

BELLCOMM, INC.

SUBJECT: Description of S-II Stage  
Structures - Case 320

DATE: April 20, 1967

FROM: T. H. Crowe

ABSTRACT

This memorandum provides a description of the S-II stage structure in sufficient detail to enable the reader to assess the impact of major problems and changes to the structure.

NASW-417

FACILITY FORM 802

(ACCESSION NUMBER)	<del>XXXXXXXXXX</del>
(PAGES)	17
(NASA CR OR TMX OR AD NUMBER)	CR-84691
(CATEGORY)	31

(NASA-CR-154767) DESCRIPTION OF S-2 STAGE  
STRUCTURES (Bellcomm, Inc.) 17 p

N79-72173

00/15 Unclas  
12561

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MEMORANDUM FOR FILE

Introduction

The purpose of this memorandum is to provide a description of the S-II stage structure in sufficient detail to enable the reader to assess the impact of major problems and changes to the structure.

Figure 1 is an exploded view showing the principal components of the structure: the forward skirt, LH<sub>2</sub> tank, LOX tank, thrust structure and aft skirt, and the aft interstage. An exploded view showing some of the details of construction of the S-II stage are shown on Figure 2. The dry weight of the S-II-1 stage is approximately 90,000 pounds and the dry weight of the aft interstage is 14,000 pounds.

Aft Interstage

The aft interstage is a cylinder 219 inches long of 7075 aluminum. It is of semi-monocoque construction with external hat section stringers riveted to the skin. The skin and stringers are supported by internal rings. The aft ring has provision for the field splice for mating with the S-IC stage. The forward ring is the mating face for attachment to the S-II aft skirt. The aft interstage has two separation planes, one 23 inches forward of the aft ring and the other at the forward ring. A door provides access to the interior and cutouts in the structure provide for umbilical connections. Eight mounting brackets are provided for attachment of ullage rockets.

Figure 3 depicts the aft interstage under construction.

Aft Skirt and Thrust Structure

The aft skirt and thrust structure are installed on the S-II as an integral assembly.

The aft skirt is a cylinder 87 inches long. It is of semi-monocoque construction with external hat section stringers riveted to the skin. The skin and stringers are

supported by internal rings. The skirt is attached to the bolting ring at the forward end and to the aft interstage at the aft end. Five  $\text{LH}_2$  lines are routed from the bottom of the  $\text{LH}_2$  tank down the exterior of the skirt, through the skirt and down the thrust structure to the engines. The LOX fill and drain line is also routed through the skirt and thrust structure.

The thrust structure is a conical frustum with a forward diameter of 396 inches, an aft diameter of 210 inches and a length of 111 inches. The frustum is attached to the interior of the aft skirt 61 inches aft of bolting ring interface with the skirt. The frustum is made up of external hat section stringers riveted to the skin. The skin and stringers are supported by internal rings. The four outboard engines are mounted on the aft ring. At each engine attach point are two longerons to assist in shearing the engine loads into the thrust structure. The center engine is mounted on a center engine support assembly consisting of four honeycomb sandwich type beams joined at the stage center line by a machined fitting. The outboard ends are attached to the thrust structure cone.

The  $\text{LH}_2$  feed lines are attached to the exterior of the cone as are various components of the electrical, measurement, control and other stage subsystems.

Figure 4 is a picture of the assembly during manufacture.

#### Heat Shield

The heat shield is designed to protect the stage base area from heating due to recirculation of engine exhaust gases. It is of fiberglass honeycomb construction protected by an ablative coating. It is a circular plate 210 inches in diameter with cutouts for each engine. Flexible silica cloth curtains are attached between the cutouts and the engines. It is located 54 inches aft of the engine gimbal plane and is suspended from the thrust structure. Figure 5 is a sketch of the heat shield.

#### LOX Tank

The LOX tank is an ellipsoidal container of 2014 aluminum formed by joining an aft and a forward bulkhead by a circumferential weld. Its volume is 11,108 cu. ft. The forward bulkhead is known as the common bulkhead because it is common

to the  $\text{LH}_2$  and LOX tanks. The joint incorporates a ring for attaching the tank to the  $\text{LH}_2$  tank bolting ring.

The aft bulkhead of the tank is made up of 12 gores and a center circular section welded together. Attached to the center of the aft bulkhead is a sump. The sump has in it five LOX outlet lines, one fill and drain line and an access manhole. Figure 6 depicts an aft bulkhead being assembled.

The forward or common bulkhead is of honeycomb sandwich construction with insulation sandwiched between plates of aluminum. The two plates are each made up of 12 gores and a center circular section welded together. Provision is made in the bulkhead for purging and a leak detection system.

In the bottom of the tank is a cruciform anti-vortex baffle. Three slosh baffle rings are supported by struts in the tank. A mast near the center of the tank supports a pressurization distributor and the LOX vent lines. Cutouts are provided for the pressurization gas inlet and the vent line outlet.

#### $\text{LH}_2$ Tank

The  $\text{LH}_2$  tank is made up of six cylindrical sections, an ellipsoidal forward bulk and the common bulkhead. The volume of the  $\text{LH}_2$  tank is 36,883 cu. ft. The forward bulkhead and the cylindrical sections are of 2014 aluminum covered with external insulation.

The cylindrical sections are made up of quarter panels welded together. The quarter panels have integral longitudinal and circumferential stiffeners. Riveted to the circumferential stiffeners are 7 inch wide rings of 2024 aluminum for additional support. Figure 7 depicts a quarter panel during forming and Figure 8 a completed cylindrical section. The aft cylindrical section has external tapered longitudinal stiffeners 25 inches long to assist in transferring loads from the bolting ring to which it is fastened. The bolting ring is 15 inches long and has provision for attachment of the LOX tank, the aft skirt and the  $\text{LH}_2$  cylinder.

The forward cylindrical section has a boss at the forward end to which is bolted the forward skirt. The forward bulkhead is welded to this section.



The forward bulkhead is constructed of 12 welded gores and a circular section welded at the center. Access to the tank is through a manhole in the center of the forward bulkhead.

One fitting for pressurization and two for venting are provided in the forward bulkhead. Five fittings for LH<sub>2</sub> engine lines, one for LH<sub>2</sub> recirculation return line, and one for fill and drain are provided in the cylindrical section just forward of the bolting ring.

Installed in the interior of the tank is the continuous level probe and a pressurization gas diffuser.

Insulation on the cylindrical section and the forward bulkhead is external to the tank. It consists of glass-phenolic honeycomb core filled with isocyanate foam covered with a nylon phenolic skin and sealed with a plastic film. Provision is made in the insulation for purging and a leak detection system. Insulation on the bolting ring is machined blocks of plastic.

#### Forward Skirt

The forward skirt is made of 7075 aluminum skin with external longitudinal hat section stringers. The skin and stringers are supported by four internal rings. The skirt is 137 inches long. The aft end bolts to the cylindrical portion of the LH<sub>2</sub> tank and the forward end has provision for the field splice to the S-IVB interstage.

A door is provided for access and cutouts are provided for an umbilical plate and the hydrogen vent lines. Antennas are mounted on the exterior of the skirt and various subsystem components on the interior. Figure 9 shows an assembled forward skirt and some quarter panels being fabricated.

#### System Tunnel

The systems tunnel is located externally to the stage and runs from the aft skirt to the forward skirt. The tunnel contains cable, piping, etc. It is constructed of fiberglass sections interconnected by supports for the cables and tubing. The inner surface of the tunnel is insulated.

*T. H. Crowe*  
T. H. Crowe

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Attachment  
Figures 1 thru 9

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(see next page)

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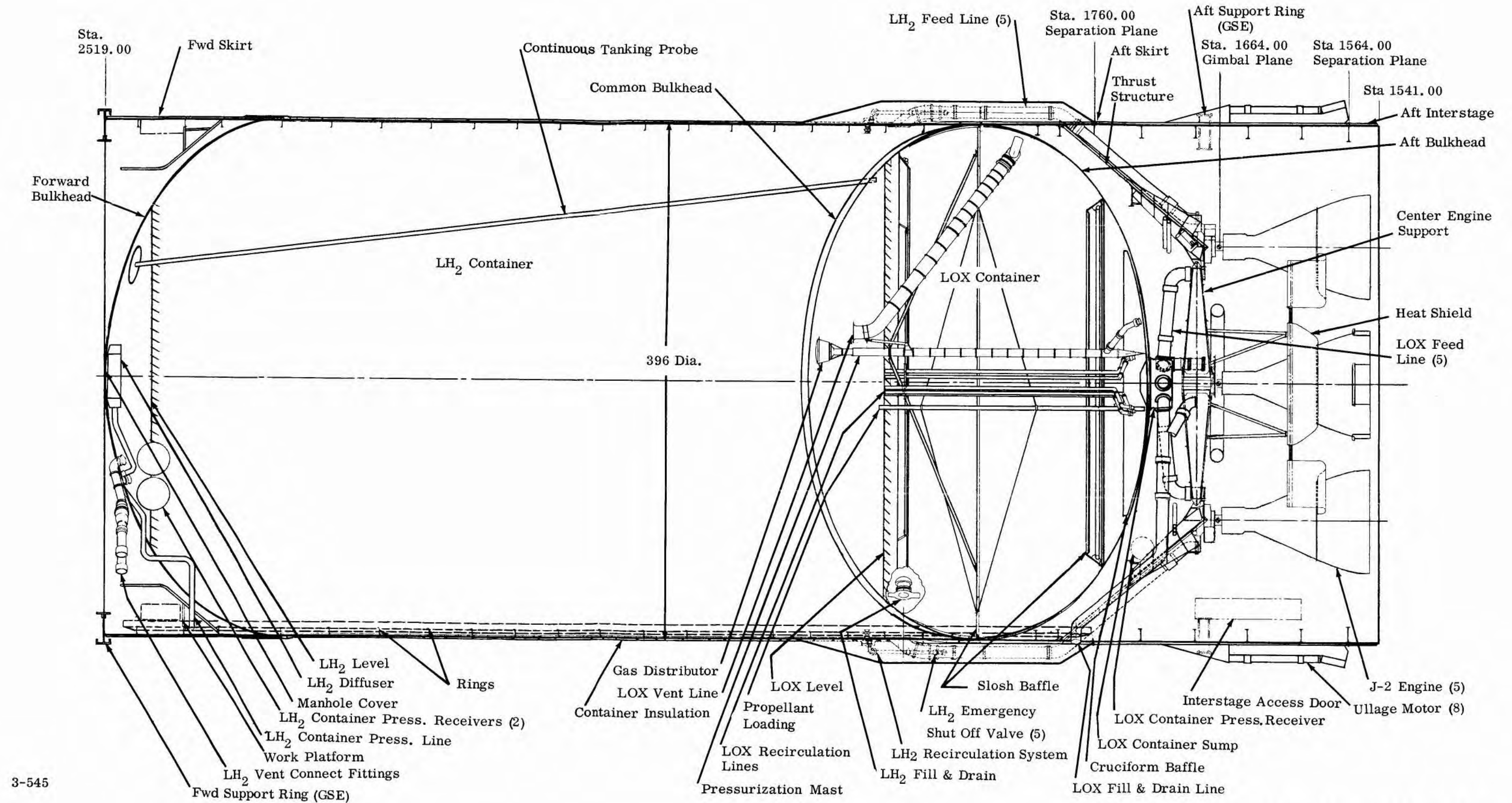


FIGURE 1 - S-II INBOARD PROFILE



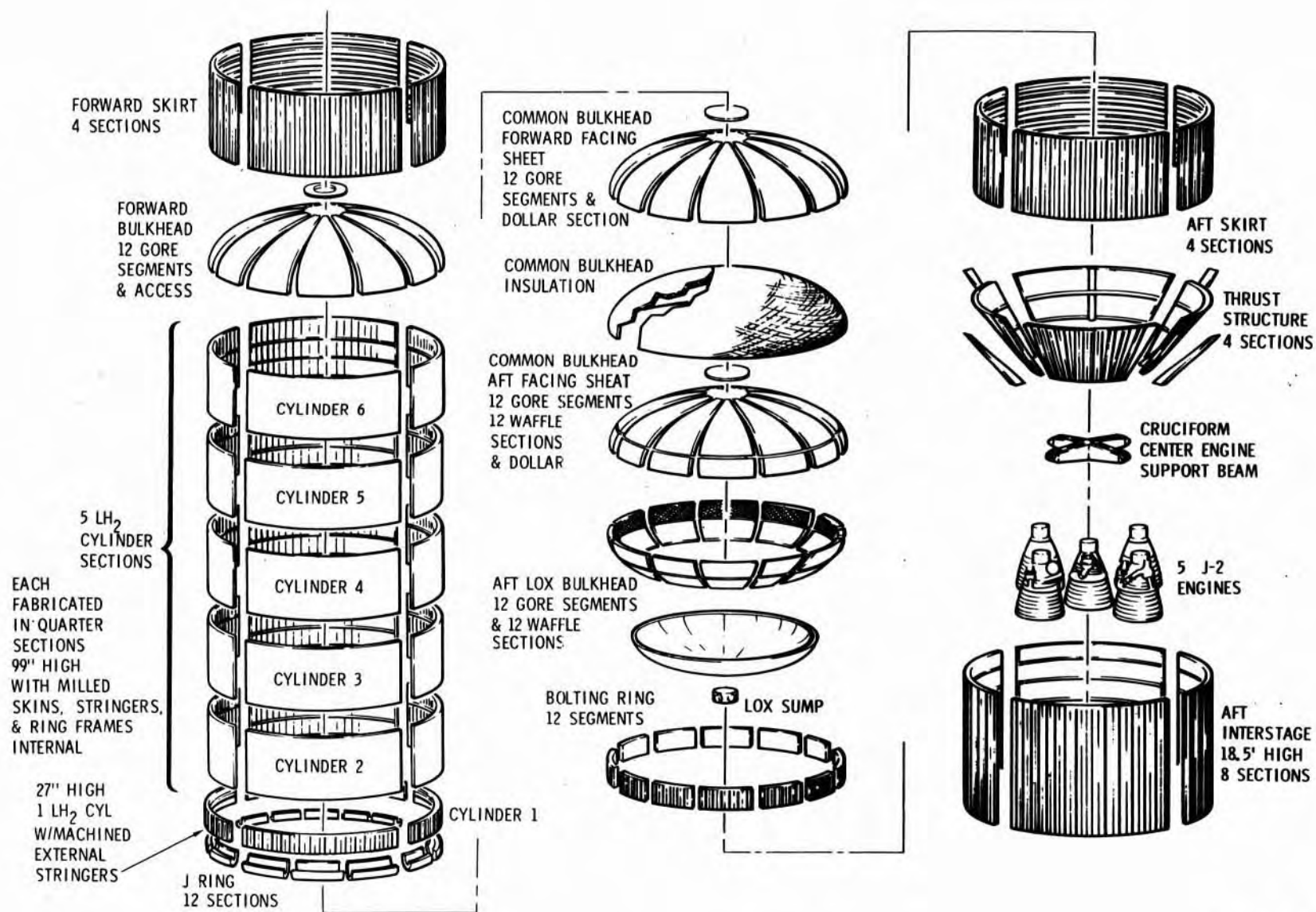


FIGURE 2 - S-II EXPLODED VIEW

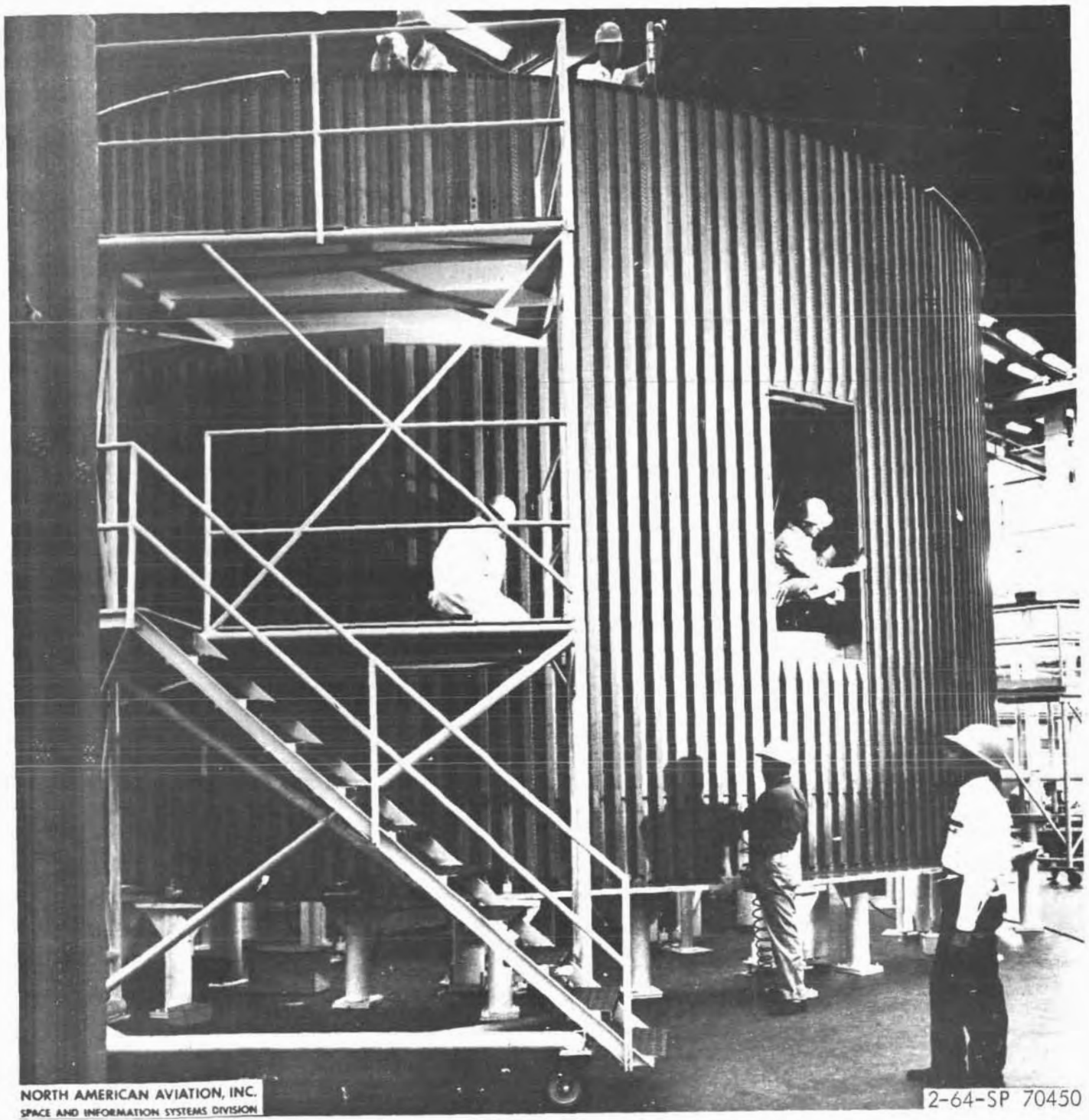
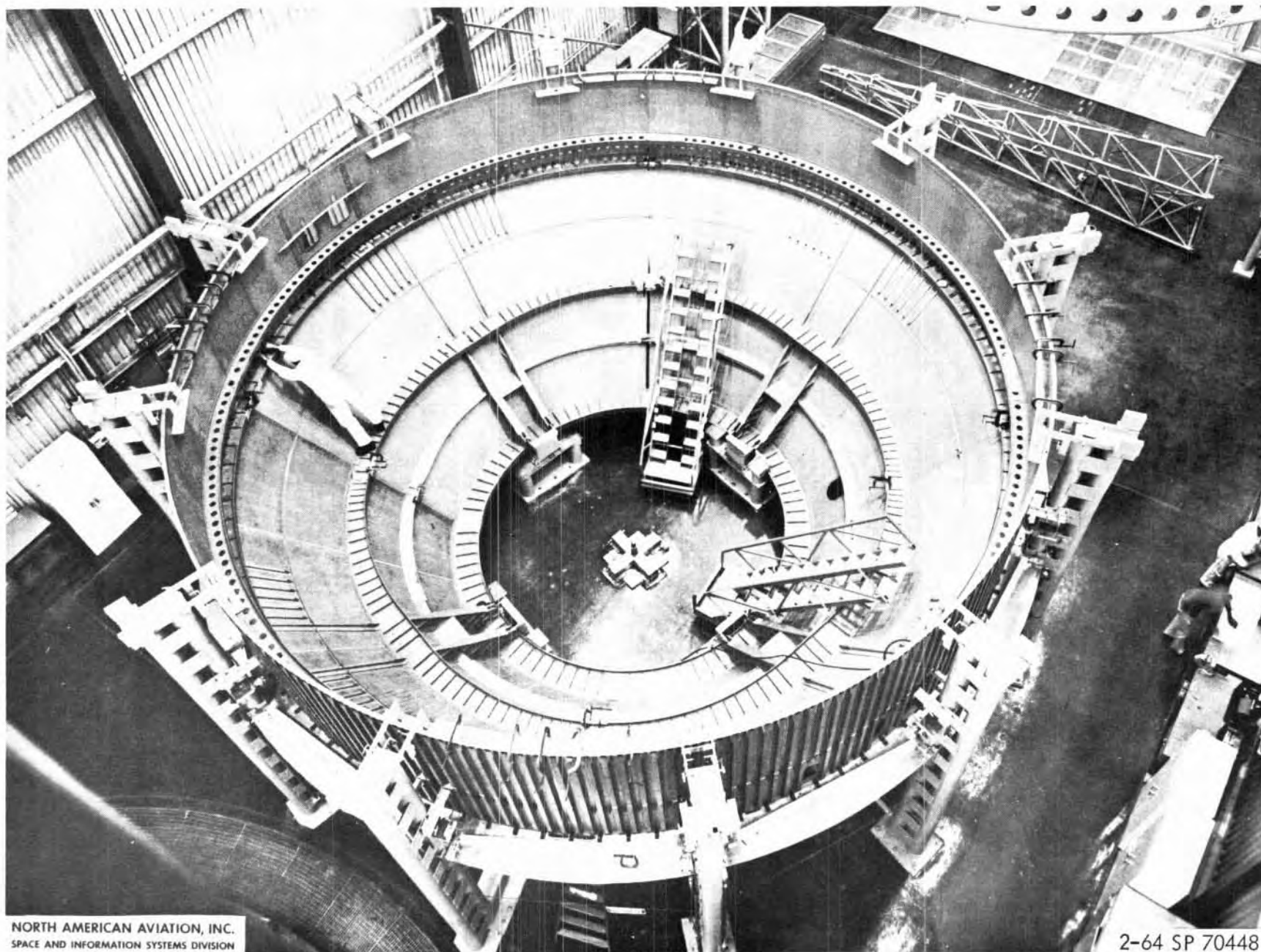


FIGURE 3 - AFT INTERSTAGE



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FIGURE 4 - THRUST STRUCTURE ASSY

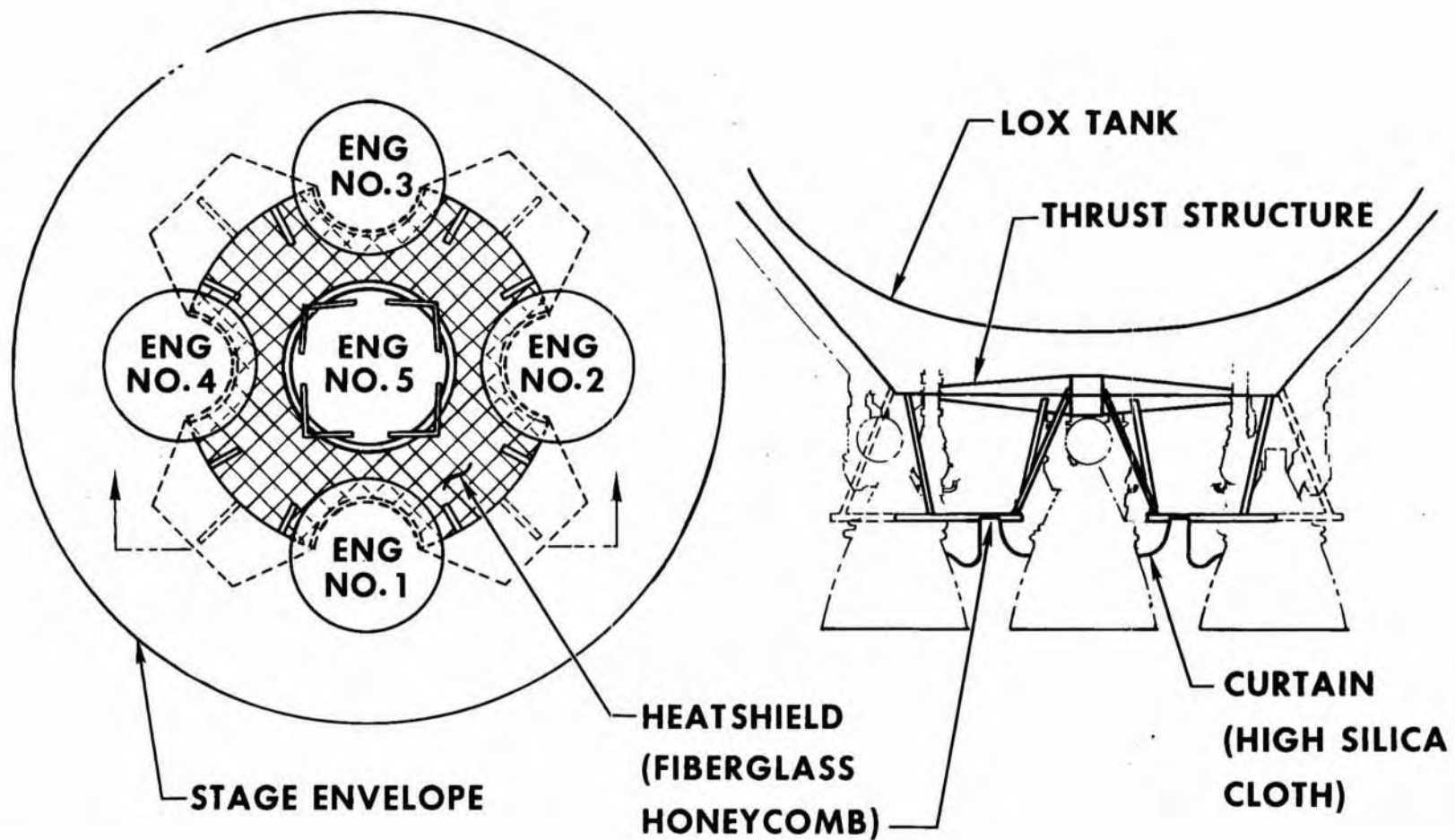


FIGURE 5 - FLIGHT BASE HEATSHIELD



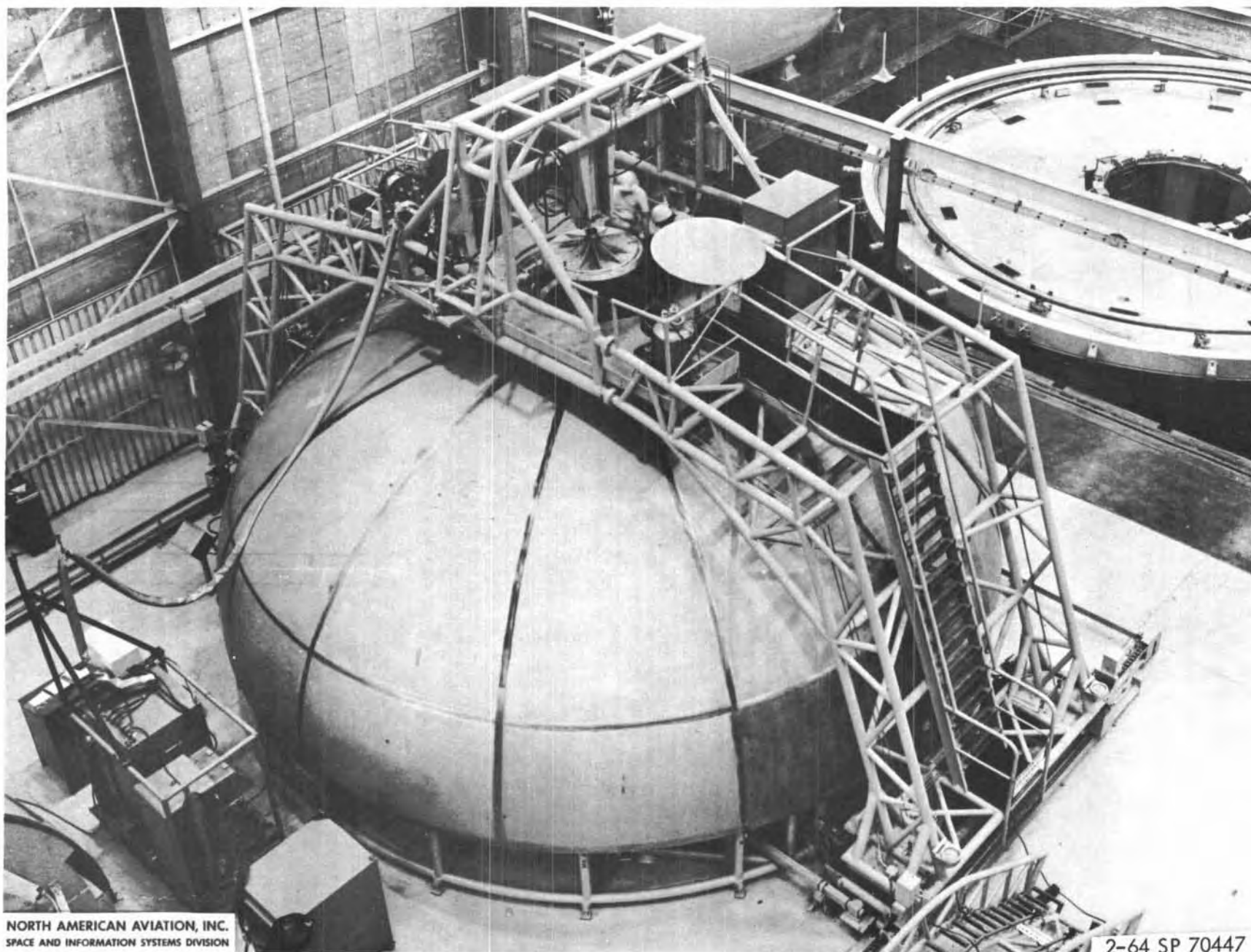
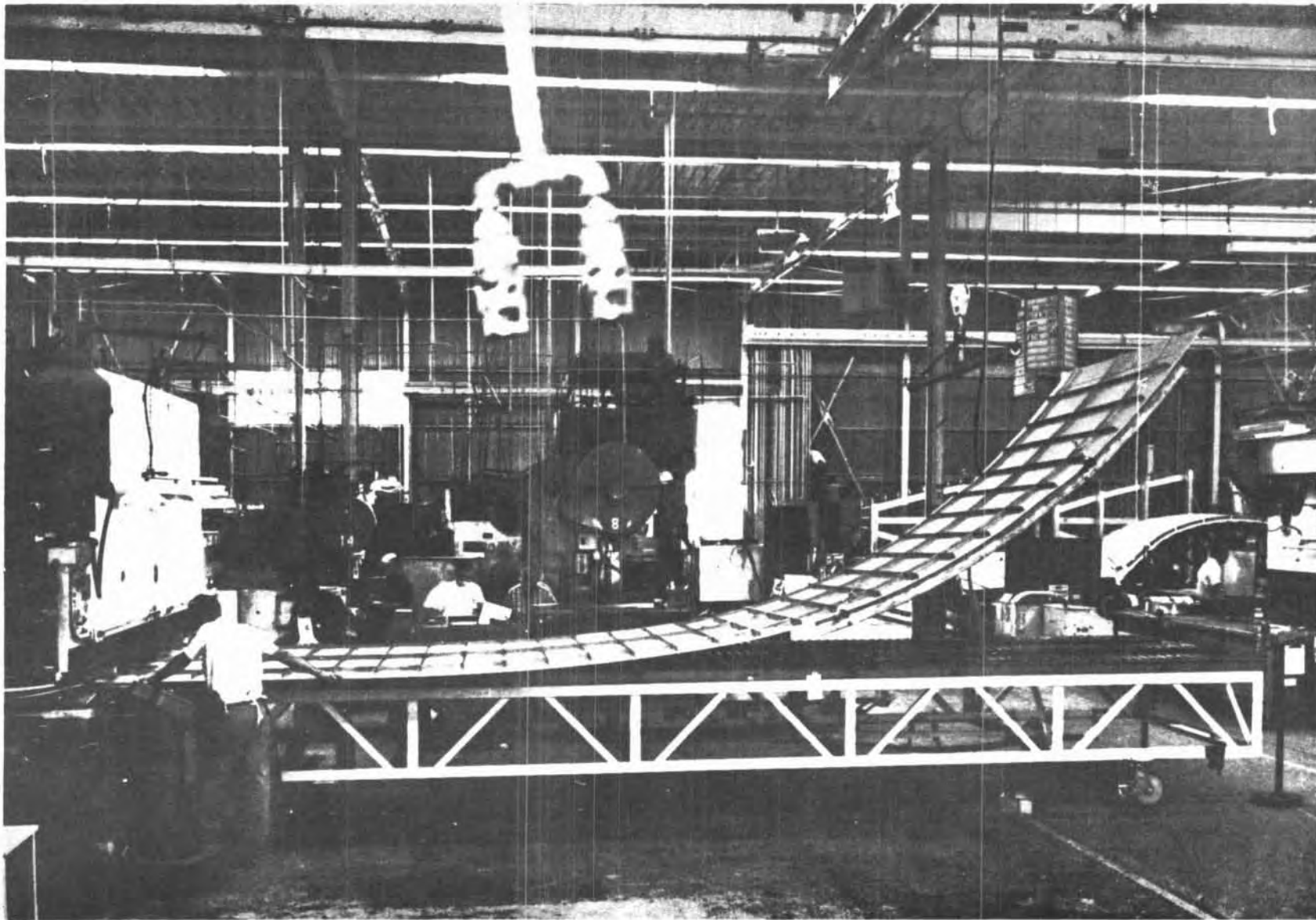


FIGURE 6 - BULKHEAD DOLLAR WELDER

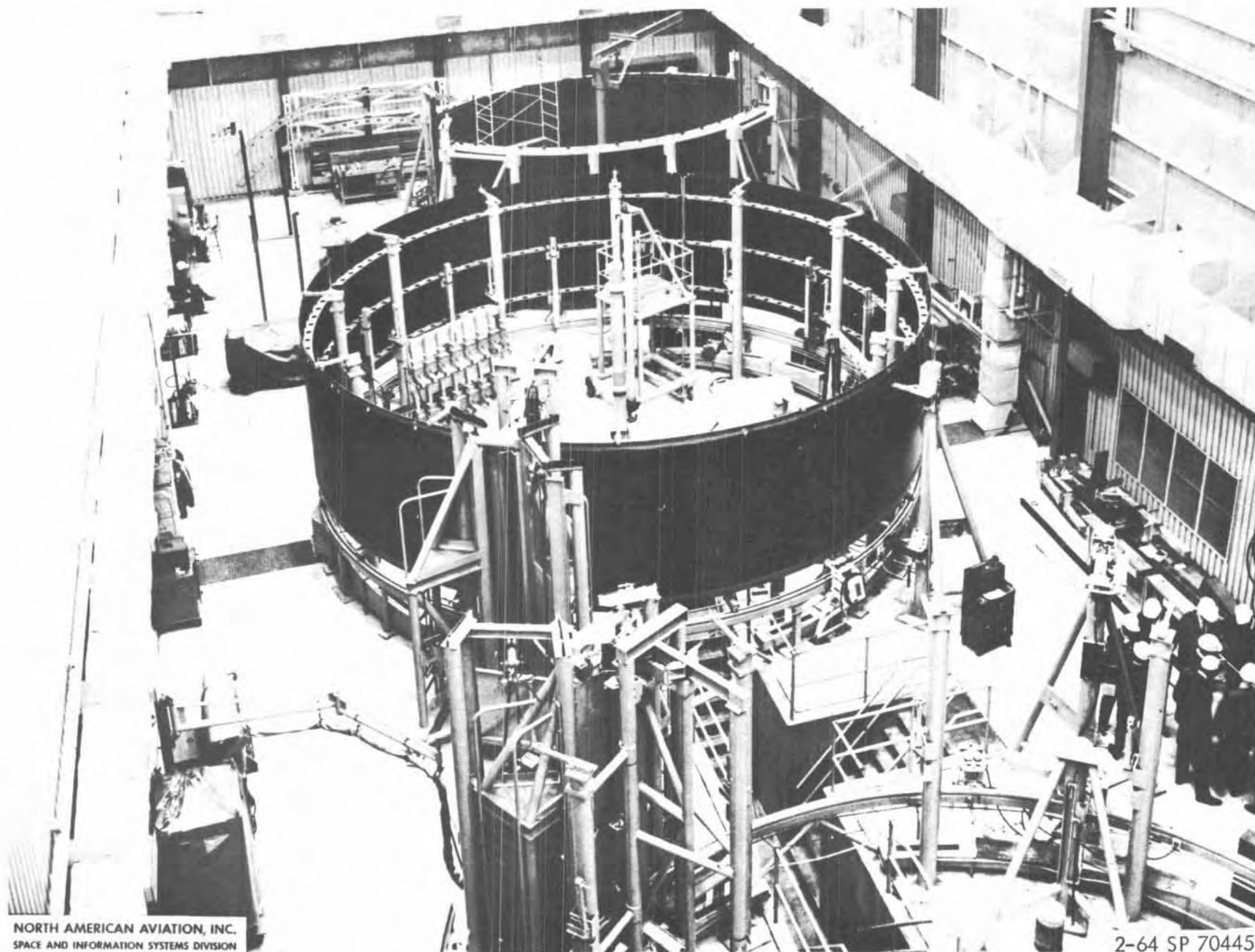




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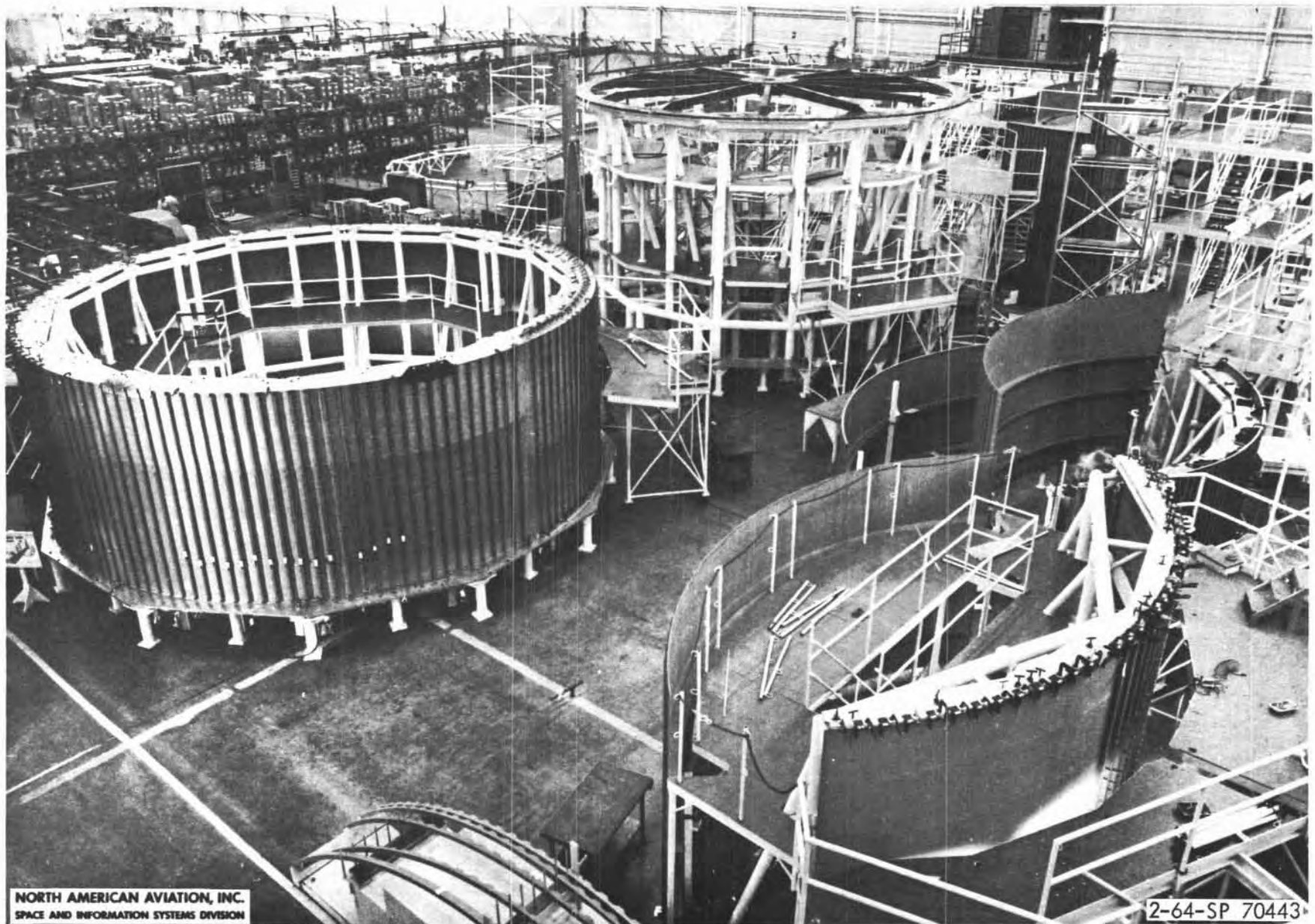
FIGURE 7 - FORMING LH<sub>2</sub> CYLINDER PANELS



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FIGURE 8 - LH<sub>2</sub> CYLINDER ASSY



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FIGURE 9 - FORWARD SKIRT