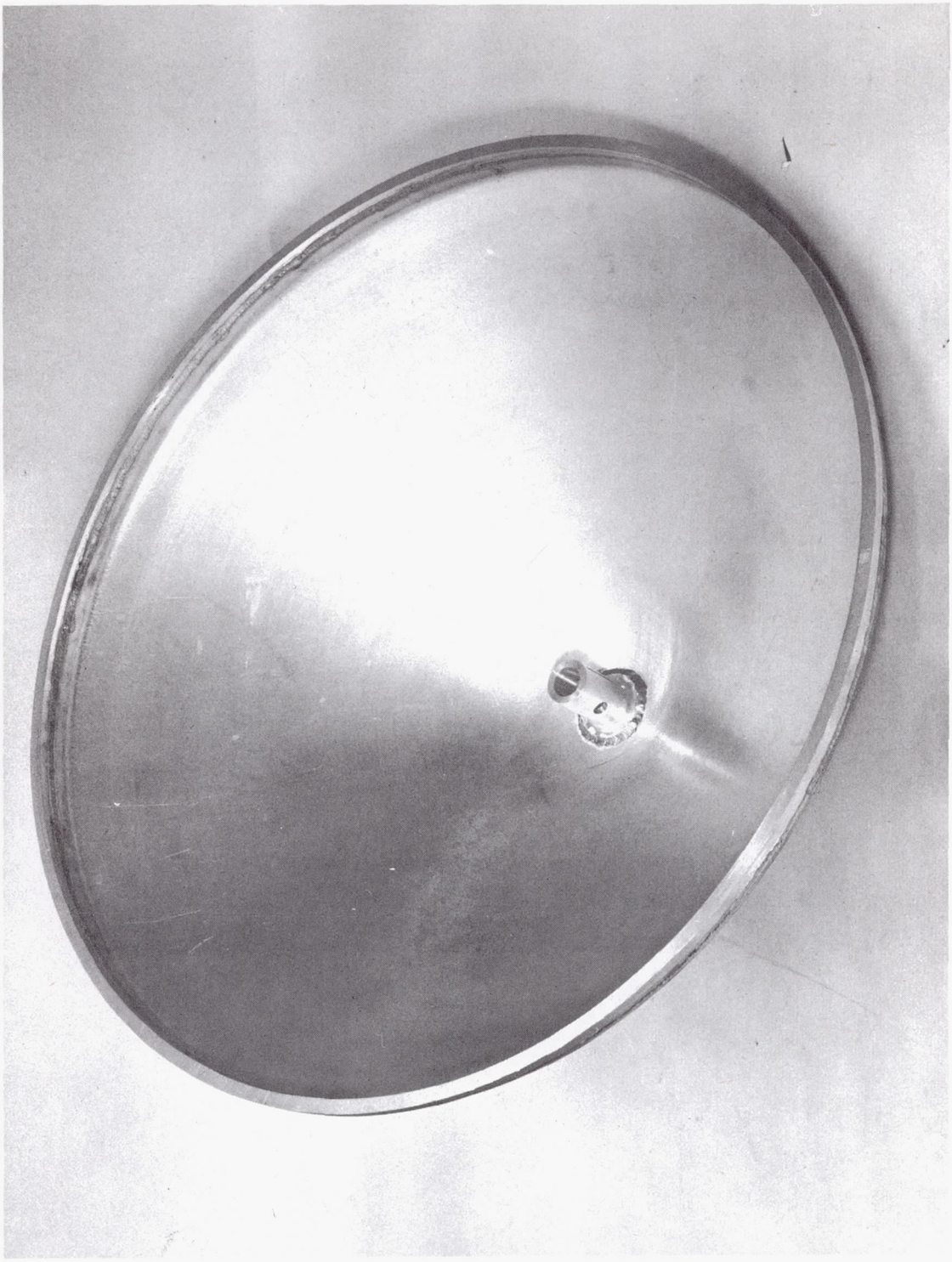


Figure 31 FRONT COVER ASSEMBLY
P14195D

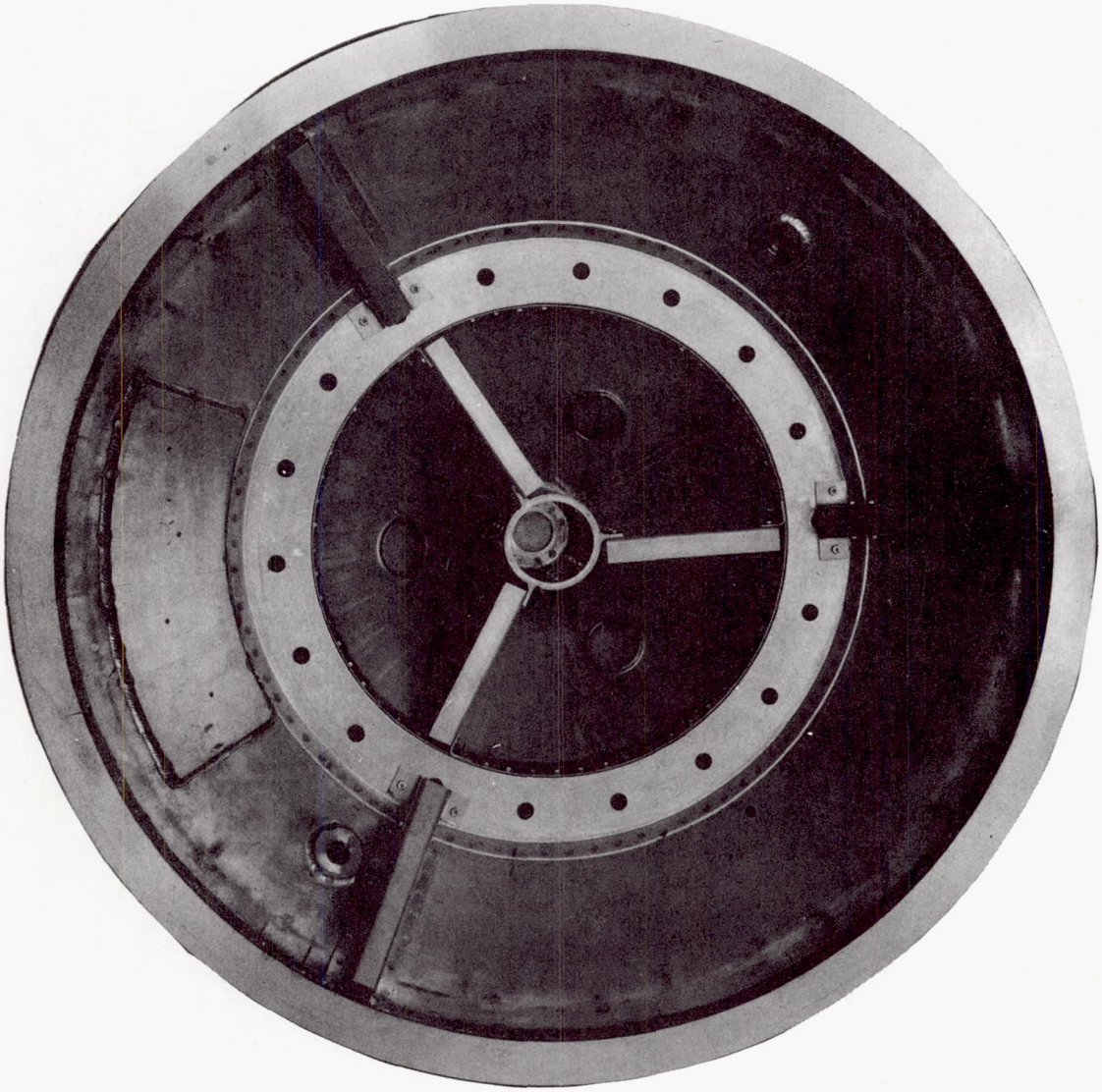


Figure 32 REAR COVER ASSEMBLY
PI4228A

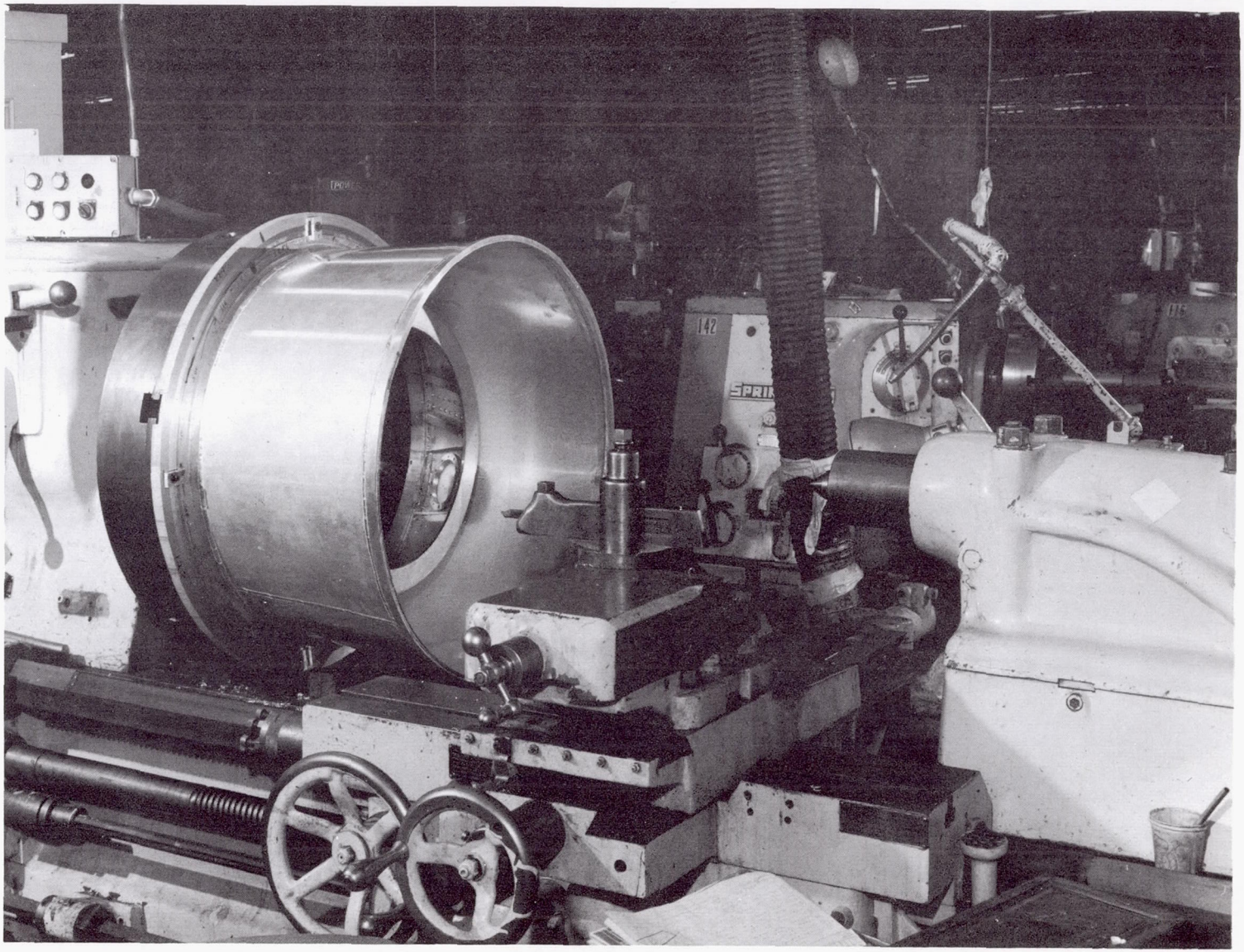



Figure 33 CONTAINER CENTER SECTION
P14228E

# 5. TEST

## 5.1 GENERAL DISCUSSION

The effort in the test area during the second quarter has been the detailing of test plans, test fixture design, test fixture fabrication, instrumentation planning, and the purchasing of instrumentation. The test plan was completed and presented in the first quarterly progress report. The plan has not been modified. The test fixtures were designed and fabrication was initiated. Instrumentation was selected and purchased.

As components of the assembly become available they will be instrumented.

## 5.2 TEST PLAN

The test plan as presented in the first quarterly progress report (RAD-SR-65-264, dated 15 October 1965) remains unchanged. To ensure maximum information from the tests performed, modification to the test plan may be made as testing progresses.

Figure 34 is a schematic of the separation test setup with the available clearance for deployment.

## 5.3 TEST FIXTURES

Test fixture details are shown in figure 35. The fixture is made up of a channel section and a stand to which the container assembly will bolt. During heat sterilization cycle tests the channel section will be removed and the stand with the container assembly will be inserted in the oven. The channel section is used only during the probe deployment test.

Figure 36 shows a handling fixture used for supporting the assembly during instrumentation and calibration operations.

Fabrication of the above-mentioned fixtures is in process. They are expected to be completed by the end of January.

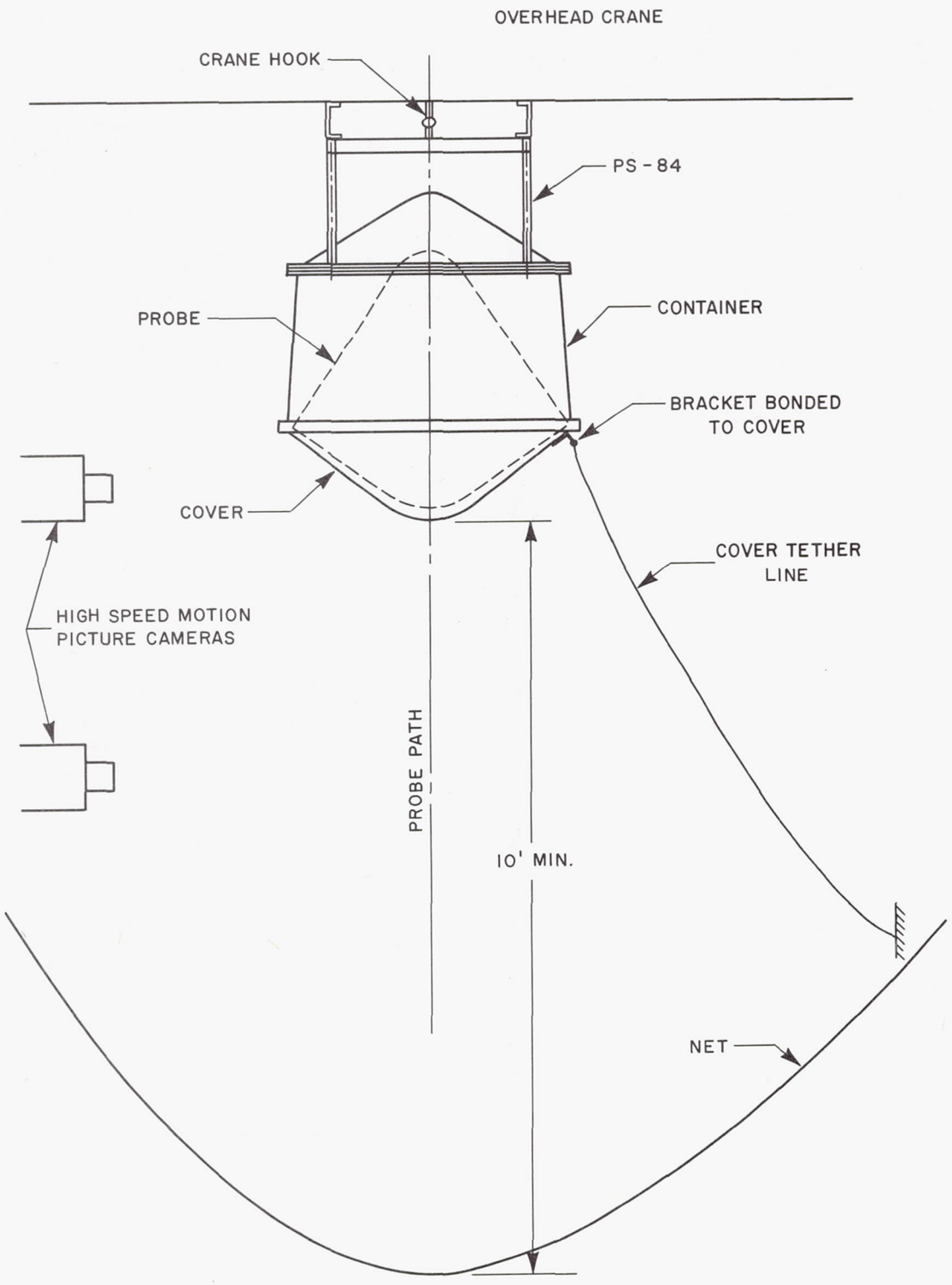



Figure 34 SEPARATION TEST SET-UP

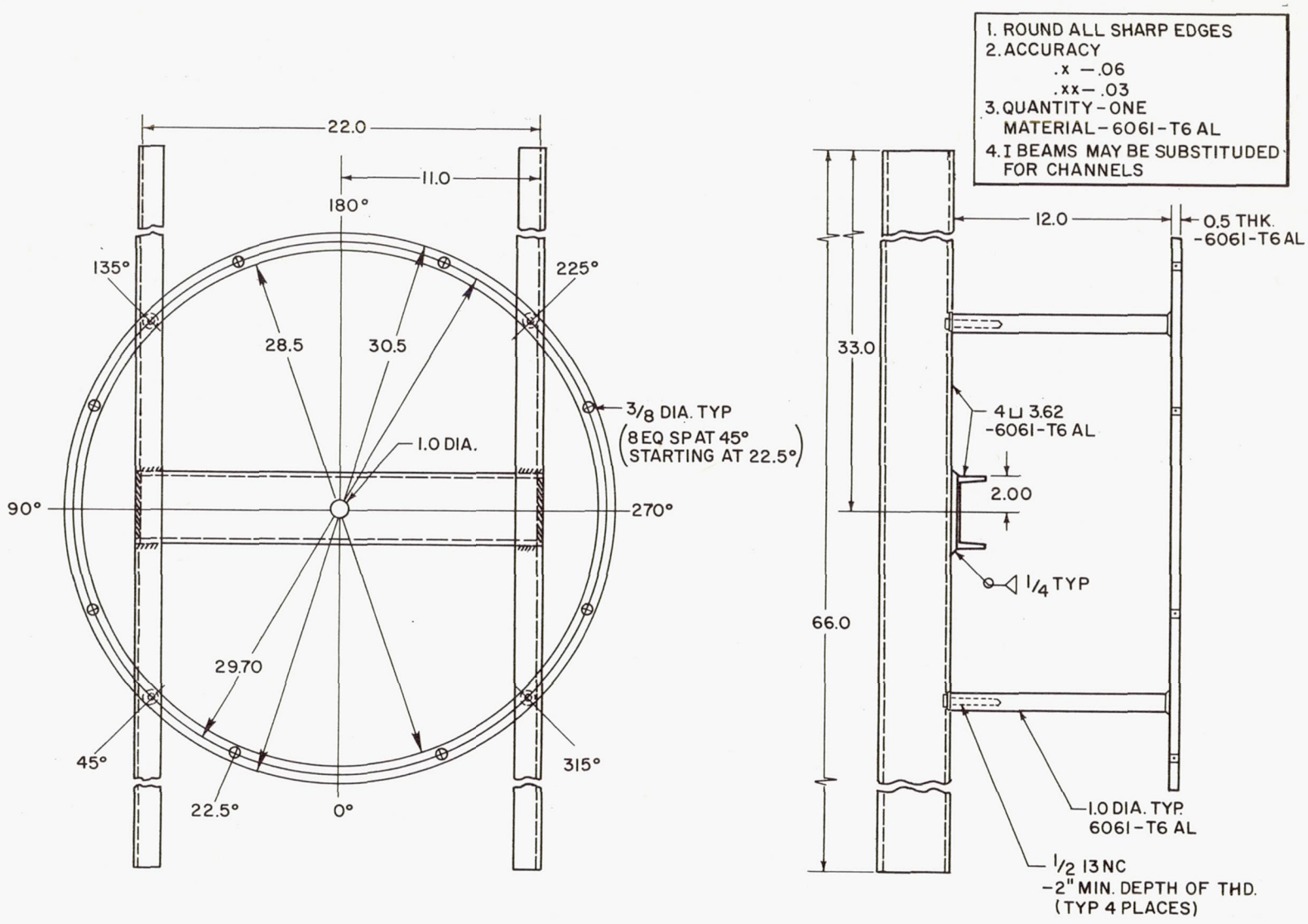



Figure 35 STERILIZATION CONTAINER TEST FIXTURE

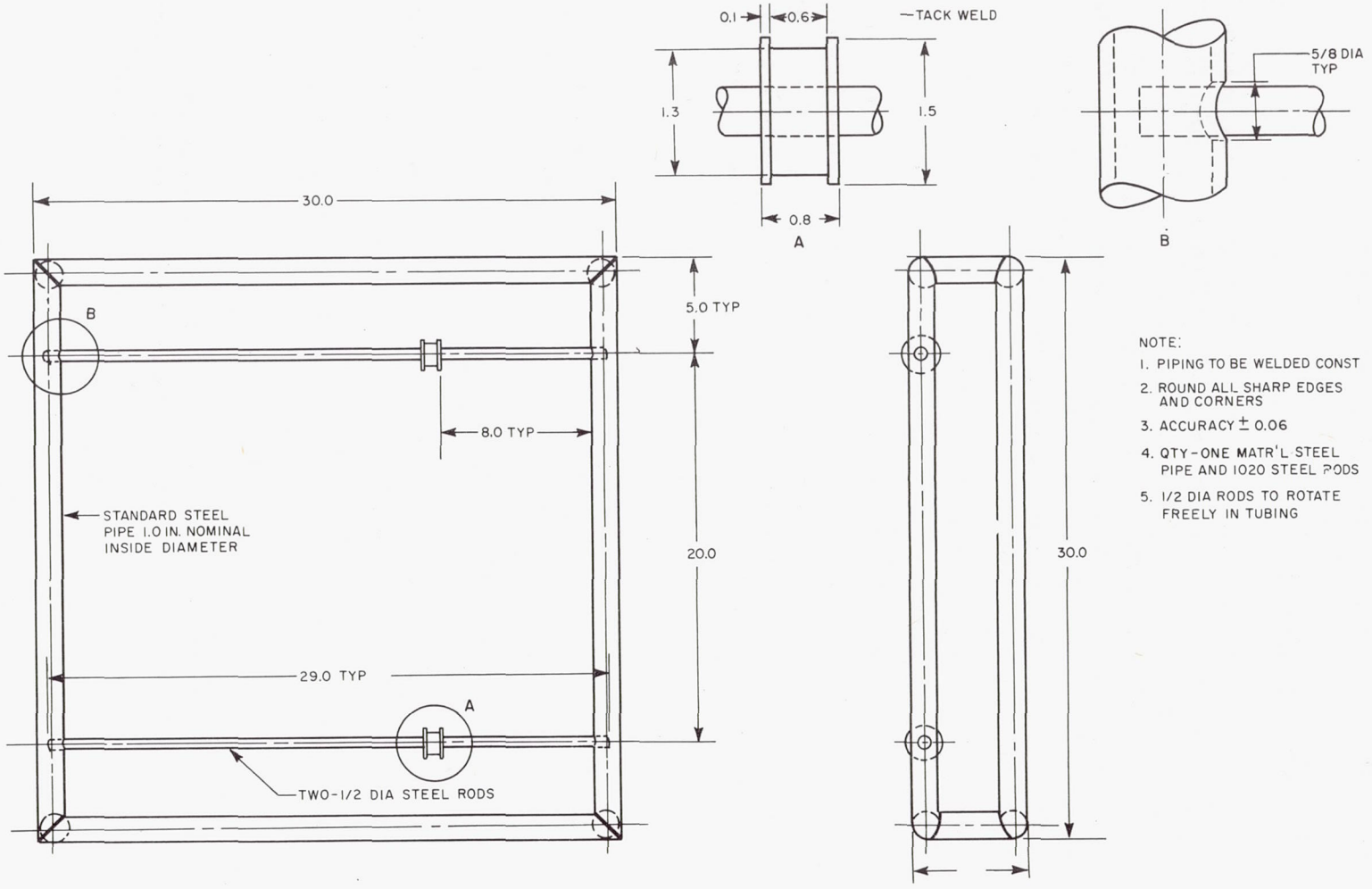



Figure 36 STERILIZATION CONTAINER HANDLING FIXTURE

## 5.4 INSTRUMENTATION AND DATA HANDLING

### 5.4.1 Instrumentation Locations

Figure 37 shows the location of the strain gages, thermocouples, and linear potentiometers. There will be 27 Baldwin-Lima-Hamilton Company FABX-25-12S13, constantan foil, bakelike base, biaxial strain gages used on the container. The container and probe assembly will be instrumented with 30 copper-constantan thermocouples, 24 gage wire. Nine linear potentiometers will be installed within the container. The support flange will be the reference point for all deflection measurements.

### 5.4.2 Data Handling

The Avco/RAD data processing staff has reviewed procedures for processing the test data obtained from the sterilization container test program. Data from thermocouples, strain gages and linear potentiometers will be acquired by a 100-channel data logger and printed out on a strip listing at 10 minute intervals in the format shown below.

| | Time | (Annotated) | |
|---|---|---|---|
| Channel Number | XX | O X X X X | strain or millivolt reading with sign |
| | 99 | O X X X X | |

These data will be key-punched onto IBM cards for computer entry. Computer programs will perform the following operations:

1. Thermocouples - printout in OXX.XX millivolts will be calibrated to temperature (T) using table lookup.

2. Strain gages - printout in OXXXX microinches/inch will be corrected for temperature effects using table lookup for the temperature measured at the gages.

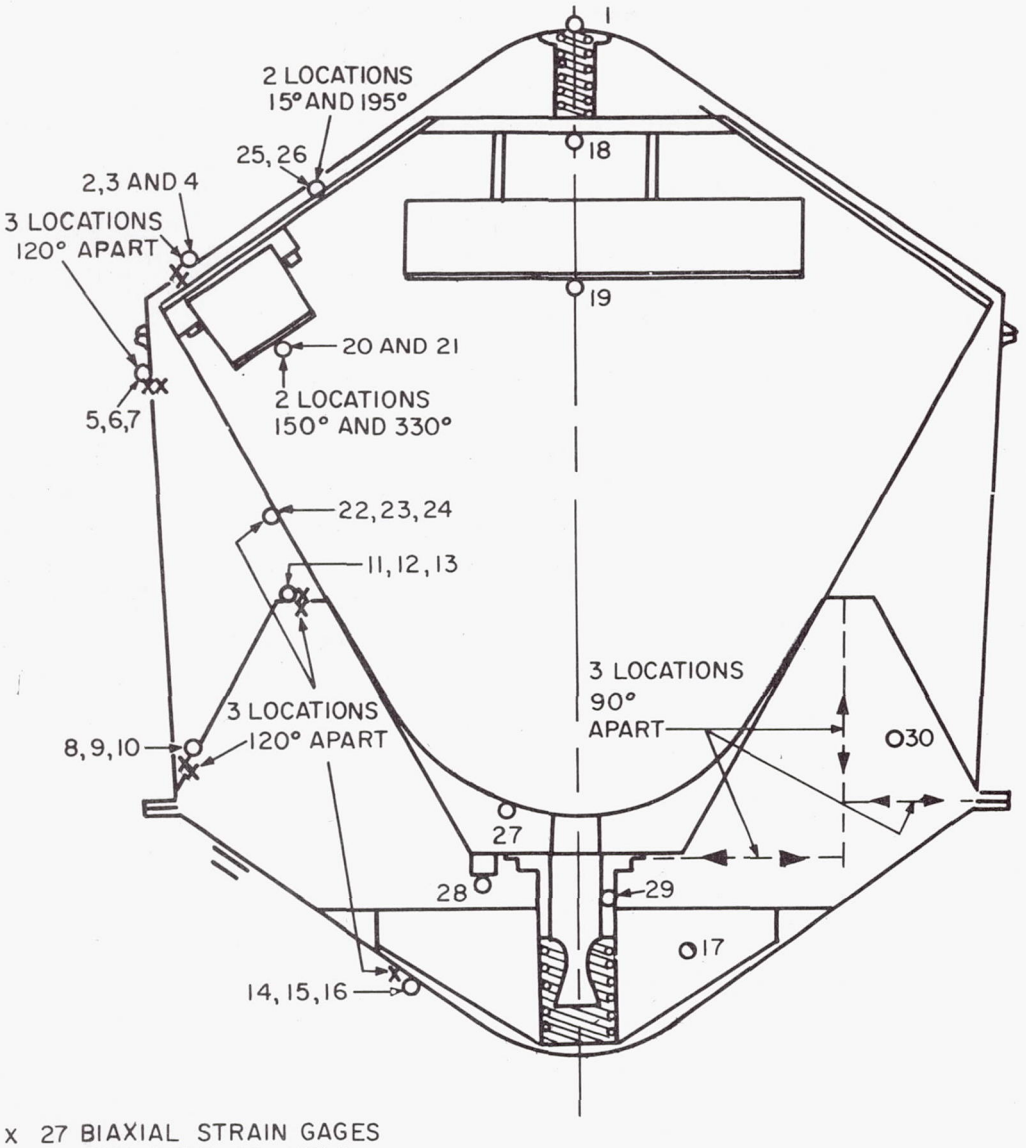



Figure 37 INSTRUMENTATION LOCATIONS

3. Stress - for each pair of strain gages the stress will be calculated from $S = K (E_1 + k E_2)$ where $E_1$ and $E_2$ are the corrected strain values.

4. Linear Potentiometers - printout in )XX. XX millivolts will be calibrated using linear mx + n calibration.

5. Calibrated time history plots of the above functions will be made on the SC-4020.

## 5.5 CONCLUSIONS AND RECOMMENDATIONS

The need for a 36-hour dwell time during the second and third heat sterilization cycles, and the possibility of reducing the dwell time to 5 hours during these tests should be considered. Analysis indicates that stresses during the sterilization cycle are low and since strain gage errors become a larger percentage of the total reading values, instrumentation should be reviewed and possibly modified to produce the most meaningful data. Consideration is being given to including more temperature, and less strain gage, sensors.