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S-ID PROPULSION/MECHANICAL

(Modified S-IC Configuration)

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Table of Contents

1.0 LOX Systems

1.1 LOX Fill and Drain Subsystem

1.2 LOX Delivery Subsystem

1.3 LOX Interconnect Subsystem

1.4 LOX Emergency Bubbling Subsystem

1.5 POGO Suppression (None)

1.6 LOX Pressurization

Figure 1 Thrust Structure - LOX Drain
Figure 2 LOX and Fuel Delivery System Disconnect
Figure 3 Thrust Structure - LOX Delivery
Figure 4 LOX Interconnect
Figure 5 LOX Bubbling
Figure 6 LOX Pressurization
Figure 7 Roller Bracket

2.0 Fuel Systems

2.1 Fuel Fill and Drain Subsystem

2.2 Fuel Delivery Subsystem

2.3 Fuel Pressurization

Figure 8 Fuel Fill and Drain
Figure 9 Fuel Delivery
Figure 10 Fuel Pressurization

3.0 Control Pressure

1.0 LOX SYSTEMS

1.1 LOX FILL AND DRAIN SUBSYSTEM

1.1.1 Intertank Installation

No change from the S-IC (Reference 60B41012-1E).

1.1.2 Thrust Structure

The LOX drain system has been reconfigured as shown on Figure 1 to provide for inflight separation. The delivery system connection is made to the outboard spool located at ~~Position~~ FIN C. There is no change at the umbilical.

1.1.2.1 LOX Drain Elbow

No similar part IS SIMILAR TO 60B41305 on the S-IC. The elbow is 6 inches in diameter and will consist of a cres tube bend with welded end flanges.

1.1.2.2 LOX Fill and Drain Valve

The valve is 6 inches in diameter and will be similar to the configuration used on the S-IC (Reference 60B41002~~0~~5F Parker P/N 2640611M4). Minor design modifications may be necessary to provide for higher operating pressures on the S-ID. Re-qualification testing is required.

1.1.2.3 LOX Drain Duct

The duct is provided from the disconnect to the umbilical. The duct is 6 inches in diameter, and the design will include the same components used on the S-IC configuration. (Reference 60B41003-1D ~~SOLAR~~ FLEXONICS P/N 107243-502). Design requirements are not exceeded on S-ID. Qualification testing of the duct assembly is required.

1.1.2.4 Disconnect

No similar part on the S-IC. The configuration shown on Figure 2 is a concept of such a device. The lower half is configured to provide support joints. Qualification testing is required.

1.1.2.5 Structural Support

The lower half of the disconnect, paragraph 1.1.2.4, is supported to the thrust structure (See structural changes). Support for the upper half is provided by the hardline connection. When the thrust structure is staged, line separation will occur.

1.2 LOX DELIVERY SUBSYSTEM

LOX is delivered to the engines through five delivery systems Figure 3 . Each outboard system consists of an anti-vortex device, standpipe, valve, suction duct, spool, disconnect, and pressure volume compensating duct. The inboard system consists of an anti-vortex device, suction duct, spool, and pressure volume compensating duct.

1.2.1 Tank Installation

1.2.1.1 Anti-Vortex Assembly

1.2.1.1.1 The anti-vortex assemblies are located inside the LOX tank at the entrance to the delivery systems. The outboard anti-vortex assemblies contain a standpipe extension which permits maximum utilization of LOX in the outboard system beforethrust structure separation. The S-IC existing anti-vortex assembly 60B41245-1 (presently used on the center standpipe) will be used on the outboard systems.

1.2.1.1.2 The center anti-vortex assembly will be similar to present outboard assemblies (Reference 60B41246-1) except diameters are reduced from ~~39.15~~ 39.50 inches to 24.00 inches.

1.2.1.2 Standpipe Assembly

The outboard delivery system standpipes will consist of 20 inch ID 2219T6 aluminum tubes approximately 190" long and .10 wall thickness. Stiffeners will be bonded or spotwelded to the tube. A flange will be welded to the bottom of the tube with a hole pattern to match the fitting in the tank. Support will be provided at the upper end. (See structural changes)

1.2.2 Intertank Installation

The outboard delivery system LOX suction tank fitting from the S-IC LOX tank bulkhead to the suction duct entrance will be shortened to provide for installation of a shutoff valve. The new suction fitting (see structural changes) will be welded to the LOX tank bottom and a flange provided for attachment of the valve. There will be no change on the inboard system.

1.2.2.1 Shutoff Valve

The valve is a 20" diameter, normally open, butterfly type valve. The valve is spring loaded to the normal position and is pneumatically actuated to close. A reverse flow system is incorporated to relieve pressure between the valve and the engine in event of valve closure with LOX loaded. The pneumatic actuator media is gaseous nitrogen at 750 psig. The media is solenoid controlled. There is no similar valve used on the S-IC. For a typical design, see GSE P/N 65B80422-3 AiResearch PN 395552. A new valve must be designed and qualified for the S-ID environment.

1.2.3 Tunnel Installation

No change from the S-IC (Reference 60B41011-17E).

1.2.4 Thrust Structure Installation

Major changes are required for both outboard and inboard delivery systems between the Suction and PVC ducts. New delivery system supporting structure and components are required. The outboard system incorporates a spool piece for attachment of an interconnect system and a disconnect that provides line separation when the thrust structure is staged. The spool at Position also provides a LOX drain connection. The inboard system supplies the sustainer engine and does not separate. A spool piece is provided for attachment of the interconnect system. A longer length PVC is provided to meet the requirements for center engine gimballing.

1.2.4.1 Suction Ducts

1.2.4.1.1 Outboard suction ducts will be the same configuration as the S-IC (Reference 20M02004-1E, Arrowhead P/N 11715-301). Latest S-ID vehicle performance definition, however, indicates that the two lower gimbals and sliding joint assemblies are at best marginal and may well exceed qualification conditions. Minor design modifications may be necessary to provide for higher operating pressures on the S-ID. Requalification testing of the complete lower assembly is required.

1.2.4.1.2 Inboard suction ducts will be the same configuration as the S-IC (Reference 60B41001-1C Arrowhead P/N 11773-301). Design modification of the two lower gimbals and sliding joint assembly is required to meet the operating conditions imposed by S-ID flight. Requalification testing of the complete lower assembly is required.

5

1.2.4.2 Spools

Spools will attach to the outlet end of the suction duct on both outboard and inboard delivery systems.

1.2.4.2.1 Three of the outboard spools are identical and are similar to the S-IC configuration (Reference 60B41023-1B). The part will be machined from a 2219 CRES aluminum forging, and the interconnect flange will be welded. The fourth spool at ~~Position~~ PIN C will incorporate an additional 6 inch welded flange for LOX drain. Qualification testing of one spool configuration is required. The other configuration will be qualified by similarity and analysis.

1.2.4.2.2 The inboard spool will be similar to the S-IC configuration (Reference 60B41021-1B) except there is no drain system port. The part will be machined from a 2219 CRES aluminum forging. Interconnect system flanges will be welded. The lower flange end will be configured to provide support points similar to the S-IC outboard spool (Reference 60B41023-1B). Qualification testing is required.

1.2.4.3 Disconnects

No similar part on the S-IC. The configuration shwon in Figure 2 is a concept of such a device that will be installed on the outboard systems only. The upper and lower halves are supported respectively to the S-ID cone and thrust structure. When the thrust structure is staged, separation will occur. The lower half of the disconnect will be configured to provide support points similar to the S-IC outboard spool (Reference 60B41023-1B). Qualification testing is required.

1.2.4.4 Pressure Volume Compensating Ducts

The PVC ducts maintain constant volume flow and counteract the pressure end loads induced on the engines.

1.2.4.4.1 The outboard PVC ducts are the same configuration as the S-IC (Reference 20M02000-1E Arrowhead P/N 11711-303). Operating characteristics of the S-ID,however, exceeds the design capability of the ducts. Design modifications must be incorporated on both gimbals and the compensator. Qualification testing of the complete duct assembly is required.

1.2.4.4.2 The inboard PVC duct is the same configuration as the outboard S-IC configuration (See 1.2.4.4.1 above). Operating characteristics of the inboard duct exceed those requirements for the outboard ducts. A single configuration can be designed for the outboard and inboard ducts, but qualification testing must be performed to the worst conditions. A small weight penalty will probably result for the outboard systems.

1.2.4.5 Structural Support

Structural supports are provided for delivery system ducting.

1.2.4.5.1 Lower support of the outboard delivery system is the same as the S-IC (Reference 60B41014-7D). Attachment is made to the thrust structure through the lower half of the disconnect (paragraph 1.2.4.3). Upper support of the delivery system is new and attaches from the spool to the cone assembly (see structural changes).

1.2.4.5.2 Support of the inboard delivery system will be the same as the S-IC outboard system (Reference 60B41014-7D). Attachment to cone structure is made through the spool support points (para. 1.2.4.2.2). No upper support is provided.

1.3 LOX INTERCONNECT SUBSYSTEM

This subsystem (Figure 4) attaches to the LOX spools and forms an interconnection between the delivery system described in paragraph 1.2. It consists of three 4 inch diameter systems composed of four duct assemblies, four valves, and two tees. No intermediate support points are provided. The function of the system is the same as used on the S-IC.

1.3.1 LOX Interconnect Valves

The interconnect valves are 4 inch diameter ball type valves three of which are normally ~~nax~~ open and the other normally closed. The valves are spring loaded to the normal position and are pneumatically operated from the normal position. The pneumatic actuator media is gaseous nitrogen at 750 psig. The media is solenoid controlled. The valves will be similar to the configurations used on the S-IC (Reference 60B41136-5B and 7B Parker P/N 2650105M2 and ~~2650106M2~~ 2650105ML). Minor design modifications may be necessary to provide for higher operating pressures (same as center engine delivery system) on the S-ID. Requalification testing of one configuration is required.

1.3.2 Interconnect ~~Ties~~ Tees

The ~~ties~~ tees are welded assemblies and are similar to the configuration used on the S-IC (Reference 60B41025-1C) except the material will be cres.

1.3.3 Interconnect Duct Assemblies

Two of the four duct assemblies are the same configuration. The ducts are 4 inch in diameter, and the design will include the same components used on the S-IC configuration (Reference 60B41006-1 & -3, 60B41007-1 & -3, and 60B41043-1 & -3 Flexonics P/N's 107284-501, 107285-401, 107293-501, 107294-501, 107289-501 and 107290-501). Operating conditions are exceeded slightly

8

1.3.3 Interconnect Duct Assemblies (Continued)

on the S-ID, but exceedances appear to be within the design capability. Each duct will be welded assemblies of three gimbals, rigid ducting, and end flanges. Qualification testing of the three different duct assemblies is required.

1.4 LOX ~~EMERGENCY~~ BUBBLING SUBSYSTEM

The subsystem, Figure 5 , consists of tubing assemblies, solenoid valve, check valve, orifice assemblies and filter assembly. Components are the same as used on the S-IC. Helium is conveyed from an umbilical connection to each of the LOX delivery systems. Installation will be similar to the S-IC (Reference 60B41221-1E) except the distribution system will be attached to the cone instead of the thrust structure ring. A disconnect similar to GSE P/N will be provided to permit line separation when the thrust structure is staged. qualification testing of the disconnect is required.

1.5 POGO SUBSYSTEM

No system provided.

1.6 LOX PRESSURIZATION SUBSYSTEM

The subsystem is designed to meet the net positive suction head requirements of the LOX turbo pump on the F-1 engines and to suppress LOX boiling. Pressurization is accomplished by converting LOX to gaseous oxygen in the F-1 engine heat exchangers. The media is then controlled and ducted to the top of the LOX tank where it enters the tank and is dispersed by a distributor. The pressurization system has been reconfigured as shown on Figure 6 for the S-ID.

1.6 LOX PRESSURIZATION SUBSYSTEM (Continued)

The thrust structure installation has been completely redesigned. Other modifications include only the installation in the lower end of the pressure tunnel where changes are required for staging.

1.6.1 Thrust Structure Installations

Two separate systems are provided in the thrust structure to meet the S-ID pressure schedule for five and single engine operation. The single engine system is located on the vehicle cone and consists of a feeder duct from the center engine, a flow control device (venturi) and a duct connecting to the distribution system. The second system consists of feeder ducts from each of the four outboard engines, a manifold, flow control device (venturi), duct, and disconnect with integral check xxxxx valve connecting to the distribution system. Ducting to the venturi is located on the 216 ring of the thrust structure. The venturi and disconnect are mounted in the lower end of the pressure tunnel. Line separation occurs when the thrust structure is staged. The check valve prevents loss of GOX from the single engine system.

1.6.1.1 Center Engine System

The center engine system will be 1½ inches in diameter and will consist of duct components presently used on the S-IC (Reference 60B51 ?.1 and 60B51403-7 FLEXONICS P/N 107242-501 and 107240-502

1.6.1.1.1 Feeder Ducts

A feeder and feeder extension duct, both of which are gimbal assemblies will be provided from the center engine to the venturi. Qualification testing of both ducts is required.

1.6.1.1.2 Venturi

The venturi will be similar to the S-IC configuration (Reference 60B51494-1) except sizing will be for a single engine only. Flow testing will be required.

1.6.1.1.3 GOX Duct

The GOX duct will be provided from the venturi to the distribution system. The duct will be a gimbal system. Qualification testing is required.

1.6.1.2 Outboard Engine System

The entire system is staged with the thrust structure.

1.6.1.2.1 Feeder Ducts and Feeder Duct Extentions

These ducts will be gimbal assemblies 1½ and 2 inches in diameter. Ducts of 1½ inch diameter will consist of components presently used on the S-IC (Reference 60B51 Paragraph 1.6.1.1 and 60B51). Two inch diameter ducting will be new.

A single configuration 1½ inch diameter feeder duct will be used for all outboard engines and ~~a~~ will extent from the engine interface to the 216 ring. Downstream ducting then consists of 1½ and 2 inch feeder duct extentions to the manifold. Qualification testing of one 1½ inch feeder duct, two 1½ inch feeder duct extentions and two 2 inch feeder duct extentions, is required.

1.6.1.2.2 Manifold

The manifold will extend from the 216 ring, enter the lower end of the pressure tunnel and connect to the venturi, paragraph 1.6.1.2.3. Feeder duct extention connections will be 2 inches and 3 inch (discharge end). The manifold will be new design incorporating gimbals. Qualification testing is required.

1.6.1.2.3 Venturi

The venturi will be similar to the S-IC configuration (Reference 60B51494-1) except sizing will be for four engines operation. Flow testing will be required.

1.6.1.2.4 Disconnect - Check Valve

No similar part on the S-IC. The disconnect will attach to the venturi and distribution system. A check valve will be provided on the stage half to prevent loss of pressure from the center engine system after staging. Flow area will be equivalent to a 3 inch diameter tube. The disconnect will be similar to GSE configuration (Reference 65B). Qualification testing is required.

12

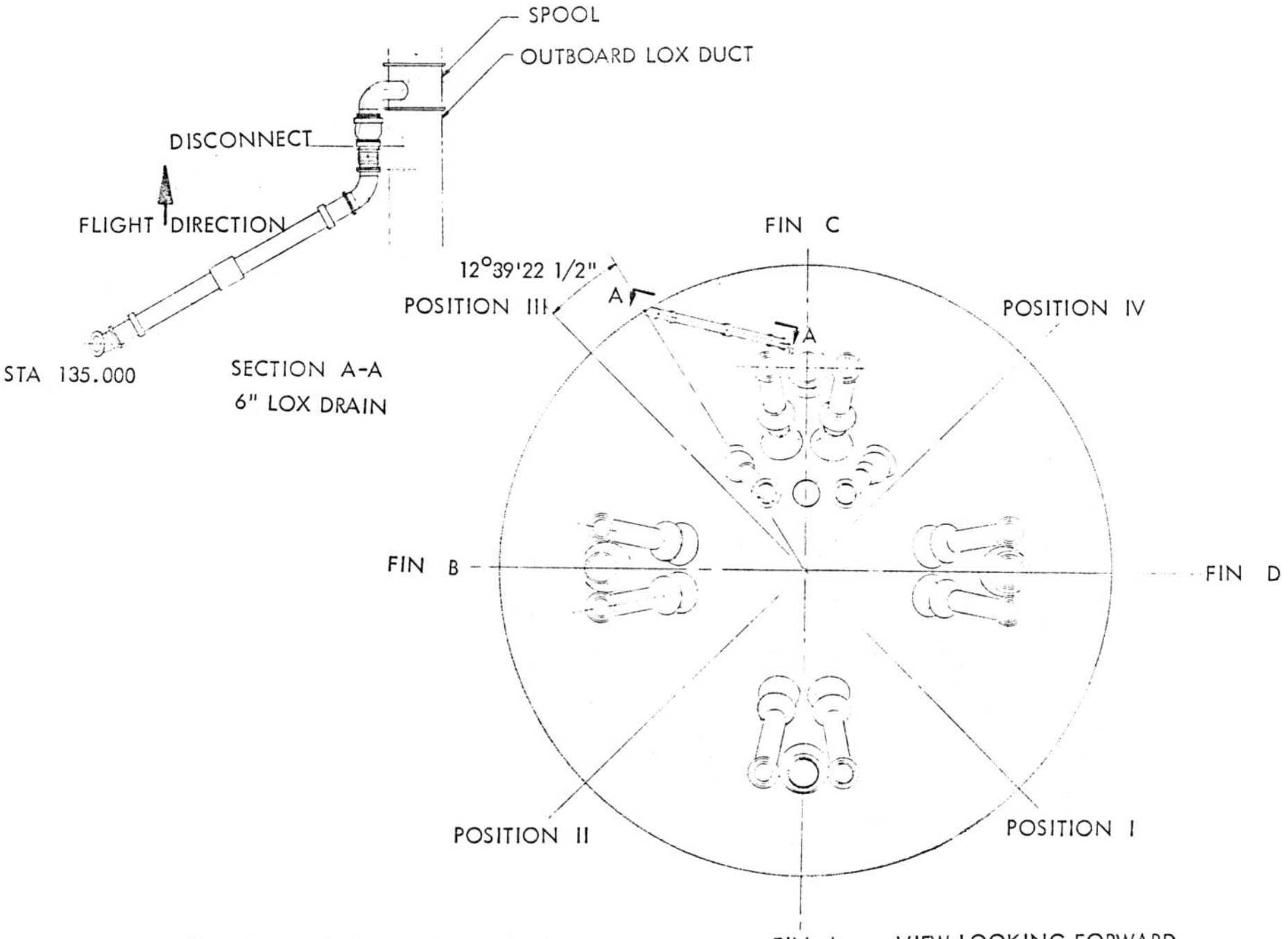
1.6.2 Tunnel Installation

Installation of the GOX ducting in the lower end of the tunnel will be modified to provide lateral connections for both single engine and outboard engines systems from the thrust structure. GOX duct 60B51603-3 will be shortened and a Tee connection added. All other components will be the same as the S-IC (Reference 60B51600-11D). Qualification of the new duct assembly is required.

1.6.3 Structural Support

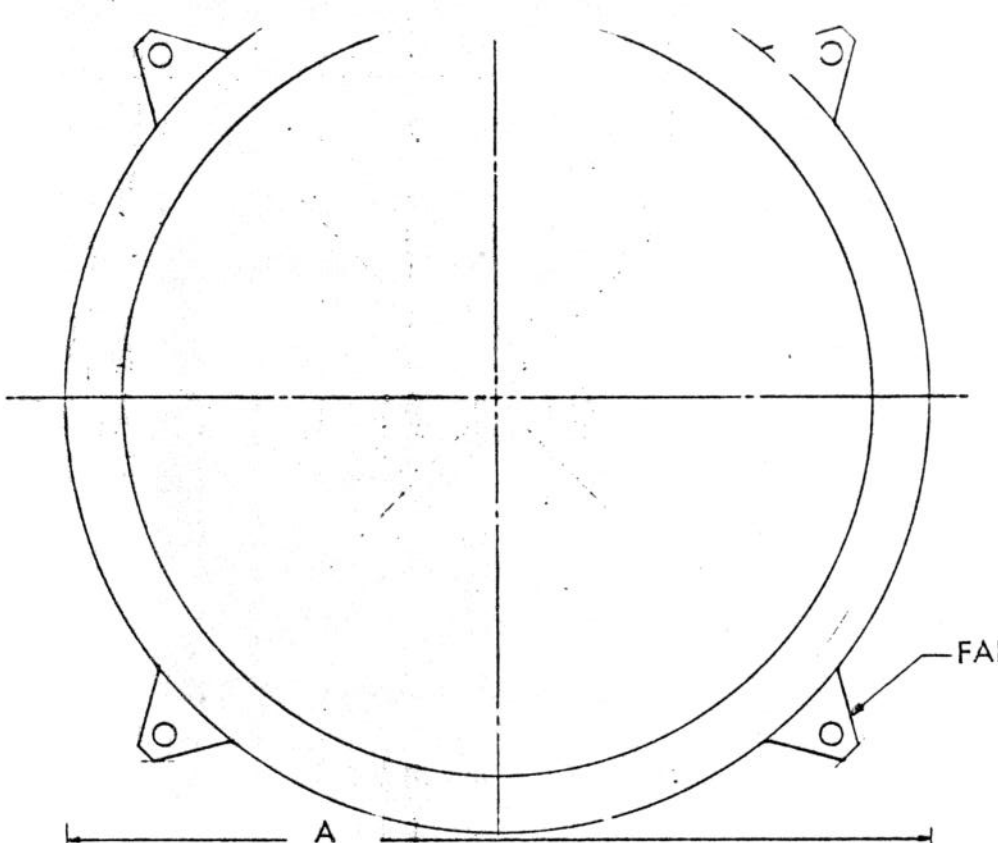
Ducting in the thrust structure and on the cone will be supported on rollers, Figure 7. Multi roller will be added as required for parallel systems.

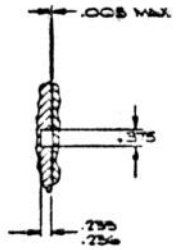
Support bracketry in the pressure tunnel will be modified where new ducting is required. In addition, support for the 3 inch venturi in the outboard engine system will be provided and will be at least equivalent to the mounting used on the S-IC. (Reference 60B51405-D



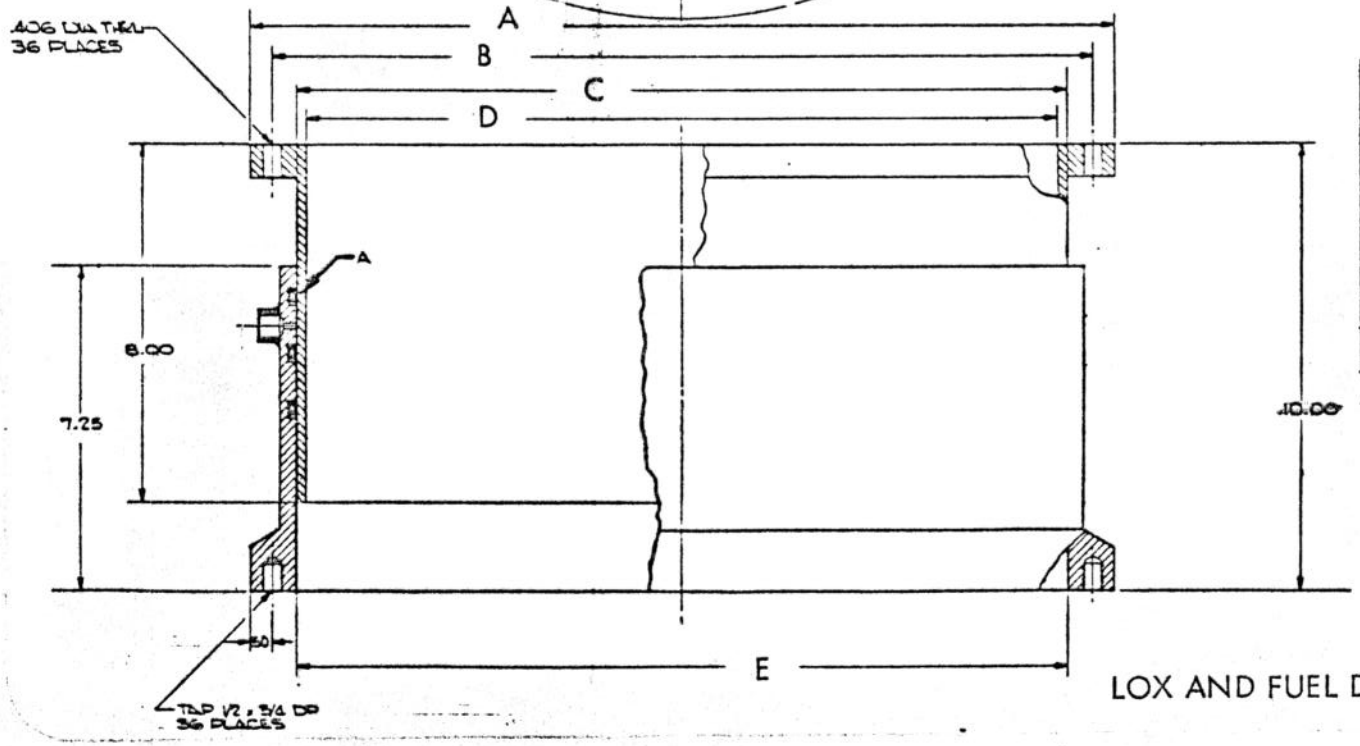
THRUST STRUCTURE - LOX DRAIN SYSTEM

FIG 1





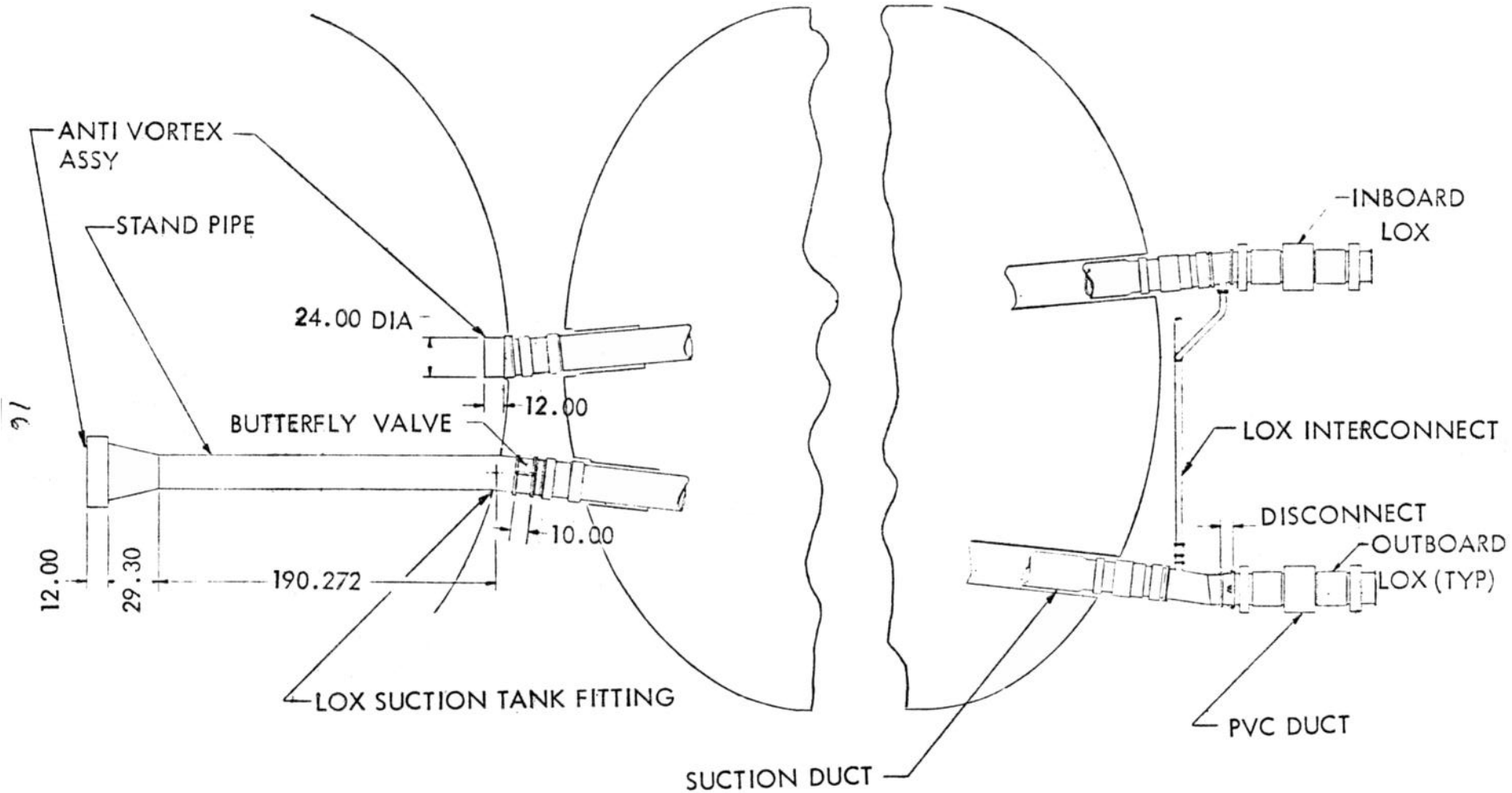
DETAIL A



DIM.	LOX DISC.	FUEL DISC.
A	19.56	14.28
B	18.56	13.28
C	17.410	12.250
D	17.00	12.00
E	17.411	12.251

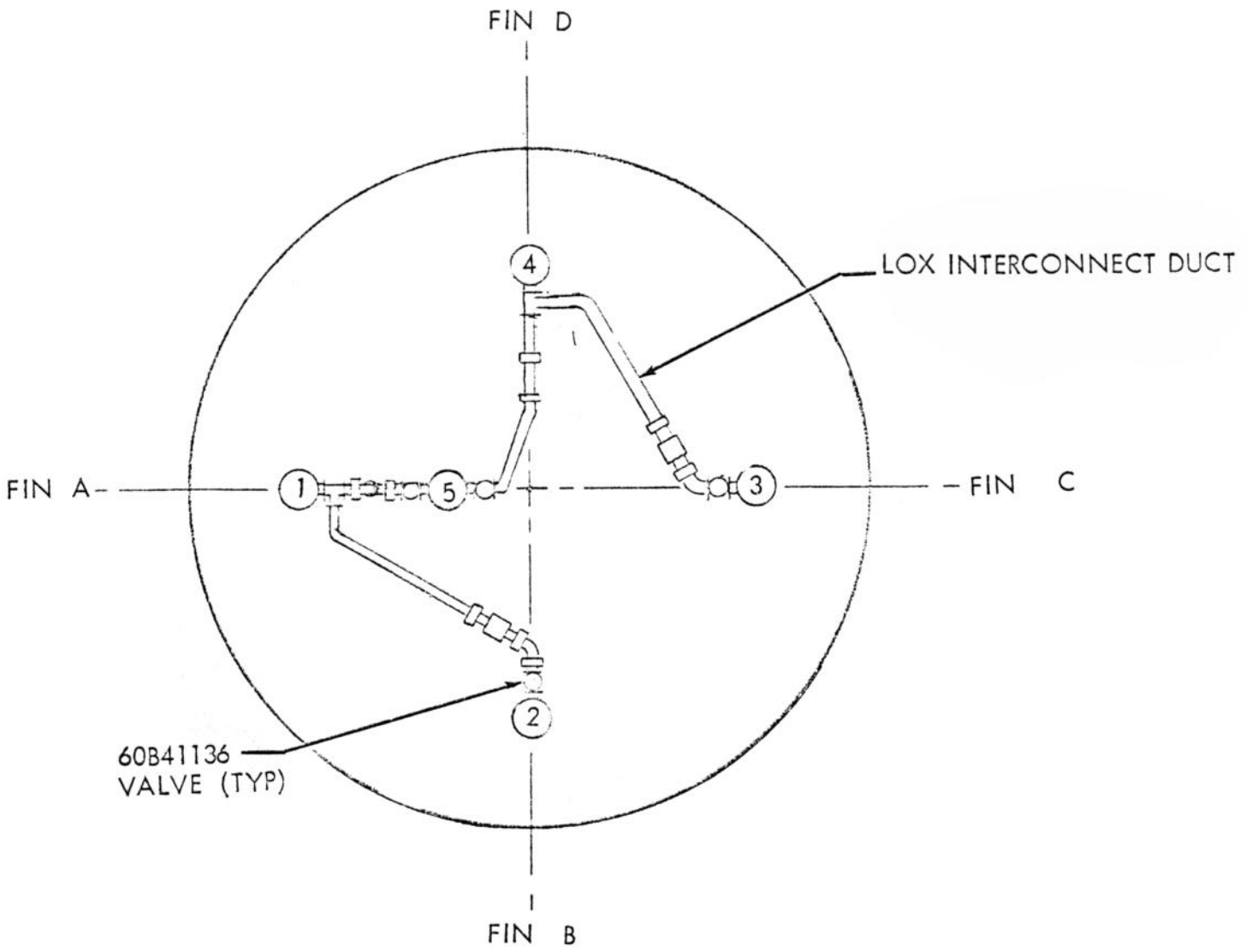
LOX AND FUEL DUCT DISCONNECT

FIG 2



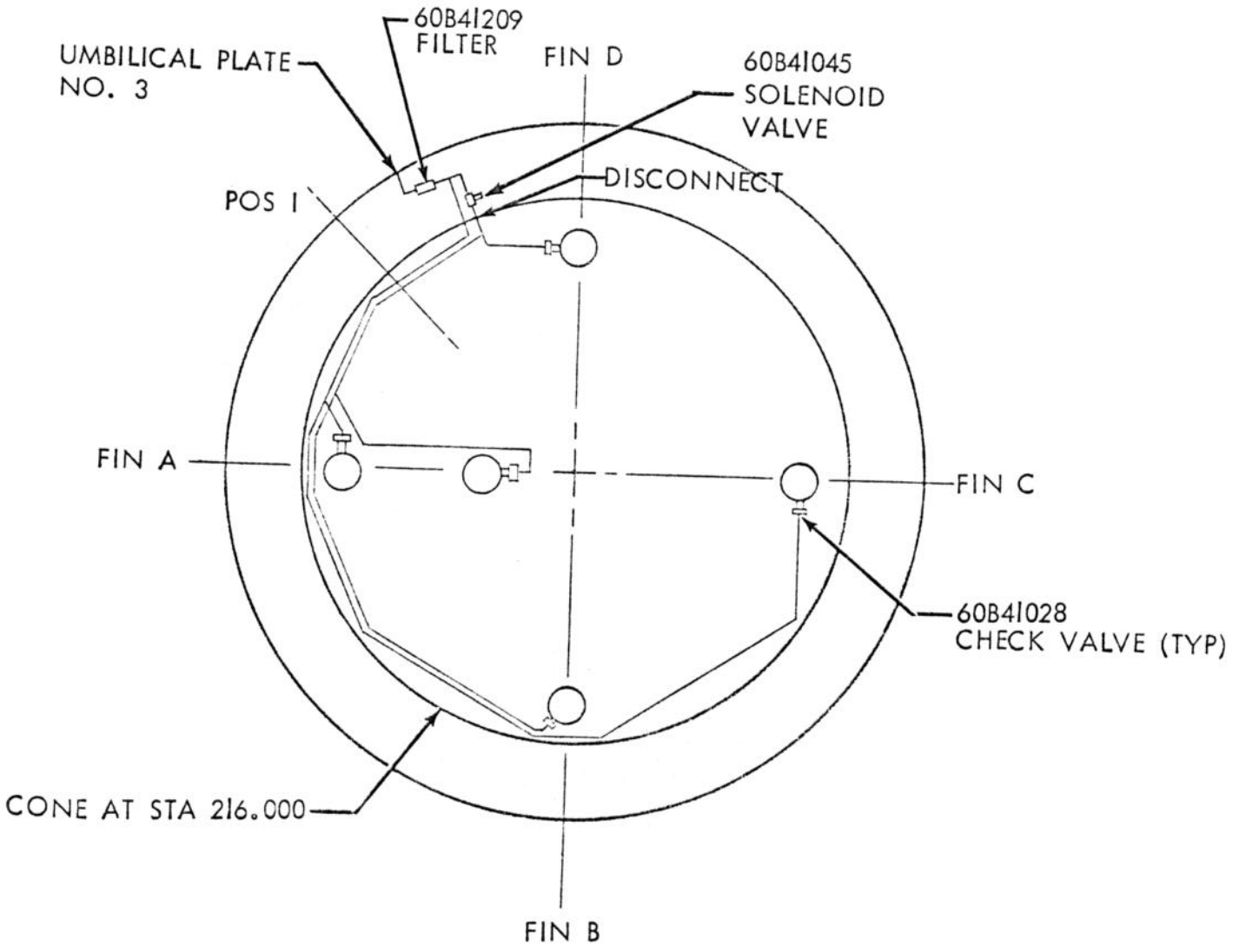
THRUST STRUCTURE LOX DELIVERY SYSTEM

FIG 3



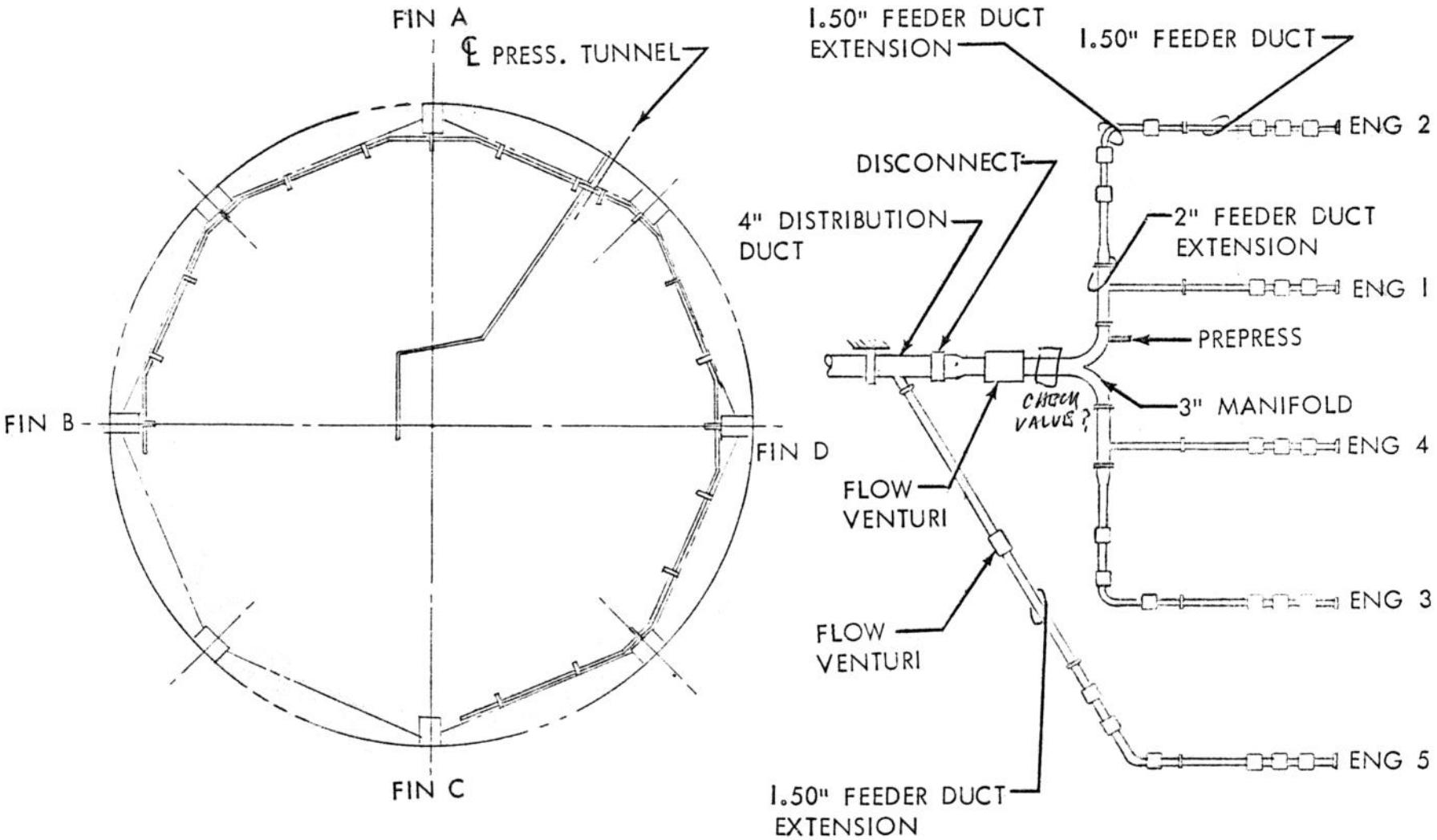
LOX INTERCONNECT SYSTEM

FIG 4



LOX ~~EMERGENCY~~ BUBBLING SUBSYSTEM

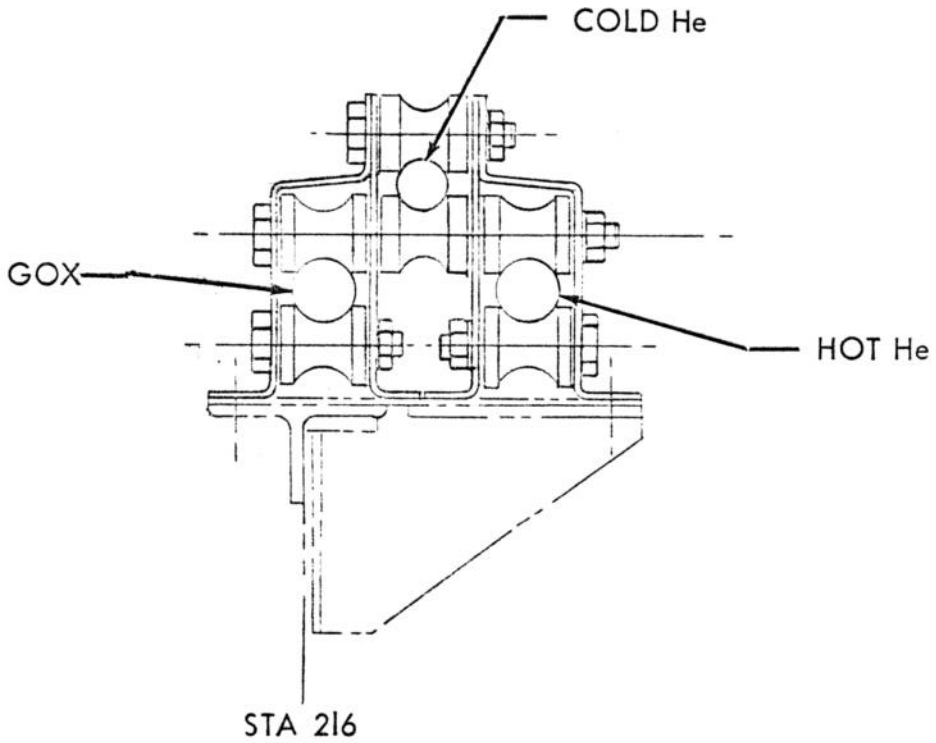
FIG 5



VIEW LOOKING AFT

LOX PRESSURIZATION SYSTEM
THRUST STRUCTURE

FIG 6



ROLLER BRACKET

PROPELLANT PRESSURIZATION
FEEDER DUCTS

FIG 7

2.0 FUEL SYSTEM

2.1 FUEL FILL AND DRAIN SUBSYSTEM

The fuel fill and drain system has been reconfigured as shown on Figure 8 to provide for inflight separation . There is no change to the umbilical or tank connection.

2.1.1 Fuel Fill and Drain Valve

The valve is 6 inches in diameter and will be the same configuration used on the S-IC (Reference 60B43002-3E Parker P/N 2640612M2).

2.1.2 Fuel Fill and Drain Ducts

Two ducts are provided, one from the valve (paragraph 2.1.1) to the disconnect (paragraph 2.1.3) and from the disconnect to the umbilical. The ducts are 6 inches in diameter and the design will include the same components used on the S-IC configuration (Reference 60B43003-1D Solar P/N 26679-300). Design requirements are not exceeded on the S-ID. Qualification testing of the duct assemblies is required.

2.1.3 Disconnect

No similar part on the S-IC. The disconnect will be similar to the LOX disconnect described in paragraph 1.1.2.3. The parts will be made identical with the exception of sealing elements. Qualification testing is required but should be accomplished in conjunction with the LOX disconnect testin g.

2.1.4 Structural Support

Structural support for the ~~fuel~~ fuel fill and drain system is similar to that provided for the LOX drain system (see paragraph 1.1.2.4). In addition, support must be provided from the upper half of the disconnect to the cone.

21

2.2 FUEL DELIVERY SUBSYSTEM

Fuel is delivered to the engines through ten delivery systems, Fig 9. Eight outboard systems consist of an anti-vortex device, valve, suction duct, disconnect and pressure volume compensating duct. Two inboard systems consist of an anti-vortex device, ~~suction~~ suction duct and pressure volume compensating duct.

2.2.1 Tank Installation

There is no change from the S-IC. Anti-vortex assemblies (Reference 60B43007-3) will be installed (Reference 60B43011-5E).

2.2.2 Thrust Structure Installation

Major changes are required for both outboard and inboard delivery systems. New delivery system supporting structure and components are required. The outboard system incorporates a new butterfly type valve for fuel shutoff and a disconnect provides line separation when the thrust structure is staged. The inboard system supplies the sustainer engine and does not separate. A longer length PVC is provided to meet the requirements for center engine gimballing. New fuel tank suction elbows are required for both systems.

2.2.2.1 Fuel Suction Elbows (See Structural Changes)

The fuel suction elbows for outboard and inboard systems will be similar to the S-IC. (Reference 60B25215-1 and 60B25212-1). New elbow sections are required.

2.2.2.2 Shutoff Valve

The valve is a 12 inch diameter, normally open, butterfly type valve. The valve is spring loaded to the ~~normal~~ normal position and is pneumatically actuated to close. A relief system must be incorporated to relieve pressure between the valve and engine in event of valve closure with fuel loaded. The

2.2.2.2 Shutoff Valve (Continued)

pneumatic actuator media is gaseous ~~nk~~ nitrogen at 750 psig. The media is solenoid controlled. There is no similar valve used on the S-IC. See 65B80422-3 AiResearch P/N 395552 Qualification testing is required.

2.2.2.3 Suction Ducts

2.2.2.3.1 Outboard suction ducts will be similar to the configuration on the S-IC (Reference 20M02006-1E Arrowhead P/N 11716). Only the elbow will be changed. Qualification will be by similarity and analysis. No testing is required.

2.2.2.3.2 Inboard suction ducts will be similar to the configuration on the S-IC (Reference 60B43001-1D Arrowhead P/N 11868). The rigid ducting between the sliding joint and gimbal assemblies will be ~~lengthened~~ shortened approximately 9 inches and the elbow will be changed. Qualification will be by similarity and analysis. No testing is required.

2.2.2.4 Disconnects

No similar part on the S-IC. The configuration shown in Figure 2 is a concept of such a device that will be installed in the outboard system only. The upper and lower halves are supported respectively to the S-ID cone and thrust structure. When the thrust structure is staged, separation will occur. Support points will be providdd on the upper half of the disconnect only. Qualification testing is required.

2.2.2.5 Pressure Volume Compensating Ducts

The PVC ducts maintain constant volume flow and counteract the pressure end loads induced on the engine.

To provide for center engine gimballing, the inboard system was modified to utilize outboard PVC ducts. All outboard and inboard PVC ducts are the same configuration as used on the S-IC

2.2.2.5 Pressure Volume Compensating Ducts (Continued)

(Reference 20MO2001-1E Arrowhead P/N 11713). S-ID flight performance indicates that operating pressure exceeds the duct qualified levels but duct design capability appears to be within the new requirements. Par tial requalification testing is required.

2.2.2.6 Structural Support

Structural supports are provided for delivery system ducting.

2.2.2.6.1 Lower support of the outboard systems is the same as the S-IC (Reference 60B43014-3B). Attachment is made to the thrust structure at the upper end of the PVC duct. Upper support of the delivery system is new and attaches from the upper end of the disconnect paragraph 2.2.2.3 to the cone assembly (see structural changes).

2.2.2.6.2 Support of the inboard system will be the same as the S-IC outboard system (Reference 60B43014-3B). Attachment is made at the upper end of the PVC duct.

2.3 FUEL PRESSURIZATION

The subsystem is designed to meet the net positive suction head requirements of the fuel turbo-pumps on the F-1 engines. Pressurization is provided by helium gas supplied from on-board storage bottles. Helium flows from the storage bottles to a bank of five ~~pressure~~ Flow control valves. At reduced pressure, the helium is then routed to the five heat exchanges on the engines. The heated helium leaving the heat exchanges is manifolded and carried to the top of the fuel tank and enters the tank ullage space through a flow distributor. The system has been reconfigured as shown on Figure 10 for the S-ID.

The thrust structure installation has been completely re-designed. Other modifications include the installation in the lower end of both tunnels where changes are required for staging. Revised electrical sequencing of the control pressure valves is required.

2.3.1 THRUST STRUCTURE INSTALLATION

Two separate systems are provided in the thrust structure to meet the S-ID pressure schedule for five and single engine operation. The single engine system is located on the vehicle cone and consists of cold and hot feeder ducts respectively from the electrical tunnel to the engine and from the engine to the pressurization tunnel. End connections are made to the existing cold helium supply and distribution systems.

2.3.1 THRUST STRUCTURE INSTALLATION (Continued)

The second system supplies cold helium to the outboard engines through a disconnect with check valve, manifold, feeder duct extensions, and feeder ducts to each engine. The hot gasses are then routed through a similar system to the existing distribution system in the pressure tunnel and consists of feeder ducts, feeder duct extensions, manifold and disconnect with check valve. The cold and hot helium ducting and manifolds are located on the 216 ring of the thrust structure. The disconnects are mounted in the lower end of the tunnels. Line separation occurs when the thrust structure is staged. The check valves prevent the loss of helium from the single engine system.

2.3.1.1 CENTER ENGINE SYSTEM

The center engine system will be approximate 1 1/4 and 1 1/2 inches in diameter on the cold and hot sides respectively. Ducting of 1 1/4 inch will consist of components presently used on the S-IC (reference 60B49007-1 and 60B49022-1 Solar PN 36472-300 and 36746-300). Ducting of 1 1/2 inch will consist of components ~~similar to those presently~~ used on ~~the GOX system of the S-IC (reference 60B51~~ 60B49007-3 and 60B49022-3 Solar PN 36473-300 and 36747-500.).

2.3.1.1.1 COLD FEEDER DUCTS

A feeder duct extension and feeder duct, both of which are gimbal assemblies will be provided from the cold helium supply located in the electrical tunnel to the center engine interface. Qualification testing of both ducts is required.

2.3.1.1.2 HOT FEEDER DUCTS

A feeder duct and feeder duct extension, both of which are gimbal assemblies will be provided from the engine to the distribution system located in the pressure tunnel. Qualification testing of both ducts is required.

2.3.1.2 OUTBOARD ENGINE SYSTEM (COLD HELIUM)

The entire system is staged with the thrust structure.

2.3.1.2.1 DISCONNECT - CHECK VALVE

No similar part on the S-IC. The disconnect will attach to the cold helium supply and 1 1/2 inch diameter manifold. A check valve will be provided on the stage half to prevent loss of pressure from the center engine system after staging. The disconnect will be similar to GSE configuration (reference 65B). Qualification testing is required.

2.3.1.2.2 COLD HELIUM MANIFOLD

The manifold will extend from the pressure tunnel to the 216 ring of the thrust structure. All end connections are 1 1/2 inch. The manifold will be of new design incorporating gimbals. Qualification testing is required.

2.3.1.2.3 COLD FEEDER DUCT EXTENSION AND FEEDER DUCTS

These ducts will be gimbal assemblies approximately 1 1/2 and 1 1/4 inches in diameter. A single configuration 1 1/4 inch feeder duct for all outboard engines will extend from the 216 ring to

27

2.3.1.2.3 COLD FEEDER DUCT EXTENSION AND FEEDER DUCTS (Continued)

the engine interface. The assembly will consist of components used on the S-IC (~~reference 60B49~~ paragraph 2.3.1.1).

Qualification testing of two 1 1/2 inch feeder duct extensions, two 1 1/4 feeder duct extensions and one 1 1/4 inch feeder duct is required.

2.3.1.3 OUTBOARD ENGINE SYSTEM (HOT HELIUM)

The hot helium system is the same as described for the cold helium system in reverse order. Only changes are in size and the discharge end is located in the pressure tunnel (see Figure 10). All components 2 inches and above are new. No similar sizes exist on the S-IC. Qualification testing of all system assemblies is required.

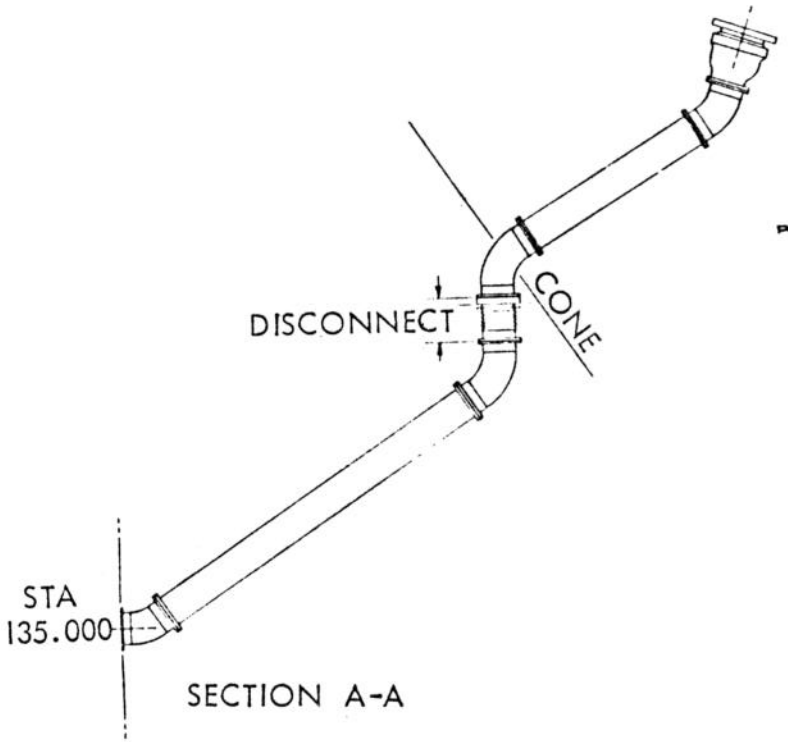
2.3.2 TUNNEL INSTALLATIONS

Installation of the ducting in the lower end of both the electrical and pressure tunnels will be modified to provide lateral connections for center and outboard engine system. Cold helium duct 60B49501-1B in the electrical tunnel and 60B49401-11D in the pressure tunnel will be shortened and ~~tie~~ tee connections added. All other assemblies will be the same as the S-IC (reference 60B49500-16 and 60B49400-10). Qualification testing of the new duct assemblies is required.

2.3.3 STRUCTURAL SUPPORT

Ducting in the thrust structure and on the cone will be installed parallel to the GOX system (Paragraph 1.6.3).

Support bracketry in the tunnels will be modified to provide for support of the disconnects. ~~The system will be at least equivalent to the~~ mounting used on the S-IC (reference).


DISCONNECT
CONE
STA
135.000
SECTION A-A

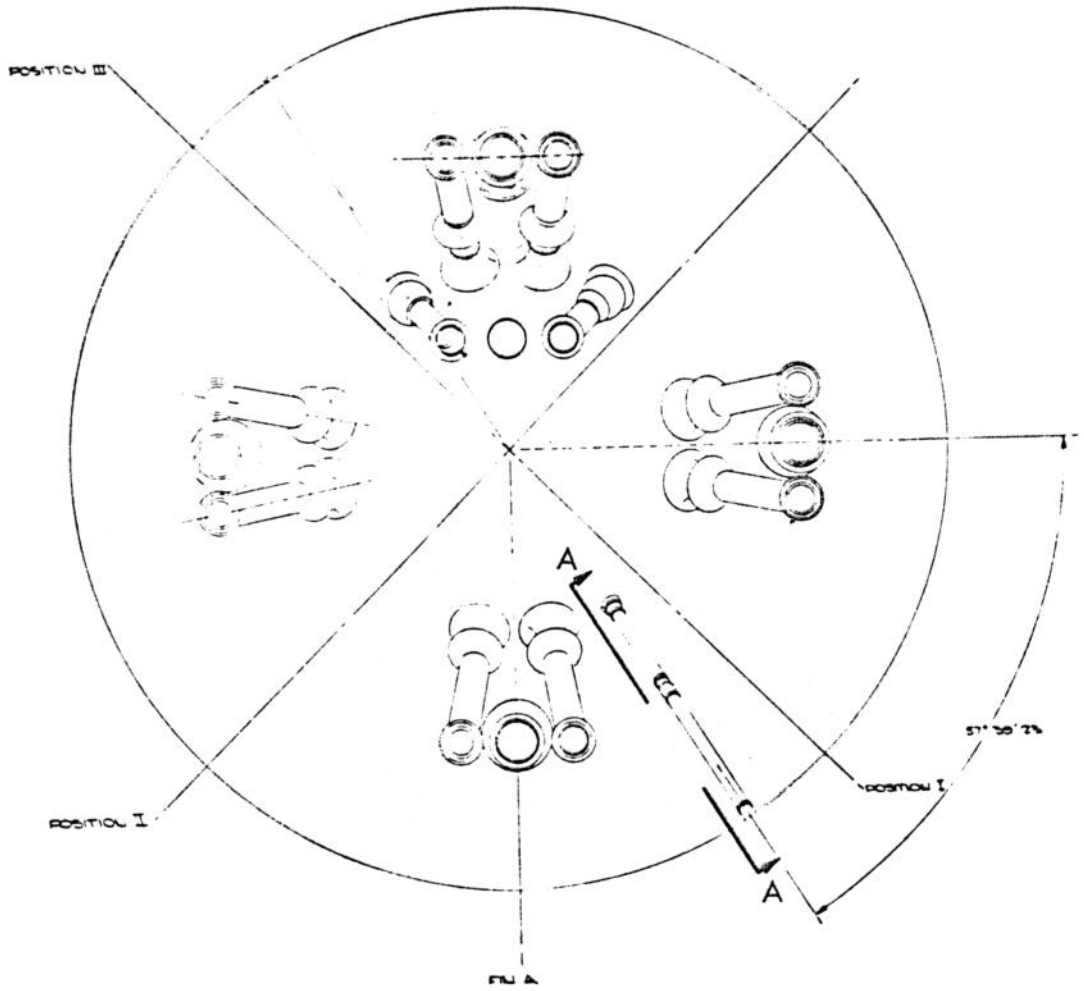
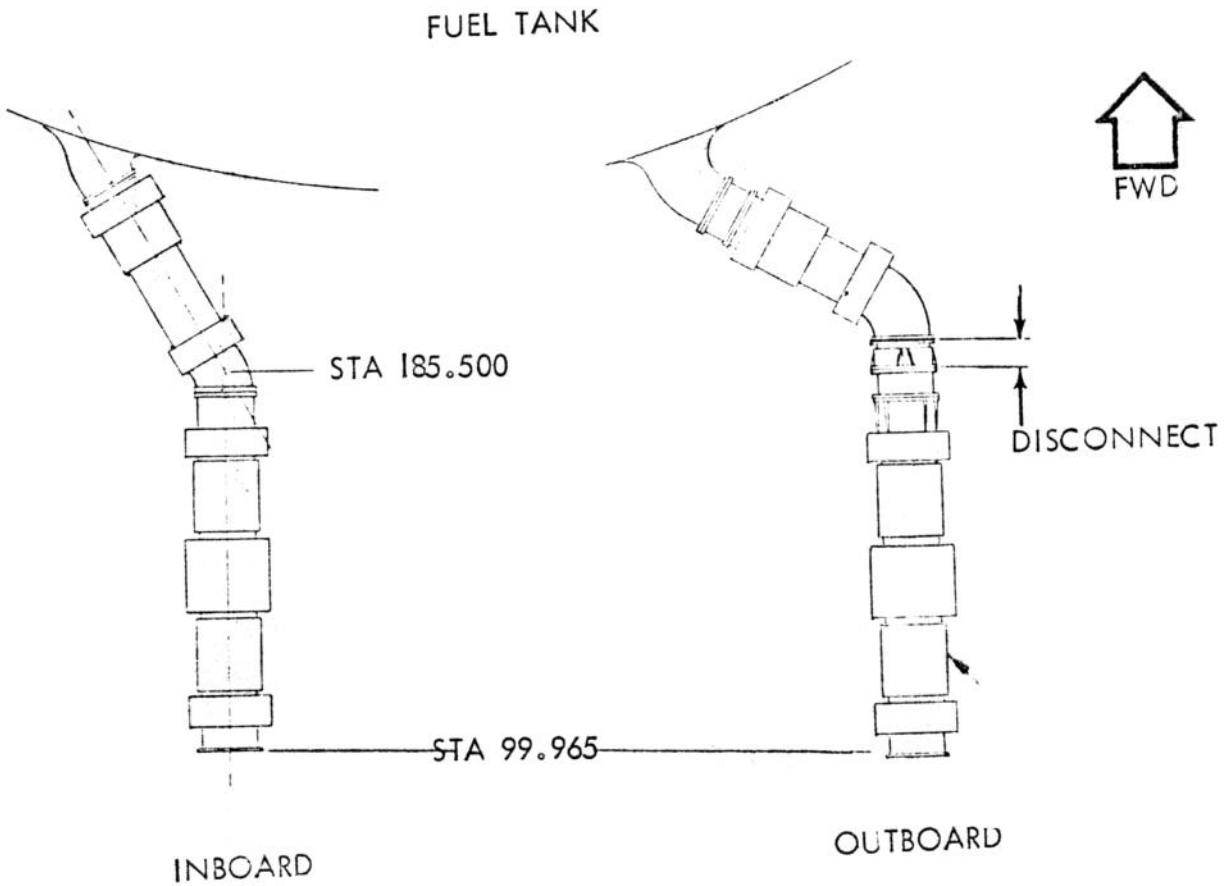
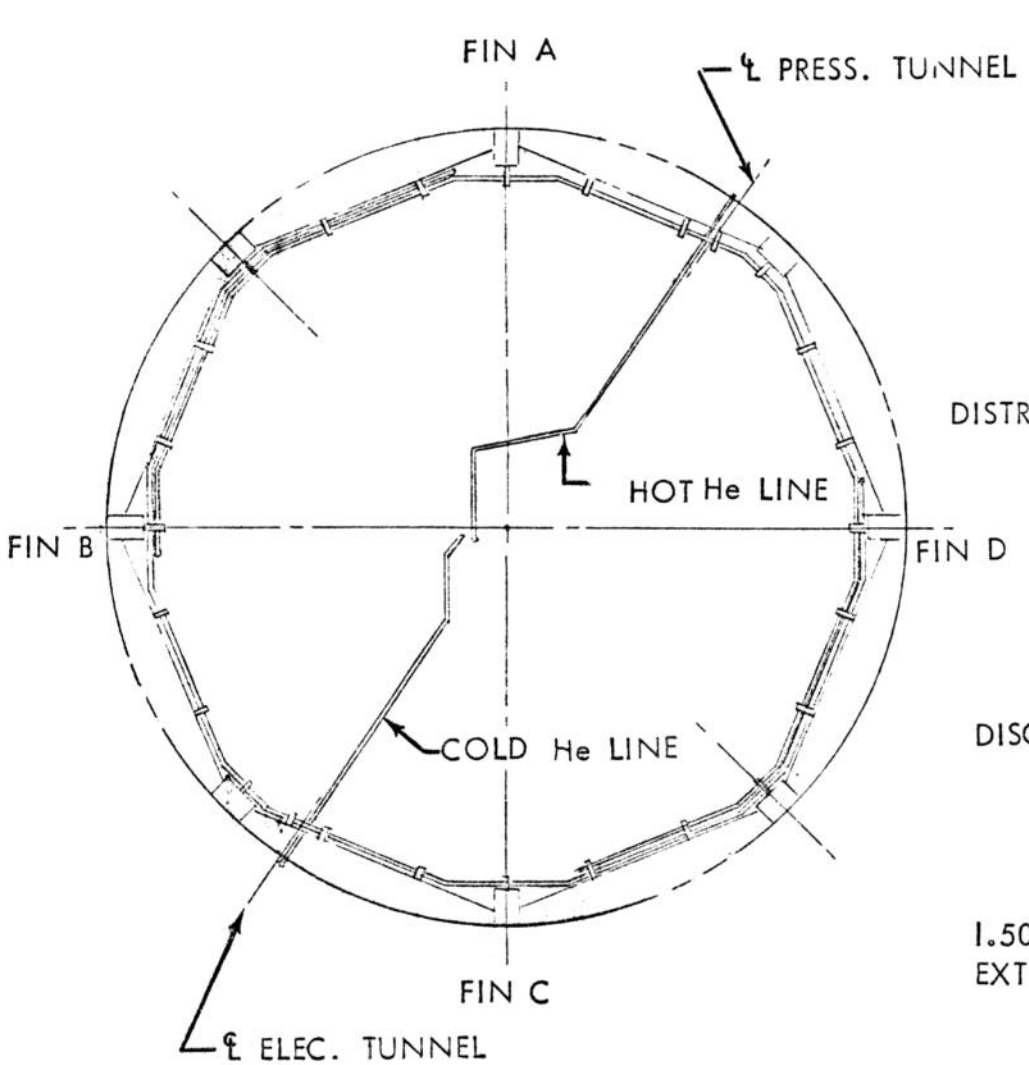

POSITION III
POSITION II
POSITION I
A
A

FIG 8



FUEL SUCTION DUCTS

FIG 9



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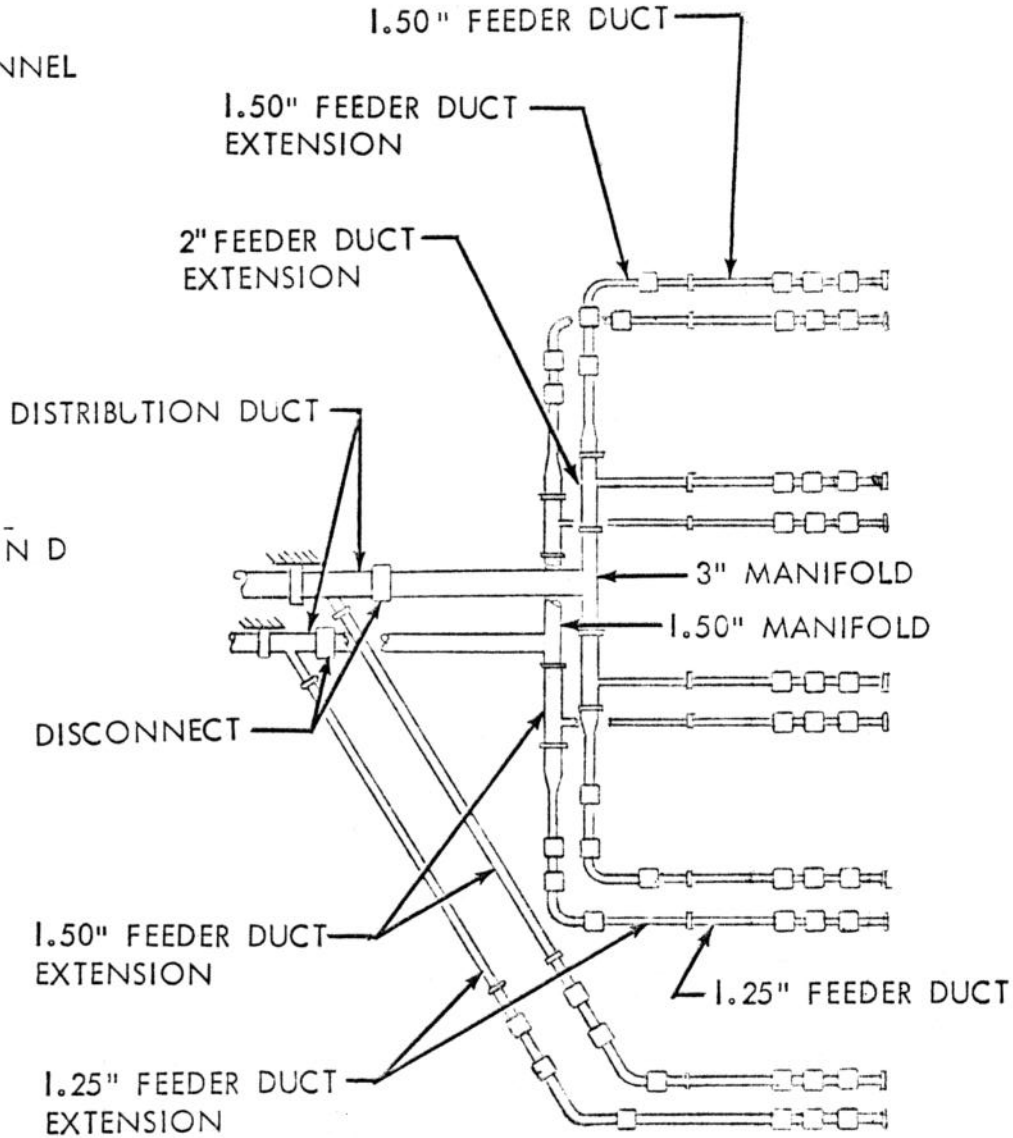


FUEL PRESSURIZATION SYSTEM

FIG 10

3.0 CONTROL PRESSURE SYSTEM

The control pressure system provides a pressure supply and distribution system for command operation of on board valves and to supply storage for the engine LOX seal purge. The system has been reconfigured as shown on Figures 11 and 12 for the S-ID. The thrust structure installation has been completely redesigned. An intertank system has been incorporated to provide for LOX delivery valve operation. Total system requirements are the same as the S-IC except for control of center engine LOX and fuel delivery prevalves which have been eliminated on the S-ID.

3.1 THRUST STRUCTURE (CONE)

The control pressure system will be installed entirely within the cone except for the fill line which will connect to the existing (Aft #1) umbilical. This line will be provided with a 1/4 inch check valve disconnect similar to GSE P/N 65B64001-33/34 for line separation when the thrust structure is staged. Other components of the system will be the same as used on the S-IC.

The system consists of one GN_2 storage bottle (60B52110-1 Airite Arrite P/N 6492-1), manifold assembly 60B52320-31E, tube runs, and seven solenoid valves (60B52101- ■) Carter P/N 6969- ■

3.1 THRUST STRUCTURE (CONE) (Continued)

The solenoids provide control gas to the four pairs of two fuel delivery butterfly and three interconnect valve actuators. Three additional GN_2 storage bottles are included with this installation to provide for engine LOX seal purge (Paragraph 4.1).

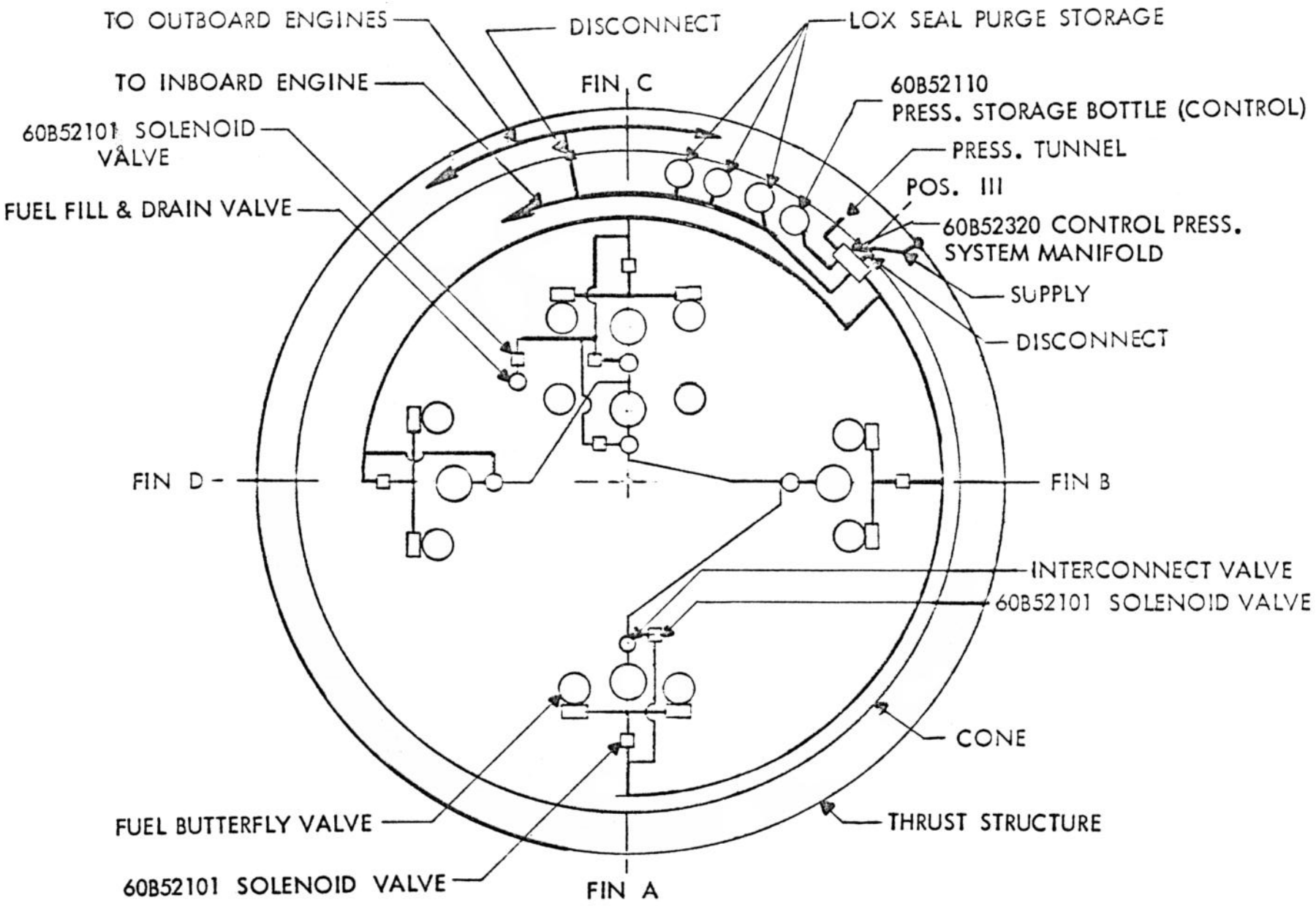
System installation will be similar to the S-IC 60B52500-1G and 60B52550-1A. Qualification testing of the disconnect only is required.

3.2 PRESSURE TUNNEL

Tube runs in the lower end of the pressure tunnel will be modified as required for thrust structure staging. Tube runs and installation will be equivalent to the S-IC, 60B52700-25C.

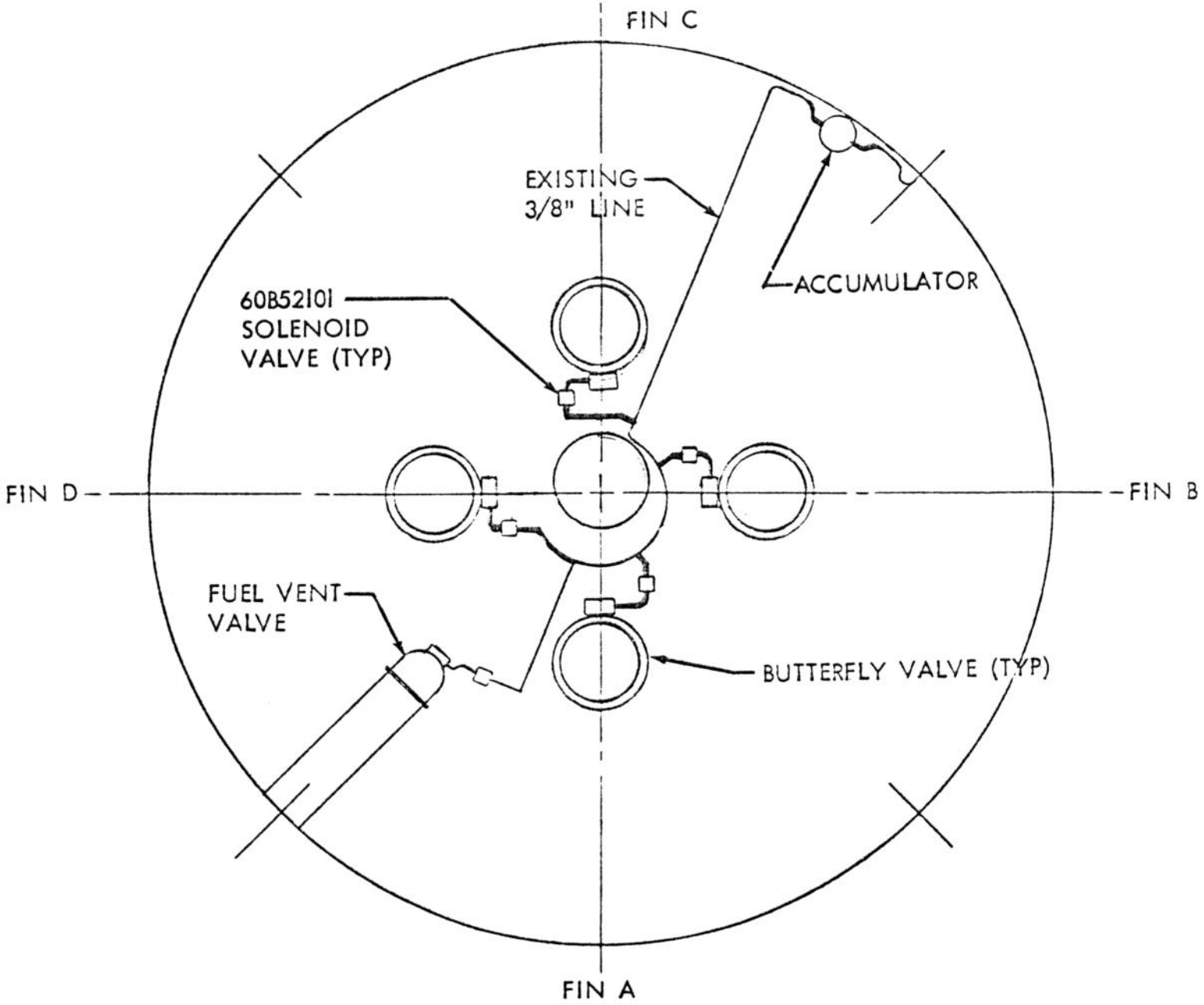
3.3 INTERTANK

The S-IC configuration provides control pressure gas to the fuel vent and relief valve. The system will be expanded to include pneumatic control of the four outboard LOX delivery butterfly valves located at the upper end of the suction ducts. Existing components will be used. The system will consist of a 750 psi storage bottle (60B52111-1) Airite P/N 6516-1) tube runs and five solenoid valves (60B52101-[illegible] Carter P/N 6969-[illegible]). Installation will be accomplished similar to 60B52500-1G.



CONTROL PRESSURE SYSTEM
THRUST STRUCTURE

FIG II



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INTERTANK

CONTROL PRESSURE SYSTEM

FIG 12

4.0 ENGINE SUPPORTING SERVICES SYSTEMS

4.1 TURBOPUMP LOX SEAL PURGE SUBSYSTEM

The turbopump LOX seal purge subsystem provides GN_2 to expel propellant leakage in the areas of the turbopump actuator housing on each engine. The system has been reconfigured as shown on Figure 13 for the S-ID. GN_2 during flight is provided from storage bottles installed with the control pressure system (Paragraph 3.1).

This system will be the same as the S-IC (60B37601-1E) except the filter (60B37478-3D) regulator (60B37476-5E) and transducers are located within the cone, and tube runs to the center engine are rerouted. A 3/4 inch check valve disconnect similar to 65B64001-107/8 provides for line separation when thrust structure staging occurs.

Qualification testing of the check valve disconnect, orifice sizing, and flow testing, is required.

4.2 LOX DOME AND GAS GENERATOR LOX INJECTION PURGE SUBSYSTEM

The purge is required to prevent fuel, ethelyne glycol, or flushing liquids from entering the LOX system through the engine LOX injector or the gas generator LOX injector. GN_2 is supplied from a ground source until umbilical disconnect.

4.2 LOX DOME AND GAS GENERATOR LOX INJECTION PURGE SUBSYSTEM (Continued)

This system is the same as the S-IC (60B37600-1E) except tube runs to the center engines are rerouted on the cone. A 3/4 inch (750 psi GMU) disconnect similar to 65B64001-107/108 provides for line separation to the center engine when thrust structure staging occurs. Qualification testing of the disconnect is required.

4.3 THRUST OK CHECKOUT SUBSYSTEM

Thrust OK pressure switch checkout before launch is provided by a tubing installation parallel to the LOX dome and gas generator purge subsystem Paragraph 4.2. The system is the same as the S-IC (60B37600-55E) except tube runs to the center engine are rerouted on the cone. A 1/4 inch (1100 psi) disconnect similar to 65B64001-33/34 provides for line separation to the center engine when thrust structure staging occurs. Qualification testing of the disconnect is required.

4.4 ENGINE COCOON THERMAL CONDITIONING PURGE SUBSYSTEM

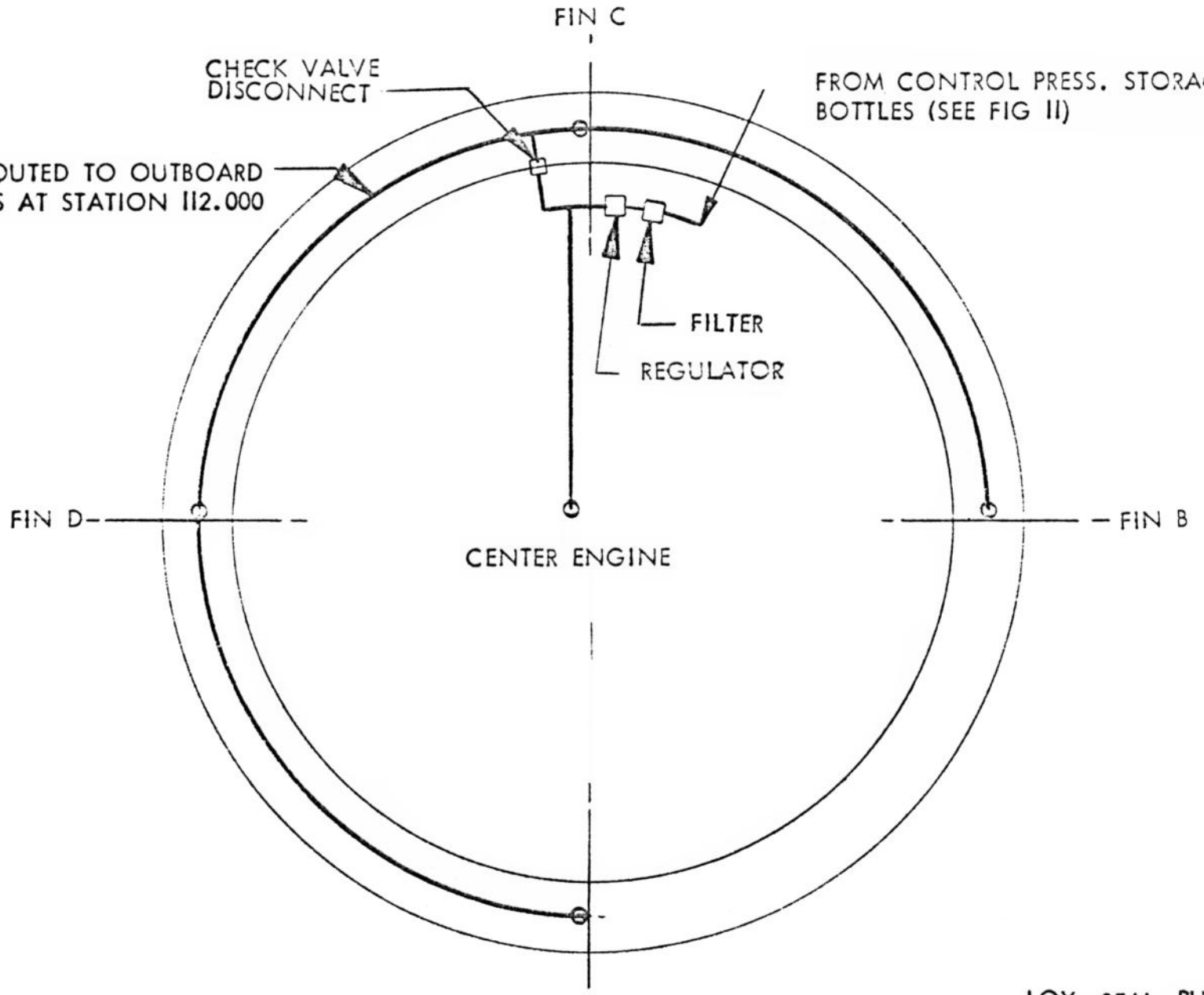
Heated gaseous nitrogen is supplied to each engine for thermal conditioning and purging the space between the engine and cocoon insulation. The system is the same as the S-IC (60B37602-1C) except tube runs to the center engine are rerouted on the cone. A 1/2 inch (200 psi 325°F) disconnect similar to 65B64001-137/138 provides for line separation to

4.4 ENGINE COCOON THERMAL CONDITIONING PURGE SUBSYSTEM (Continued)

the center engine when thrust structure staging occurs. Qualification testing of the disconnect is required.

4.5 THRUST CHAMBER PREFILL SUBSYSTEM

The prefill subsystem supplies ethelyne glycol to the engine thrust chamber tubes and fuel manifold prior to engine start. The system is the same as the S-IC (60B37550-1D) except tube runs to the center engine are rerouted on the cone. A 1/2 inch (160 psig) disconnect similar to 65B64001-105/406 provides for line separation to the center engine when thrust structure staging occurs. Qualification testing of the disconnect is required.



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LOX SEAL PURGE

FIG 13

5.0 FLIGHT CONTROL SYSTEM

5.1 THRUST VECTOR CONTROL SUBSYSTEM

The thrust vector control subsystem provides alignment of the gimbaled engines to obtain the desired stability, attitude and flight path during power boost. Staging of the S-ID thrust structure requires that gimbal capability be provided for the center engine.

The S-ID system consists of ten servoactuators, two on each engine, Figure 14. The outboard installation is the same as the S-IC (60B84000-1B and 60B84009-1A). Servoactuator installation on the center engine will be similar. Attachment is made to the vehicle cone.

The servos are subjected to a more severe environment than the S-IC. Depending upon definitive loads analysis, modifications and or requalification testing may be required.

FLUID POWER SUBSYSTEM

The fluid power system supplies a hydraulic actuating force to the F-1 engines to actuate and position valves and to the thrust vector control system to gimbal the engines. The fluid power system consists of high pressure supply ducting, low pressure return ducting and filter manifolds.

5.2.1 THRUST STRUCTURE INSTALLATION

The installation is the same as the S-IC (60B82000-1D) except the high and low pressure flexible ducting to the center engine is re-routed to the cone. Two one-inch (RP-1 3000 psi) check valve disconnects similar to 65B64001-131/-132 provide line separation to the center engine when thrust structure staging occurs. Modification of connecting ducts is required.

New flexible ducting will consist of components presently used on the S-IC (Reference 60B82013-1 and -3, Stainless Steel P/N 3303576-220 and 3303575-10). Qualification testing of four new center engine duct assemblies and the two check valve disconnects is required.

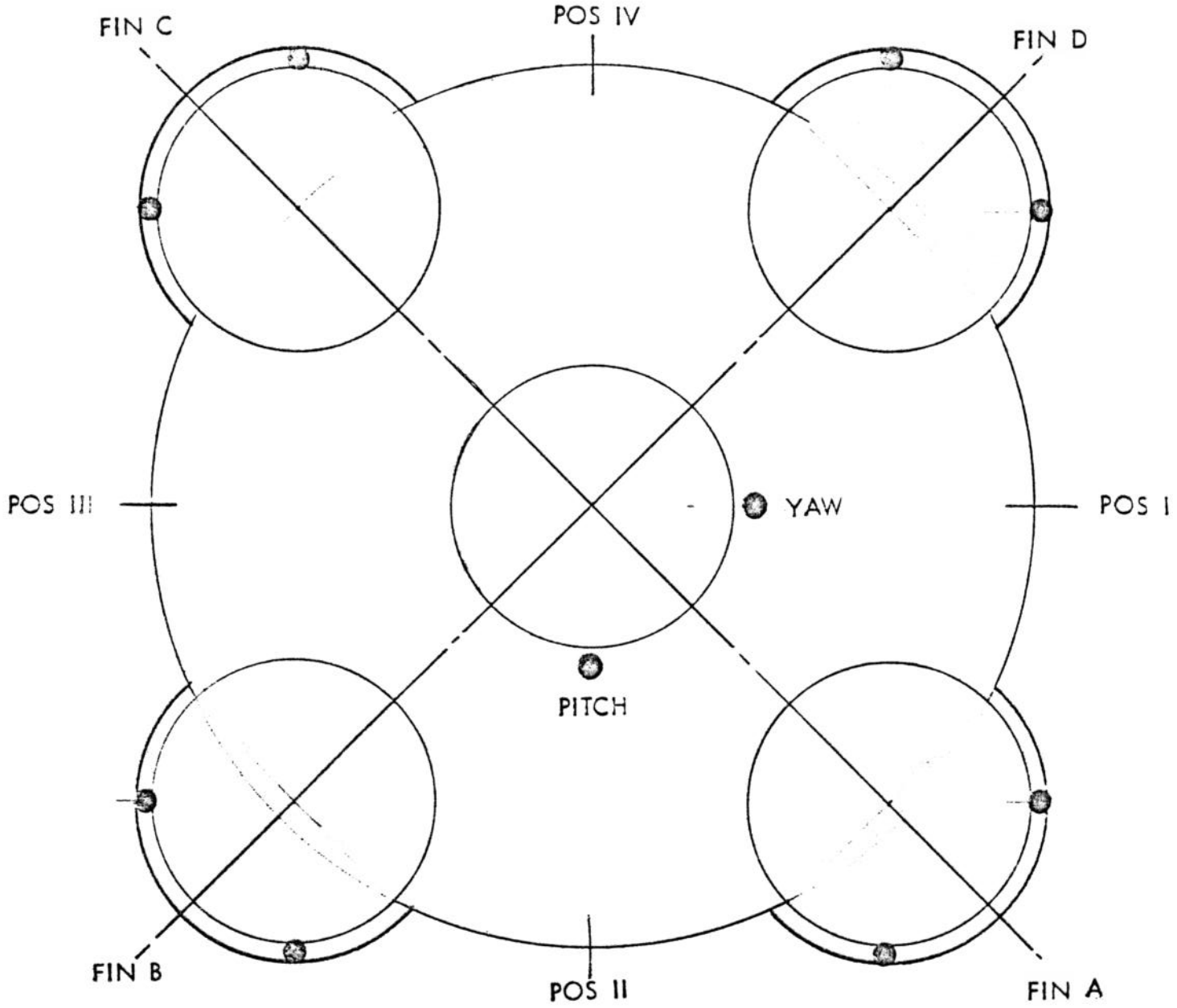
5.2.2 ENGINE INSTALLATION

Engine mounted equipment is the same for all engines on the S-ID. Fluid power installations on the outboard and center engines are the same as the S-IC, 60B83000-3C.

5.3 ROLL CONTROL

BEING A

Roll control is required during S-ID center engine burn after thrust structure staging. There is no similar system on the S-IC. Control will be provided by four vernier engines located per Figure 15. Propellants will be supplied by direct tap-off from the F-1 center engine discharge ducts. Solenoid operated fuel and LOX valves about one inch diameter maximum will be provided for propellant and vernier engine actuator control. The system has not been fully defined and requirements will be presented at a later date.



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THRUST VECTOR CONTROL

FIG 14

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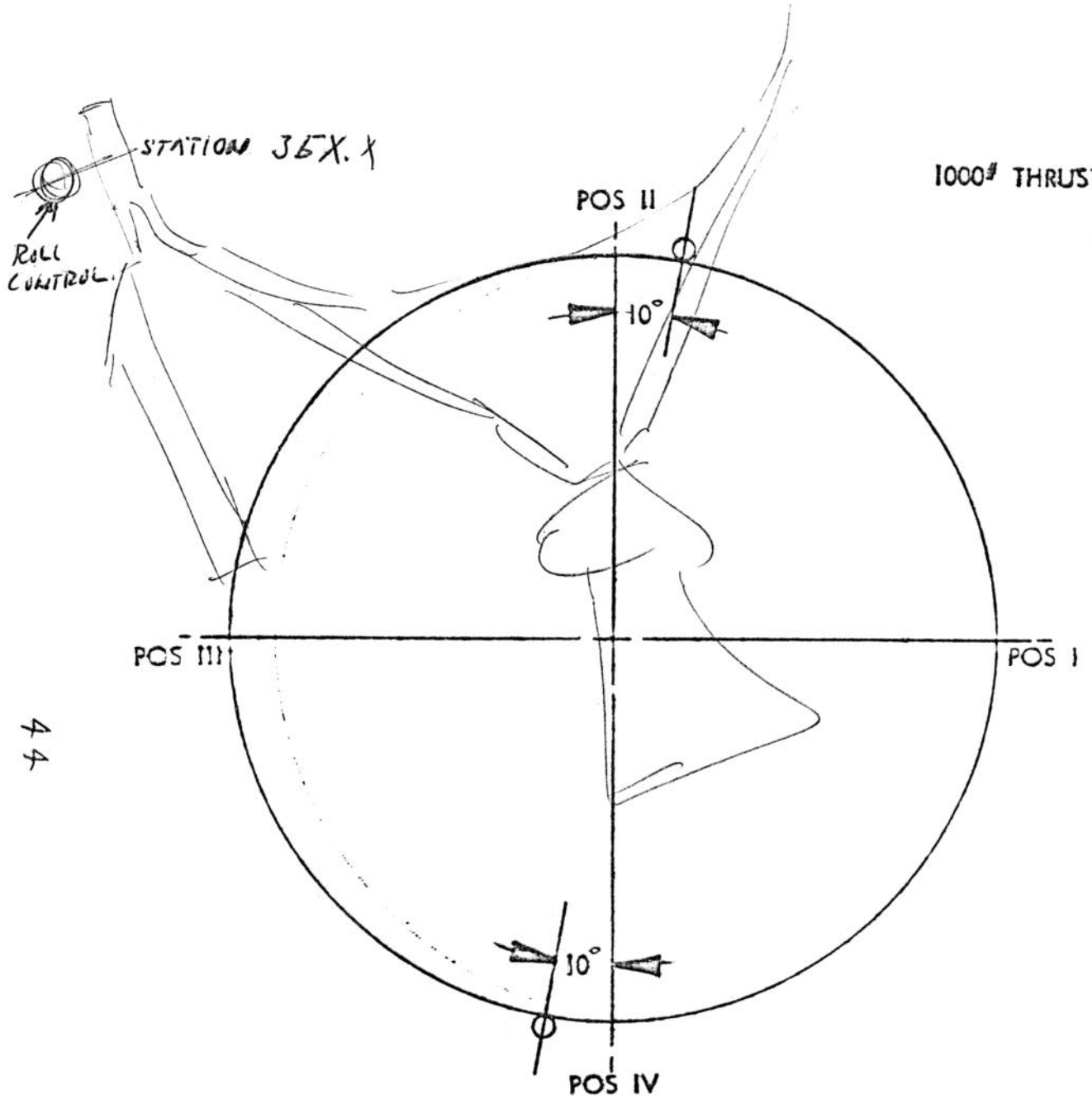

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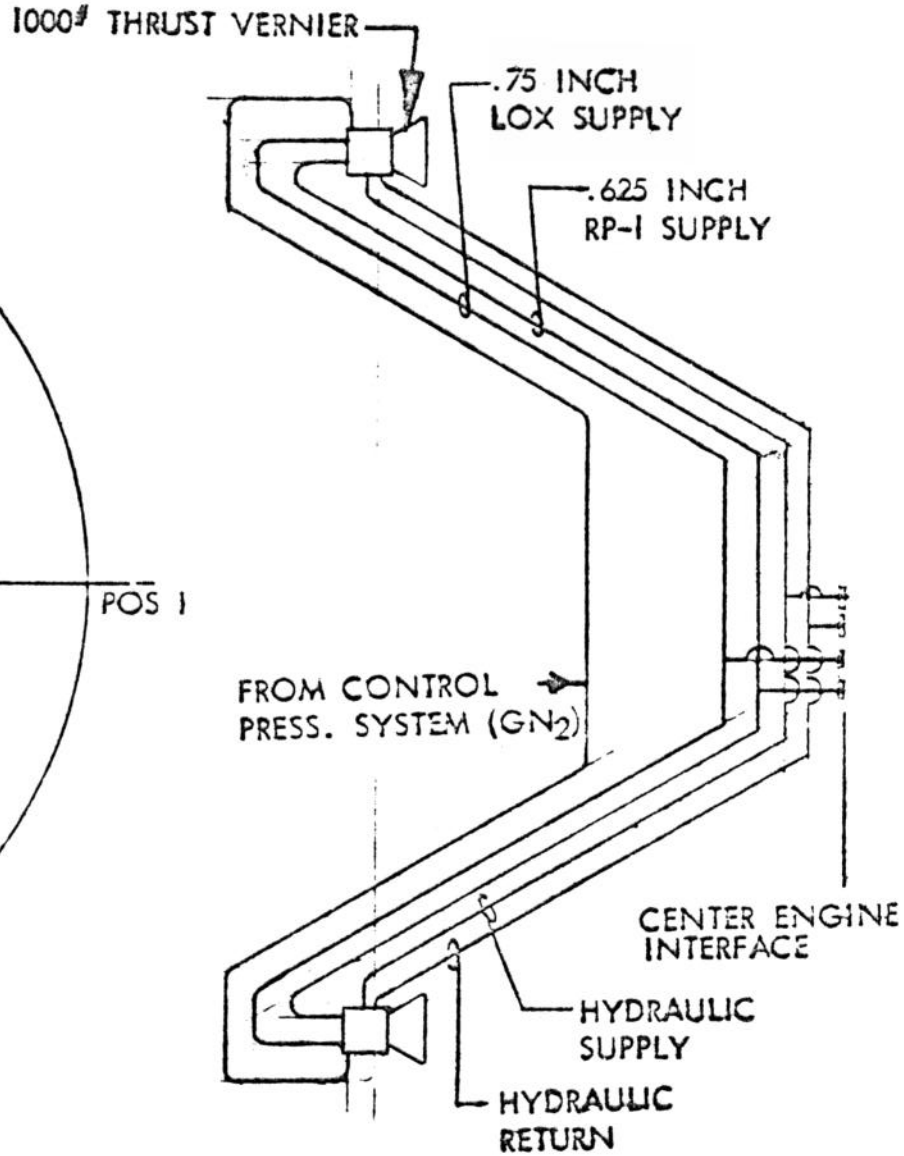

ROLL CONTROL

FIG. 15